Limina

Foundations, Frontiers and Future Prospects of UAP Studies

The Journal of UAP Studies

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Limina – The Journal of UAP Studies

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Editorial

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1. *Limina* and the challenge of "UAP Studies" as its own field of inquiry.

Limina is a journal created out of necessity. Ever since publication of the *Journal of UFO Studies* came to an end in the early 2000s, for the English-speaking audience there has been no serious and sustained scholarly publication focused *exclusively* on the subject of what is now termed "unidentified aerial or anomalous phenomena" (UAP). Papers on the subject are scattered throughout the existing ecosystem of academic journals, if they are published at all. We might pause to reflect for a moment on why this is, and the significance this situation has for UAP Studies.

It perhaps goes without saying that the subject matter (UFOs or now UAP) has long been considered unserious – even "fringe" (Hynek 1972; Appelle 2000; Wendt & Duvall 2008; Watters *et al.* 2023). Study of the subject had been tolerated, if at all, only to the extent to which it could be shown to be unworthy of organized, substantial scientific research, and best handled as a purely psychological or sociological curiosity (or a matter for scholars of religion). Whenever work on UAP or UFOs has appeared in mainstream scholarly publications, it is found mostly confined to acceptable and well-established academic disciplines and the journals corresponding to them.[1] For example, since at least the 1970s and 1980s one can find numerous studies of UAP or UFOs in journals devoted to atmospheric science or astronautics, or in those devoted to psychology, sociology or religious studies – even political theory.[2] With little exception, the subject is examined without further question as one that

1 There are of course a number of journals operating explicitly beyond the pale of the mainstream scholarly ecosystem, where one can find high-quality papers on the subject. One thinks here of the open-access *Journal of Scientific Exploration*, spearheaded in the early 1980s by Prof. Peter A. Sturrock of Stanford University (himself a "ufologist"), or more recently, the German/English *Journal of Anomalistics* (affiliated with the pioneering Freiburg-based research group IGPP, the *Institut für Grenzgebiete der Psychologie und Psychohygiene*).

2 One thinks here of a more recent example: Wendt & Duvall's seminal paper "Sovereignty and the UFO", published in the prestigious journal *Political Theory* in 2008. The journal's website lists the paper as having been viewed or downloaded over 27,000 times since tracking was begun in December of 2016. This paper is arguably one of the first in a high-impact, mainstream academic journal to *not* immediately treat the subject of UAP as one which can easily be reduced or explained away in conventional terms; on the contrary, the essay argues that serious (i.e. non-dismissive) treatment of the subject in academia is prohibited (treated as taboo) because the phenomena are potentially incompatible with key presuppositions – such as that human beings hold a place of *sovereignty* in the ontological hierarchy of being. If they are right, then the dismissiveness or unease with UAP as a serious topic in mainstream scholarship can be explained as basically *ideological* in origin, rather than as "rational" (i.e., evidence-based).

can be unproblematically handled by an existing academic discipline; rarely if at all is it treated as a problem requiring a discipline or field of its own.[3] Indeed, the fact that research and reflection on UAP is acceptable for publication in reputable, mainstream academic journals only if such work can be processed through existing disciplinary channels, corresponding to established university departments, reflects a deeper epistemological and even ontological uncertainty regarding the very *status* of the subject itself. What are UAP, after all, if we don't treat them as mere case studies (for example) in atmospheric or aeronautical physics, or the psychology of human perception – curiosities sure to be resolved on further physical or psychological (which is to say, scholarly) analysis? This also reflects a corresponding unease with treating – or unwillingness to accept – UAP or UFOs as phenomena whose (objective) reality is established, i.e. as due neither to human perceptual error nor instrument artifact, as the evidence now seems to clearly indicate.[4] As a result, the landscape of scholarship on the subject is deeply problematic (even confusing), with papers frequently unreliable as authoritative sources of knowledge or information about the subject, leaving scholars outside of UAP or UFO circles in a position of radical uncertainty.

Requiring that study of UAP be channeled into existing academic disciplines, and the work published in corresponding journals, allows this ambivalence and uncertainty to persist, so that the subject can always be safely (and indeed must be) reduced to a mere problem in atmospherics, the psychology of human perception, or the sociology of human belief – or be taken as a problem in the history of human religion and religious experience. It avoids the far more challenging approach that treats these phenomena as "real" in themselves and therefore as constituting their own field of study, which in turn searches for a further refinement of the reality of these phenomena beyond the pale of existing assumptions governing current fields of scholarly study.

Surely it is obvious and uncontroversial that certain aspects of UAP have relevance for any number of existing academic disciplines; such study can be and indeed has been quite illuminating. Those aspects of UAP which seem to intersect with existing fields of study can, therefore, be unproblematically approached through historically well-established scholarly techniques, methods and assumptions. However, if real progress on understanding UAP is to be made, where we are not simply furthering the presuppositions and aims of these existing fields of study (or engaged in endless, unconstrained and therefore fruitless speculation if we exit them), but rather are focused on the nature of UAP themselves, the study of UAP cannot be so confined.

So the fact remains that this ambivalence or uncertainty regarding the status of UAP within academia has helped keep the subject confined to existing scholarly disciplines; it has therefore prevented the emergence of one (be it a field or discipline proper) devoted to the scholarly research and analysis of these phenomena *in their own right* – research and analysis, moreover, that is not necessarily governed by existing disciplinary frameworks but which seeks those proper to its subject. As there currently exists nothing called "UAP Studies" in the landscape of modern academics, *Limina* therefore partly aims to correct this, and so seeks to move the study of UAP well within the mainstream by providing a resource for a new area of serious, sustained scholarly inquiry.

Adopting the broader term "UAP Studies" as part of *Limina's* name, then, signals a fundamental shift in academic-scholarly outlook on the core phenomena it examines: It reflects a purposeful reorientation and refocus, a decisive move away from older attempts to find a place for the study of these enigmatic phenomena in modern academia. Calling the study of these phenomena "ufology", for example, and thereby attempting to conceive of it as some sort of a *scientific* discipline[5] (which is what the suffix "ology" signals), was both premature and unnecessary. It immediately put this nascent field of inquiry into direct confrontation with centuries-old and well-established scientific fields – research traditions which have accumulated a number of methodological and ontological assumptions the relevance of which cannot be assumed or even assessed when it comes to the UFO phenomenon. Since even the very elementary data on these phenomena was (and continues to be) difficult if not

3 That there is a clear distinction to be made between an academic 'field' vs. a 'discipline' (and what, in particular, the study of UAP should be considered in this regard) is itself an interesting question – one that must at some point be addressed carefully and reflectively if "UAP Studies" is to emerge within modern academia as an accepted part of its educational-institutional ecosystem. For a recent discussion of the field/discipline distinction itself, *see* Tight (2020). On the question of the disciplinary status within academia of the study of what were called "UFOs", *see* Stuart Appelle's classic treatment (Appelle 2000), although here the problem is construed specifically in terms of "ufology" – which is not the same as UAP Studies, as we discuss below.

4 See for example the relevant discussions in Watters *et al.* (2023) and in the recent – and significant – report issued by NASA's Independent Study Team on UAP (NASA 2023). By speaking about the "reality" of UAP, I mean to refer, of course, to that smaller subset of all initial UAP reports which cannot be explained by means of the standard menu of mundane or conventional possibilities (e.g., human malperception, instrument malfunction, and so on). Such a "recalcitrant residuum", as it were, is now widely acknowledged.

5 This was the almost unquestioned assumption guiding Stuart Appelle, for example, in his seminal treatment of the issue of UFOs and academia (Appelle 2000).

impossible to obtain (partly because of ongoing stigma and profound doubt regarding their very status), attempting to conceive of the study of UAP as a strictly "scientific" one was (and is) therefore doomed to fail. In the least it is unnecessary. Using this broader term "UAP Studies" we consciously step away from classical "ufology" *per se*, and allow our inquiry to proceed afresh – to find its own way, even while it draws significantly from existing sciences, from the humanities and from other more mature scholarly fields and disciplines which make contemporary academic research so dynamic, diverse and fruitful.

By using the term "UAP Studies" we do not therefore prematurely *limit* research on these phenomena, and are thereby held open to new possibilities (perhaps even a new Renaissance for the academy and learning itself, as had accompanied and even presaged the development of the sciences).[6] And by calling the journal "Limina" we indicate as well that not only the phenomena themselves, but also their scholarly study, operates of necessity in-between what is currently known and accepted as consensus reality: the *liminal* is what inhabits an epistemological, methodological and perhaps even an ontological zone of transition – one part within the known and accepted, and another oriented away from it.

2. *Limina* and its intellectual inspiration.

Our journal faces, then, a unique challenge. Given the absence of something called "UAP Studies", by its very existence *Limina* contributes to the formation and interrogation of this new area of scholarly study. It is created with the purpose of being a publication where scholars can explore the very meaning of "UAP Studies" as they explore the subject of UAP from their various disciplinary perspectives (because of the absence of UAP Studies *per se*, this remains of course a practical necessity). And so, by its very nature, *Limina* is deeply inter- and cross-disciplinary in terms of its authorship and its intended audience.

The necessity to create a journal whose purpose is partly formative of a unique area of scholarly study – an area that, for contingent, even ideological, reasons could not be formed – is certainly not unique to *Limina*, nor is it unique to the subject of UAP. Indeed, in creating this journal I have been inspired by another, founded under similar conditions and organized around a subject that had also been considered either taboo, or thought best approached by channeling it into existing academic fields of inquiry, similarly allowing for a convenient abeyance of the deeper intellectual challenges which the subject provokes. *Mind and Matter* was formed at the beginning of this century (c. 2003) by Prof. Dr. Harald Atmanspacher, who soon after formed (as I did) a corresponding scholarly Society devoted to the subject. I can do no better than to quote at length from Dr. Atmanspacher's own inaugural editorial, which, I think, contains a number of observations that are directly relevant to our efforts at *Limina* (and with the *Society for UAP Studies*) to create a journal which both fills a scholarly void and opens up a new, more challenging area of study:

> The title of this journal [*Mind and Matter*] makes its core topic self-evident. The question of relationships between the material world and its apparently non- material counterpart or complement is one of the oldest, most puzzling and most controversial issues in the philosophy and history of science. There exists a vast literature addressing its many different aspects from a wide variety of viewpoints. Monistic, dualistic, and even pluralistic approaches have been proposed in both epistemological and ontological interpretations, and elaborated in quite a number of variants.
>
> Although the issue of consciousness and the brain is presumably the most discussed mind-matter issue in contemporary research (the notion of the "hard problem" has been coined and several journals have been created to address it), its boundaries have become somewhat fuzzy and permeable. Today we are witnessing an increasing interest in mind-body questions, be it due to a revival of psychosomatics or due to the emergence of relatively new fields such as psycho-neuro-endocrinology. These areas have even started to involve relations to and the impact of social and cultural environments. But the role of the material environment of agents has been emphasized as well, for instance in recent studies of embodiment. Yet any basic understanding of the relationship between the categorically different concepts of mind and matter has remained lacking for centuries. It must be admitted that progress in individual sciences has most often not only disregarded problems

6 Even so, we should ask how classical "ufology" and UAP Studies are related, and how the two may inform each other going forward.

> of this kind, but even depended on disregarding them. The traditional methodologies of physics, chemistry, biology and the neurosciences illustrate this insofar as they restrict their interest exclusively to the material domain of their respective level of reality. However, this must not be taken as a proof of the validity or even necessity of such a procedure. With the present journal, we want to explore basic mind-matter questions in a way which is unbiased by the presuppositions of individual disciplines, yet builds on their achievements. It would be outright impossible to investigate general or specific mind-matter issues without explicitly considering the important results of the individual disciplines involved.
>
> With this background, Mind and Matter is conceived as an interdisciplinary journal, aimed at an educated readership interested in all aspects of mind-matter research from the perspectives of the sciences and humanities. It is devoted to the publication of empirical, theoretical, and conceptual research and the discussion of its results.[7]

If I were to highlight the most important sentence here which has direct and immediate relevance for us, it is this – and it can be modified to fit exactly our purpose: "With the present journal, we want to explore basic … questions [about the subject of UAP] in a way which is *unbiased by the presuppositions of individual disciplines, yet builds on their achievements*. It would be outright impossible to investigate general or specific [questions related to UAP] without explicitly considering the important results of the individual disciplines involved." The rest of Dr. Atmanspacher's opening remarks in the first issue of *Mind and Matter* are equally germane to our endeavors here at *Limina*, and so you are encouraged to read on.[8]

3. An editorial survey of articles in this inaugural issue.

Some of the articles in this first issue were submitted for review by scholars who presented at *Limina's* Inaugural Symposium, held in early February 2023 and organized on behalf of the journal by the *Society for UAP Studies* (with immense and invaluable behind-the-scenes help from Karin Austin and Mark Hurwitt of the *John E. Mack Institute*, and the team at vFairs, who provided our online platform). Others were submitted during the course of the previous year. They represent a sample of the kinds of submissions that *Limina* is honored to review and publish, and reflect the broad interdisciplinary scholarly ecosystem where UAP Studies can thrive.

The theme for our first issue was taken from *Limina's* February 2023 Symposium: **"Foundations, Frontiers and Future Prospects of UAP Studies"**. A total of five articles comprise the substance of this issue. The first two are essays that engage very fundamental – even preliminary – questions that should inform all UAP research (especially scientific research). These first two papers also seek to address some of the most important historical challenges this research faces going forward. Both offer key insights regarding best research practices, including the communication of results and proper handling of the (often sensitive) data obtained during the course of UAP research (with special attention given to those cases involving crucial *witness testimony*). The next article presents results of some decades of research done by means of instrumented field observations of UAP (primarily using astrophysical techniques) and offers further substantial methodological considerations for, and theoretical reflections on, the general physical science of UAP. The issue concludes with two further articles: a book review and a Letter to the Editor. The review covers a 2023 text by Durham University Prof. Michael Bohlander (also one of *Limina's* subject-area editors), who writes on the serious legal questions raised by any potential intelligence associated with UAP (particularly relevant as future physical science of these phenomena would seem to require a closer and sustained *interaction* with UAP). Finally, the Letter to the Editor outlines an intriguing historical case from 17th century Germany that offers suggestive connections to contemporary UAP Studies, and which is submitted to the wider research community for further consideration.

7 Atmanspacher 2003, p. 3 (emphasis added). We should also note that Prof. Dr. Atmanspacher was an affiliate of the IGPP, referred to above.

8 We might also pause to reflect for a moment on another important correspondence between *Limina* and *Mind and Matter*: the very focus and content of Dr. Atmanspacher's journal – a broad and interdisciplinary study of what can be called "psychophysical" (matter-mind) relations – is itself directly relevant to UAP Studies, and can profoundly inform it. As we have seen time and again, the question of the nature of the relation between mind and matter is one very prominent in discussions of the subject, especially where the focus is on the *human experience* of UAP. Given the conspicuous absence of a general theory of this relation, UAP Studies is, when probing issues related to the mind-matter question, caught in endless speculation. This fact should prompt further interest in forging definite ties between UAP Studies and the field of Mind-Matter research.

4. Scientific and empirical research is preparatory and foundational – not final.

As the reader will no doubt discover, in our inaugural issue papers tend to emphasize the foundational importance of methodologically sound *scientific* work done on UAP and related phenomena. But I would like to emphasize that this is not where UAP Studies as such ends. Rather, it is where it begins: by determining and more clearly understanding the physical characteristics of UAP insofar as they are able to be established *within* the parameters of existing science. Even if UAP can be shown to be profoundly *anomalous* (in one way or another – and different UAP may present different challenges on this question, since we cannot assume that all UAP have a single origin or cause), it must be demonstrated as such *against* our existing understanding of matter and mind; this means that we must first bring *what we already know* (or think we know) to bear on the phenomena. If (some) UAP prove to be anomalous, perhaps even constituting a true *scientific anomaly* (as many suspect – a question deserving of further philosophical scrutiny on its own), the only way for this to be both clear and productive is by producing compelling and widely-accepted results of methodologically sound physical research, using accepted parameters of observation and measurement; this can in turn offer specific suggestions as to exactly where, how, and for what reasons known physics is inadequate to the phenomena (if that is what is discovered). This is how many fundamental breakthroughs were achieved in the history of physical science (for example, the discoveries that lead to the development of the quantum theory of matter): by trying to render new and puzzling observations consistent with classical (i.e. known and widely accepted) physical assumptions, one can show precisely where and how those assumptions lead to inconsistencies – or even paradoxes – given what the new observations and measurements reveal. But even this is not enough, if some UAP have an essential connection to their human percipients (again as some suspect). Here, it would not even be enough to document and study human witness testimony, for what would be at issue are the *mind-matter* connections – something which, if we are to take Prof. Dr. Atmanspacher's own suggestions in his opening editorial from 2003 to heart, would require deciding on a *theory* of those connections. And this is something which we do not yet possess (indeed there is no general agreement even on what such a theory would look like). In this way we see that neither the physics, nor the psychology or human testimony alone (neither the physical nor the "psychical" aspects) are individually sufficient for a full understanding of and intellectual engagement with the UAP enigma. Rather, as for other complex phenomena that challenge the limits of human understanding, both – and perhaps something else altogether – will be required. Hence do we seek the development of a new field of inquiry in which such complexities find their own conceptual voice. We seek, that is, the essence and scope of "UAP Studies" proper.

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Acknowledgments

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Editorial

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Dr. Cifone, *Limina* Editor-in-Chief, has written an introductory Editorial that is wise, insightful, and that places this new scholarly enterprise into the history of the study of UFOs/UAP[1] and its treatment by academia. He has explained precisely why a field of UAP Studies is necessary if we collectively are to make progress (necessary, though not yet sufficient given the various limitations that still hamper UAP research).

My editorial contribution to this first volume is to provide some historical and personal perspective to the launching of *Limina*, based on my long involvement with the Center for UFO Studies (CUFOS) and several other UFO organizations.

The frustrations of those who were engaged in substantive, non-dismissive studies of UFOs were pervasive in the early days, as established journals would not publish articles that were anything but dismissive. An article that epitomized this was published in *Science*, no less (Warren 1970), making the claim that UFO witnesses were "status inconsistent." The evidence for this was not close to persuasive[2], and Warren later revised his ideas and moved away from his hypothesis, but *Science* had published it. Dr. J Allen Hynek and I later discussed how he had tried to interest the editors of various journals in a UFO paper but was rebuffed although he was the scientist with the longest sustained engagement with the data.[3]

It was not impossible to publish research that was at least neutral on the UAP subject. A social science paper still worth reading today was published in the journal *Social Studies of Science* (the flagship journal in the sociology of science and technology, the field in which I received my Ph.D.) by Ron Westrum (1977) on the "social intelligence" about UFOs, explicating how information about UFOs was generated and disseminated, to the public, but especially to the scientific community, and the barriers to its acceptance.

It is true that Westrum's article was not about UAP but the social organization surrounding their study, and so acceptable to a social science

1 I shall use both the acronyms UFO or UAP as appropriate for the context or historical era to which I refer.
2 Not persuasive, among other reasons, because most witnesses were not status inconsistent, only some!
3 Hynek is seen, not altogether unfairly, as someone who was slow to recognize that there was an unexplained UFO phenomenon that demanded serious study. Yet he early on presented a talk, and then published it, for the Optical Society of America (Hynek 1953) that argued that "nocturnal lights" – his first use of this term which became a category in his UFO classification scheme in 1972 – were not readily explainable.

journal. In our nascent field of UAP Studies the remit should likewise be any serious inquiry into topics in the umbra, or penumbra, of UAP. Who sees UAP, how are they reported, what effect do the experiences have on witnesses (psychological, physiological, or even spiritual) are all fair game, along with studies that focus, as Dr. Cifone mentions, on how consciousness may be implicated in the UAP subject.

Although it took much perseverance, it was also just barely possible to publish research on the physical characteristics of UAP in this era, as Maccabee (1979) did in his analysis of bright objects filmed off the coast of New Zealand on Dec. 31, 1978. His success was the exception to the academic rule about UAP: research in favor of existing paradigms is welcomed; research that challenges those paradigms is not only rejected, it often won't even be reviewed.

This state of affairs was intellectually intolerable, especially because the closing of Project Blue Book led in the 1970s to the first sustained study of UFOs by scientists and professionals from a range of disciplines. Without the Air Force's ongoing project, academics who nonetheless had not been discouraged by years of negative messaging were emboldened to grapple with the subject. As a result, publication outlets were necessary, and so Hynek, and CUFOS, rose to the challenge and founded the *Journal of UFO Studies* (*JUFOS*[4]) in 1979. The goals were modest as there was no hope of becoming affiliated with a journal publishing house. The intent was to publish a peer-reviewed journal with the best current work being done, whether in the social or physical sciences. In that it did succeed. What it did not accomplish was to create a viable financial model that could sustain publication (once per year). CUFOS struggled financially in the early 1980s, and so did *JUFOS*, and only three volumes were published before publication ceased in 1983.

Once again, there was no outlet for serious work that would undergo a rigorous vetting and that was supported by a reputable, albeit UFO, organization.[5] The first to step into this gap was the Society for Scientific Exploration, with the *Journal of Scientific Exploration* (*JSE*), founded in 1987. *JSE* quickly became a welcome place to publish UFO-related research, along with research notes and book reviews (and I've been fortunate enough to have a long tenure as an Associate Editor).

When I became Scientific Director of CUFOS shortly before Dr. Hynek's passing in 1986, I initiated a review of current activities with the intent of increasing our connections to the academic community, and also helping promote serious research. It became clear that resuming publication of *JUFOS* was a high priority, and after the necessary preparation we subsequently published the first volume in the New Series in 1989.

For any journal, the editor and editorial board are critical to its success, and my experience shows this to be even more so in a field such as UAP studies. Articles are sometimes promising and come from those who today we label "citizen scientists," and sometimes require more encouragement and editorial assistance compared to submissions at more established journals, and the editors must be willing to work on that basis. We were fortunate that two accomplished scholars and persons of dedication and suitable temperament accepted the role as Editor in the second run of *JUFOS* (Michael Swords and Stuart Appelle). Given the importance of peer-reviewed publications, I consider my role in re-establishing *JUFOS* as one of my key accomplishments in my ufological career.

After publishing nine volumes, the last in 2006, we hit two serious snags. The one that is familiar is funding. We were still primarily hard-copy based, and general support for UFO groups began dwindling in the late 1990s, in part because of the rise of the internet. But the new, and discouraging problem, was the dearth of serious work that could withstand peer review. For a variety of reasons, though not funding for research (because there has always been practically zero funding for research, so that is a constant), while ufology ground on in the first decade of this century, and some quality work was being done, it often resulted in books or something other than a research paper (for example, the volume by Swords and Powell *et al.* 2012). Realistically, there weren't enough papers to be spread between two journals (*JSE* and *JUFOS*), so we made the painful decision to once again cease publication.

Then came December 2017 and the *New York Times* article that kicked off, along with the Navy videos, the current upwelling of UAP interest among the public, media, and politicians, and importantly, many academics who took a fresh look at UAP and saw, quite frankly, what they had overlooked all these years. So (almost) everything has changed, as we

4 All volumes of *JUFOS* are now available digitally on the CUFOS website at [Journal of UFO Studies - Center for UFO Studies (cufos.org)]

5 Mention should be made of the combined publishing effort of *UPIAR Research in Progress* and *UFO Phenomena International Review* that appeared in Europe at around this same time, sponsored by a consortium based in Italy. These journals were serious efforts to publish quality work (their appearance at this same time is no coincidence as the same factors were at work in Europe as in the United States), but they faced similar barriers and had limited impact.

have entered what I call the "new modern era" of UAP investigation (the period before 1947 is conventionally the pre-modern era, and from June 24, 1947 with Kenneth Arnold's famous sighting, the modern era began – one I thought might outlast me).

JSE is thriving under a new editor, who assumed that role in 2022, yet since 2006 there has been no dedicated journal for UAP-focused research. Publication in established journals is always a worthwhile target (*see* Knuth *et al.* 2019 or Medina *et al.* 2023 for recent examples), *if* UAP work can be tied into the disciplinary interests represented by a particular journal, or submitted to a journal that publishes on a range of subjects, and the work can overcome the continuing stigma associated with the field – which is declining but hardly exponentially.

Established academic fields/disciplines are, appropriately, studying topics that have collectively by a scholarly community been defined as comprising that field, are worthy of study, and likely to move the field forward towards its empirical and theoretical goals. UAP qua UAP don't fit comfortably in any field – although there are some, such as atmospheric physics, in which a subset of the UAP data should have long ago found a welcoming home. Still, I expect that more papers related to UAP will be published in existing journals, and that is a good thing.

