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HYPER-SETI – A NEW WAY OF SEARCHING FOR EXTRATERRESTRIAL INTELLIGENCE

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Abstract

In this paper a new way of searching for extraterrestrial intelligence is proposed by using a unique combination of a new search strategy and modern technologies such as machine learning, which is called "HYPER-SETI".

HYPER-SETI presumes, that extraterrestrial civilizations, who are technologically more advanced than ours do not communicate by means which is used by the classical SETI instruments, namely search for artificial and decodable signals in different wavelengths of the electromagnetic spectrum. Communication is obviously too ineffective this way (even though principally possible) because of the limiting speed of electromagnetic waves. This may be the main reason, why we don't "hear" or "see" anything up to now using classical SETI methods. The absence of such an intelligent signal is not necessarily due to the non-existence of intelligent life but simply due to the unsuited technology we use for the searching. Our communication devices are simply incompatible for an effective interstellar communication. Even if there are some other civilizations, who use similar techniques for communications, the chances to find and even communicate with them are small, at least due to the huge distances.

HYPER-SETI takes a new approach, not repeating, what did not find any results up to now. It rather starts with the question, which type of technology would be necessary for effective interstellar communication and what is maybe more important, would it be possible for us to detect signs or at least side effects of such a new and fantastic technology? Although, we obviously don't have such a technology and not even the physics yet, we can start with describing, which properties it should have and see, if there is a possibility to observe traces of such communications between others, even if we are not able to directly interfere with it or are even not the target of the communication.

So, we do not necessarily have to detect or understand the communication itself, but at the beginning it might be sufficient to discover side effects or accompanying phenomena, which are observable within the physics known to us, in a conventional way, using conventional sensors but advanced information technologies. The crucial point is, that as this type of communication technology has to be unknown to us, attendant circumstances must appear also unknown or unexplainable to us, otherwise it was something we already know.

Thus, HYPER-SETI proposes to start intentionally searching for unknown and unexpected phenomena within the electromagnetic spectrum, which might be signs of communication, instead of only searching for communication patterns itself. This type of search can nowadays be supported by methods of machine learning and artificial intelligence.

Keywords: (SETI, OSETI, satellite, AI)

1. Introduction

In the fifties, when Enrico Fermi asked his question "where is everybody" and Frank Drake formulated his equation for the estimation of the amount of civilizations in the galaxy, the discussion about the existence of intelligent life in the universe was considered to be rather exotic. Today, almost 70 years later, the situation begins to change dramatically due to advances in science and technology, which enables the increase of knowledge about our cosmos.

Especially the latest ongoing and very successful discoveries of fast increasing number of extra solar planets are strongly supporting the idea of possible life beyond our solar system. As of end of 2019, NASA counts more than 4000 confirmed exoplanets and more than 4000 candidates. There is a run to hunt exoplanets and especially ones in the habitable zone of their stars which could support life by an increasing number of Earth-bound observations and dedicated past, ongoing

and future space missions such as KEPLER, TESS or PLATO.

Apart from the mere number of exoplanets, the techniques for studying the atmospheres of exoplanets are getting better and better. Especially the detection of water or maybe even organic molecules is becoming more and more probable due to the rapidly improved measurement systems. Very recently, in September 2019, the discovery of water vapor in the exoplanet K2-18b's atmosphere was announced and needs further confirmation [1].

Another very relevant and interesting aspect in the search for live beyond Earth are new findings about under which extreme circumstances live is able to exist and was not assumed to be possible before. There is a rapidly growing field of microbial life in extreme environments. Today, it is assumed, that alien life might even exist in the icy water moons of Saturn and Jupiter as it was found that microbiological life forms exist in the dark and cold regions of the Earth's ocean floors, which survive due to the heat and nutrients from hydro-thermal vents and under the ice of Antarctica.