A good thing, but not enough. As Dr. Cifone has so incisively discussed, the field of UAP studies is only now establishing itself, gaining the intellectual heft and organizational resources to become "devoted to the scholarly research and analysis of these phenomena in their own right – research and analysis, moreover, that is not necessarily governed by existing disciplinary frameworks but which seeks those proper to its subject." To fulfill that mission statement, a journal becomes *sine qua non*, and *Limina* is the vehicle to establish the space for our nascent field to respond to the even more pressing question today than before: what are UAP?

I truly am grateful to be involved with *Limina*, and its supporting organization SUAPS, and so from the first to now latest effort to publish a peer-reviewed journal, and thus to provide a through line from J. Allen Hynek to today in 2024. The prospects for *Limina* are bright, as they are for the re-invigorated field of UAP studies. Personally, I don't quite have the energy that I did when I was first volunteering with CUFOS in the mid-1970s. My excitement about the future, though, matches and exceeds the expectation we had then, when UAP research was making strides it had not before. May *Limina* "Live long and prosper" in this new modern era.

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Exploring Unidentified Aerospace Phenomena through Instrumented Field Studies: Historical Insights, Current Challenges, and Future Directions

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ABSTRACT

The study of Unidentified Aerospace Phenomena (UAP) requires a shift from a historical, narrative-based approach to a scientific and technology-based study. To conduct unbiased and agnostic research on UAPs, rigorous scientific study is necessary, including the collection of hard data to support credible explanations or scientifically prove the existence of unknown phenomena. Obtaining reliable and valid data requires instrumented observations, including multi-wavelength and multi-mode sensors (e.g., optical, radar, infrared). We present herein an overview of the benefits as well as the strategic and tactical considerations of instrumented field studies, highlighting common limitations and shortcomings with the objective of contributing to the development of future projects. We provide an overview of some past and current UAP military and civilian projects and analyze a timetable of instrumented projects spanning the years 1950-2023, encompassing contributions from both citizen science and professional/academic science. In conclusion, this paper reflects on how UAP field experiments might look going forward. Newer technologies like digital cameras, scientific instruments, computing, big data analytics, artificial intelligence, and satellite imagery are becoming more advanced and cost-effective. This is leading to the growth and progress of technical field studies, complementing local projects with global-scale investigations. Researchers can enhance their chances of success by adopting a more disciplined approach and exploring innovative avenues. Collaboration, transparency, and standardization in data collection and analysis are crucial, while also acknowledging the complex nature of the UAP phenomenon.

1. Introduction

Over several decades, UAP research has focused mainly on collecting eyewitness reports and supplementing them using various measurements, many of them retrospectively such as physical traces, radar scope data, photographs, film and video footage, physical effects, and medical records, when these are available. This approach has been necessary as UAP events are often brief and unpredictable, making it challenging to study the phenomenon in a rigorous and empirical manner. Researchers quickly recognized the need for a new methodology to advance our understanding of the UAP phenomenon, as existing data was insufficient. Instead of post-event analysis, a proactive investigative approach was necessary. This required trained observers with suitable instruments to be present and record UAP events, or the deployment of automatic stations for continuous monitoring of a large area during long periods.

Despite decades of stigma and negative perception towards UAP study, some civilians, organizations, and scientists have conducted instrumented field studies to detect and measure aerial anomalies. These efforts demonstrated that UAP can be studied scientifically, even before the recent renewed interest. Since 2017, the US government's perspective on the role of science in the study of UAP has shifted dramatically. The Office of the Director of National Intelligence's report (ODNI) to Congress in June 2021 (ODNI 2021) emphasized the scientific importance of UAP and recommended their continued study with improvements in data collection and analysis software, including the use of artificial intelligence. The Department of Defense (DoD) subsequently established the All-Domain Anomaly Resolution Office (AARO, website) to lead efforts to document, analyze, and resolve reports of UAP using a rigorous scientific framework and data-driven approach. The engagement of the US government has significantly enhanced the credibility of the topic, sparking heightened scientific interest within the field. As a result, there has been a notable surge in instrumented field studies concentrating on the lower atmosphere, as well as the increasingly important near-Earth space environment.

The paper is organized as follows: In section 2 we provide an overview of instrumented field research, discussing its benefits, purposes, and strategic as well as tactical aspects. Section 3 presents and discusses a comprehensive timetable of instrumented projects spanning the years 1947 to 2023. Section 4 offers an overview of noteworthy past UAP projects, spanning both military and civilian domains. We delve into the challenges these projects encountered, ranging from organizational hurdles to funding and data collection. Additionally, we emphasize the unique characteristics of civilian projects, distinguishing between citizen and academic science efforts, with the aim of refining future endeavors. Section 5 briefly highlights the common limitations and shortcomings observed in past instrumented projects, providing additional insights for improving future research. Section 6 showcases the novel citizen and academic scientific projects launched in recent years. We explore potential directions for future UAP field experiments in section 7, discussing important considerations and suggesting recommendations to enhance the rigor and effectiveness of this field research. The paper concludes with a summary of findings and key takeaways in section 8.

2. Instrumented field studies

2.1 Benefits

Deploying UAP instrumented projects offers advantages over human observers. First, instruments like infrared and magnetic sensors detect phenomena beyond human senses. Second, instruments eliminate subjective elements, being unbiased and objective in data collection. This facilitates analysis and comparison. Third, instruments enable consistent monitoring day or night, in all weather conditions, unlike human observers. Fourth, instruments can cover a wider geographical area, increasing chances of UAP detection. Finally, instrument-collected data can be recorded for future analysis of patterns and trends. Using various sensors across the electromagnetic spectrum offers significant advantages for studying UAP, as more metrics recorded in parallel can provide greater scientific insights into the chemistry, origin, and physics of these phenomena. However, optical sensors are the primary choice for initiating UAP field research due to their ability to capture images that closely resemble human perception, operating independently without any supporting data from other sensors, and providing useful context for the data collected by instruments. Still, human observers can also play a valuable role by providing visual observations and context for the data collected by instruments. In general, the adoption of a comprehensive methodology for gathering UAP data enhances the rigor of research and generates increased interest among mainstream academia and scientists.

2.2. Strategic-tactical considerations

Engaging in UAP instrumented field research involves thorough planning and execution, focusing on strategic and tactical aspects. The decision-making process requires considering long-term goals and short-term actions. By analyzing objectives, plans, and strategic considerations, we can identify key features of past and current projects in this field.

In general, the existing literature on UAP lacks comprehensive information regarding observable parameters, instrument trade-offs, and their selection. However, a few noteworthy exceptions stand out. One such exception is the Norwegian Project Hessdalen, which documented their implementation in a Field Technical report (Strand 1984). Additionally, in 2015, Dr Massimo Teodorani contributed to the UFODATA project by producing a document that outlines the physical parameters that can be derived using readily available measurement instruments. This resource aims to facilitate the determination of the nature of Unidentified Flying Objects (UFOs) and the extraction of relevant physics-related data (Teodorani 2015). Lastly, a recent significant development comes from the Project Galileo, which has published in 2023 crucial peer-reviewed papers (The Galileo Project, website). These papers not only offer a comprehensive roadmap for establishing UAP measurement requirements but also introduce a science traceability matrix. This matrix enables the connection between sought-after physical parameters and the corresponding observable and instrument requirements. This is the first time a dual-purpose, both civilian and professional, project has decided to build a dedicated instrumentation system and integrated software to conduct a multimodal census of aerial phenomena and recognize anomalies. Given this context, we provide below a list of key strategic and tactical points to consider for instrumented field studies.

2.2.1 Purpose

Clearly defining the primary goal of the project and its associated objectives is vital to drive its development forward. Are we primarily focused on collecting data on UAP sightings, identifying patterns, and gaining a deeper understanding of these phenomena? Or are we also exploring the potential for interaction and communication with the phenomenon? It is imperative to establish a clear vision and direction for the project to ensure a focused and effective approach.

2.2.2 Instrumentation

Developing a tactical plan involves carefully selecting the appropriate equipment for detecting and measuring UAPs. However, this selection involves making trade-offs between factors such as available resources, equipment complexity, completeness, portability, and sensitivity. To accurately document UAP events, researchers must measure multiple physical quantities simultaneously and synchronize all measurements and optical imagery to a single clock. This approach helps determine if changes in the visible characteristics of a UAP are correlated with significant changes in any measured quantities over time. Additionally, measuring the distance between the instrumentation and the UAP enables establishing spatial correlations and variations. However, due to the unknown nature of UAPs, determining which physical quantities should be measured, their required accuracy, and frequency of measurement is challenging. Some reports only describe unusual appearances or behaviors in visible light, while others mention electromagnetic, gravitational, and audible effects. Therefore, it is crucial to gather as many types of measurements as possible. The UFODATA project has outlined the scientific justification for measuring the type and intensity of radiation emitted by UAPs, including the use of spectroscopy and the valuable insights gained from analyzing a spectrum (UFODATA, website). When planning a research project, researchers need to decide whether to use off-the-shelf instrumentation already employed in field research or design a customized instrument. This choice depends on several factors, including the availability of resources, both in funding and qualified personnel, the project's objectives and strategies, and the motivations of the project leader(s).

Finally, it is of paramount importance to calibrate instruments to meet intended measurement objectives (e.g., accuracy, range of response), while considering both the level of effort required, the practicality of calibrating an instrument, and the precision required for measurement. Calibrating instruments not only underpins the reliability of data collected during UAP research but also facilitates meaningful comparisons across various studies. The Project Galileo requirements offer illustrative instances of both laboratory and on-site instrument calibration (Watters *et al.* 2023), while astrophysicist Teodorani emphasizes the critical role of wavelength calibration in the context of light spectra

(Teodorani 2004).

While instrument calibration is generally important and should be diligently carried out, the absence of perfectly calibrated instruments should not deter field work. For instance, initiatives like UFODAP (website) and UFODATA (website) represent initial efforts to gather evidence aimed at unequivocally demonstrating the existence of UAP through images and instrumented data. Notably, in their case, the precision of measurements may not be as critical due to the inherently gross nature of emissions from the intended UAP targets. The potential impact of UAPs on electromagnetic and gravitational fields could be so substantial that while absolute measurements remain important, UFODAP's equipment may be primarily focused on capturing the overarching impact rather than precise calibration. This valuable information could serve as a foundation for subsequent generations of instrumentation, driving precision improvements and generating support for further research due to their successful UAP detections in the field. In contrast, the Galileo Project, with its ample funding and high-caliber talent, exemplifies the highest level of instrument calibration, providing even more refined data and advancing our understanding from these early detections.

2.2.3 Strategies

These UAP instrumentation strategies encompass critical topics and actions for selecting an appropriate location based on factors like accessibility, visibility, and weather. The preference is for areas with higher UAP activity known as 'Hotspots' or 'Flap Areas'. This is because one persistent challenge has been the low probability of a UAP appearing where high-quality sensors are positioned. Deciding whether to establish a permanent or temporary location is also essential, with some projects like Project Hessdalen opting for permanence, while others like the Toppenish Field Survey remained mobile. Personnel with the necessary skills should be recruited, and resources such as employees, volunteers, equipment, and funding should be realistically assessed. Protocols should be established for data collection, analysis, and reporting, along with contingency plans for unforeseen circumstances. A plan for data management should also be developed, and partnerships with experts in relevant fields such as meteorologists or physicists could eventually be formed. Finally, clear communication channels should be established with stakeholders, including team members, partners, the UAP community, and the public.

3. Instrumented Field Research Timetable

A comprehensive list of fifty-two instrumented field studies spreading over the period 1947-2023 can be found in table 1. The table contains essential details such as the country where the research was conducted, the responsible organization or project leader(s), the duration of the study, and its operational status. This list contains all the studies that are widely recognized and regarded as significant contributions to the UAP research field. Most of these projects are based in North America (~46%) and Europe (~31%), with no information available for Asia, the largest continent in the world. The same lack of knowledge applies to Africa, the second largest continent, which is likely related to economic conditions. Highlighting the significance of UAP research, it is crucial to recognize that many of these investigations predate the public disclosure of the Pentagon's classified UFO program (AATIP) and the release of Navy videos. Moreover, it is worth noting that numerous endeavors have been made to study and quantify UAP through field experiments, although only a handful of them have entertained the hypothesis of extraterrestrial visitation. Most of these initiatives have primarily concentrated on the examination of 'nocturnal lights', revealing that this phenomenon appears to happen more frequently than the occurrence of 'unidentified structured aerial objects'. The timetable shows that field experiments peaked in the 1970s and early 1980s but virtually disappeared in the 1990s. The decline may be attributable to different factors, such as the closure of the American project 'Blue Book', a decrease in UAP sightings, a shift in focus to other topics in the US (e.g., Roswell, abductions), and a less supportive institutional and scientific climate for studying UAP. However, there has been an obvious increase in the number of initiatives around the world since the 2000s, mainly in Europe. Several long-term field projects continue into the new millennium, including Project Hessdalen in Norway, which has been running since 1984. Since the early 2010s, the increase in instrumented projects can be attributed to technological advancements such as high-resolution digital cameras, off-the-shelf scientific instrumentation, low-cost computing platforms, and progress in information technologies. This has also been further accelerated by the continuous reduction in the size and cost of equipment. In addition, the field has experienced since 2017 a resurgence in new actors such as the Galileo Project, UAPx, and the

Ref.	Research Project	Country	Project Leaders
1	**First Civilian's UFO Detection station**	USA	Los Alamos scientists
2	**Project Twinkle**	USA	U.S. Air Force
3	**Project Magnet**	Canada	W. B. Smith
4	**Videon Cameras**	USA	U.S. Air Force
5	**Network of Magnetic Detectors**	France	Lumieres Dans La Nuit
6	**Harrisburg all-sky camera**	USA	G. Rothberg (Project Blue Book)
7	**Tully Monitor Stations**	Australia	S. Seers, V. Mele
8	**Projects "HAVE FEAR","LETHAL CHASER"**	Viet Nam	U.S. Air Force & 4th Infantry Div.
9	**RESUFO**	France	M. Monnerie, Lumieres Dans La Nuit
10	**The Exeter Experiment**	USA	J. Oswald
11	**Lockheed P-3 Orion aircraft**	New Zeland	N.Z. Air Force
12	**Project MADAR**	USA	F. Ridge
13	**Toppenish Field Studies**	USA	D. Akers, B. Vogel
14	**Project Identification**	USA	H. Rutledge (Southeast Missouri State Univ.)
15	**UFO Watch**	USA	PMS
16	**Project Starlight International**	USA	R. Stanford
17	**Operacao Prato**	Brazil	Brazilian Air Force
18	**Copper Medic**	USA	J. Vallee
19	**Programs " Setka-AN" & "Setka-MO"**	USSR	IZMIRAN & NII 22
20	**Filters Jobin-Yvon**	France	GEPAN
21	**MFI-6 Magnetic Detectors**	Denmark	SUFOI
22	**Team Note Field**	Portugal	CEAFI
23	**Project " Krug" ("Circle")**	USSR	Soviet Ministry of Defense
24	**Project Hessdalen**	Norway	E. Strand & B. Hauge (Østfold Univ. College)
25	**Identification OVNI & Tours Hertziennes**	Belgium	SOBEPS, Belgium Air Force
26	**Automatic Optical Station & SkyScan project**	Germany	MUFON-CES
27	**Brown Mountain Lights**	USA	LEMUR; D. Caton & L. Hawkins
28	**The Ambient Monitoring Project**	USA	UFO Research Coalition
29	**45°GRU**	Italy	J. Ercolini
30	**Marfa Lights Investigation**	USA	J. Bunnell
31	**Kingsland Observatory**	Ireland	E. Ansbro
32	**Mount Adams)**	USA	D. Akers, M. H. Adams, E. Strand
33	**UAP Missions**	Various	M. Teodorani
34	**UFO Camera Project**	USA	W. Hollenbeck, C. O'Brien, A. Palfreyman
35	**Smart Optical Sensor Observatory (SOSO)**	Italy	M. Silvestri (CIPH)
36	**Automatic Measurement Station**	France	Les invisibles du Col de Vence
37	**Institut Fur Technische UFO-Forschung**	Poland, Norway	G. Gröschel
38	**Project UAP-Italia**	Italy	N. Tosi
39	**Platform**	USA	BAAS
40	**UFODATA and UFODAP**	USA	M. Rodeghier, A. Wendt (Ohio Univ.), R. Olch
41	**VISION OVNI (ECOS)**	Argentina	J. Perez
42	**MF & MA (Physical & Aerospace Monitoring)**	Ukraine	ZOND
43	**UAP Tracker**	France	P. Wright
44	**UAPx & O.S.I.R.I.S**	USA	G. Voorhis, K. Knuth & M. Szydagis (Albany Univ.), J. Mc Gowan
45	**Skinwalker Ranch**	USA	R. Bigelow, B. Fugal
46	**Excursions**	Brazil	Group Ufológico
47	**(Ukraine)**	Ukraine	B.E. Zhilyaev, V. N. Petukhov
48	**Field work "Serra da Beleza"**	Brazil	UAP Brazil (R. Vernet)
49	**Sky360 (after SkyHub)**	Austria	R. Hopf, O. Coutinho, C. Ambros
50	**SkyCAM-5 camera system**	Germany	H. Kayal (Würzburg Univ.)
51	**Project Galileo**	USA	A. Loeb (Harvard Univ.), W. Watters (Wellesley College)
52	**EXOPROBE research program**	TBD	B. Villarroel (Stockholm Univ.), G. Marcy

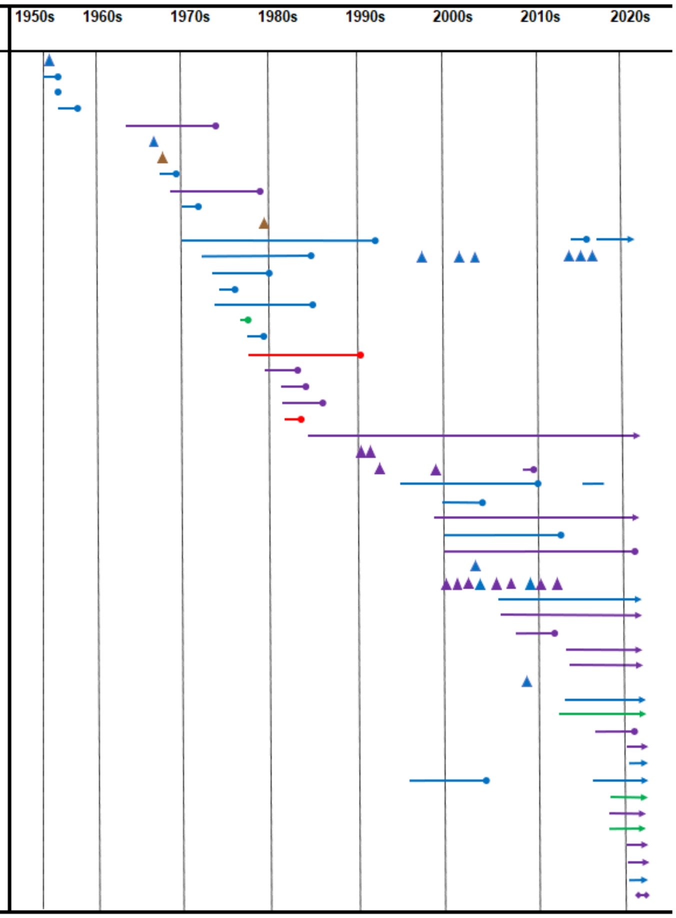

Table 1. Instrumented Field Research Timetable. *Note:* Color coding is used to represent different regions: North America and Canada are denoted in blue, South America in green, Russia in red, Europe in purple, and Australia/New Zealand in brown. Line end shapes represent project statuses: arrow = ongoing, round = stopped, lozenge = to start, none = status unknown, while a triangle indicates a short-term mission on the field.

University of Würzburg, involving scientists, astronomers, and academia, due to increased government attention and more serious reporting from mainstream media. Furthermore, over the past two years, the legitimacy of studying UAP with instrumentation has been established from two different angles. On the defense side, the 2021 ODNI report acknowledged that many sightings represented physical objects and emphasized the need to collect consistent data on UAP. On the scientific side, NASA's unprecedented decision in June 2022 to establish an independent study to examine UAP from a scientific perspective has further bolstered the topic's legitimacy. These official governmental announcements have helped to reduce the stigma associated with the UAP topic, piqued greater curiosity, and sent an encouraging signal to the scientific community. Finally, the timetable shows that most field investigations were instigated by proactive individuals or civilian associations who astutely recognized the imperative to act. It appears that governments have been hesitant to support UAP research due to concerns about public ridicule, the possibility of wasting tax money, the belief that scientific discoveries will not be made, or national security implications. Therefore, civilians have taken the lead in pursuing UAP research, demonstrating their dedication to understanding this enigmatic phenomenon.

4. Projects review

To maintain a concise paper, we will limit our focus to a specific subset of UAP instrumented missions, including select historical and recent projects. Our examination will commence with a review of UAP-related military projects, followed by an analysis of relevant civilian research initiatives, categorized into citizen and academic science projects. Military and civilian projects differ in their objectives, funding, investigation methods, and transparency. Military-led projects aim to assess UAP's threat to national security or military operations and often involve classified information and advanced technologies. Civilian research projects are usually self-funded or rely on donations and focus on exploring the nature and origins of UAPs and their implications for humanity. Military projects tend to be less transparent, and this is evident from the lack of details provided in the ODNI year 2021 report on the 144 reported events, while civilian projects are more open with their findings and data made available to the public.

4.1 Military instrumented projects

Starting in 1948, inexplicable lights were seen in the southwestern US close to critical government research and military facilities such as Los Alamos and Sandia National Laboratory. Credible witnesses reported frequent sightings, prompting concern from security agencies (Elterman 1951). To gather data, the Air Force tasked the Geophysical Research Directorate, a group focused on atmospheric phenomena, to study the lights. Project Twinkle was launched in 1950, using instruments such as optical tracking with Askania photo theodolites, cameras, and electronic frequency equipment. Observation posts were established close to Holloman and Vaughn Air Force bases. Despite that the final report (Elterman1951) concluded that no conclusive opinion on the phenomena had been reached, it stated that some objects were photographed during some Bell aircraft missile and V-2 launchings, and several photos were also obtained in 1950. The report indicated also that the project suffered from issues such as delayed deployment and reduced activity at equipment locations (Elterman 1951). In retrospect, the project was not optimal from the beginning. The camera system was not located near the areas of reported incidents, and its deployment was delayed until after the incidents had decreased.

In the mid-1970s, Colares, an island off the coast of Pará in Northern Brazil, experienced a surge in UFO activity. The Brazilian Air Force's First Regional Air Command was alerted by a city mayor about alleged injuries caused by UFOs to fishermen and locals ("Óvnis no Brasil" 2017). The phenomena intensified from October to December 1977 and the first half of 1978, causing rising concern. The city mayor requested Air Force assistance and organized night vigils and used fireworks to deter the UFOs. In response, the Brazilian Air Force sent a small team led by a Captain of Aeronáutica, Uyrangê de Hollanda Lima, to investigate. The team consisted of approximately 10 unarmed soldiers and spent four months using various equipment, such as cameras and binoculars, a meteorological theodolite, and a Huey helicopter, to observe and record strange events reported by residents. Known as Operação Prato (Operation Saucer), the team conducted interviews, drew maps of events, used base camps at locations where sightings had regularly been reported and worked at night to increase their chances of observing a UFO. During the initial two months, no significant sightings were reported. However, in the latter part of the operation, Captain Hollanda's team documented numerous close-range observations of unknown phenomena on the outskirts of Belém ("Óvnis no Brasil" 2021). The team managed to capture hundreds of photos and several hours of super 8- and 16-mm films of these UFOs. Government documents declassified in 2009 contain details of the missions carried out by the team, including eyewitness sketches of the UFOs, pictures, and intelligence officers' reports (Portal Estudos do Brazil Republicano, website). After four months of relentless efforts, Captain Hollanda and his team successfully restored peace and tranquility among the local population. Despite their remarkable achievements, Operação Prato, unfortunately, ended abruptly as the Air Force decided to terminate the mission, leaving the public without any further updates or explanations. The Operação Prato, in hindsight, highlighted the inadequacy of the approach taken towards investigating UAPs. The absence of involvement from scientists or academics resulted in a lack of planning for data collection, and in understanding and dealing with unfamiliar phenomena.

Concerning other military files, it wasn't until 2016 that some US military records related to tracking UFOs during the Vietnam War came to light. According to these documents, in 1968, the US Air Force Weapons Laboratory established two special projects to observe UFOs from Con Thien, the highest hill in the eastern demilitarized area (Dean 2016). The first project, called 'HAVE FEAR' utilized laser range finders and night observation devices to identify the sightings. This project's personnel saw red lights and captured video blips. The UFOs typically traveled at speeds ranging from 30 to 80 mph at altitudes of 1,200 to 1,600 feet. After several days of tracking, the red blinking lights would disappear when under 'HAVE FEAR' surveillance. The project ran from August 4-12 and resumed from August 18-31 in 1968. The second project, called 'LETHAL CHASER', utilized manpack radar and joined forces with 'HAVE FEAR' in mid-August. From August 18 to September 3, 1968, the observation systems conducted a joint, integrated search that also employed another radar further north at Dong Ha, known as 'Waterboy' which covered the southern areas of North

Vietnam. This joint exercise produced 67 valid tracks, but no conclusive identifications. The two projects were stopped by late August due to lack of results.

In a completely distinct strategic context, given the ongoing challenges faced by the US Government when assessing UAP within or in proximity to DoD training areas and installations, it becomes compelling to delve into an alleged experiment undertaken by the Russian military in the early 1980s. This experiment aimed to summon UFOs. It's worth noting that this experiment coincided with the existence of a state program for UFO research called 'Setka' in the Soviet Union, which included both civilian and military components and had been operational since 1977 (Gershtein 2015, 22-28). The objective of the 'Setka-MO' ('Ministry of Defense Network') was to conduct a military investigation into anomalous atmospheric and space phenomena and their impact on the performance of military equipment and personnel well-being. During the early 1980s, a significant number of UFO sightings were reported in the vicinity of a military range near Akhtubinsk, located within the Kapustin Yar military training ground in the Astrakhan region. According to retired Federal Security Service (FSB) Air Force Major General V. Eremenko, it became apparent that UFOs were consistently appearing in areas where military equipment and weapons were extensively tested. In response to this phenomenon, a project known as 'Krug' (translated as 'Circle' in English) was set-up. This six-months project involved a substantial increase in military aircraft flights and military equipment movement, accompanied by the installation of sensitive equipment to monitor UFO activity (Kruglyakova 2016, 72-77). Having been engaged in the experiment, Eremenko firmly stated that through the escalation of military operations, the regularity of UFO sightings increased, frequently manifesting as luminous spheres. This experiment, which effectively garnered significant scientific data such as photographs and radar detections of the phenomenon, ultimately contributed to an understanding of how to potentially summon a UFO. During this experiment, Eremenko also stated that the soldiers on the proving ground began to experiment with interacting with the UAP, the soldier in question made arm movements that were remarkably mirrored by the UFO, creating a mysterious connection between them (Kruglyakova 2016, 72-77). Nevertheless, despite the dedicated efforts of the military and scientists engaged in the endeavor, a conclusive explanation for these phenomena remained elusive (Kruglyakova 2016, 72-77).

To round out the list of military projects, it's also worth mentioning two airborne actions taken outside the USA in response to UAP sightings. On the nights of December 20th and 21st, as well as the 30th and 31st in 1978, there were numerous sightings of UAP above the Kaikoura Mountain ranges in New Zealand. The Wellington Air Traffic Control radar and the crews of a SAFE Argosy aircraft witnessed these sightings both visually and on radar ("Kaikoura Lights," n.d.). On December 30th, a television crew from Australia captured footage of these UAP during their flight to Christchurch. After the second sightings, a Royal New Zealand Air force Lockheed P-3 Orion reconnaissance aircraft was sent on a reconnaissance mission to Kaikoura in January 1979 in an official attempt to accurately observe and report on unusual visual, electronic, or meteorological phenomena. The military plane was equipped with radar, cameras and a host of other sophisticated tracking and monitoring equipment. The search returned a negative result (Siegert 1979). Declassified files reveal that an administrative error prevented the launch of the Orion aircraft during the second UAP sightings (Siegert 1979). The January mission was in fact a response to negative media coverage and accusations of the defense ministry acting irresponsibly. Certainly, the unpredictability and elusive nature of the UAP indicate the need for better preparedness and quicker reactions to maximize the chances of collecting scientific data.

Between late 1989 and mid-1991, a wave of anomalous sightings occurred in Belgium, with UAP observations reported almost daily (COBEPS, website). Witnesses included civilians, military personnel, and police officers. The UAP reported were typically triangular, over 15 meters in size, and equipped with large 'headlights' that projected intense beams of light. They were also capable of tight changes of course and lightning accelerations. The continuous flow of UAP reports prompted the involvement of the country's authorities, including the Ministry of National Defense, the Air Force, and the Gendarmerie. In April 1990, a joint operation with a civilian UFO association (Société Belge d'Etude des Phénomènes Spatiaux) was organized to collect data and determine the nature of the phenomena. The Operation Identification involved a network of observers and resources provided by the Belgium armed forces, including the Liege's town airport (Bierset) as headquarters, two military planes, with one equipped with infrared thermal cameras and night vision equipment, several optical cameras, and military pilots and technicians. However, the operation was unsuccessful in detecting or observing any UAP during the 4-day long campaign. Despite this, the collaboration between civilians and the military marked the first time in Europe that joint efforts were made to seek answers to the UAP phenomenon. One of the most important lessons learned from this operation was to avoid media coverage as it can create unrealistic expectations and hype, leading to disappointment when reality doesn't meet the portrayed image. These remarkable UAP events also led to a resolution being proposed by Belgian deputy Elio Di Rupo to the European Parliament in 1991 to develop UAP research at a European level (European Parliament 1990). This proposal, which received substantial ridicule in the media, was ultimately rejected in early 1994.

Is there a trove of UFO instrumented projects related information hidden in US military archives? This question gains importance with the recent U.S. Fiscal Year 2023 National Defense Authorization Act (NDAA), H.R. 7776, which mandates the Director of the Office of the Assistant Secretary of Defense for Intelligence and Security to provide a comprehensive report on the U.S. government's engagement with UAPs from January 1, 1945, onward (Johnson 2022, 9-10). Anticipating the future publication of the AARO Historical Record Reports, the first volume, currently in preparation for delivery to Congress and the public in January 2024, holds the potential to reveal previously unknown insights into military UAP projects, enriching researchers' understanding of this historical requirement (Kirkpatrick 2024).

4.2 Civilian instrumented projects

Within this section, we delve into the realm of civilian research. The related projects encompass a wide spectrum of endeavors, with a particular focus on the involvement of both non-professional and academic or scientists. Citizen science, or the participation of non-professional scientists in a scientific project, has a long history and often characterizes efforts driven by enthusiastic individuals from various backgrounds (Mordechai (Muki) Haklay, Mazumdar & Wardlaw 2018). Conversely, academic, or professional science projects represent the domain of experts and scholars within the scientific community. These initiatives are characterized by the application of rigorous methodologies, adherence to established scientific standards, and the use of specialized equipment and resources.

Categorizing projects as either citizen or academic science can be nuanced. The criteria, multifaceted in nature, primarily depend on the level of involvement, methodology, and project objectives. Regarding projects labeled as 'academic science' in this paper, it's important to clarify the role of university professors. The criteria aren't solely based on their affiliation or time commitment but rather on research goals, methodologies, and adherence to academic standards. If a project meets these criteria, it falls under academic science, irrespective of professorial involvement or affiliation.

4.2.1 Academic or professional science projects

The notion that UAP might represent a physical phenomenon with quantifiable attributes that could be studied through instrumentation dates to the early 1950s. Edward Ruppelt's book details one notable instance of early scientific interest and the first professional scientific field research effort in this direction during his time as the head of Project Blue Book from 1951 to 1953 (Ruppelt 1956, 203-209). Ruppelt recounts an experiment conducted by scientists to test whether UAP activity could be correlated with radiation increases, based on a case where observers reported a simultaneous visual sighting of UFOs and a sharp rise in radiation levels in an area near the Mount Palomar Observatory. The experiment began in the summer of 1950, when some physicists working for the Atomic Energy Commission at Los Alamos, New Mexico, met on weekends at a shack atop a low mountain near the installation where they set up a UFO detection station. The detection device they devised consisted of rows of Geiger tubes arranged to measure radiation levels continuously, with a tape recorder attached to document any fluctuations. Meanwhile, they monitored local news reports to check for any UFO sightings in the Los Alamos region. In early 1951, the equipment registered three abnormal radiation spikes coinciding with reports of visual UAP sightings, one of which was also picked up by radar. The team kept the equipment running until June 1951, but did not detect any further correlations between UAP sightings and radiation anomalies. Despite expert consultations, no satisfactory explanation for the UAP-radiation correlations was found (Ruppelt 1956, 205).

In the mid-1970s, a pioneering academic UAP project arose in response to numerous sightings near Piedmont, Missouri. Led by the Chairman of the Physics Department at Southeast Missouri State University, this seven-year 'Project Identification' aimed to measure the physical properties of observed lights and objects in the sky and identify their origins

(Rutledge 1981). Dr. Rutledge and his team, comprising university staff, qualified students, and scientists, employed advanced scientific instruments, established 158 viewing stations in key geographic areas, and engaged over 600 observers, amassing 427 hours of sky observation. The project documented 157 sightings, including 34 class A sightings with unusual properties defying conventional explanations.[1] However, no Class A sightings were captured in the 700 project photographs claimed by Dr. Rutledge. Unfortunately, these photographs were limited to nighttime exposures, lacking broad daylight images or anomalous light spectra. According to Dr. Rutledge, his research not only confirmed the UAP phenomenon's existence but also revealed a unique connection between observers and the phenomenon, as he claimed that on at least 32 recorded occasions, the lights' movements synchronized with the actions of the observers (Rutledge 1981).

In a parallel historical context during the mid-1970s, a little-known but significant UFO chapter unfolded in Gorredijk, the Netherlands. This recent revelation (Smedes, 2024) has brought to life the pioneering initiative of a high school teacher named Geert Meijer. Motivated by his personal sighting, Meijer aimed for a scientific approach, setting up observation posts with 10-25 participants, including students and adults, not only in Gorredijk but also in five neighboring villages. What sets this case apart is the concentrated and numerous UFO observations confined to a limited geographic area only during February 1974.

The observed phenomena encompassed predominantly dynamic lights, often in motion but occasionally stationary, displaying a spectrum of colors. Additionally, formations of lights emerged, some with accompanying flashing lights. Intriguingly, serving as precursors to subsequent decades, witnesses reported sightings of a sizable 'boomerang'-shaped object and a triangular craft. Enhancing the fascination, Gorredijk witnessed both solitary sightings and occurrences where multiple individuals concurrently reported observing the same UFO. To validate these sightings, Meijer introduced innovative methods like cross-referencing and a 'game of right and wrong',[2,3] Equipping participants, who were both students and adults, only with binoculars and cameras, Meijer orchestrated simultaneous sightings across different observation posts, enhancing the credibility of the observations. This approach resulted in some remarkable instances where multiple student and adult observers reported the same UFO. Furthermore, a few photographs were taken during these observations, adding a visual dimension to the documented sightings.

As February ended, the sightings and reports of UFOs above Gorredijk abruptly ceased, almost overnight, marking the swift conclusion of this UFO wave. The enigmatic phenomenon concluded without yielding any definitive answers regarding its causes. Similar to Dr. Rutledge's Project Identification in the United States, Meijer's initiatives marked a noteworthy early endeavor in European UFO studies, contributing valuable optical data to document the presence of unexplained aerial phenomena.

Nowadays, one particularly well-known academic science initiative is the Norwegian Hessdalen project which is internationally known as the 'UAP Laboratory'. Led by professors from the Department of Engineering and the Faculty of Computer Science at Østfold University College since 1984, this project continues to attract additional resources and the interest of the scientific community, serving as a prime example of success (Hauge 2005 and 2007; Teodorani and Nobili 2002; Teodorani 2023). This is evidenced by the organization of science camps, procurement of new equipment and implementation of innovative strategies, as well as the forging of collaborations with international experts across various scientific disciplines (Hauge 2010). Certainly, investigating mysterious light phenomena in the concentrated area of the Hessdalen valley in central Norway is viewed as a safer pursuit compared to chasing most UAP cases. These lights, confined to this specific region, exhibit intriguing geophysical aspects such as piezoelectricity, tectonic strain, and gaseous emanations linked to the rare mineral Scandium, making them more scientifically credible (Hauge 2007).

A different approach to UAP research has been undertaken by the Ukrainian Scientific Research Center for Analysis of Anomalies (SRCAA) 'Zond'. Established in 2004 within the Aircraft and Space Systems department of Kyiv

1 Dr. Rutledge, drawing from direct field experience, categorized UFO sightings into two classes: A and B. Class A encompassed sightings of extraordinary phenomena, involving lights and/or objects exhibiting peculiar behavioral and/or physical properties that defied conventional explanations. On the other hand, Class B UFOs, more commonly observed than Class A, referred to lights and/or objects that remained unidentified by available instruments. However, these sightings, in the observer's judgment, lacked the unusual behavioral or physical properties that would challenge rational explanation.

2 The term 'cross-referencing' here refers to the practice of comparing and verifying UFO sightings from different locations to validate the observations.

3 In the context of Meijer's UFO studies, the 'game of right and wrong' involved participants intentionally making claims about observed UFOs. If someone made a deliberately incorrect claim about a stationary UFO, corrections from others were sought to validate the collective sightings.

Polytechnic University, this organization is at the forefront of studying anomalous phenomena in Ukraine. 'Zond' initiated the deployment of hidden ground-based monitoring systems, known as MF-2, between 2016 and 2019 (Kovalenko, Bilyk, and Kyrychenk 2020). These systems were strategically placed in areas where alleged UAP landings occurred or where frequent sightings were reported. MF-2 devices were equipped with various sensors, automatically gathering environmental data such as temperature, air pressure, magnetic fields, gravitational fields, and geoelectric statuses, all of which could potentially indicate the presence of aerial anomalies. This approach has allegedly proven effective in the field, with notable instances of recorded abnormal changes in the magnetic field as documented by 'Zond' (Kovalenko, Bilyk, and Kyrychenk 2020). Unfortunately, due to the ongoing war situation, the vital fieldwork of the SRCAA 'Zond' has been suspended. The team remains committed to resuming their research as soon as circumstances permit, continuing their valuable contributions to the study of anomalous phenomena in Ukraine.

4.2.2 Citizen science projects

Since 1947, significant evidence has emerged concerning the physical effects that accompany UAP sightings. These effects often involve peculiar magnetic disturbances (Akers 2001), such as interfering with airplane compasses, creating residual magnetic effects on cars, rocks, and soil at landing sites (Maccabee 1994), and disrupting electronic equipment (Rodeghier and Longden 1981). Hypothesizing that UAPs generate, rely on, or can manipulate magnetic fields, civilian researchers worldwide began using instruments to detect magnetic changes as early as 1952. These devices were later integrated into early detection projects as UAP early-warning alarms. To increase the chances of UAP detection, some researchers deployed several of such devices across a wider geographic region. Table 2 shows the principal projects undertaken. Although there have been instances of detector alarms and claims of potential correlations with certain UAP sightings, the systematic and dependable detection of UAPs by such instruments remains unverified.

	Period	**Location**	**Project Leaders**
Project Magnet	1952-1954	Canada	W. B. Smith
Saucer Seeker Detector	~1967	USA	Aerial Phenomenon Research Organization
Network of Magnetic Detectors	1963-1974	France	Lumières Dans La Nuit
Tully Monitor Station	~1968	Australia	S. Seers, V. Mele
UFO McCarthy Detector Network	1968-1970	UK	D. Lloyd
The Exeter Experiment	1970-1973	USA	J. Oswald, D. Webb
The MADAR Project	1970-today	USA	F. Ridge
The Toppenish Field Studies	1972-2002	USA	D. W. Akers
Project Starlight International	1972-1985	USA	R. Stanford
Precision Monitoring Systems	1974-1976	USA	J. Herr, H. Boylan, G. Wolter
MFI-6 Magnetic Detectors	1981-1984	Denmark	Scandinavian UFO Information

Table 2. Principal Magnetic-based UAP Detection Projects

Furthermore, it is evident that most past detector alarms were false positives, resulting from technical deficiencies in the detectors (over-sensitivity) and other sources of magnetic interference such as thunderstorms, lightning, nearby passing cars, and active televisions (UFO-Nyt 1983, 43-47). Despite the extensive efforts made, the potential relationship between UAP and magnetic fields continues to be a topic of great interest. To gain a better understanding of this potential connection, all current UAP detection projects systematically incorporate magnetometers (e.g., fluxgate magnetometers). One notable ongoing project is the MADAR project which aims to develop and deploy sensors for detecting electromagnetic disturbances possibly associated with UAPs. Additionally, it seeks to correlate citizen reports with instrumented data (MADAR, website).

More recently, the secret UFO study, Project Condign, conducted by the British Government's Defence Intelligence Staff from 1997 to 2000, explored magnetic field effects in a dedicated working paper (The National Archives 2006). This report emphasized the importance of purely magnetic effects in relation to UAP, as they influence human brain responses and resemble UAP reports.

Regarding civilian instrumented research, it is also important to acknowledge Robert C. Beck, an American engineer and inventor, as a true pioneer in advocating and practicing such studies. Beck advocated for a variety of possible instrumentation and emphasized the need for detailed records, including photographs of the sky and weather conditions. He was a fair-minded and objective skeptic and had his own mobile UAP laboratory before anyone else had even taken any realistic action about such possibilities. While others only talked about ideas for instrumented studies, Beck was actively conducting some in the 1950s, as evidenced by Max B. Miller's 'Saucers' publication (Beck 1960).

As a response to the ongoing reports of the UAP phenomenon and technological advancements, researchers in the mid-1970s began integrating revolutionary sensors, leading to increased levels of sophistication and affordability. Speculation arose due to the sensors' ability to detect various segments of the electromagnetic spectrum, suggesting that UAPs could potentially emit radiation across a range of wavelengths. Instrumented research was focused on convenient locations such as Project Starlight International (Stanford 1976, 177-190) and Kingsland observatory (Ansbro 2013) or areas where 'nocturnal lights' were frequently seen, such as Toppenish field studies (Akers 2007) and Marfa lights investigation (Bunnell 2009). In addition to the location considerations, some researchers have also adopted an 'on the go' strategy, moving their experts and instruments to areas where UAP activity was recently observed (e.g., the Toppenesh field studies, Project Starlight International (Meessen 2012), Operação Prato).

Various innovative approaches have also been developed to capture the elusive UAP, including disguising automatic cameras as rocks to provide long-term photographic surveillance of UFO sites. In 1978, Dr. Vallée obtained clearance from the state of California to install equipment on public land, including an automatic camera with a 25mm lens, an intervalometer timing circuit, and a battery unit for power. The device, named 'Sleeping Beauty', was discreetly placed in the hills around Redding. It captured one picture every six minutes for six hours daily, from 6 a.m. to noon, and then remained dormant for 18 hours. This experiment ran for one year, from August 1978 to July 1979, resulting in 1,800 exposures in a single month. However, no UAP were observed in the exposures, leading to the project's termination (Vallée 1990, 231-247).

In the face of complex phenomena potentially under intelligent control, employing multiple strategies becomes relevant, as these occurrences may not be easily captured or understood through conventional photography alone. For instance, a Brazilian researcher documented an elusive UAP encounter during a nighttime observation, with the UAP abruptly vanishing and reappearing (Do Carmo, email, July 3, 2014). In another case during fieldwork, a different researcher experienced interference with photography and data acquisition, suggesting an interaction (Akers, personal email, October 20, 2023).

The Ambient Monitoring Project, a lesser-known initiative, was begun in 1998 and focused on gathering data about the physical phenomena associated with purported 'alien abductions', a subject popularly intertwined with the UAP phenomenon. The project involved designing a sensor system to continuously record 11 environmental variables (e.g., temperature, pressure, gravity, electric and magnetic fields) and placing it in the home of a repeat abduction experiencer for 4 to 8 months (Deuley 2008, 3-7). While 13 individual research cases were completed between 2000 and 2003, yielding large amounts of physical data that may or may not correspond to the abduction phenomena, the statistical data analysis is today still pending analysis and publication.

In summary of this section on military and civilian efforts, although several projects have gathered preliminary data in the past decades (Meessen 2012), the data remains inconclusive. This emphasizes the need for continued and enhanced field work. A crucial observation that has come to light is that the instrumentation projects that have yielded the highest success rates thus far are the ones where researchers could physically be present on-site with the necessary equipment. This enabled them to both initiate and visually confirm the accuracy of the UAP instrumented observations and ensure successful operation of the equipment.

5. Limitations and implications for further research

The analysis of historical instrumentation projects reveals common issues and shortcomings that have practical implications for future initiatives. These findings provide valuable insights that can serve as a checklist for addressing critical challenges before embarking on new projects. Throughout this section, we will reference specific projects from Table 1, e.g., [1, 2, 3] to illustrate these issues and their impact, while acknowledging that this list is not exhaustive.

- <u>Inadequate Financial Resources:</u>
  A recurring challenge in all the projects is the insufficient financial resources to cover the costs of equipment, software algorithm development, and overall manpower, which hampers their effectiveness and progress [16, 22, 36, 40, 44, 50].
- <u>Organizational and Logistics Challenges:</u>
  Project organization and logistics capabilities often

presented significant hurdles to successful implementation [2, 7, 11, 13, 24, 30, 42].

- Insufficient Availability of Competent Technical Personnel:
  The lack of consistently available, competent technical personnel in the field has been a recurring issue, impacting project performance [5, 17].
- Limited Familiarity with Instruments:
  Inadequate familiarity with the specialized instruments used in these projects has affected their efficiency and outcomes [5, 21].
- Maintenance Difficulties:
  Difficulty in promptly maintaining hardware or software during failures has presented an ongoing challenge, affecting the continuity of functioning [1, 4, 24, 36].
- High Suggestibility of Researchers:
  Researchers and participating members of field surveys, particularly in novel observation situations, have shown high levels of suggestibility, which could potentially lead to erroneous conclusions [5, 25, 47].
- Unprepared Governmental Teams:
  When faced with the challenges of studying a novel phenomenon like UAP in the field, government teams frequently found themselves ill-equipped and unprepared to meet their assigned tasks and responsibilities [2, 17].
- Limited Publication of Results:
  Results from UAP field experiments were not consistently published, even when they were negative, limiting knowledge-sharing [12, 16, 19, 22, 34, 36, 39].
- Lack of Knowledge-Sharing and Collaboration:
  Until recently, there has been a general notable lack of cooperation and knowledge exchange among researchers, resulting in duplicated efforts and imposing a significant global financial burden.
- Challenges in Maintaining Long-Term Motivation:
  Sustaining long-term motivation among project development teams proved to be a significant challenge [9, 27, 36, 40].
- Careful Instrument Calibration:
  It is uncertain whether projects have consistently paid sufficient attention to instrument calibration in laboratories and on-site. It is important to emphasize that this factor is widely recognized as crucial for accurate data collection and analysis (see page 7).

6. Recent developments

In recent years, several novel citizen and academic scientific projects have come to light, as listed in Table 3. Each of these projects adopts a distinctive approach to studying these phenomena, presenting its own array of obstacles in terms of coordination, financing and data gathering.

6.1 Academic or professional science projects

UFODATA, which was launched in 2015, aims to establish an extensive network of automated surveillance stations equipped with advanced sensors to ensure continuous monitoring of the skies for any anomalous activities (UFODATA, website). However, due to limited funding and a lack of volunteers, the project has experienced slow progress in developing a viable station design and building a prototype. To expedite progress, a decision was made in 2020 to partner with another project called UFODAP which already had functioning versions of automated stations in various configurations, including a camera and tracking system (UFODAP, website). As of February 2023, UFODAP had already provided 54 sensor systems to various clients.

Project	Science Lead: Citizen (C) or Academic (A)	Year created	Project Leaders	Objective
UFODATA	A	2015	Dr. M. Rodeghier, Dr. A. Wendt (Ohio Univ.)	Building a large network of automated surveillance stations with sophisticated sensors that will monitor the skies 24/7 looking for aerial anomalies.
UFODAP	C	2016	R. Olch, C. O' Brien	Enabling UAP/UFO research by deployment of advanced data collection technology.
MADAR	C	2018	F. Ridge	Attempting to correlate citizen UFO reports with the instrumented data (magnetic anomalies) collected through a wide network of devices.
Field Work "Serra da Beleza"	C	2018	R. Vernet	Instrumented research around Serra da Beleza, Rio de Janeiro.
UAPx	A	2019	G. Voorhis, Dr. K. Knuth (Albany Univ.), Dr M. Szydagis (Albany Univ.)	Collecting, Analyzing, Studying, and Publishing Actionable Data on the UFO/UAP Phenomena.
SKY360	C	2021	R.G. Hopf, C. Ambros	Facilitating a citizen science project to observe the skies and all their phenomena around the globe, 24/7 and provide harmonized high-quality results and analysis - available to everybody.
UAP Tracker	C	2021	P. Wright	Observing and documenting potential UAP events using consumer-grade equipment, and featuring a live dashboard streamed on YouTube.
Galileo	A	2021	Dr. A. Loeb (Harvard Univ.), Dr W. Watters (Wellesley College)	To determine whether there are scientific anomalies in Earth's atmosphere, by conducting an aerial census.
SKYCAM-5	A	2021	Dr. H. Kayal (Würzburg Univ.)	Detection of unidentified aerial phenomena using artificial intelligence methods.
Exoprobe	A	2024 (TBC)	Dr. B. Villarroel (Stockholm Univ.), G. Marcy	Searching for probes from extraterrestrial civilizations in orbit around the Earth and in the solar system.