And in the context of SETI, the more important aspect of the current results of search activities is maybe, that the number of possibly life supporting extra solar planets is much more than earlier imagined. If we look at the history of astronomy, we should actually be talking about a paradigm shift in the discussion about whether we are alone in the universe. For in the last century scientists who had applied for funding for the search for life on alien planets would have had difficulties getting it financed due to the apparent lack of seriousness. The author of this article personally experienced in the 80's how a young scientist, who only talked about the possible existence of life building blocks on asteroids or comets, was massively discredited by well-established others. Today, astrobiology is an established discipline in science, and we spend billions of dollars on satellite missions in search of exoplanets and extraterrestrial life without anyone being banished to the stake.

Thus, the possibility of successful detection of life on an exoplanet has increased dramatically in the past few years. It seems that, it should only be a question of time, when the first discovery of signs of life will be made.

Because life in general is a precondition for intelligent life forms, as a logical consequence, this situation changes the attitude on the search for *intelligent* life in the universe. Although many new planets are being found these days, the classical search for intelligent life did not deliver any positive sign up to now. The Fermi paradox still seems to be unresolved, but due to the potential big impact of success, it is definitely worthwhile to continue working on it with new ideas.

The following Table 1 is a very brief summary of the introduction and what has been achieved until today.

Table 1 Brief overview of the results of the search for extraterrestrial life and intelligence

Live in solar system	partly successful	• detection of extraterrestrial organic materials by observatories and robotic missions [2] • realization that life can exist under the most difficult circumstances • no live and complex live found yet
Search for Exoplanets	highly successful	• Discovery of >4000 exoplanets [3] • First signs of planets with liquid water [1]
Search for extrasolar live	started	• ongoing, improvements expected soon
Search for extraterrestrial Intelligence	unsuccessful	

2. The foundation of communication and classical SETI

2.1 Levels of communication and a possible SETI extension

In order to better classify the efforts of classical SETI and possibly new approaches in the future, it seems worthwhile to take a brief look at the communication and our expectations on Earth in general. In order not to deviate from the actual topic, only a few relevant basic aspects of communication will be discussed here.

The first question that arises is what communication is. Although it may sound banal at first, on closer inspection not even the term seems to be completely clearly defined. Whereby the definition of information and the interdependency between information and communication is a discussion in itself. However, for practical reasons, there seems to be a consensus, that communication usually involves the transmission of some kind of information.

One relevant aspect is, that communications happens not always by intention. Actually, any kind of basic *interaction* could be interpreted as communication. To take it to the extreme, imagine for example, a magnet that we bring close to a metal plate. They will attract each other and thus interact. The question is, if we can already speak of a "communication" here. Our intention would say, no. But where exactly is the border between communication and interaction, if there is one at all?

If one pursues this thought further, we may come to the conclusion that in principle any communication at a higher level is based on a lot of interactions at lower levels. Thus, communication is based on some kind of interaction, but the border depends also on the participating systems capability of interpretation of the information. The interaction of atoms leads to interaction on a higher level, more complex systems such as molecules. Then we call this for example a chemical reaction. The chemical reaction together with electrical reactions is used for communication between neurons within our brain. An information generated in our brain is then transferred to audio waves to communicate with other people. Thus, the transition between a mere interaction and information transfer is fluid and it is up to the viewer to evaluate a process as a mere interaction or already higher-level communication.

An interaction between two primitive systems that is simple from a human point of view can already be evaluated as effective communication from the perspective of the simpler, less complex system. One example of this is plant defense mechanisms that can interact with each other to ward off pests.

We can also think of two human explorers in a wild environment, where no one has been before. They walk in this place, talking to each other. Some ants on the ground will not understand the arguments of the persons and the philosophical implications of their scientific discussion but they will be able to sense the changes in the air pressure. This way, they will take part in the communication unintentionally, without really understanding anything.

So, we might be able to catch some kind of interaction or communication from significant more advanced alien civilizations at some unknown level, which we don't understand, but could sense it as an unexplainable change in our observable environment. The analogies from above can be seen as examples for this.