Table 3. Current Civilian Projects.

However, the main UFODATA challenge remains the lack of a centralized network and data collection point to gather potential information on interesting detections for scientific analysis. Consequently, the primary focus of the UFODATA team is nowadays to develop the necessary software infrastructure to support the uploading, storage, and sharing of data collected using UFODAP's technology (UFODATA, 2023).

Another organization called UAP eXpeditions (UAPx, website) has also recognized the advantages of utilizing UFODAP's equipment. UAPx aims to be mobile and deploy the equipment into the field, targeting hotspots to collect their own high-quality data. In July 2021, UAPx conducted a five-day research expedition to a suspected UAP hotspot in the Catalina Channel off the coast of Los Angeles in July 2021. Collaborating with physicists from UAlbany SUNY, the expedition detected unusual atmospheric anomalies and energetic particles. The preprint report submitted in December 2023 (Szydagis *et al*. 2023) clarified ambiguous observations, with none definitively classified as true anomalies. Key successes included stress-testing equipment, developing versatile software, and extracting valuable lessons for future fieldwork. Recommendations include using at least two sensors of each type, employing two distinct sensor types, and establishing quantitative rigor in defining ambiguities vs. anomalies. Future excursions, which will include visits to Catalina and other locations, will incorporate improvements to equipment and methods, building on past work.

The main challenge of fieldwork is that, regardless of the sophistication of the instrumentation, the likelihood of detecting highly conclusive evidence during relatively short expeditions appears to be quite low. Additionally, short-term field studies face the challenge of not comprehensively grasping the 'background', which includes rare events that may appear unusual but are, in fact, typical for a given area due to a limited understanding of the local environment.

In recent years, the academic sphere has also made notable progress in the field of UAP research. While independent scholars have been contributing to the study of UFOs across various disciplines for decades (Appelle 2000), there is now a significant emphasis on instrumented research within the academic community. This shift is particularly noteworthy because it involves two major universities, one in Europe and the other in the US, each hosting a UAP project.

Historically, one prominent example of academia's involvement was the University of Colorado UFO Project, which received funding from the United States Air Force Project Blue Book from 1966 to 1968. Led by Edward U. Condon, an esteemed professor of physics and astrophysics, this project sought to conduct a comprehensive investigation into UFOs. A noteworthy, instrumented reference relates to the summer of 1967 when concerted efforts were made to enhance the objectivity of data collection during a localized surge in UFO sightings within a specific geographical region. The project conducted a field investigation in Harrisburg (Pennsylvania) to study the ongoing UFO sightings (Case 27, Condon 1968). The investigator used various tools such as cameras, infrared sensors, and a Geiger counter. They stayed in contact with a telephone answering service to record sighting reports. Additionally, an all-sky camera on a hospital roof captured thousands of exposures over 17 nights. Despite receiving multiple reports, the investigator found nothing noteworthy. The project's conclusion in the Condon report was highly negative, stating that the likelihood of placing a trained and equipped investigator at the scene of a UFO sighting was virtually nil (Case 27, Condon 1968). However, this discouraging outcome did not stop future researchers and projects from exploring different approaches in subsequent decades, leading to some valid observations and valuable preliminary data.

In 2022, the Julius-Maximilians-Universität of Würzburg (JMU) in Germany made history as the first high-profile Western university to recognize UAP as a legitimate subject of academic research. The university's Interdisciplinary Research Center for Extraterrestrial Science (IFEX) expanded its goals to include UAP research, alongside space exploration, celestial objects, and signs of extraterrestrial life. This approval by the university's senate marks a paradigm shift in how these phenomena are approached academically, both in Germany and worldwide. IFEX aims to collaborate with relevant institutions and authorities, such as the Max Planck Society, the German Aerospace Center, and the Federal Aviation Office, to advance UAP research. The chairman of IFEX, Dr Hakan Kayal, focuses on addressing the lack of rigorous data in UAP research. He is developing intelligent sensor systems, such as the SkyCAM-5 camera system, which has been undergoing outdoor tests since December 2021 on a university building's roof (Universität Würzburg 2021). This system employs artificial intelligence (AI) methods to detect unknown celestial phenomena. However, significant funding is needed to expand the UAP detection system, add different sensor types in various spectral ranges, and deploy multiple systems in Germany, Europe, or worldwide. Despite the growing interest and improved accessibility of advanced and affordable scientific sensors, the lack of public funding remains a major obstacle to UAP research. Researchers advocating for financial support should highlight the undeniable link between substantial funding and significant progress in complex scientific problems. History has demonstrated that almost every scientific breakthrough is inseparable from adequate financial resources.

However, the Galileo project, launched in July 2021 by Harvard University astrophysicist Avi Loeb, stands today as a remarkable exception. This project focuses on obtaining high-resolution images of UAPs, studying interstellar objects like 'Oumuamua', and searching for potential extraterrestrial satellites exploring Earth. In line with the 'Matthew Effect' in the sociology of science, the Galileo Project has already amassed millions of dollars in private donations and secured a notable roster of researchers from various institutions worldwide because of the reputation of Loeb[4]. This support has contributed to rapid progress, exemplified by the construction of a state-of-the-art UAP observatory on the roof of the Harvard College Observatory in 2022. Equipped with advanced instruments such as infrared, optical, radio, audio, magnetic, energetic particles, and weather sensors, such observatory is designed to monitor the entire sky at all times from one location, collecting high-quality data, which is then analyzed using AI algorithms. In the coming years, the project plans to replicate the observatory design and deploy them in ten different locations across the United States for up to five years (Watters *et al.* 2023, p. 32).

The project's recent release of several open-access UAP peer-reviewed scientific papers signifies a significant step toward mainstream acceptance. The Galileo Project is developing three classes of instruments to tackle the UAP investigation challenge. Firstly, observatory systems based on the original telescope at Harvard University. Secondly, portable systems for rapid deployment and continuous operation in favorable conditions. Lastly, low maintenance 'Mesh' systems optimized for cost and scalability (Watters *et al.* 2023). In retrospect of several decades of UAP research, this remarkable work and the technological advancements achieved highlight the stark contrast in resources available to large teams of scientists and technicians with sufficient funding, as opposed to previous or current under-funded UAP research endeavors.

Space provides a distinctive vantage point for real-time Earth data collection, a capability that is becoming increasingly indispensable for scientific research. Acknowledging the superiority of space-based data collection over extensive ground sensor deployment, the Galileo Project has also prioritized a groundbreaking method for UAP detection. This innovative approach utilizes satellite imagery from Earth Observation (EO) satellites (Keto and Watters 2023). Enabled by extensive EO datasets, this global strategy represents a noteworthy departure from previous decades' localized UAP studies. By harnessing the advantages provided by satellites, including their wide-area coverage, frequent and systematic image acquisition of the Earth's surface and atmosphere, the project strives to create software that employs pattern-recognition techniques for the automatic identification of moving objects in commercial satellite images provided by company Planet Labs. The primary objective is to identify objects exhibiting velocities, accelerations, sizes, or shapes that deviate from those expected of natural phenomena, common vehicles, or projectiles. Of particular importance would be satellite data capturing objects entering Earth's atmosphere that do not follow ballistic orbits like meteors or rockets. Undoubtedly, this undertaking poses significant complexity and challenges. The task of analyzing an extensive volume of Earth observation data is time-consuming, and retrieving satellite data coinciding precisely with a UAP event has a low probability.

Regarding new professional actors collecting observational scientific data, noteworthy articles by Ukrainian astronomers (Zhilyaev, Petukhov, and Reshetnyk 2022) have emerged on arXiv, a free scientific preprint publication archive. The Main Astronomical Observatory of the National Academy of Sciences of Ukraine independently investigated UAPs using two meteor stations in Kiev with a specialized observation technique. However, these reports were discredited by the National Academy of Sciences of Ukraine due to scientific rigor issues and errors in determining distances to observed objects. Some scientists suggest that certain UAPs in the report may be related to foreign surveillance or military technologies, given the ongoing Russian invasion of Ukraine since February 2022. While previous UAP field experiments have faced limited publication options, this case involves a reputable

4 The 'Matthew Effect,' originating from the biblical verse 'For to everyone who has, more will be given, and he will have abundance; but from him who does not have, even what he has will be taken away' (Matthew 25:29), is a sociological concept in the realm of science. This phenomenon suggests that established individuals in a field tend to accumulate more recognition and resources, while those who are less established may struggle to gain recognition. In the context of the Galileo Project, the 'Matthew Effect' has contributed to the project's ability to amass significant financial support and attract esteemed researchers, who are drawn by the reputation of Professor Loeb and the Harvard University.

astronomical institution's publication, albeit lacking peer review and scrutiny. Such unverified claims should be avoided to maintain the integrity of UAP research.

6.2 Citizen science projects

UFODAP is not the sole citizen-led UFO research initiative with affordable observation stations monitoring the skies 24/7 for UAPs. In October 2021, a European group of astronomers, software developers, and hardware engineers founded Sky360, a non-profit non-governmental organization (NGO) registered in Austria (Sky360, website). The Sky360 stations are comprised of inexpensive off-the-shelf components, aiming to find the most effective combinations at the lowest cost. Detailed schematics, blueprints, and suggested equipment are available on their website. Currently, 20 stations are operational worldwide, spanning from the USA and Canada to remote regions like the Azores in the Atlantic. However, the challenge lies in motivating enough people to acquire these systems, thereby increasing the chances of success for these citizen-led networks of UAP monitoring stations.

In addition to technological advancements, smaller sensor sizes, and reduced costs, it can be argued that the rise of popular social media platforms has also contributed to the increase in detection projects since the 2000s. Researchers have recognized the value of utilizing platforms like 'YouTube' and 'Twitter' to share UAP optical information recorded in the field, such as videos and pictures. These online tools allow for widespread dissemination of research activities and intriguing detections, reaching a global audience, and engaging viewers. Furthermore, this offers opportunities for projects to generate income and support further research. For instance, UAP Tracker, a prominent UAP research platform, has noticed substantial growth in its viewership, with an average of 2.7k monthly viewers, since they began live streaming a few years ago (UAP Tracker, email communication). Similar engagement is observed in projects like UAP Brazil, where their videos have gained significant attention (Vernet 2021). Watching UAP videos on 'YouTube' has become a convenient alternative for those seeking a UAP experience, providing a sense of witnessing something genuinely unidentified and extraordinary. However, it is important to note that legitimizing serious UAP research and maintaining data credibility can be challenging on popular free media platforms, where hoaxes and fake videos can rapidly spread.

7. Future directions

Due to the increase of instrumented projects and as time progresses, there might be instances where different projects studying UAP share similar objectives or collect comparable data. While this may lead to some overlap, it is crucial to view this as an opportunity rather than a drawback. Having multiple research groups independently investigating the same phenomenon allows for cross-validation of findings, verification of results, and the discovery of complementary insights. The nature of scientific exploration often thrives on collaboration, as it encourages diverse perspectives, methodologies, and approaches to problem-solving. With UAP research, the significance of collaboration becomes even more pronounced, considering the intricate and enigmatic nature of the phenomena under investigation. Our current understanding of what precisely we should be pursuing is lacking, and we may encounter substantial obstacles in exploring a subject that potentially possesses awareness, actively eludes, or distorts our observations, and might even have an interest in studying us. By having various groups examining UAPs from different angles, we increase the chances of gaining a more comprehensive understanding of these anomalous events.

Based on the research conducted for this paper, the enhancement of rigor and effectiveness in instrumented UAP field studies should prioritize two key areas:

Firstly, building a more disciplined approach to such studies is essential. This can be achieved by establishing closer collaboration between interested parties to share ideas, methods, and findings. Regular meetings and workshops should be organized to facilitate this process. Table 1 clearly illustrates that the current stage has brought together a substantial number of dedicated researchers, enabling the establishment of more frequent communication channels for the exchange of ideas. The UFO research community should moreover capitalize on the fact that several reputable organizations have now integrated instrumented research into their agendas. For example, the American Institute of Aeronautics and Astronautics (AIAA) established the Unidentified Anomalous Phenomena Integration & Outreach Committee (AIAA UAP, website) and has been organizing technical sessions on UAP since 2021 (Aviation Forum, website). The Scientific Coalition for UAP Studies has conducted annual conferences for the past four years (SCU, website), while the newly formed Society for UAP Studies

(SUAPS, website) aims to serve as a unifying platform for strategic planning and collaborative research. SUAPS also hosted its inaugural symposium in 2023.

To complete this picture of newly created organizations, it's worth noting the Sol Foundation, which officially launched in August 2023 (The Sol Foundation, n.d.). Led by Dr. Nolan, Professor in the Department of Pathology at Stanford University School of Medicine, and sociocultural anthropologist Dr. Skafish, the Sol Foundation is a pioneering think tank dedicated to researching the philosophical, policy, and scientific implications of UAP. Beyond academic research, the Foundation aims to be a leading source of UAP-related research and to provide informed policy recommendations to governments. Noteworthy for its commitment to government transparency and scientific rigor, the Foundation stands out in its objective to offer advisory and policy recommendations to the public sector.

In the past, numerous instrumented projects operated in isolation, lacking mutual awareness, and failing to draw from the collective knowledge gained by others. However, in the digital age, with the advent of modern communication channels like the internet, email, and social media, collaboration and information-sharing have become more accessible. Given the complexity of addressing the UAP enigma, no single organization can tackle it effectively. Consequently, researchers must collaborate on field work efforts to lower costs, avoid duplication, and pool resources.

A unified research plan could also be established to ensure that studies are conducted consistently and with a common goal in mind. As suggested by Dr. Rodeghier in a personal email on October 2nd, 2022, the astronomical community conducts a decadal survey every ten years to prioritize research, including the construction of new telescopes, space missions, and other projects. Considering this, it raises the question of why the UAP community shouldn't adopt a similar approach for instrumented field investigations.

In terms of dissemination results, ensuring that the findings reach a wide range of stakeholders and contribute to future research is equally crucial. This can be achieved through conferences and research publications.

Secondly, it is important to explore new potential and innovative avenues for increasing the chances of success. By leveraging established calibrated automated monitoring stations like UFODAP or SKY360 and integrating them into a future network such as UFODATA, we can enhance the effectiveness of data collection and analysis. In terms of software, machine learning techniques can also be implemented to aid in analyzing large volumes of data and uncovering patterns and insights that may have been missed through manual analysis. Finally, expanding the instrumented field research to include the atmosphere, low Earth orbit, bodies of water like lakes and oceans, or deserts, can provide valuable information and insights into phenomena that are not easily observable from the ground.

While field research in the maritime domain presents increased complexity and cost, it should be regarded as a viable avenue. UAP sightings are not confined to land; they have been observed by both military and civilian mariners in oceans and seas, as well as by pilots from the sky. It's worth noting that the 2023 AARO report emphasizes its commitment to advancing the integration of the maritime domain (AARO report 2023). For civilian projects, a feasible initial step could involve continuous water-facing instruments placed along the coast, such as Catalina Island or Florida beaches, with similar technical challenges as inland UFO detection systems. Subsequently, floating instrument platforms could be deployed in areas with higher UAP sightings. Additionally, satellite data covering coastal proximity could complement this research. American oceanographer and retired Rear Admiral Gallaudet has recently proposed several actions, including a survey by the Naval Studies Board of universities with ocean datasets to investigate anomalous phenomena (Gallaudet and Mellon 2023).

When it comes to mining civilian satellite imagery data for UAPs and considering the initial approaches taken by the Galileo Project, there is room for improvement by adopting a more practical approach that involves reversing the workflow. In this alternative approach, researchers interested in studying UAPs could start by leveraging well-established databases of significant UAP events. These databases can help identify high-quality reports that serve as reliable starting points. Subsequently, researchers can narrow down their focus and target specific areas or timeframes for satellite imagery data collection, optimizing the resources and efforts involved in the search for anomalies.

Significant progress is underway in Defense and military initiatives, and these efforts are expected to yield positive outcomes in the near future. Recognizing the limited scientific data available on UAP, the US DoD has adopted a proactive approach, moving beyond passive evaluation of past military sightings and associated data. At the recent public meeting of NASA's UAP Independent Study Team (UAP, NASA UAP-IST) on May 31st, 2023, Dr. Kirkpatrick, the director of

AARO, unveiled the development of new sensors specifically designed to enhance detection, tracking, and characterization of typical UAP objects. Dr. Kirkpatrick's presentation also highlighted the deployment of such purpose-built surveillance systems in high-activity areas for extended periods, enabling 'Pattern of Life' analysis (NASA Unidentified Anomalous Phenomena Independent Study Team, May 31, 2023). This analysis aims to prioritize locations for data collection, potentially offering valuable insights. Additionally, AARO has initiated collaboration with the 'Five Eyes' alliance, comprising the United States' allies, to establish processes for sharing UAP data and calibrating assets, thus improving investigations.[5]

In terms of recommendations, AARO suggested that NASA explore techniques to integrate 'Tip and Cue' collection capabilities throughout the scientific architecture, both overhead and ground based. This innovative approach holds significant potential for UAP research. 'Tip and cue' refer to the practice of monitoring an area or object of interest using one sensor and requesting another complementary sensor platform to capture images. Typically, this process starts with a cost-effective, wide field-of-view sensor to identify an object or location, followed by a higher-resolution sensor for further investigation and analysis, which may be more expensive. It is worth noting that civilian UAP projects had already envisioned such an approach, similar in essence to the original UFODATA concept of employing an all-sky camera for UAP detection, with higher-resolution cameras zooming in to capture photos and videos, albeit on a much larger and more capable scale.

In relation to the latest developments involving NASA and AARO, there are several important suggestions that warrant attention. Firstly, it is crucial for these organizations to recognize the potential benefits of studying the valuable work conducted by civilian groups, which can provide valuable insights for their own plans. This entails conducting a thorough examination of field studies and the most compelling evidence from UFO cases, regardless of their origin. It is noteworthy that during the NASA public meeting, the UAPIST conveyed a limited awareness of the range of UAP reports and deferred to the AARO characterization of sightings as small objects at high altitudes (UAP, NASA 2023). Acknowledging the full breadth of UAP reports is essential in determining the scope of study and the appropriate strategies to employ. Secondly, it is highly advisable for NASA and AARO to explore the possibility of collaborating with external experts such as the Scientific Coalition for UAP Studies, UFODATA, UFODAP, UAPx, and similar organizations. By engaging these experts as consultants for planned studies, NASA and AARO can leverage their extensive expertise, which has been developed over time. These external experts can provide valuable guidance and contribute their specialized knowledge to enhance the effectiveness and thoroughness of the research conducted. Finally, it is worth noting that incorporating past research and leveraging the knowledge of established experts are fundamental practices in the pursuit of scientific progress, and, therefore, treating the UFO field no differently from any other field of science is crucial in this regard.

Without a doubt, the widely held belief that advanced extraterrestrial civilizations are visiting or observing Earth, referred to as the extraterrestrial hypothesis, will continue to inspire new instrumental projects for studying UAPs. This is partially attributed to the extensive promotion of the Galileo Project and the unprecedented decision made by NASA in 2022 to establish a study team to investigate UAP. In the foreseeable future, we can therefore expect the emergence of innovative projects with a specific focus on the space surrounding Earth, aiming to detect probes within Earth's orbit, such as the 'EXOPROBE' project (Villarroel & Marcy 2023). This research naturally complements the recent interest within the SETI (the Search for Extraterrestrial Intelligence) community to search for 'Technosignatures', defined as observational evidence for the existence of industry or technology in the universe. However, these endeavors will encounter a significant challenge in assuming the existence of such probes and differentiating them from human-made objects using their intended instruments. Nonetheless, it is important to recognize that the extraterrestrial hypothesis is just one of numerous explanations for UAP occurrences, and we should remain open to other possibilities.

As a final consideration, venturing into uncharted territory in UAP research involves exploring the high strangeness aspects of these phenomena. In the study of the UAP literature, it's becoming more apparent that these occurrences can exhibit complexity beyond conventional explanation. Some researchers advocate critically examining the more unusual facets of UAP events and considering them for field experiments. As mentioned on pages 7, 9, and 11, the instances of UAPs apparently interacting, vanishing, or

5 The NASA-IST released their final report on 14 September 2023. It can be found on the UAP section of NASA's website (https://science.nasa.gov/uap).

interfering with data acquisition during observations raise questions about the potential influence of the observers. These cases suggest that observers may impact UAP behavior, akin to quantum mechanics principles where measurement choices affect subsequent particle behavior. In contemplating future UAP research and despite the added layer of uncertainty in data collection and interpretation, it appears important to investigate the potential role of human presence in UAP behavior. While designing field experiments to test observers influence may be challenging, researchers must remain mindful of this phenomenon and its implications for data quality. Collaboration with experts in various fields, including physics, psychology, anthropology, behavioral sciences, and neuroscience, can provide valuable insights and ensure rigorous methodology. As we delve deeper into UAP studies, these high-strangeness aspects serve as reminders of the mysteries challenging our understanding.

Through the implementation of the key steps outlined in this section, it is the central premise of this thesis that we can enhance the quality and reliability of UAP research, thereby advancing our understanding of this captivating phenomenon.

8. Conclusions

Instrumented field research has played a crucial role in establishing the scientific study of UAP, providing much-needed legitimacy to the field. Despite being more common in some areas, UAPs still appear intermittently, making long-term funding essential for sustained research efforts. Placing instrumentation at sites where UAPs are frequently seen has proven more successful than relying on convenience alone. While UAP photographs, and some instrumental data, have provided clear evidence of their existence, the lack of scientific measurements has hindered our understanding of the phenomenon. Developing reliable methods for measuring UAP characteristics remains the major challenge and opportunity in the field, and recent technological advancements and improved software tools offer new and more effective options for detection and analysis. With the recent surge of interest in UAP and the involvement of more qualified professionals and research organizations such as NASA, AIAA and the US Department of Defense, the efforts to detect, track and measure the UAP phenomenon in real time has recently entered a new phase. We can cautiously expect that continued and expanded efforts as described in this paper will lead to increased scientific understanding of the characteristics of the UAP phenomenon.

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Development, Dissemination, and Revision of Good Scientific Practice for Research on UAP

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ABSTRACT

Research on UAP experiences, especially in the form of a single case study or investigation, is primarily conducted by lay or citizen scientists worldwide. There is a need for responsible and methodically justified research to be established to receive verifiable, comparable work results and to ensure ethically conscientious interactions with other researchers and experience reporters. In this article, principles of good scientific practice for research on UAP in Germany are presented. In part, these principles are derived from existing professional norms, but they are further specified for UAP research. Predecessors of the principles are identified; then the process of their development and different stages of review are described. Furthermore, the application of the principles and their revision process are discussed. The paper concludes with the presentation of the research principles in the current version. In conclusion, the establishment and application of such principles can improve the quality of research conducted by volunteering individuals or non-profit organizations and thus generate better data on UAP.

1. Background and Methods

Since their appearance as modern phenomena, sightings of flying saucers, UFOs, or UAP have been investigated by interested parties to determine their origin and cause. Because of the nature of the phenomena and how they are being handled in western societies, the study of UAP is confronted with some difficulties. This is reflected in the usage of different terms or acronyms over time, where suggestive or constricting words like "saucers" (on a frequently reported form that has been perceived) or "flying object" (predetermining self-propelled, solid objects as a cause for sightings) have been replaced by the current UAP as "Unidentified Aerial Phenomena" or even "Unidentified Anomalous Phenomena" to clarify a broader coverage of experiences. In this sense, the renaming of the research topic over the decades was also accompanied by a certain shift in meaning, because "flying saucers" or "flying objects" encompass a different set of phenomena than "unidentified aerial phenomena" or even "unidentified anomalous phenomena", from very concrete object shapes to general anomalies. To reflect the current transitional period from UFOs to UAP (in the sense of "aerial phenomena"), these two terms are used synonymously here insofar as they are in no way intended to promote any certain *ad hoc* interpretation or hypothesis about the causes of the phenomena. The research principles presented here focus on the investigation of perceptions of unidentified phenomena through the questioning of witnesses.