I prefer to use the term "signature" for this type of information or communication, as it is, in my opinion, a rather general term for any information. A signature can be an electromagnetic signal, an eruption of radiation or an artefact. Since we don't know in advance what advanced extraterrestrial communication looks like, we shouldn't include artificial boundaries in the search and thus unnecessarily restrict the search space.

To be seriously sensitive to such unpredictable and unexplainable changes as a possible side effect or signature of an intelligent alien communication is a fundamental new way of thinking in contrast to classical SETI, where we typically use technology know to us and only presume, that others do the same.

2.2 Brief history of communication

Communication is a fundamental aspect for intelligent live. None of the species on Earth, including mankind, would be living in the world as we know it today, without the ability to communicate. It is useful to survive, to develop intelligence and to improve their capabilities for all species including humans. People communicated with each other in the beginning with only the help of their natural abilities. All five senses were and are still used today for communication. Later, new technologies were developed, which extended the ability to communicate. For example, the optical communication range could be significantly increased by using artificially generated fire chains. Much later, with the discovery of electromagnetic waves, there was a huge step forward. Today, the transformation from analog to digital communication improved the communication capabilities once again drastically in the history of mankind.

Nowadays in digital communication technology, the transmission of information is often considered in layers. The common model is called OSI and stands for Open Systems Interconnection model. It facilitates the interpretation, analysis and design of the components involved through standardization and characterization.

The lowest layer, the so-called physical layer is responsible for the transmission and reception of raw data between a device and a physical transmission medium. It converts the digital bits into electrical, radio,

or optical signals [4]. Such signals at the physical layer is what classical SETI is searching for.

2.3 Classical SETI

Classical SETI assumes a communication link that corresponds to our state of the art in science and technology. Typically, it searches for a modulated signal in the physical layer as described above at many different (unknown) frequencies. “Classic" refers here to the search in the radio and optical wavelength using radio antennas and telescopes. One of the main assumptions is undoubtedly the limitation of the propagation speed of signals to the speed of light. This seems necessary at first, because we can only use the technology we know. It would also be conceivable that there are other civilizations that have roughly reached our level of technology and are not much further advanced than we are. From this point of view, it makes sense to continue the existing classic SETI activities, at least for an area that is not too far from our solar system, where due to the very long signal propagation times at the speed of light, communication still seems to be reasonably effective. For the author personally this would be at about 100 light years in radius, which can be related to a long human live from today’s perspective. For longer distances, this type of communications delay seems simply ineffective to the degree of unusable.

However, in recent years newer ideas for the search for extraterrestrial intelligences have been proposed. In concrete terms, today the classic search for extraterrestrial intelligences is already extended a little and can be divided into the following types:

Search for

a. signals at radio frequencies
b. signals at optical wavelengths
c. signs of control of extreme high energy
d. extraterrestrial artefacts

With type a, we assume that extraterrestrial civilizations transmit information by modulating a signal in the radio wavelength range from roughly a few millimeters to about 10m, exactly as we do. Since radio SETI has so far only been operated from the ground, the permeability of the atmosphere plays an important practical role. That is, from the ground, we can only search meaningfully in the wavelength ranges in which the signals are transmitted by the atmosphere.

The same applies to type b. In the optical wavelength range, we are also subject to atmospheric restrictions. Only a small part of the electromagnetic spectrum is let through by the atmosphere [Fig. 1]. Here it is assumed that extraterrestrial civilizations could send messages in the form of very intense but short laser pulses specifically towards Earth.

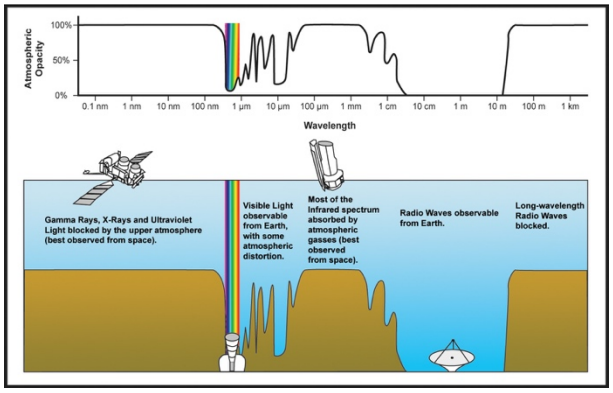

Fig. 1 Overview of the absorption bands in Earth’s atmosphere [5]

Of course, one could in principle shift the search to outer space, so that we are no longer restricted by the Earth's atmosphere. In fact, the author of this paper proposed a dedicated satellite mission that could search from orbit for artificial signals in the optical wavelength range, thus a satellite mission only for optical SETI (OSETI). This proposal has already been investigated for its feasibility in the context of a nanosatellite mission and has basically been found to be feasible and could be one of the next satellite missions from the University of Würzburg, if funding could be assured [6].

Similar missions could also be realized in principle in other wavelength ranges by space missions on board satellites or, for example, by SETI stations on the Moon, thus significantly widening the search window for classical SETI.

Due to a lack of success in the previous search, new search methods have been proposed in recent years. These include type c, which assumes an artificial and controlled eruption of extremely high amounts of energy, such as the fast radio bursts (FRB). The search for Dyson spheres can be seen in a similar category.

Type d is dealing with the search for extraterrestrial artefacts (SETA). This mostly refers to extraterrestrial probes that are to be searched for [7]. Considering that other civilizations with at least the technical state as mankind might have existed long ago or still may exist for millions of years, the search for probes, which may have entered our solar system is thinkable. the recent discovery of Oumuamua as the first extrasolar object has increased the awareness that extrasolar objects can pass through our solar system. Thus, there is no

theoretical reason why we should not further search for such probes. The locations for where to search within our solar system differ, depending on what we assume, why and how such probes might come to us. But in principle any location is possible, including the surfaces of all planets, moons, asteroids and even Earth itself as part of the solar system.

Nowadays, for all types the search can even be further improved by the use of modern information processing technologies such as artificial intelligence methods.

So far, the result of the search is obviously negative. There are several possible reasons, why we don't receive any intelligent signal yet. These have been discussed already in depth. Within this paper, only a short general summary will be useful to support the position of the proposed HYPER-SETI at this point.

3. Possible reasons why we don't have found an intelligent signature yet

The following is a short summary of most of the possible answers to the Fermi paradox, which are in discussion so far. Maybe it is not complete, but it covers the most common ideas.

A. There is simply no other intelligent live (yet)
B. Intelligent live beyond Earth exist
   B.1. but not in our current generation or time frame (could have been existed but already destroyed for whatever reason or will arise in the future)
   B.2. but did not reach the technological level to perform interstellar communication at least at our level yet
   B.3. and have the technological capacity at least at the level of humankind but
      B.3.1. are too far
      B.3.2. are too different to be recognized by us as intelligent live
      B.3.3. don't want to communicate for whichever reason
   B.4. and have reached a much higher scientific and technological level
      B.4.1. but are too different to be recognized by us as intelligent live
      B.4.2. but don't want to communicate for whichever reason
      B.4.3. but our search or communication systems are not compatible
      B.4.4. and there are already measurable signs of interaction (or communication), but they are not interpreted as such or are ignored

It is also clear, that the appropriate answer is maybe a combination of all the possible answers and change in time.

All four types of search mentioned in chapter 2.3 are all based on the current state of knowledge in science and technology - and not beyond. For example, although we are far from building Dyson spheres practically, there is no fundamental theoretical reason why this should not be possible. It is also possible to send probes to other stars. This is reasonable but with extraterrestrial intelligences, we are looking here for something, which may exceed our level of knowledge easily. Thus, by excluding the assumption of significantly advanced, not yet existing physics or technology, we unnecessarily restrict the search based on the current, in the context of SETI, surely very limited scientific and technological state. This is especially remarkable against the background of new discoveries in the last century especially in quantum physics but also known large gaps in cosmology and theoretical physics.