The UFO Experience (Hynek 1972) is an anomalistic spontaneous phenomenon: witnesses have made an extraordinary observation, often unique and perceived as beyond the usual everyday world. To date, such observations could not be confirmed by measurements such as photos, video, radar, etc., in their entire range, so that for many aspects of the phenomena witnesses must be resorted to.

The phenomena themselves belong to the field of anomalistics, an umbrella term, which can be defined as the investigation of anomalies or phenomena that fall outside current understanding—e.g., parapsychological or cryptozoological topics—and their evaluation by the general application of scientific methods, see Truzzi 2000).

In most cases, observations occur spontaneously, i.e. without any common and known external cause, independent of the phenomenon or the experience itself. A UAP experience is in the vast majority of cases not individually repeatable. This core of the appearance of UAP—the reports of UAP sightings—is often documented in single case studies and the observed phenomenon is categorized. In most cases, an attempt is also made to attribute what is reported to a known, conventional stimulus. Further investigations of UAP then deal with the analysis of all data obtained by single case studies, contemplate the subject "UAP reporter" or refer to the way that UAP are dealt with in society. Research on UAP is therefore a highly interdisciplinary endeavor due to the various aspects involved: knowledge of meteorology, for example, can be just as useful as that of psychology.

Most organizations and researchers basically strive to obtain intersubjectively valid knowledge about UAP and are therefore committed to logical, methodical investigative approaches that should be in line with general scientific work. Furthermore, when investigating single cases, the protection of personal information as well as the reporters themselves is required for ethical as well as legal reasons.

Although they might share the basic approach as well as a responsible acting with professional scientists working at research institutions, UAP researchers can have a different background: They are for the most part lay or citizen scientists who pursue their activities of collecting and providing data for any subsequent research in their free time with limited resources and varying levels of education. While the basic scientific process and its principles today are often put down in the form of professional norms (e.g., DFG 2019, MPG 2021 in Germany), subject- and institution-specific training, research and publication rules as well as legal foundations exist for professional scientists, whereas lay researchers are free to approach the topic of UAP as they wish, apart from legal conditions that apply to all people. The pursuit of a methodical and ethically responsible approach to UAP is therefore a purely voluntary one.

The research principles presented below have been gradually developed since 2008 with the participation of many people from the various German UAP research organizations (see acknowledgment). We wanted to express in written form how we aspirate to act in accordance with appropriate scientific and ethical standards in the investigation of UAP, and we wanted to publicly share the result to make them accessible and recognizable by everyone involved in this research. For UAP reporters who turn to us, it is proven in this way that the quality of the case investigations is secured with the means of common research principles. We also wanted to specify that, due to the different levels of education of the people involved, a transfer of knowledge and skills similar to the teachings organized at universities is indispensable for future UAP researchers.

1.1 Methods & Principles

Four methods were used to develop the principles:

- literature review and content assessment of professional norms from general science
- research and consultations on existing codices from UAP research
- literature reviews and consultations on codes from anomalistics
- composition and reworking of the first version of the principles in several iterations in a mailing list with involved people

The resulting initial version of the research principles was published in two German journals (Ammon 2011, Ammon 2012) and on the Internet (GEP 2023). The publication triggered a discussion process that led to a revision within a short period of time. Furthermore, the two other major German UAP research organizations of the time, MUFON-CES and DEGUFO, adopted the research principles as a common working basis (Müller 2015).

In the years that followed, three further revisions of the principles emerged, culminating in the current version of May 5, 2023. In addition to minor linguistic adjustments, the focus was particularly on how to deal with hypnosis procedures for reporters of abduction experiences, around which a discussion arose in different publication organs and through direct conversations among board members of UAP research organizations (von Ludwiger 2012; Kramer 2019).

With the current version of the research principles, an English-language translation is presented for the first time. With the translation, we would like to make the work from Germany more widely known and subject the principles to an even more extensive discussion process. This process has already been started by announcing the English-language principles in two UAP-related mailing lists: the Google Group “UFO Collective” and the community “EuroUFO”, on which a large part of European, but also globally active researchers are represented (UFO Collective 2023; EuroUFO n.d.).

The applicability of the research principles refers to conducted and published research, especially on single case studies. Reported work or published case documentation including appropriately described methods can be reviewed to determine whether specific requirements from the research principles have been met. If, in the opinion of readers or discussion participants, this was not the case, a violation can be presented within the discussion or in addition to the case documentation and discussed in turn. This approach has already been taken in some of the regularly published case documentation in Germany. In this way, it is possible to subject the research on UAP experiences to continuous review and discussion based on common principles of good scientific practice.

2. Discussion

Efforts to establish comparable work on UAP experiences through appropriately explicated codices have existed for several decades. Besides publications concerning methods for single case studies (Hendry 1979, Randles, 1981), this concerns especially the “Code of Practice for UFO Investigators” of British UFO organizations, which was already created in 1981/82 and further developed until the 2000s (BUFORA n.d.). The Code of Practice was used as a basis for the German research principles since the beginning of their development. Due to the previous lack of awareness in Germany, the potential for further development and the comparable developments of different specifications of good scientific practice in academic sciences, a further discussion process on research principles *per se* is justified. This applies in particular since to date, the development of the research principles happened only in German-speaking countries. This limitation is to be overcome with the present English-language translation.

Another advancement in the field of UAP research concerns approaches to the technical detection of UAP without the need to rely on experience reports from eyewitnesses. Currently, these approaches have even found their way into academic projects in the USA as well as in Germany (Loeb and Laukien 2022; Kayal 2022). While many of the basic guidelines in the principles also apply here, additions or even separate research principles may be required in the future for measurement based UAP detection. It should be noted that it is still unclear whether observed and measured UAP contain the same set of phenomena or whether there are differences. This has not been investigated so far and remains an urgent research desideratum, otherwise UAP could be understood to mean different things by different researchers.

Unlike the professional norms of academic scientists, the developed research principles cannot be used for sanctioning: lay or citizen science researchers cannot be stripped of academic titles or dismissed from employment. However, even without these more stringent ways of monitoring adherence to norms, research principles serve a purpose: they provide a basis for methodological critique of any individual work by researchers who acknowledge such principles. The application or failure to apply any of these principles should be apparent to everyone from the work results. It is hoped that these opportunities will also exist, at least in part, for new government efforts in this area, especially in the USA (DNI 2022; DNI 2021; NASA 2023).

The publication, recognition, and application of the research principles described here is intended to contribute to further serious research on UAP based on generally valid, methodologically developed findings, for which transparency, cooperation, and protection of UAP experiencers or measurers are paramount.

3. Results: Principles of Good Scientific Practice for Research on UAP, Version May 5, 2023

Preamble

"We can define the UFO simply as the reported perception of an object or light seen in the sky or upon the land the appearance, trajectory, and general dynamic and luminescent behavior of which do not suggest a logical, conventional explanation and which is not only mystifying to the original percipients [UAP/UFO in the wider sense] *but remains unidentified after close scrutiny of all available evidence by persons who are technically capable of making a common sense identification, if one is possible* [UAP/UFO in the stricter sense]*."* (Hynek 1972, 26)

The existence of UAP/UFOs as defined above—encompassing all personal, social, and scientific consequences resulting from these experiences—can be explored by scientific means. This research can be seen as a branch of anomalistics (as noted earlier), since it exhibits basic characteristics that are explored by this field (Truzzi 2000). It is highly interdisciplinary and knowledge production is often due to interested people in the form of isolated or cooperative work as well as in associations (*citizen science*). The abbreviation UFO stands for "Unidentified Flying Object" without any further meaning concerning origin or type of such an object. Due to historically negative aspects and ridicule of the definition of the term UFO (Martin 1982), the term UAP (Unidentified Aerial Phenomenon) is synonymously used. Both terms are used here exclusively phenomenologically in the sense of descriptive science.

The aim of the principles outlined here is to establish a model for ethical research and specific guidelines for responsible behavior in the investigation of all aspects of UAP/UFOs for laypersons or *citizen science* researchers. In recognition of the general scientific working methodology, the principles are based on existing professional standards for scientific work in Germany (DFG 2019; MPG 2021), but also include existing codes of conduct for the analysis of UFOs and related spontaneous phenomena (Baker and O'Keefe 2007; BUFORA PA 2005).

From time to time, the principles will be reviewed and, if necessary, revised. Researchers who wish to propose improvements or extensions are invited to contact one of the boards of the organizations that respect the principles.

Complete coverage of all ethically and professionally appropriate procedures in all conceivable research situations is clearly impossible in a document on basic principles. Where appropriate, further regulations from scientific fields, from anomalistics research and from legal requirements should be considered, or detailed and standardized working methods for the research on UAP/UFOs are to be applied or developed.

The following points describe general guidelines for research as well as for the handling of experiencers and the public, which are essential in the investigation of UAP/UFOs. Adhering to the basic principles requires a disciplined and responsible approach of all those who respect them. This responsibility forms the basis of cooperative research work and a secured knowledge gain.

3.1 General Research Practice

1. To investigate UAP/UFOs by scientific means implies a methodical search for findings that are valid intersubjectively. The structure of such efforts must always be committed to truth, honesty, and fairness: We want to acquire, not invent knowledge. This aim is to be achieved in fair partnership with other researchers.
2. The work on UAP/UFOs must be carried out *lege artis*: The basic rules for the collection and selection of data explained here must be observed strictly. Wherever such rules have not yet been established, researchers (as their investigation as a form of *citizen science*) are to develop basic principles together and in conjunction with relevant reference sciences and expand the present document.
3. Research on UAP/UFOs takes the form of scientific-critical work: openness to different perspectives and the willingness to question one's own results, to discuss them self-critically with others and to accept unpleasant findings are basic prerequisites for all researchers. Implicit axiomatic assumptions should become known as such and wishful thinking must be overcome by means of a factual investigation.
4. Many research questions on UAP/UFOs require highly interdisciplinary efforts to solve them. The research object as a spontaneous phenomenon can be grasped methodically only to a limited extent. As a result of these hurdles, systematic attention must be paid to possible misinterpretations among all those involved. This applies especially to the process of hypothesis formation in individual case analyses. The assessment of an individual case as an event that remains unexplained (UAP/UFO in the stricter sense) may only take place after extensive

and methodologically strict investigation; neither may the assignment of a known occurrence as a cause for an individual case be made lightly, but it must be based on comprehensible and verifiable conclusions.

3.2 Collegiality and Cooperation

1. The search for knowledge about UAP/UFOs that is based on scientific criteria unites researchers. It has the effect that people who once were strangers now have something in common and, by this, become colleagues. Additionally, interdisciplinarity and the laypersons status of the research mean that each individual person is only capable of independent judgement and competence in a limited area. They remain dependent on the preparatory and supportive work of other researchers or need to do such work for others. All researchers must be able to trust contributions by colleagues. It is therefore essential that research on UAP/UFOs takes place in forms of work and organization that fully permit and support extensive communication and cooperation between all involved.
2. Since each researcher's work forms a building block for gaining knowledge about UAP/UFOs, it should be characterized by comprehensibility and accountability for all interested parties and should enable the application of the methodology or the results in further research, and complete transparency of the procedure, the means used, and the results obtained in all areas should be aimed for. Details which counteract the protection of a reporter of an experience according to section 3.6 sentence 5 are to be excluded from this.
3. Research on UAP/UFOs must be characterized by absolute openness to criticism and doubt from colleagues and co-workers, but also from representatives of opposing positions. These are to be taken seriously and treated on a strictly objective basis. If necessary, own research results must be adapted or abandoned.
4. The scientific work of colleagues shall not be hindered in any way. Therefore, deliberate delaying of factual communication or reviews, disclosure of confidential scientific data or results, misleading communication, or presentation of partial information about cases or results or deliberate publication of untruths of any kind must be avoided or sanctioned as counterproductive actions. Instead, a careful, unselfish, and unbiased assessment of the work of others is both important and the basis of any cooperation. A researcher aware of their bias should refrain from assessing or commenting on the work of others.
5. Relevant and non-confidential information about one's own work shall be provided to all interested researchers who act responsibly in accordance with these principles, even if they plan a publication. The source for the information must then be clearly indicated in the publication.
6. Persons whose professional qualifications or relevant level of knowledge is considered lower than their own should be helped and supported objectively and cooperatively. This can be done by referring to existing and published findings, by organizing conferences and seminars or by making an offer to act as a discussion partner.

3.3 Debate Culture

1. An important component of collaborative research on UAP/UFOs is open communication about data, results, and methodological issues. Receiving comments, ideas, questions, or counterarguments to one's own work shapes and improves every public statement by providing more secured knowledge even before it occurs. An open, tolerant discussion culture which allows everyone involved to contribute their ideas and arguments is necessary.
2. In the scientific struggle for understanding, as a first step different theories are possible and useful for navigating facts, but also for the interpretations of subjective experiences. They then must be considered carefully. The basis of any reasonable discussion is the recognition of the constructive research work done by others, regardless of whether it seems to be supportive or contrary to one's own methods and results.
3. Research on UAP/UFOs is characterized by a strong polarization of opinion and, unlike for established science, it is currently rarely an institutional or professional affair. For these reasons, it is equally important from a research-ethical as well as from a research-practical point of view, to distinguish the researchers' personal preconceptions from their work. No one should have to experience ignorance or contempt solely because of a "skeptical" or "supportive" position. Instead, the object of criticism should always be the specific approach and argumentation employed [or used] in research practice.
4. Insulting, dogmatic, threatening or otherwise inappropriate comments, similar reactions to professional

criticism or personal attacks on the reputation of a researcher should be excluded from all discussion on investigation of UAP/UFOs. Such comments should be ignored so as to prevent a culture of *ad hominem* rebuttals. Instead, in such cases, the necessary objectivity should be calmly requested, and the discussion should return to factual issues.

3.4 Backup and Storage of Data

1. Research on UAP/UFOs depends on obtaining raw data by interviews, measurements, observations, or other direct and indirect methods, where the experiencer usually plays the most important role as a source. Scientific investigations, calculations and experiments can only be reproduced or reconstructed when all important steps of data collection are transparent. Therefore, a sufficiently complete filing of all methods used, and results obtained, and a long-term storage of these protocols is necessary, if only to be able to access such records when published results are questioned by others.
2. Each individual case study of UAP/UFOs shall be documented in a file labelled with a unique identifier. The file should include the name of the witness, date of report, date, time and place of the reported experience, possible other witnesses, case classifications, names of the investigators, their assessments and all other documents relating to the investigation of the case (communications between investigators and witnesses, collection of secondary data, discussions during investigations, etc.).
3. Statements made in interviews shall, where practicable and with the consent of the respondent, be documented in video or audio recordings. If the interviewee objects to this procedure, a transcript as detailed as possible should be made. The names of those present during the interview must be documented.
4. Personal theses about an individual case or about UAP/UFOs, for example in the context of case assessments, shall be identified as such and strictly separated from the data collected, both in case documentations and in publications.
5. Fraud in scientific research includes deliberate inventions or distortions of facts, of research data or of circumstances of investigation. It also includes the deliberate concealment of information that makes the validity or reliability of data or of conclusions in an investigation appear questionable, as well as other similar misconduct. Anyone who encounters false statements or cover-ups of limiting facts by a fellow researcher should make extensive efforts to eliminate them, from a personal discussion with the person responsible to contact with the board of the organization in which the person responsible is active.

3.5 Publication of Results

1. Research on UAP/UFOs should be conducted to maximize knowledge gain and benefit for society. The publication of specialist work is therefore a particularly important area of responsible scientific action. In a publication, authors announce results for whose professional and scientific reliability they assume responsibility. His or her publications determine the perception of a researcher both by colleagues and by the public.
2. Papers which announce new scientific results must therefore describe the results and the methods used in a comprehensive and logical manner. This especially applies to the consistent handling of all source material, the use of which must be marked, and which must be clearly cited in the publication, since only this practice makes possible verification by third parties.
3. Strict honesty shall be sought in the recognition and appropriate acknowledgement of contributions from predecessors, competitors, and co-workers. All findings supporting or questioning the results presented should be reported in accordance with this principle.
4. In an effort to establish a fault-tolerant research culture, falsified hypotheses shall also be published in an appropriate manner, and errors shall be admitted.
5. If several authors are involved in a research project or in the publication based on it, everyone should be named as co-author who contributed significantly to the concept of the study or experiment, to the development, analysis, and interpretation of the data or to the recording of the manuscript itself and who agreed to its publication. The authors are always jointly responsible for the content of their publication.

3.6 Dealing with Experience Reporters

1. An essential part of the investigation of UAP/UFOs as a largely spontaneous phenomenon is the scientific examination and assessment of individuals reporting

their experiences to the investigators. These witnesses as well as any persons acting in the name of experiencers must be protected in a particular way. They voluntarily report an unusual and socially controversial experience which defies their rational judgement, and they cooperate in the investigation of this experience.

2. The intensity of efforts to uphold the personal protection of the witness shall depend on his involvement in the investigation: the greater the personal involvement of the experience reporter, the more he must be protected from any resulting damage.
3. The primary objectives of the protection of witnesses are their personal integrity and their mental and physical health. No research method may be designed in such a way as to give the personal characteristics of an experience reporter which are worthy of protection a low priority or deliberately impair them.
4. All personal data submitted, whether in the context of individual case investigations, of research projects or of studies, are also particularly worthy of protection. Regardless of whether such research activities are carried out within the framework of an association, of another organization or as individual researchers, the relevant regulations of the German Federal Data Protection Act (BDSG) and of the EU General Data Protection Regulation (GDPR) for non-public bodies apply to the collection, processing and use of personal data based on the right of informational self-determination. The principles of data avoidance and data economy, i.e., the collection of only the personal data required for the respective purpose, are hereby central. This results in both obligations (for the researcher) and rights (for the witness) which need to be strictly observed. For the researcher, this essentially means informing the witness about the voluntary nature, scope, purpose, and duration as well as storage and use (dissemination) of the collected data they provide. Furthermore, the witness shall be informed about his rights: the right to receive information at any time as to whether and which data are stored, as well as the right to have the data deleted or rectified or blocked.
5. Each experience reporter decides to participate in an individual case investigation, and they can revoke it at any time without reprisal. To place the voluntary decision on a well-founded factual basis, informed consent must be obtained in more detailed investigation (starting with the standardized interview based on sighting questionnaires) by providing the witness with standardized information on the working methods, objectives, specific steps, and type of data to be collected during the case investigation.
6. All direct interviews with the experience reporter should be arranged in advance. In any event, a rejection of such an appointment or interview by the witness, their wish for a third party to participate in an interview or for interviews by case investigators of other organizations must be respected.
7. All personal interviews of a witness should preferably be conducted by two case investigators. At least one of the case investigators should be of the same self-reported gender-identity as the witness. The parents or legal guardians should participate in an interview of underage reporters.
8. Each interview exposes the witness to the influence of the researcher's beliefs, which can obstruct free memories and influence statements. In this regard, the highest priority of an interviewer should be the possibility for a witness to recount his or her experience free of intervention. Personal theses and speculations about the case, about UAP/UFOs or about other topics are not to be expressed by the investigator during the interview. If such details are discussed later, they shall be declared as unproven statements to the experience reporter.
9. The investigator shall always speak in a clear and unambiguous way to the witness during any case investigation. A strong formal or professional terminology should be avoided. Special interview techniques (e.g., questionnaires, psychological tests) or examination devices that are unknown to the witness must be explained and may only be used with their permission. The case investigator must be professionally qualified for the application of these techniques or the devices.
10. The performance or commissioning of polygraph tests (so-called "lie detectors") to assess the credibility of a witness statement does not produce reliable results about their truthfulness (Ickinger 2011). Polygraph test results are inadmissible as evidence in German criminal trials. Experience reporters who wish to undergo such a procedure shall be informed of these problems. Results of polygraph tests in case documentation or in case publications must not serve as sole evidence of the credibility of a witness or of the credibility of their statements.
11. Regression hypnotic techniques are to be excluded from any case investigation. The request of experience

reporters for such methods is to be rejected. The problem of pseudo-memories and possible negative effects such as memory impairment should be pointed out (Fiedler 2008; Revenstorf 2006). If experience reporters persist in their wish, they should be referred to medically trained personnel, but the case investigation should be terminated or properly completed before regression hypnosis is performed.

12. If there are signs of trauma or stress in an experience reporter, they should be immediately informed about the possibility of support by psychologists, physicians, or other qualified advisers. The handling of witnesses whose report belongs to the category of the so-called *abduction experience* should be regulated in separate guidelines for psychologically qualified investigators (Gotlib *et al.* 1994).
13. Without the consent of the owner, holder or an authorized representative, no private property must be damaged through the work of case investigators. Caused damages are to be compensated without request.
14. For the publication of an individual experience case containing UAP/UFOs which is relevant to data protection laws, the consent of the party or parties concerned must be obtained. In any case, the anonymity of a witness must be kept in any publication, unless the witness specifically agrees to the disclosure of personal, identifying data. In this case, each witness shall be informed of the potential consequences of the publication. Their decision for or against a publication is to be considered binding.
15. When a person contacts an organization to report a UAP/UFO experience, in most cases they are interested in an explanation of the causes of that experience. Witnesses must therefore be informed of the results of the investigation. In addition, they have the right to access case files kept under their name.
16. A witness might report something or submit material such as photographs and videos to be investigated with the intent to deceive. Researchers must be aware of this possibility and should be familiar with such forms of hoaxes without putting witnesses under general suspicion. If there are clear indications of a hoax, the experience reporter must be confronted with the judgement of the researcher. Their statement should be requested and included in the analysis before the results of the investigation are published.

3.7 Conduct Towards the Public

1. Society is interested in understanding the research on UAP/UFOs and its consequences. However, the more complex scientific research becomes, the greater efforts are needed to explain its objectives, methods, and results to the general public in an intelligible way. Moreover, with every public statement a researcher represents both his own organization and research on UAP/UFOs in general. Therefore, a professional willingness to inform the public with the participation of the media about the scientific character of the research work and its individual aspects in a purely factual form is desirable.
2. The responsibility to appropriately inform the public may contradict the characteristics of mass media presentations. Researchers should be aware of this and should not publish unconfirmed statements, unproven allegations, subjective speculation, or confidential information. Particularly impermissible are statements made in the name of an organization or researcher without his or her consent or the consent of the board as well as presentations of unpublished material from others without their consent. Publicly expressed doubt of the integrity of experience reporters or of fellow researchers can only be made if there is clear evidence and it is relevant to the public.
3. Researchers should cooperate with authorities, especially in circumstances which could affect social security or the life or physical integrity of people. Threats to the public or potential damage to property arising in a case investigation must be reported to the police or other responsible persons immediately, and all possible measures must be taken to protect society and property.
4. Participation in research on UAP/UFOs and in individual case investigations does not constitute a specific privilege. For example, researchers may be forced to disclose confidential information in court. In such cases, individual principles laid down here may become temporarily invalid.

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Investigating UAP Events Using Astronomical Techniques

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ABSTRACT

The most important measurements for the scientific investigation of Unidentified Aerial Phenomena (UAP) using astronomical methods are presented and discussed, where results obtained in the past motivate the proposal for new observations using multiwavelength and multimodal instruments. A special emphasis is given on the techniques of magnetometry, photometry and spectroscopy, and on the importance of studying the variability of the phenomenon in order to try to understand the physical process that governs it, including a possible propulsion mechanism. The most important obtainable physical parameters are discussed in detail, with a particular emphasis on how they might be correlated together. Calculations of the integration times needed for obtaining optimum signal-to-noise-ratios in photometry and spectroscopy are presented. The idea of placing measurement instruments at areas of the world where the phenomenon is recurrent is strongly suggested. Past monitoring campaigns at such locations are briefly described together with the pertinent literature.

1. Introduction

Anomalous phenomena in the Earth's sky have been noted in many forms, ranging from so-called "nocturnal lights" to apparently structured crafts that cannot be identified with known technology, and which often show (especially as with nocturnal lights) kinematic and light emission characteristics that are unusual and apparently not explainable by known physics laws (Knuth *et al.* 2019).

Most of these manifestations can be identified as misinterpretations of known manmade and natural phenomena (Brovetto and Maxia 1995; Condon 1969; Pettigrew 2003), of poorly known natural phenomena (Freund 2003; Monari *et al.* 2013; Pascoli 2021; Smirnov 1994; Straser 2007; Zou 1995) or as hoaxes, especially in this era in which the CGI technology can be used to easily generate fake videos and photos. Independently from this and so far, witnesses are the main "data" that can be evaluated (Hynek 1972; Hendry 1979). Unless we have at our disposal a well-populated database with which acceptable statistics can be built up (Teodorani 2009; Thibault *et al.* 2015), mere human testimony of anomalous phenomena – although sometimes interesting *per se* for human and social sciences

– cannot be used as evidential proof. In principle, this lack can be quite well compensated by the utilization of sensor technology, through which it is possible to obtain an objective and rigorous measurement of the observed phenomenon.

Unfortunately, UAPs are not objects with known coordinates such as stars, and their appearance cannot be predicted in time. This makes any attempt at monitoring extremely difficult and usually unsuccessful, even when an all-sky survey strategy is carried out. We can find the same problem with the SETI Project, which has so far produced no concrete results (Wright 2022). SETI attempts to target specific stars of G and M spectral type, have been unsuccessful as well so far (Lazio *et al.* 2002).

Can we adopt an instrumented "targeted search" strategy for UAP research too? Fortunately yes. Previous research shows that anomalous phenomena tend to occur sometimes in some specific areas of the world with reasonable recurrence. That is where measurement instruments can be used, and this has happened since 1984 in the area of Hessdalen in Norway (Strand 1984). So far, the results of the research carried out there do not show that "Earth is being visited", but rather that prominent anomalies occur in the behavior manifested by the observed phenomena (Teodorani 2004). This partial result shows, at a minimum, that such areas of the world can be used indeed as a laboratory to study the phenomenon systematically using multimodal and multi-wavelength instrumentation. In fact, a new research plan is in preparation for the research in this Norwegian location (Teodorani 2023b). Hessdalen is not the only world location of interest regarding recurring anomalous phenomena (Akers 2001; Rutledge 1982; see Table I).

The main goal of this research is not aimed at searching for the evidence of extraterrestrial intelligence, but rather at trying to understand the physics of the observed phenomena, especially what may be plasma bodies in the atmosphere, which manifest as "nocturnal lights" characterized by strong light and color variability and by unusual kinematic behavior. Sometimes plasma-like objects are overlapped with the transient apparition of apparently solid objects (Project Hessdalen, website; Hessdalen Short Films: 4 December 1999): the reason for this connection is not known yet, but it must be investigated in-depth. Both manifestations may occur together at the same time (as it is shown in the Dec. 1999 film) or alternate over time, being plasma-like ones largely predominant in a number of cases.

LOCATION	STATE	LATITUDE	LONGITUDE	NOTE
Colares	Brazil	00° 56′ 13″ S	48° 16′ 55″ W	Aggressive UAP flap in 1977 / Massive military investigation
Boulia	Australia	22° 54′ 35″ S	139° 54′ 24″ E	Famous "Min-min" anomalous lights
Marfa	Texas, USA	30° 18′ 42″ N	104° 01′ 28″ W	Famous recurrent anomalous lights
Capilla del Monte	Argentina	30° 51′ 31″ S	64° 31′ 27″ W	Frequent UAP sightings and anomalous light phenomena
Victoria Entre Rios	Argentina	32° 36′ 39″ S	60° 10′ 49″ W	Recurrent anomalous lights
Brown Mountain	North Carolina, USA	35° 54′ 57″ N	81° 44′ 45″ W	Recurrent anomalous lights / Monitored by cameras
Taos	New Mexico, USA	36° 24′ 26″ N	105° 34′ 24″ W	Most famous recurrent humming sound
Quapaw	Oklahoma, USA	37° 05′ 03″ N	94° 30′ 47″ W	Recurrent anomalous lights
Piedmont	Missouri, USA	37° 09′ 14″ N	90° 41′ 45″ W	Huge UAP flap in 1973-80, investigated by Dr. Harley Rutledge
Caronia	Italy	38° 01′ 12″ N	14° 23′ 21″ E	Recurrent anomalous fires + UAP / Italian Navy investigation
Uintah Basin	Utah, USA	40° 15′ 29″ N	109° 53′ 18″ W	Multifaceted anomalies + UAP
Pine Bush	New York, USA	41° 36′ 32″ N	74° 17′ 55″ W	Recurrent anomalous lights + UAP
Yakima reservation	Washington, USA	46° 14′ 00″ N	120° 49′ 19″ W	Recurrent anomalous lights + UAP
Hoja Baciu forest	Romania	46° 46′ 31″ N	23° 33′ 43″ E	Multifaceted anomalies + UAP
Molebka M-Zone	Russia	57° 14′ 17″ N	57° 55′ 59″ E	Multifaceted anomalies + UAP
Hessdalen	Norway	62° 47′ 35″ N	11° 11′ 17″ E	Recurrent anomalous lights + UAP / Currently monitored

Table 1. A few of the most important locations in the world where recurrent UAP-like phenomena occur. The phenomena are somewhat persistent, since several decades in some cases. In general, photographic, video and witness documentation on most of these crucial locations, has not been considered by mainstream science but it is easily traceable on the web. This documentation has been presented and discussed (Teodorani 2008, 2023a).

Measurements show that unusual phenomena in such recurrence locations do occur, independently from witnesses, and now their behavior is empirically quite well known (Teodorani 2004). What is lacking is the understanding of the physics that produce such events. After all, we shouldn't be so much interested in the possibility of extraterrestrial visitation *per se*, even if the eventuality of interstellar colonization has been theorized quantitatively (Jones 1981), but rather in the physics of the problem. This physics might deal with a natural phenomenon of possible geophysical origin (Freund 2003) as well as with a possible propulsion mechanism that has nothing in common with the one we use with our own aircrafts and rockets (Davis 2004; Holt 1979; Meessen 2012a, 2012b; White 2013). We can investigate all of this using a procedure very similar to that we use in astrophysics and the standard methodology of science.

The key for unveiling the governing physics lies not only on "static characteristics" such as spectra, CCD images or luminosity distribution over extended surfaces but above all on the phenomenon's temporal variability within a wide range of wavelengths. This is especially relevant to understanding nocturnal lights. Multi-wavelength observations of strongly varying phenomena – both kinematically and photometrically – can allow us to understand the physical mechanism on which such phenomena are based. This means acquiring data 24 hours per day and in automatic mode (Watters *et al.* 2023). The interpretation of this dynamics can help us to understand quantitatively what is going on, by subjecting such data to mathematical modelling.

If we hypothesize that Earth is visited by alien intelligence (Loeb 2021), we should expect to see possibly transient anomalies in our atmosphere that have a technological signature and/or a non-random behavior. The difficult task here is to distinguish very carefully which ones of these anomalies are of natural origin, which ones are a product of advanced terrestrial technology, and which ones cannot be identified with the first two categories. Once the third category is possibly identified as an exogenous visitation, the next task consists in trying to understand how this category works in terms of the known laws of physics. This involves both the investigation of possible propulsion systems, which might be identified from the mechanism of radiation emission in a wide range of wavelengths, and the investigation of how such devices are potentially controlled.

2. Astronomical methodology

It is assumed that measurement instruments (Szenher *et al.* 2023; Watters *et al.* 2023) can be deployed at hotspots and used automatically 24 hours per day. Data must be collected using high-resolution and high-sensitivity detectors and analyzed using sophisticated software and artificial intelligence. In a further phase, data must be examined dynamically focusing on the time variability of the observed phenomenon and on possible correlation between physical parameters. A procedure very similar to that is used in the astrophysical field, through which the physical mechanism of celestial objects can be deduced.

Some concrete astrophysical examples (Lang 1991) can illustrate better the concept of how a physical mechanism can be understood from an accurate dynamical analysis of the problem in terms of time variability of physical parameters:

- *Binary Stars* – The light variation of an apparently variable single star is due in reality to the periodic occultation of one component by the other orbiting component of a binary system (Kallrath and Milone 2009).
- *Pulsating Stars* – The pulsation mechanism of Cepheid stars shows evidence of an acoustic wave traveling to the stellar surface and bouncing back to the center in a regular way after a certain time (Catelan and Smith 2015).
- *Pulsars* – The regular very short-period pulsation in some compact radio sources is due to the ultrafast rotation of a neutron star whose rotational axis is misaligned with the magnetic axis along which high-energy particles are accelerated, giving rise to synchrotron radiation (Becker 2009).
- *Supernovas* – The sudden turning on of a light source whose luminosity is exponentially increasing with time inside a galaxy is due to the fast expanding shock wave of a supernova (or hypernova) phenomenon (Branch and Wheeler 2017).
- *Quasars* – The outbursts in the nucleus of galaxies show evidence of material transiently overheating inside an accretion disk located around a giant black hole (D'Onofrio *et al.* 2012).

Astronomical methodologies, when they are devoted to the study of variable and transient phenomena, can be applied to the scientific study of UAP as well, once multi-wavelength and multimodal well-calibrated sensors are used in a simultaneous way. A fuller understanding of the physics of UAP can be obtained from the way in which the measured physical parameters vary both with time and with space, and from the way in which they are correlated together. The accurate measurement of parameter variability of UAP can bring us to the understanding of the physical mechanism, whether natural or caused by some kind of propulsion system. These data will surely generate tremendous insights, but may not be definitive or lead to a complete understanding. After all, astrophysicists have the benefit of studying large populations and making many repeated observations of the same object.

3. Observing UAPs scientifically

As the UAP phenomenon occurs most often inside our atmosphere and is often very luminous (Vallée 1998) we expect to obtain an acceptable signal-to-noise ratio, considering that this research, in order to be carried out using an astrophysical methodology, would deal mostly with the so-called "nocturnal lights" (Hynek 1972).

Scientific data obtained by instrumentation studies at Hessdalen (Strand 1984; Teodorani 2004, 2014) showed characteristics that are not easily interpreted:

1. Optical spectra do not follow a standard behavior but can be both line and (often multi-peaked) continuous spectra.
2. Luminosity is sometimes very high and regularly or irregularly variable, as well as the color.
3. The visibility of UAPs is often correlated with pulsating magnetic disturbances and oscillating radio signals.
4. The UAP shape is often variable as well and it can change from simple light ball to geometric shapes (SCU

2023c).

5. VLF and UHF radio emission can show some anomalies – such as Doppler effects and periodic pulsating signals – which are not explained by manmade or ionospheric causes.
6. Radar signals are often intermittent and sometimes present with nothing in sight.
7. Night vision systems often show something that is not in sight or has disappeared from sight.

Very little of the data obtained so far, although highly anomalous, leads us to think that we are really dealing with a technological phenomenon of exogenous nature, and yet the doubt remains.[1] In fact, we cannot with certainty exclude that the UAP phenomenon represents in reality a multiplicity of manifestations ranging from natural (similar to ball lightning), manmade (such as new kinds of drones) and possibly advanced non-human technology.

Considering that nowadays highly sophisticated instrumentation is available, especially the equipment that the *Galileo Project* is using (Loeb and Laukien 2023; Watters *et al.* 2023), past research experience based both on instrumented field missions and on the quantitative analysis of witness cases makes clear the next observational steps in this research:

1. Obtain a high-resolution image of a UAP, using a little telescope or zoom lens tracked to the target – using a pan-tilt unit – by optical and infrared all-sky systems and using the most advanced CCD or CMOS detectors.
2. Calculate the distance and the linear size of the UAP, using triangulation via multiple radar, optical/IR systems and acoustic detectors.
3. Measure the intrinsic luminosity and its variation with time, once the apparent luminosity is accurately obtained.
4. Obtain high-time resolution images (at least 1000 fps) of a UAP in order to measure both possible fast light/color variations and fast movements in the sky, using 30-300 mm zoom lenses.
5. Measure the velocity, the acceleration and their variation with time, using also medium or high-resolution spectroscopic methods in case of velocities exceeding 10 Km/sec, by detecting blue or redshifts in spectral lines (if present in the spectrum) produced by "nocturnal lights" whose direction of motion is aligned along the line of sight.
6. Measure the intrinsic magnetic field intensity deduced from a possible Zeeman Effect (Lang 1991) recorded in a line spectrum (when lines are present) using a slitless medium-high resolution spectrograph, and its variation with time, compared and simultaneous with the measurement in distance using a magnetometer in order to deduce the action of a moving electric dipole source.
7. Testing a UAP using a Laser beam in its vicinity in order to verify if there is a gravitationally induced deviation and/or (without Laser) if the field stars around the object are displaced by their normal position (Teodorani 2000, 2020).
8. Search for correlations between intrinsic luminosity, radio luminosity, radar signature, infrared luminosity, velocity, audio signals, highly energetic particle emission, magnetic field strength and Laser deflection angle. Do they vary together with time or is there a phase lag?

The most crucial questions are if there is a correlation between: a) luminosities of up to 30,000 MW, velocities up to 3000 m/s or more and accelerations of up to 5,000 g as deduced by physical scientists, engineers and radar operators (Coumbe 2023; Knuth *et al.* 2019; Maccabee 1994, 1999; Vallée 1998), and: b) an hypothesized magnetic field strength of $10\ T \leq B \leq 1{,}000\ T$, assuming that in this specific case a magnetically induced Zeeman splitting effect can be detected spectroscopically using a tracking slitless echelle grating with a resolving power of at least R = 1,000 (see Appendix A). Considering that the predicted magnetic field intensity of ball lightning is expected to be at least a factor 1,000 less than these values (Fedosin and Kim 2001), the main question is: what kind of flying object is able to produce such a high magnetic field strength?

4. The importance of magnetic fields and their measurement

Interesting magnetic measurements were carried out at several locations of the world where anomalous light phenomena occur more often, in particular in Hessdalen, Norway (Strand 1984) and at the Yakama Indian Reservation (Akers 2001). In particular, direct measurements obtained in Hessdalen in February 1984 when the phenomenon was

1 I take 'anomaly' here to mean the any of the following: excessive speed and acceleration; impossible maneuvers (like right-angle turns at high velocity); occasionally extremely high luminosity (greater or much greater than 10 MW); shape changes; object splitting in more parts and vice versa; sudden appearance and disappearance; intermittent radar signals; oscillating magnetic fields and electromagnetic interference.

relatively far away, showed magnetic field strength ranging from 0.5 to more than 10 nT during a few seconds (see Figure. 1), while the amplitude was manifesting an oscillating behavior.

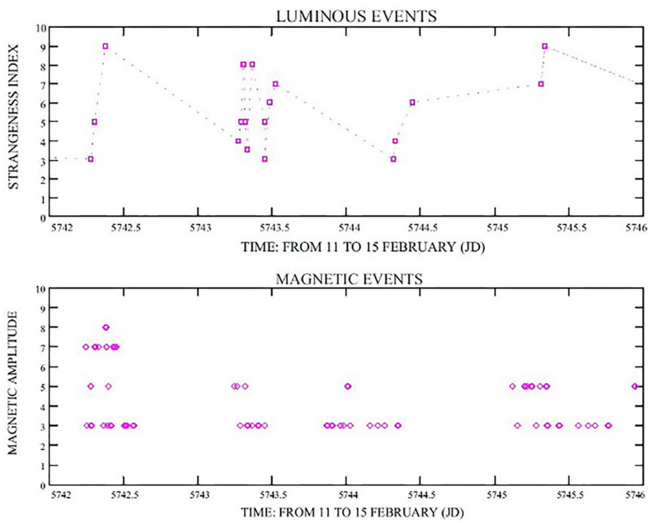

Figure 1. Detailed graph (Teodorani 2004) showing the time-variation of the amplitude of magnetic pulsations (126 data points) occurred in Hessdalen, Norway, in the period 11-15 February 1984 (lower plot, diamonds), compared with the time-variation of the strangeness index of the luminous phenomenon (upper plot; squares). The data were collected continuously. Only unidentified cases are shown (upper plot). The strangeness index is not a quantitative measurement but rather a qualitative one – although determined by an accurate and rational screening process – showing that the level of anomaly grows from 1 (identifiable case) up to 10 (totally unidentified case) (Hynek 1972). Events occurring in the period 25-26 February showed a strictly similar behavior (Strand 1984). As the original plots of the magnetograms could not be digitally recorded or printed out at that time (they were in fact written out as notes about the readings of magnetic strength and their exact timing, which was the only data then available from the Hessdalen researchers), due to the practical ease of viewing values of magnetic amplitude, they have been transformed into the following artificial values: 8 for readings > 10 nT, 7 for readings = 10 nT, 5 for readings = 2 nT, 3 for readings = 0.5 nT (Strand 1984). Due to necessity of time accuracy, the time scale was expressed in Julian Date (JD) after this author's re-plotting of original data (Teodorani 2004).The exact Julian Date in this case must be expressed as JD-2440000 (from 2445742 to 24458746, i.e. four days). What is important to note in these graphs is, above all, the approximate contemporaneity of luminous events and magnetic events.

Let's now consider the striking behavior of the reported UAP phenomenon all over the world (Coumbe 2023; Knuth *et al.* 2019; Maccabee 1994, 1999; Vallée 1998). If we hypothesize that we are dealing with flying machines that are occasionally enveloped within very high electric currents causing strong resistance-driven high temperatures and consequently ionizing effects on the air, there are logical reasons to wonder if the very high values deduced for UAP luminosity may be correlated with a very high intrinsic value of magnetic field intensity, and if velocity and acceleration are strictly related to the magnetic field intensity as well.

According to many reports, very strong magnetic fields related with UAP sightings were responsible for electromagnetic interference with electrical devices (Rodeghier 1981). In particular, in cars, a high magnetic field might saturate the ignition coil and reduce voltage to the spark plugs, and could cause a momentary halt to current flow or increase resistance in some engine component.

The received magnetic field intensity produced by an electric dipole or electrical engine of some kind typically decreases with the inverse of the cube of the distance, so unless the emitted magnetic field is very high, e.g. 100,000 T, what we would be able to measure with our magnetometer at the distance from the source is expected to be a very low value. The simulation illustrated in Figure 2 shows very clearly that beyond a certain distance – for a magnetometer with a good sensitivity of the order of 30 mV/nT (Grosz *et al.* 2017) – any possibility of measuring the magnetic field ceases already when the distance of a source of magnetic field B = 10 T reaches 2 Km.

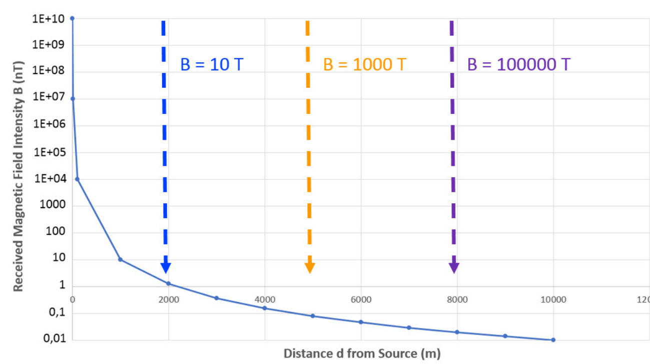

Figure 2. Expected decay of magnetic field intensity with distance from the source if B = 10 T. Comparison with B = 1,000 T and B = 100,000 T is also shown. The vertical dashed arrows show the maximum distance at which a magnetic field can be recorded, according to the magnetic field strength.

If the UAP is some sort of "machine" (manmade or not) very strong values of the magnetic field might be expected (Meessen 2012a, 2012b). Nowadays our technology has reached the capability to build magnets (in the case for plasma confinement in nuclear fusion experiments) where the magnetic field intensity reaches values of up to 1,200 T. If this is the case for the monitored UAP phenomena then – using the same calculation as the one done for the case of B = 10 T (see Figure. 2) – the magnetic field can be still measured at a distance of 5 Km. If B = 100,000 T the magnetic field can be measured at a distance of 8 Km. If the intensity is even a factor 10 higher – which human technology cannot produce yet – then the distance limit might almost reach the maximum range of the general observatory installed by *The Galileo Project*, which is around 12 Km (Watters *et al.* 2023).

Due to their small size and very short duration, it is highly unlikely that a natural phenomenon of the ball lightning kind is able to produce an excessively high magnetic field strength, which according to theory is expected to be typically in the range $0.001 \text{ T} \leq B \leq 0.5 \text{ T}$ (Fedosin and Kim 2001) and for an extended period of time (typically hours, and not seconds as expected from ball lightning phenomena) as observed during previous observations of UAP phenomena (Akers 2001; Strand 1984), as already discussed in the previous section. Other natural phenomena such as fireballs, reentry events (meteors or space debris), Chelyabinsk-like events and powerful conventional lightning are expected to be much more magnetically powerful than ball lightning and with a much shorter duration than in the case of reported UAP events.

In any case, the measurement of a magnetic disturbance alone cannot be considered remarkable if an optical, infrared, radio and/or a radar counterpart ascribed to an UAP is not recorded at the same time. The same can be said for an electromagnetic (VLF, VHF and UHF) disturbance if it is not accompanied by a UAP manifestation in the sky that is visible in the optical and in the infrared.

In conclusion, due to the inverse law of the cube of distance, unless a UAP is just flying very close to the monitoring station (which is highly unlikely, and which would anyway cause the saturation of the magnetic sensor), what would be realistically measured is expected to be in the approximate range of 10-100,000 nT, assuming that the effects due to geomagnetic storms, ferromagnetic rocks, internal instrument noise and manmade machinery can be removed. The intrinsic magnetic field strength of the source can be obtained once the distance is known using radar and/or triangulation. A further and solid confirmation of such a value might come from a possible measurement of the Zeeman Effect (Lang 1991) in optical spectra of the UAP under investigation, if a relatively high resolution is used, if the spectrum shows emission lines and if the intrinsic magnetic field strength is very high.

The measurement of the magnetic field might turn out to be of paramount importance if what we are observing of a UAP is due to the effect of some kind of propulsion mechanism (Griffiths 1984; Meessen 2012a, 2012b), where extremely high electric currents flowing through superconducting devices could be produced. If the surface of the UAP is able to support up to a million or billion volts in order to produce very high magnetic fields without undergoing an appreciable factor of electrical resistance and consequent overheating, and if this effect is able to excite/ionize atmospheric air around, then the object might be highly self-luminous as has been reported very often. Clearly, verifying if there is a time-correlation between magnetic strength and other fundamental physical parameters such as velocity, optical luminosity, color, radio brightness, radar signature, and particle emission would give us fundamental insights regarding the physics of the observed phenomenon, and in particular regarding the propulsion mechanism.

Reasonably high resolution – not more than 1 nT, but preferably 0.1 nT – would also allow us to verify if the detected magnetic field is subject to pulsations, as was recorded in the past during previous research (Strand 1984), and if they are correlated with fast variations of luminosity, color, radio brightness and particle emission. We might be observing a constant or monotonically increasing and/or decreasing pulsation, which can be accurately measured using all of our instruments.

In practice – in the case that we are in fact observing a technological phenomenon of some nature (not necessarily non-human) – our monitoring operations would take the form of "dynamical back-engineering", not by dismantling a machine inside a hangar but rather by meticulous observation of the behavior during flight. Otherwise, if it is not an artificially produced phenomenon, we might have the chance to study in detail a high-energy natural phenomenon that we have never been aware of. In both cases, our knowledge of physics could be greatly enhanced.

5. The importance of optical photometry

The measurement of photons emitted from the surface of a UAP can be of fundamental importance in order to try to understand the physical mechanism that is producing light, especially at night. This is normally done in astronomy when extended sources – such as galaxies and planets – are studied (Henden and Kaitchuck 1982; Kitchin 1984). Leveraging a comprehensive understanding of the physics of light (Lang 1991), once the distance is known using radar or triangulation procedures, the following measurements will be the most helpful for characterizing the intrinsic physical parameters of the source (Teodorani 2000, 2001):

- Superficial intensity – Construction of isophotal contours.
- Luminosity distribution – Measurement of the "slope factor" (or intensity gradient) from the center to the peripheral area of an extended luminous source.
- Total luminosity – Luminosity in a given wavelength interval of the entire surface, once the intrinsic (linear) radius is known after the distance (in some cases the temperature too) has been determined.
- Color index – Ratio of measured fluxes in several contiguous wavelength ranges corresponding to different filters, ranging from the near ultraviolet to the near infrared (analogous to U, B, V, R, I in astronomy).
- Period of luminous variability – Time variation of total luminosity and superficial intensity, of PSF and of color indexes.

In the case that the object contains only one or more luminous spots over the surface, then high spatial resolution would make it possible to resolve the precise location of such spots. A strong dynamic range of the CCD or CMOS cameras will allow distinguishing contiguous areas with weakly luminous and strongly luminous spots. High time resolution will allow ascertaining if the luminous spots are rotating, pulsating or moving across the surface.

Clearly, an optimal quality of measurements will be guaranteed if the object is relatively close to the sensors, so that a better determination of the linear size can be obtained, and/or if it is sufficiently luminous in order to allow short integration times of the optical detector. Both of these situations will greatly help to study the variability of light with time and with radius across the surface.

Photometric observations are intended to be simultaneous with spectroscopic ones, where separate CCD or CMOS detectors are used for imaging and acquisition of spectra.

- CCD/CMOS photometry

Compared to conventional photographic emulsion and plates of the past, present CCD and CMOS cameras allow much improved performance in measuring the light of astronomical objects (Walker 1987), especially when weakly luminous sources are considered. The same technology can be used to study luminous unidentified objects in the sky, whatever they are, and at any time of the day.

- High-speed photometry

Rapidly varying luminosity is not generally detectable during the acquisition of electronic images or video frames of weakly luminous UAPs, for which a long integration time is needed: all possible time variations would be washed out inside the acquired image. According to a scientific evaluation of some witnessed cases (Vallée 1998), UAP's luminosity can occasionally reach very high values (from 500 up to 30,000 MW). In this specific case, due to the very short integration times needed it is possible to verify if what appears as a stable luminosity is in reality the result of a high-speed regular or irregular pulsation that is not ascribable to atmospheric scintillation. We are mostly searching for fast and high-amplitude UAP's light variations in the range 1/1000 – 1/10000 sec, which is typically 10 or 100 times faster than atmospheric scintillation (Osborn *et al.* 2015). This may turn out to be important in order to infer the physics of the phenomenon, natural or otherwise. A regular or semi-regular pulsation or a pulsation with a monotonically increasing period might furnish some insight into a possible propulsion mechanism or a merely physical mechanism of phenomena of natural origin, especially if such pulsation is time-correlated with the color, the speed, the acceleration or even the linear dimension of the UAP. Similarly to the case of high-speed photometry of stars, a light curve of the luminous target with high temporal resolution is obtained. Light curves in astronomy are a crucial measurement that can help to interpret several kinds of phenomena. Exactly the same kind of procedure can be used to investigate unidentified phenomena that are seen in our atmosphere. High-speed luminosity variation (Warner 1988) can be due to the fast rotation of one or more light spots on the surface of the object, to the pulsation of the object's luminosity, to the fast variation of the apparent dimensions of the object itself (due to the possible fast rotation of an elongated or amorphous shape) or to transient light beams that are emitted from the surface of the object. Theoretical modeling of the kind routinely applied in astrophysics may be used to deduce which of many possible mechanisms are responsible for the observed variations.

In order to study fast brightness variations of UAPs, two sensors are of special interest: i) a multi-pixel photon counter (MPPC) and ii) a high-speed camera. In the first case (PANOSETI, website) it is possible to detect transient very short duration luminous events located on an extended surface, using both high time resolution (up to a nanosecond) and high spatial resolution via a many-pixel CCD detector where every pixel works as a photon counting photometer. This procedure is ideal to have a quantitative description of the emitted photons across a luminous surface and their variation in time, in the case of luminous UAP at night, assuming that the detector is attached to a telescope or to a zoom lens. The same technique is currently used in Optical SETI in order to search for Laser events from other stars. In the second case (i-Speed, website) a camera monitoring system is used with a maximum time resolution of up to one millionth of second; as the spatial resolution of every frame decreases with increasing time resolution, using in practice 1,000-5,000 fps is an optimal compromise between time and spatial resolution. This procedure is ideal to study any possible fast variation in the daytime of luminous and non-luminous objects and at nighttime for very luminous objects. Both detectors can be used in wide-angle mode also in order to verify if UAP phenomena are able to move very fast from a point to another in the sky.

6. The importance of optical spectroscopy

In the field of astrophysics, optical spectroscopy is crucial in determining important physical parameters, especially temperature, velocity and chemical composition. The use of spectroscopy in UAP research might turn out to be of paramount importance in understanding the physical characteristics of anomalous "nocturnal lights". Using a diffraction grating (Teodorani 2014, 2021), if we are observing a UAP whose apparent luminosity is very high, we can obtain a spectrum using a very short integration time, such as a few seconds, although with a resolving power of order $\lambda/\Delta\lambda = 10^2$, which is normally considered low resolution. This can be useful if we are able to identify very well separated and intense (presumably emission) lines, and also if we want to measure the continuum once the spectrum has been calibrated in flux and where the responsivity curve has been subtracted. In such a way, we have at our disposal an important tool for spectrochemical identification and for temperature determination.

As has been stressed before, UAPs can be occasionally extremely luminous at night. Witnesses and pilots have reported luminosities that have been estimated approaching 30,000 MW (Vallée 1998). This means that, if the telescope or lens to which the spectrograph is attached has sufficiently large aperture and the detector is sufficiently sensitive, it is possible to obtain a good S/N ratio in a small fraction of a second of integration, a more than sufficiently short time to be able to avoid any possible sudden motion change of the UAP.

In general, using low-resolution spectroscopy is useful for line identification and for the identification of the thermal or non-thermal nature of the UAP from the continuum spectrum that it produces (Lang 1991). Using this option, it is possible to use extremely low integration times. This allows us to obtain a time sequence of many spectra of the same object in order to carry out time variability studies.

The extremely high apparent luminosity that UAP can often show are for physicists a favorable opportunity to perform in particular situations medium ($\lambda/\Delta\lambda = 10^3$) or even high-resolution ($\lambda/\Delta\lambda = 10^4$) spectroscopy. Imaging spectrometry would be considered as well. Using medium and high-resolution spectrography in normal astrophysical situations, the light source is centered inside a slit for dispersion. In the case of UAP, this is not possible due to the fast movements and changes that such objects can show, and accurate tracking during the relatively long integration times that are sometimes required for high-resolution spectroscopy can be very difficult (see Appendix A) . However, the problem can be solved using a slitless wide field spectrograph (Masters 2014), using which tracking can be much easier also when anomalous kinematics are present. The wide field and slitless mode allows compensating possible lack of precision of target tracking especially when the UAP moves with sudden accelerations and/or in an erratic way.

Assuming that tracking is viable for medium or high-resolution spectroscopy, extremely luminous UAPs should permit use of relatively short integration times, even short enough to permit acquisition of several spectra of the same target in time sequence in order to study time variability of the spectrum's characteristics, especially at the time in which a change of color and/or of light intensities and speed occurs.

If a spectral resolution as high as $\lambda/\Delta\lambda = 10^4$ yields a S/N ratio greater than 10, we would have at our disposal a very powerful tool to try to understand the physics of the light source in great detail, especially if spectra are obtained simultaneously with measurements obtained using different instruments, such as radio frequency spectrum analyzers, infrared and optical direct imagers and sensors, magnetometers, particle detectors and radar.

The availability of high spectral resolution or at least of medium resolution ($\lambda/\Delta\lambda = 10^3$), would allow us to obtain crucial physical information regarding the following:

1. Ability to resolve blends of spectral lines, as for instance the bands of Oxygen in the red part of the spectrum (Teodorani 2014) and to clearly identify spectral lines of Hydrogen and Nitrogen, assuming that the phenomenon is able to excite the surrounding atmospheric gases.
2. Spectral identification of some chemical elements characterizing materials that are occasionally ejected by the UAP. Evidence of this has been recently analyzed in a lab, where some molten material was dropped on the ground by a hovering UAP (Nolan *et al.* 2022).
3. High accuracy in the measurement of the equivalent width of spectral lines (if present), which would allow determination of the number density of atoms that contribute to the formation of spectral lines and the associated excitation temperature (via Boltzmann equation) able to cause this (Lang 1991).
4. Measurement of the Zeeman Effect in spectral lines, which would allow determination of the magnetic field strength which is responsible for line splitting (Lang 1991). This would be of great importance for drawing inferences about a possible propulsion system (Meessen 2012a; 2012b) hypothetically based on extremely high magnetic fields and superconductors able to sustain very intense electric voltage without appreciable electrical resistance and consequent high temperature. However, a Zeeman Effect (or even Stark Effect, if line splitting is caused by a strong electric field) might also be a sign of an unknown natural event such as a hypothetically enhanced version of the ball lightning phenomenon (Kuersten *et al.* 2021; Fryberger 1997; Rabinowitz 2002; Stenhoff 1999; Turner 2003) whose physics could be investigated in greater depth. Such a measurement might be studied in correlation with measurements obtained using a magnetometer having a resolution of 1 nT and a dynamic range of 100.000 nT; in such a case, simultaneous magnetic detections (where the intensity of magnetic field decreases with the inverse of the cube of distance for a dipole) would confirm the spectroscopic Zeeman detections.
5. High accuracy in studying spectral line broadening at line basewidth (Griem 2013) and its possible variation with time. This could be used to illuminate possible fast plasma vortex-like rotation and/or turbulence, or even more exotic effects such as gravitational broadening. Numerical modeling of these hypotheses can help to decide which effect is more important. Time variability of this effect could be studied if it is possible to obtain many spectra in sequence of very luminous UAPs.
6. High accuracy measurements of blue or red shifts in spectral lines would help to study possible fast plasma ejections and/or collapses at speeds of the order of 1000 Km/sec, in form of a possible P-Cygni-like effect (characterized by a stationary emission line contiguous with a red or blue shifted absorption component) that we often observe in several kinds of unstable stars of early spectral type (Templeton 2009). Such a measurement might be studied in correlation with measurements obtained using a radioactive particle detector and a muon coincidence detector, by hypothesizing that high-energy particles are possibly ejected by the object. Doppler effects in emission lines might be studied also if a luminous UAP is moving faster than 10 Km/sec and if its direction of (approaching or receding) motion is along the line of sight.
7. High accuracy in studying the slope of the continuum, verification of the presence of LED-like bumps caused by quantum dots of natural origin (Teodorani 2004, 229) or simply the manifestation of LED (Light Emitting Diode) lights of human origin. In such a way, spectra could be used to identify mundane sources; Sodium, Mercury, or fluorescent lights, for instance would be other ones, which would help us to exclude these kind of illumination systems from the study.

The advantages of slitless medium-resolution spectroscopy, based on an echelle grating – for which tests have already been done by its designer (Masters 2014) and by this author (Teodorani 2014, 34) – for UAP Research are the following:

- The wide field permits easy tracking of a moving object and therefore also long integration times of sources that are relatively weakly luminous, in order to obtain a good S/N ratio. A calculation shows that it is possible to obtain a value of S/N = 10 using an integration time of about 20 seconds for a UAP whose luminosity is 1 MW and whose distance is 10 Km, assuming that the spectrograph is attached to a lens connected with a CCD or CMOS detector (see Appendix A).
- It permits acquisition of spectra of both point-like and extended luminous sources. A transmission grating allows only the first option and its resolution is a factor 10 less

(see Table 2, Appendix A).

- With a resolution of R ≥ 10^3 it is possible to resolve Zeeman line splitting if the magnetic field intensity in the source is 1 T ≤ B ≤ 10 T, for 0.28 Å ≤ Δλ ≤ 2.8 Å (see Appendix A).
- With a resolution of R ≥ 10^3 it is possible to resolve blue or redshifts with a precision of 1 Å in spectral lines produced by a luminous source that is moving at a speed of V ≥ 100 Km/sec along the line of sight, for Δλ ≈ 2 Å. Line broadening effects are also well discerned (see Appendix A).
- With a resolution of R ≥ 10^3 it is possible to make an accurate line spectrochemical identification and measurement of the equivalent width (energy subtracted by the line from the continuum).

All echelle spectral orders, once they are rectified from the typical sloping appearance they show as soon as a spectrum is obtained (Kitchin 1984; Teodorani 2014, 34), can be wavelength calibrated separately, once an appropriate calibration lamp is used, and then merged together in a single spectrum. The use of *RSPEC* software is strongly recommended (RSPEC, website).

There is no doubt that some of the spectroscopic measurements in particular – such as of the Zeeman and Doppler effects – could shed some light on the propulsion mechanism of a UAP, in the case that it is a flying object, especially if some correlations can be found with measurements obtained by other instruments, such as radio spectrum analyzer, particle detector and magnetometer. The study of the variation of all these physical parameters with time might guide us to the most appropriate theoretical deductions, from which to build up a physical model.

The accuracy of pixel-wavelength calibration (Moore and Burrows 2021) of medium-resolution spectra is of paramount importance in this research, especially when we are searching for Doppler effects produced by objects whose speed is 10 ≤ V ≤ 100 Km/sec. The use of He-Ar or Hg calibration lamps allow us to identify a large number of well resolved spectral lines of known wavelength, which permit to minimize the error of calibration after we use high-order polynomial functions (at least third-order fit). The accuracy of flux calibration is important as well, especially when we concentrate our attention on the continuum. Therefore we need to use a "standard candle" of reference, which could be a star of known luminosity such as Vega or a 1 kW reference lamp.

The luminous source is expected to be tracked in such a way that is maintained inside the view field of the slitless (medium resolution) spectrograph while the source is moving in the sky and while an exposure is taken in order to obtain a spectrum with an acceptable S/N ratio (at least ≥ 10). The spectrograph is expected to be attached to a pan tilt zoom CMOS camera (PTZ), using fiber optics (StellarNet, website) in order to avoid possible problems of mechanical inertia caused by the unbalancing effect of the spectroscopic device while tracking. If the light source is moving linearly and slowly in the sky, tracking is expected to be relatively easy. Not the same might happen if the source is moving randomly and/or with sudden inversions of the direction of motion or sudden accelerations. In order to try to solve this problem it is inevitably necessary to carry out preliminary tests flying illuminated drones and recalibrate via software the micrometric movements of the PTZ camera, by expecting that we would use one camera for photometry and one for spectroscopy.

7. Concluding remarks

It is conceivable that some kind of propulsion mechanism is able to provide non-aerodynamic lift to some UAPs. Many physical models, more or less well-founded, have been proposed so far, independently from measurement data that have not been acquired yet. We cite two of them, to provide examples of hypotheses that are testable using the techniques described in the paper.

> "*The conducting fluid will be created by electrodes that cover each of the vehicle's surfaces and ionize the surrounding air into plasma. The force created by passing an electrical current through this plasma pushes around the surrounding air, and that swirling air creates lift and momentum and provides stability against wind gusts.*" (EM Drive) – Subrata Roy, Ph.D. (Roy *et al.* 2011).

> "*The principle is that UFO produce an intense alternating magnetic field with a supraconductive outer shell. They then ionize air around the UFO in specific locations when the intensity of the magnetic field grows or shrinks. This produces a Lorentz force applied on electrons and ionized air in a huge volume. By the principle of reaction, this applies a force on the UFO.*" – Auguste Meessen, Ph. D. (Meessen 2012a, 2012b).

Certainly, our goal is not to plan our measurement experiments on UAPs based on theories that have not been tested experimentally yet. For now our goal is merely to identify what kinds of measurements can lend physical insight, and only later build up a theoretical physics model. For these reasons, data must be of the highest quality and obtained using very well calibrated instruments that are working simultaneously in several wavelength ranges. However, there is no doubt that here the most crucial measurements should involve magnetic fields. In particular, we must investigate if a correlation exists between very high values of luminosity, velocity, acceleration and magnetic field intensity. We have already discussed how the concerted use of different measurement instruments can potentially help to find an answer to this so important problem, assuming that the sky is constantly monitored using optical and infrared all-sky cameras able to direct narrow-field pan-tilt analytic (photometric and spectroscopic) instruments towards the target, while electromagnetic, radar, acoustic and particle detectors are simultaneously monitoring the sky. This procedure is currently employed by the measurement equipment used by the Galileo Project (Watters *et al.* 2023). A similar procedure is being planned for a new phase of Project Hessdalen (Teodorani 2023b).

Theories and hypotheses about the nature of UAPs do not deal only with a possible extraterrestrial visitation and related propulsion mechanisms, but also with something more exotic such as "plasma life forms". In this specific case, measurements of the kinds that have been described here might furnish important hints. Prominent lab experiments and computer modelling have shown that in particular conditions plasma behaves like biological systems (Tsytovich *et al.* 2007). We have to be prepared for any possibility, and be very aware of what data, once analyzed and assembled, are able to show to us (Teodorani 2022). There is no doubt that a possible discovery of the existence of plasma life forms not only would revolutionize our concept of life, but also would allow life to exist in what have been assumed to be the least hospitable environments in the universe. Only the future will be able to give an answer to this, including the possibility that the UAP phenomenon may consist of several classes of phenomena. We have to be very attentive to all possibilities, including natural phenomena of the ball lightning class, about which we have still a lot to learn from a physics point of view.

APPENDIX A – Preliminary numerical simulations for medium resolution spectroscopy

Some calculations have been carried out in order to predict the capability of a slitless medium-resolution spectrograph to measure Zeeman and Doppler effects using acceptably short integration times while a luminous UAP is tracked using a pan tilt unit.

Spectral line H_β 4861 Å (Hydrogen) is used for this test, because it is more or less close to the center (more luminous) of the optical spectrum's range allowed by the used grating and because it is expected that water vapor (H_2O) may be ionized/excited by a heated source, so that H and O emission lines could be seen. O lines are typically blended together and mostly in the red part of the spectrum (its less luminous part), not ideal to see the Zeeman splitting effect. The g-factor is approximated to 2.5 for an "average line". Table 2 shows how **Δλ** varies with the resolution used.

Accuracy of a Spectrograph according to Resolution			
Resolution R = λ/Δλ	**Δλ(Å)**	**VR = ± (Δλ/λ) c (Km/sec)**	**Note**
100	48.6	3000	Transmission grating (low res.)
1000	4.86	300	Medium resolution
2500	1.94	119	Standard Masters' spectrograph
10000	0.486	30	Masters' latest version (high res.)
100000	0.0486	3	Very high resolution

Table 2. Wavelength ranges and radial velocity for different values of spectral resolution.

R = 2500 (giving a precision of the order of $\Delta\lambda \approx 2$Å) is the spectral resolution that is considered and is exactly the one of the spectrograph that has been tested in the field (Masters 2014; Teodorani 2014). Such a resolution is potentially able to resolve a Zeeman splitting for a magnetic field whose strength is $B \approx 10$ Tesla, and to measure a Doppler intrinsic radial velocity if the UAP is traveling at a speed that exceeds 119 Km/sec or if it ejects or it absorbs gases from its surface.

This formula was used to calculate the Zeeman splitting $\Delta\lambda_Z$:

$$\Delta\lambda_Z = \frac{\pi \cdot e \cdot \lambda^2}{m_e \cdot c} \cdot g \cdot B = 4.67 \cdot 10^{-13} \cdot \lambda^2 \cdot g \cdot B \qquad (1)$$

Where:

B: magnetic field strength = 10 T; λ: wavelength of the spectral line = 4861 Å; e: charge of the electron; m_e: mass of the electron; c: speed of light; g: Landè factor of the spectral line = 2.5.

The calculation shows that a magnetic field in the range 1 T ≤ B ≤ 10 T generates a Zeeman splitting of 0.28 Å ≤ $\Delta\lambda_Z$ ≤ 2.8 Å.

The Integration Time IT needed to integrate photons in a satisfactory way in order to be able to detect $\Delta\lambda_Z$ = 2.8 Å, caused by B = 10 T produced by a target whose intrinsic luminosity is L = 1 MW at a distance of 10 Km (realistic), was calculated (see Formula 2). The result is: IT = 28 min if we want an S/N = 100 (ideal, but not at all realistic), and IT ≈ 17 sec if we accept an S/N = 10 (realistic). It is assumed that photons are emitted from an extended source of 10 m in diameter D, using a focal length F_T = 286 mm and an aperture A_T = 200 mm, plus other indicative instrumental factors, such as sky background noise, seeing = 1", and quantum efficiency of an average CCD of 0.25.

$$IT = \frac{\left(\frac{S}{N}\right)^2 \cdot b \cdot \Delta\lambda \cdot F_T^{\,2} \cdot \beta^2}{\left(\frac{L}{4\pi \cdot d^2} \cdot \Delta\lambda\right)^2 \cdot \pi \cdot D^2 \cdot A_T^{\,2} \cdot \varepsilon} \qquad (2)$$

Where:

UAP diameter D = 10 m; UAP shape approximated to a sphere with diameter D; UAP distance d = 10 km; UAP luminosity assumed to be constantly L = 1 MW; Signal-to-Noise ratio S/N = 10 (dimensionless); Sky background noise b = 2.5 x 10^{-6} $n_{photons}$ sec^{-1} cm^{-1} $arcsec^{-1}$ $Å^{-1}$; Telescope aperture A_T = 20 cm (of a typical portable telescope of the *Celestron* or *Meade* type); Telescope focal length F_T = 286 cm (same as above); Disk-like dimension for a point-like source (the "seeing") β = 1 arcsec; Photometric CCD detector efficiency factor ε = 0.25.

Here it is easy to see that if luminosity reaches values of up to 30,000 MW (Vallée 1998) the integration time would decrease by several orders of magnitude, with the big advantage of tracking the source during a very short period of time and the opportunity of acquiring several spectra in time sequence.

A graphical example of this kind of calculation is shown in Figure 3, where the integration time IT is calculated for a UAP whose luminosity is L = 1 MW and a diameter D = 10 m, for different values of the spectral resolution (expressed as Δλ) while the UAP distance d varies from 100 m to 10 Km.

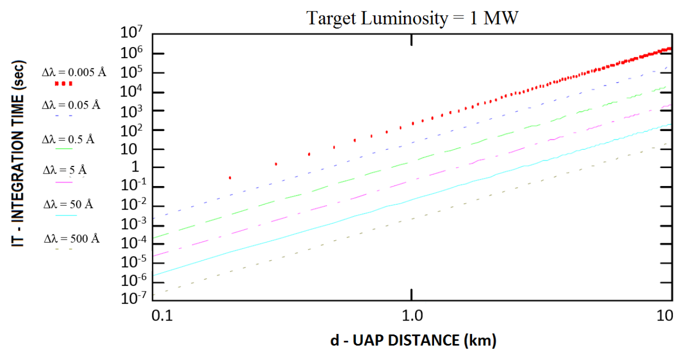

Figure 3. Integration times for a UAP target with luminosity L = 1 MW, given Δλ = 0.005 Å, Δλ = 0.05 Å, Δλ = 0.5 Å, Δλ = 5 Å, Δλ = 50 Å, Δλ = 500 Å. Target diameter is assumed to be D = 10 m. Distance d is varied from 100 m to 10 km. Graph is plotted on a bi-logarithmic scale.

These are the conclusions that can be drawn from these calculations:

1. If we want R = 10,000 or more we would need a very expensive instrument, which – although being potentially connected to the PTZ camera via fiber optics – is not practical at all for our necessities. If we use a cheaper non-echelle instrument, the higher the resolution the shorter the available wavelength range is (StellarNet, website). It is unthinkable to use high-resolution gratings that offer only a wavelength range of 100 Å, even if we can have at our disposal 45 interchangeable gratings (ranging from 3500 to 8000 Å). If we use an echelle instrument (Kitchin 1984) the complete visual range is available simultaneously but the cost is excessively high and the instrument is far too heavy for this kind of utilization. In all cases in which we want to use high resolution, if the UAP is occasionally weakly luminous the integration time while the UAP is tracked would be prohibitive. All this shows that high-resolution is not a viable solution in order to take spectra of UAP

phenomena.

2. The use of a medium resolution slitless echelle spectrograph with R = 2,500 (Masters 2014) is an acceptable compromise. The system – whose wavelength extension is at least 4000 Å – is very light and easily used on a pan-tilt mounting, or even more practically, customized with a fiber optics connection. Due to the absence of a slit, target tracking is relatively easy if the target is moving linearly. Above all, this instrument allows one to use integration times that are at least 10 times shorter than in the case of a high-resolution spectrograph, and consequently being less obliged to track a UAP (which might also suddenly disappear or change its direction of motion) for a too long time.

In general, it is evident that when the value of $\Delta\lambda$ increases, the integration time IT decreases (see Formula 2). In fact, when we use low resolution (typical of a diffraction grating) instead of medium resolution spectroscopy the integration time decreases of a factor 10 for a light source with fixed value. When $\Delta\lambda$ is around 1000 Å, for which no spectroscopy is possible due to lack of resolution, we enter into the realm of direct imaging (for every U, B, V, R, I filter used), namely (CCD or CMOS) photometry, which obviously permits us to obtain extremely short values of the integration time and which, consequently, allows us to carry out high-speed photometry for very luminous sources.

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Bohlander, Michael. Contact with Extraterrestrial Intelligence and Human Law: The Applicability of Rules of War and Human Rights. Leiden, The Netherlands: Koninklijke Brill. 2023. ISBN 978-9-00467-769-2.

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Michael Bohlander's *Contact with Extraterrestrial Intelligence and Human Law: The Applicability of Rules of War and Human Rights* (2023) both starts and ends in a position of strength. In this regard, it serves as an excellent introduction to an emerging, currently somewhat amorphous field of study – what might be termed *extraterrestrial studies*. It also sounds a cautionary tone regarding the limitations of our conceptual and (especially) our legal framework as per the possibility and consequences of extraterrestrial contact, as well as exploring how such limitations relate to existential risk considerations in the Space Age. In other words, we do not really have a conceptual or legal framework for contact contingencies, and this is a problem. As Bohlander opens the book, "It is statistically rather unlikely that humans are the only intelligent and spacefaring species in the known universe, yet we can know nothing about the species identity of other civilisations until and unless contact is made [...]," yet, in such a case, "[r]elying on alien altruism and benign intentions is wishful thinking. That is the fundamental premise of this book" (1).

Perhaps one of the most important features of Bohlander's argument is that he does not merely postulate contact as an occasion for posing an abstract thought experiment. Neither does he make preemptive assertions, or unwarranted assumptions, about the nature or reality of extraterrestrial intelligence (ETI). Instead, he accomplishes the rather difficult task of positioning his intervention *conceptually* within the historical frameworks of relevant disciplinary areas and within the normative discourse of legal theory. As he establishes fully, this is a valuable thing to do because we – that is, humans, as such – are largely unprepared for such contact, if it occurs. It is worth noting here that studying existential risk is always an uphill battle, because existential risks are always prospective until they are not – at which point, it is too late. (Climate change is perhaps the prime instructive example here, as collective inaction, failures of imagination, and ignorance or skepticism have all contributed significantly to the intractability and magnitude of a planetary-scale problem that now affects everyone and easily costs hundreds of billions of dollars per year.)

In Chapter 1 ("Introduction"), Bohlander justifies the need for the book's intervention, as well as responding to some relatively familiar objections to addressing the possibility of contact in the first place. Correctly, Bohlander notes the epistemological limitations of dismissals and negations of the extraterrestrial hypothesis (ETH). Indeed, a significant theme in the book is the "lack of mutual understanding between what one might call the scientific and the normative disciplines," which only contributes to the difficulty of addressing the prospect of contact realistically (8). He also notes the difficulty or limitations of his own position, which perhaps mirrors the difficulty of the issue area itself (not to mention the haze of obfuscation that so frequently surrounds it). Bohlander is quite clear on the following point, however: the book does not presume that contact has occurred, nor does it presuppose the ETH.

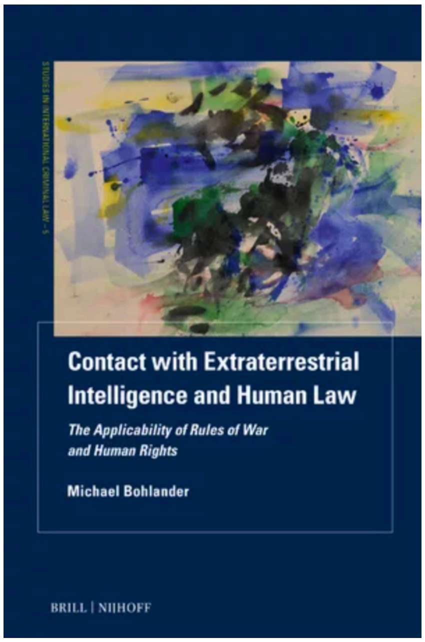

Fig 1. Cover image of *Contact with Extraterrestrial Intelligence and Human Law: The Applicability of Rules of War and Human Rights*
Source: https://brill.com coverimage?doc=%2Ftitle%2F68174&width=300&type=webp

That being said, Bohlander registers both the scale of impact such an event or revelation likely would have, as well as the degree of existential risk that necessarily attends it. Importantly, whether or not contact occurs (or even whether or not ETI exists), the existential risk factor remains quite real. As noted above, this is a conceptual quirk of addressing existential risks at all. For existential risks are and remain real risks, *whether they materialize or not*. While Bohlander does not entirely frame his intervention explicitly in terms of existential risk analysis (although he does provide an admirably complete footnote citing this literature in Chapter 3), such concerns clearly haunt the book. As he writes, if ETI (in the form of either distant signals or UAPs) "are indeed at some stage found to be of nonhuman or extraterrestrial origin, humanity thus has so far no reason to believe that they would be invariably benign in an altruistic sense, or that any other ETI would be in the future" (7). This raises the specter of hostile contact and its potential consequences for the human species, not to mention our preparedness (or, rather, *unpreparedness*) for such an eventuality.

Chapters 2 and 3 ("The Scientific SETI Environment" and "Social Science Aspects of SETI") survey familiar aspects of the conceptual and historical landscape surrounding the ETH. For example, Bohlander presents clear and succinct explanations of the Drake Equation, the Fermi Paradox, the field of astrobiology, the history of SETI approaches, and the conceptual and strategic costs of anthropocentrism and anthropomorphism in this area. What emerges from this survey is the observation that entertaining the ETH is not at all unreasonable, especially given the risk factors at play. Additionally, Bohlander suggests, so-called "contact optimism" is probably dangerous and untenable (whether it is conceptual, i.e., assuming that ETI will be humane or even comprehensible, or practical, e.g., in the case of *Voyager* or of various signals that have been broadcasted relatively willy-nilly into outer space). In Chapter 3, Bohlander provides a similar such survey, describing the Rio and San Marino Scales (intended to quantify impact factors of contact), as well as some competitor models. As he notes, despite various attempts to outline or recommend mitigation strategies, preparations, or reply protocols, none of these have been implemented in any significant way (e.g., by national or international actors with the capacities or resources to respond to contact at scale). Perhaps surprisingly, the impression that emerges from these surveys is not of meaningful human provisioning for the possibility of contact as much as of our total lack of preparedness – conceptually, materially, and strategically. This is a major theme of the book.

Chapter 4 ("Science Fiction and (First) Contact Scenarios") effectively serves as an expanded postscript to the foregoing surveys in Chapters 2 and 3. In the chapter, Bohlander provides representative characterizations of contact scenarios drawn from a range of science fictional accounts. At first glance, this seems extraneous to the purpose of the book. Perhaps it even undercuts the book's aims to some extent. After all, if we are to treat the ETH as a serious risk, why risk muddying the discussion with a plethora of fictional accounts? However, the purpose of Bohlander's discussion emerges quite clearly over the course of the chapter. He is using fictional scenarios as a way of exploring and interrogating conceptual parameters related to how contact (and the ETH, more generally) is conceived. In other words, Bohlander's aim in this chapter is arguably critical and interrogative. You could say he is using these scenarios to unsettle assumptions and possible intuitions about what ETI might be like – and, therefore, what contact means for us as a planetary species. This is precisely what Bohlander warns against consistently throughout the book, and the host of examples he marshals from the archives of science fiction accomplishes this goal admirably.

Chapter 5 ("Hostile Contact and Current International and Domestic Law") provides a broad survey of the details and history of current international and domestic law insofar as these domains apply (or fail to apply) in the contact scenario. Bohlander asks, "are the rationales underlying our current law of armed conflict adequate for, or at least adaptable to, war with an alien species?" (108) Specifically, the chapter addresses the liability of humans and the liability of ETI. Regarding the liability of humans, Bohlander discusses complexities related to territorial jurisdiction and the applicability of categories and concepts drawn from law and legal theory, including genocide, crimes against humanity, war crimes, and crimes of aggression (including preemptive warfare). He notes the legion of conceptual difficulties here, as well as noting the degree to which these concerns (e.g., identifying agents in order to ascribe liability, motivations, and responsibility) ostensibly overlap with other domains of concern (e.g., artificial intelligence, autonomous drones, drone swarms, etc.).

On the whole, Bohlander's conclusions are quite stark. As he writes, "in a hostile first contact scenario, rapid dominance will most likely (have to) be the paramount goal of each side, in order to dictate unilaterally the conditions of a surrender and future relationship or, in the absence of a willingness to compromise, to ensure the ability of annihilation of all meaningful resistance in order to extinguish the risk of a future rise of retaliatory action by the vanquished species" (125). Partly, these conclusions derive from the aforementioned conceptual difficulties, but they also derive from the transformative stakes in question (e.g., potentially ranging from planetary autonomy or control to species-level survival). Bohlander also notes the prospective difficulty of navigating potential incompatibilities between humans and ETIs regarding communication, goals, legal norms, and moral values, much less the material and strategic gaps implied. As such, he concludes, it is an open question to what extent *any* of the conceptual and legal norms discussed could apply to an interspecies conflict. "The somewhat disconcerting conclusion is that the values which we subscribe to in an interhuman context are nigh impossible to adhere to in a situation when the preservation of the human species from annihilation or its freedom from occupation and enslavement are at stake" (137).

In Chapter 6 ("Preparing for Hostile Contact"), Bohlander discusses the material and strategic parameters of a hostile contact scenario. In summary, as a warfighting domain, outer space is subject to exotic difficulties for which humans are largely unprepared. Bohlander surveys some recent developments in conceptualizations of outer space as a theater of conflict, and he also notes the degree to which the ETH does not largely feature in discussions about space law or the militarization of space. Much of the discussion in this chapter involves highlighting the degree to which familiar assumptions about domains of conflict, in fact, do not extend to space for a variety of physical and technological reasons. This places humans – viewed as a planetary species – at a distinct disadvantage in any conflict which might arise following hostile contact with an ETI.

In other words, Bohlander's argument in this chapter synthesizes all too well with his conclusions in the foregoing chapters: (1) We do not know if the ETH obtains. (2) If it obtains, then we do not know what ETI is like. (3) This has consequences for how we might communicate with, or even conceptualize, ETI. (4) We cannot rely on existing norms and precedents to regulate a contact scenario (or, potentially, any future relations) with ETI. (5) Regardless of 1-4, we are strategically and technologically unable and unprepared to defend or police the planet or its immediate environs in any meaningful capacity whatsoever. This litany of incapacities and vulnerabilities does not, however, warrant dismissing the ETH as "unthinkable." If anything, it calls for additional attention and inquiry, especially given the impact factors potentially at stake. Simply ignoring a big, wicked problem because it is big and wicked is a totally inadequate response to the problem.

Finally, in Chapter 7 ("Legal Prolegomena of Peaceful Relationships with ETI"), Bohlander begins to explore the connections between, and potential consequences for, human rights law (or, as he calls it, somewhat pithily, "humans' rights law") in light of the ETH. First and foremost, it is worth noting here that Bohlander is quite clear about the prospective nature of such an exploration, as well as the degree to which any of his findings or suggestions may need revision following real-world contact. As the foregoing chapters testify, the complexities and possibilities here are legion. That being said, he frames his contribution in this chapter as an exploration of "the human baseline for negotiations with ETI within a range of potential conceptual options that humans could expect to be faced with" (161).

To start, then, Bohlander identifies two of the most relevant factors affecting human rights guarantees if the ETH obtains (and diplomatic relations are in any way possible): network regulation density (i.e., the density of requirements imposed on network members) and rights hierarchies and enforcement mechanisms (i.e., the degree of leeway regarding regional versus universal requirements, as well as the means by which rights are enforced). In this context, Bohlander surveys the range of human rights considerations in terms of their potential negotiability or non-negotiability. As he notes, "certain rights would be relatively uncontested candidates for negotiation while others quite certainly would not" (186). Specifically, he reviews the recognition of legal personhood (ostensibly necessary for any form of rights law in the first place), the self-determination of a species, equality and minority rights, bans on cruel or degrading treatment, due process, freedom of movement and freedom of religious expression, privacy rights, and family and child rights. While Bohlander's work here is detailed and precise, in addition to covering many relevant caveats and considerations, it is nevertheless difficult to avoid observing that the conceptual framework of human rights itself is a relatively recent artifact in the history of human culture. This suggests, in turn, that human rights (or perhaps even "rights" altogether) may well be a far more contingent, local conceptual formation than broadly Kantian universalists might want to acknowledge. Additionally, while it may (or may not) be that human rights law serves as the optimal starting place for our normative orienteering, there are numerous and perhaps even pervasive enforcement problems already, in both national and international contexts, whether or not the ETH obtains.

As noted at the start, Bohlander starts and ends the book in a strong position. The book starts in a strong position by justifying the need for his intervention and then (throughout Chapters 2-5) by providing the reader with the information needed to frame the whole book's intervention correctly and to register its significance. Likewise, the book ends in a strong position because Bohlander begins to explore the conceptual framework and normative (legal and political) consequences of contact and the ETH. Throughout the book, Bohlander provides detailed and extensive surveys of the complex, multidisciplinary background to this issue. Much of the takeaway from these surveys is *the degree to which we are conceptually, legally, materially, and strategically underprepared for any contact scenario whatsoever*. In conclusion, Bohlander's book targets some specific weaknesses in our conceptual and legal framework as regards contact and the ETH. These weaknesses matter because of the existential risk implications they entail, which cannot be addressed *except* prospectively. Addressing them after contact is made will already be too late. Hence, Bohlander's book should be read by anyone willing to entertain the possibility that existential risks can, and should, be preempted. A colorful analogy to insurance could perhaps be made profitably here. For everyone else, I suppose the existential risk will be addressed after it obtains – and, doubtlessly, with great equanimity and strategic purpose.

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Polymath Prof. Wilhelm Schickard (1592-1635): Inventor of the mechanical calculating machine and the world's first academic UFO-witness and investigator

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Dear Editor,

with this letter I would like to point out the early results of my research into the so far little known UFO/UAP-sighting of one of the most famous German polymaths, contemporary and befriended astronomy-colleague of Johannes Kepler, Wilhelm Schickard (1592–1635). This sighting was so far undescribed even in most of UFO research literature. Not only does the sighting itself hold many fascinating parallels to modern days UFO encounters; being almost 400 years old, the account most likely represents the world's first and earliest form of a detailed description and discussion of a UAP-sighting by a full and respected academic. The German government just honored Schickard with a special 20-Euro collector's coin that celebrates the 400th anniversary of his invention of the first mechanical counting machine. Less known, if known at all, is the fact that Professor Schickard could be rightfully considered the first academic UFO/UAP researcher in history. The observation he encountered and described also set himself up for vehement criticism and outrage from his colleagues through his advocacy for the most precise description of the "miraculous sign" he observed and described in 1630.

Figure. 1. Portrait of Prof. Wilhelm Schickard, holding his *hand planetarium* (orrery), painted by Conrad Melperger in 1632.
Source: Tübingen University (via WikimediaCommons), Public Domain

About Wilhelm Schickard

In addition to his teaching of Hebrew at the University of Tübingen, Schickard was also involved in astronomy. In 1623, he invented an "Astroscopium" (a paper cone representing the night sky), and in his work "Ephemeris Lunaris," he developed a theory of the moon's path, enabling the most accurate ephemerides of his time, which are position values for moving astronomical objects. Furthermore, he was the first person to determine meteor paths from simultaneous observations from different locations (Figure 2). He also introduced graphical methods for calculating eclipses and for making calculations within the Copernican system. He was not only an accomplished scholar but also a skilled mechanic, constructing many of his instruments himself. Johannes Kepler even called him the "ambidextrous philosopher." In 1623, he built the first calculating machine, referred to as the "computing clock," which could add and subtract up to six-digit numbers. To perform more complex calculations like multiplication and division, he attached cylindrical Napier's bones to it, which contained the multiplication table.

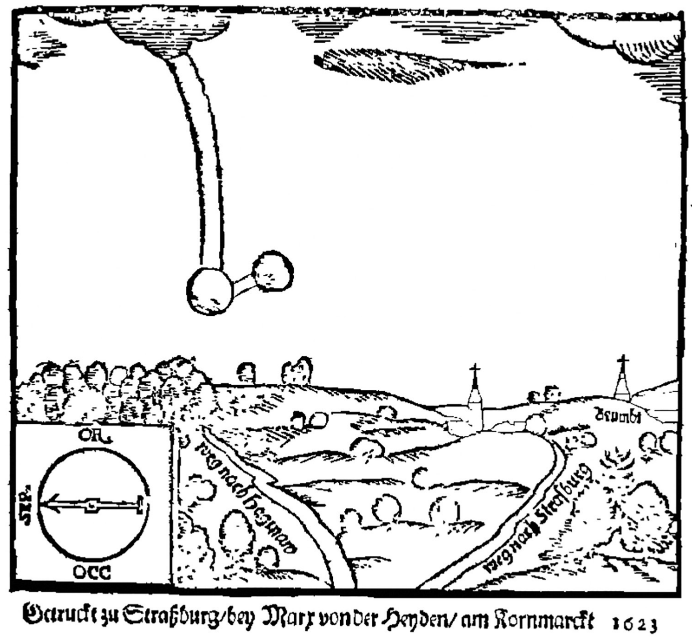

Figure. 2. Illustration of the meteor Schickard observed himself on November 7, 1623, and recounted its hight and path.
Source: Habrecht I. 1623 (Strassburg) „Von einer wunderbaren grossen vom Himmel gefallenen Feuerkugel" (Max v.d. Heyden).

In 1631, Schickard succeeded the astronomy professor Michael Mästlin at Tübingen University. As a strong proponent of the heliocentric system, he maintained a collegial and likely friendly exchange with Kepler and invented the first hand-held planetarium, as depicted in his 1631 portrait (Figure 1).

The Sighting

After years of experience in astronomical observations and calculations, during which he was among the first to determine the height and path of a meteor through simultaneous observations from different locations, Wilhelm Schickard became an eyewitness to a celestial phenomenon on January 27, 1630. This event could be described today as a classic UFO sighting. However, during the course of the observation that spanned several hours, it became increasingly peculiar, evolving into one of those "miraculous signs" known as an "air battle" that were already questioned by his academic colleagues. Nevertheless, Schickard, being an eyewitness to the phenomenon, was determined to describe it as precisely and scientifically as possible.

In his 33-paged manuscript, titled **"Beschreibung Des Wunder Zaichens [...] Abends von 7. biß zu 10. Uhr Vormittag / am haiteren Himmel / gegen Nord gesehen worden [...]"** (Engl.: "Description of the Miracle Sign [...] seen in the evening from 7 o'clock on the evening to 10 in the morning / in the clear sky / towards the north,") which was printed just two days later (!) on January 27, 1630, Schickard described the event as follows:

„Als ich eben meiner Gewohnheit nach/ an dem damals klaren Himmel / die Sternen contemplirt, unnd nach langer Sudostischer Beschawung / das Gesicht endtlich zum andern Laden underm Dach / gegen Nord West hinau. gewandt / da erzeigete sich ohnversehens / ein Schneweisse materi, welche ich nicht wohl ein Wolcken nennen kan / dieweil sie nicht so geflocket / noch am Rand herumb zersetzet war / wie das Natürliche Gewölck / sonder hüpsch glatt / und polit, (so villeicht zu dem Widerschein etwas geholffen) kans auch nicht füglich einen Dampff heissen / weil es sein gewisse beständige / und zwar zierliche oval figur oder Ay Gestalt gehabt / die Dünst aber sonsten unbest.ndiger Form hin und wider fladern: Zuge= schweigen / da. es an Helle unnd Schein all gewohnliche Wolcken weit ubertroffen / auch gar lauter und homogenischer Art war.“ (Schickard 1630)


Beschreibung
Deß
Wunder Zaichens/
Welches Montags den 25. Januarij/ eben am Loß Tag S. Pauli Bekehrung/dieses eingehenden 1630. Jahrs/Abends von 7. biß zu 10. Vhr Vormittnachts/ am haitern Him̄el/ gegen Nord gesehen worden.
Sampt beygefüegtem Gründtlichen Bericht/ von dem Stern/ welcher folgenden Dinstags vmb den hellen Mittag erschinen/
Beedes warhafftig mit allen Vmbständen verzeichnet/ vnd auff Begehren/zur Gedächtnuß in Truck gegeben/
Durch
Wilhelm Schickharden/
Professorn zu Tübingen.
Getruckt bey Dieterich Werlin/den 27. Januarij. Anno ut supra.

Figure 3. Frontpage of Schickrads 33-paged manuscript, titled „Beschreibung Des Wunder Zaichens […] Abends von 7. bi. zu 10. Uhr Vormittnachts. / am haiteren Himmel / gegen Nord gesehen worden […]“
Source: Bayerische Staatsbibliothek

"As I, in accordance with my habit, contemplated the stars in the then clear sky and, after a long southern observation, finally turned my gaze to the northern sky, an unexpected phenomenon presented itself: a snow-white material, which I cannot well call a cloud, because it was not so fleecy or fringed at the edges as natural clouds usually are. Instead, it was quite smooth and polished (perhaps somewhat brightened by reflection). It also cannot be easily called vapor because it had a specific, constant, and elegant oval shape, whereas vapors otherwise flutter around in an unstable form. Not to mention, it far surpassed the ordinary clouds in brightness and radiance, being completely pure and homogeneous in nature."

In summary, Schickard described the sighting of a bright, white, oval or "egg-shaped" (tick-tack-shaped?) object in the northern sky, which differed significantly from known clouds due to its smooth and polished appearance. After additional astronomical observations, Schickard returned to the description of the object's development. He reported that after 7 o'clock, two more white objects, though now in three different shades, appeared next to the "oval shape". He described one as "resembling an overturned kettle" and the other as "resembling a long sharpening stone [a "Wetzstein"] with both sides already heavily worn off" (see for comp. Figure 4) to make the description understandable with common objects of the daily use of his time.

Figure 4. A traditional natural heavy used Whetstone (bottom) compared with an artificial whetstone (top).
Source: Ulfbastel (via WikimediaCommons) / CC BY-SA 4.0

These objects shimmered in a way different from the "hurried twinkling of fixed stars," causing the appearances to come and go, making it difficult for Schickard to determine "whether it had indeed vanished or only concealed itself."

The entire observation and Schickard's detailed account of it would exceed the scope of this letter. Schickard's manuscript on the event alone comprises 33 densely printed pages. The quality of his account is enhanced by his own astronomical and natural observation experience, which is a testament to his standing as one of the leading polymaths of his time. Readers are left to decide whether to trust Schickard's distinction between known natural and astrophysical phenomena, like clouds etc., and his interpretation of an otherworldly "miraculous sign." In the context of modern day UFO phenomena, there are clear parallels, including sightings of oval or egg-shaped UFOs, as frequently described in UFO literature. These parallels extend to recent observations by US Navy pilots, who detected and tracked unidentified flying objects with their onboard sensors, describing them as "Tic-Tac" shaped.

Wilhelm Schickard: Between Orthodox and Heterodox Religion and Science

During his lifetime at the University of Tübingen, Schickard faced criticism for his heterodox religious leanings, and his work, particularly the description of the celestial event mentioned above, served to solidify this criticism and was publicly exploited by his opponents, who tried to oust him from the University. This issue parallels the challenges that contemporary scientists interested in academic and scientific engagement with the unknown often face. For instance, Harvard psychiatrist Dr. John E. Mack faced severe criticism in the mid-1990s due to his research on alien abductions, which drew controversy. Similarly, Harvard astronomer Prof. Avi Loeb is currently experiencing criticism from the orthodox scientific community for suggesting that the interstellar object 'Oumuamua might be an extraterrestrial artifact. His efforts to search for UFOs in the sky and alien probes in the solar system through the "Galileo Project" at Harvard have garnered both attention and criticism from the astronomical community and the media.

Preview on further research and publications

I am currently collaborating with a historian friend on an extensive elaboration of Schickard's description and writing of his sighting. This will be published in the form of either a non-fiction book or a scientific research article. I would be happy to keep you and the readers of *Limina* updated on this project's progress.

A scan of Schickards booklet can be found here: https://books.google.de/books?id=jFZcAAAAcAAJ&printsec=frontcover&hl=de&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

Best Regards,
Andreas Müller

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Andreas Müller, born in 1976, studied Communication Design at the University of Fine Arts Saar at Saarbruecken, Germany. During his studies, he also began his work in science journalism, focusing on frontiers of sciences and anomalistic research. His two books on the scientific background and exploration of the crop circle phenomenon are among the standard works on the topic in the German-speaking countries. In 2014, Müller co-curated the first exhibition on this topic for a cultural-historical museum in England (Wiltshire Museum, Devizes). Since 2007, he is the editor of www.GrenzWissenschaft-aktuell.de (GreWi), the much-read German-language daily news portal on fringe science, paranormal and anomalistic topics. In 2014, he became the first journalist to gain access to the little-known UFO files of the German Federal Intelligence Service (Bundesnachrichtendienst, BND). In 2021 his book „Deutschlands UFO-Akten - Über den politischen Umgang mit dem UFO-Phänomen in Deutschland" (Germany's UFO-files) was published, a 450-paged full compendium on Germanys UFO-Files. This work was followed in 2023 by his latest book „Deutschlands historische UFO-Akten" (Germanys historical UFO-files), that deals with UFO-sightings between 776-1889. Müller is an associated member of the Interdisciplinary Research Center for Extraterrestrial Studies (IFEX, www.uni-wuerzburg.de/ifex) at Julius Maximilian University of Würzburg and a member of the Society for UAP Studies (SUAPS). (www.SocietyForUAPstudies.org). Contact: redaktion@grenzwissenschaft-aktuell.de