To use a metaphor for our current classical search methods, we can recall a small story from Paul Watzlawick [8]: "A drunk man is looking for something under a lamppost. A policeman comes up and asks him what he missed. The man replies: 'My keys.' Now there are two looking. Finally, the police ask the man if he is sure he lost the key right here. The man responds.' No, not here, but back there, but the light is better here"'. The story is an example for the strategy of "more of the same", which never solves the problem.

So, what we need are really fundamentally new search strategies, which accept the possibility of more advanced civilizations then ours and assume the use of technologies far from ours used today. We should not only look under the lantern but also beyond it. What we need is a real paradigm shift and the courage to pursue new approaches, without knowing the result.

To summarize this chapter in short:

1. We didn't find anything with existing methods

2. existing strategies forbit assumptions which are outside of the current state of physics and does not allow assumptions on a much further developed physics, although further developed civilizations might already have a better physical understanding than we

3. The main reason, why we didn't find anything yet is, like in the story of Paul Watzlawick, we are only looking under the lantern

4. HYPER-SETI

4.1 The basic idea

The only way to solve a stuck problem is to completely change the solution strategy and think of solutions, previously unthinkable or unconventional. This applies to all kind of problems in the world and should inspire us for the SETI case too.

Based on this principle consideration, HYPER-SETI concentrates on not, what we cannot do but rather on what would be necessary. So, in short, the HYPER-SETI proposal is as follows:

Main hypothetical assumptions:

1. There exist Intelligent live beyond Earth and

2. A number of them have managed to solve at least some of the important questions in physics and cosmology that we still have (e.g. understanding the combination of quantum physics and the theory of gravity, entanglement, zero point energy, dark matter and dark energy and even the hypothetical possibility of parallel universes) and made faster than light (FTL) communication/travel already possible

3. The answer to the fermi paradox is in general a combination of all the possible answers discussed with the exception on the non-existence of intelligent live beyond Earth (A), but especially B.4. (incompatibility, misinterpretation/ignorance)

4. The most effective search method is to concentrate our own existing technical capabilities on the search for unusual signatures/side effects ("Hyper-SETI") in which the potential of a new (so far undiscovered) technology could lie that can overcome the speed of light.

5. This is mostly based on the hypothesis mentioned in B.4. as our search was not focused on B.4. up to now. It overcomes the problematic strategy of "more of the same".

6. Only in this way is effective interstellar communication (perhaps even transportation) possible in the long term. And this is why other communication channels are usually not used by highly advanced civilizations.

In addition, classical SETI should still be continued in parallel, since civilizations with a comparable level of development could nevertheless exist and use them in the vicinity of Earth.

4.2 Signatures

Of course, there are a lot of questions involved with such a courageous strategy. And maybe not all of them can be answered satisfactory yet. But it is worth trying in order to overcome the “more of the same” issue.

Among the practical questions that arise from the proposal, perhaps the most important question is whether it is even possible for us to detect signatures of a hypothetically assumed form of communication/transportation that is completely unknown to us. And if so, how exactly? What would such signatures look like? How can we practically search for them?

There is a possibility that the technological distance is too great for us to even recognize it as such. However, even if the underlying technology is not known and cannot be detected and decoded directly, it would still be possible that the use of this technology would result in an interaction with the environment known to us, which we could in principle observe in the electromagnetic spectrum.

The key point is, that these signatures *must* necessarily present themselves as deviations from the current models of the physical world known to us around us, since we do not know them (otherwise they would be known phenomena/objects of some kind). By using such a search strategy, we also could discover new natural phenomena, which has nothing to do with extraterrestrial intelligences. This alone would be worth investing in such projects.

Therefore, the search for exactly such “unknown” signatures by intention is worthwhile. In the history of science many discoveries were made by chance, because of something, which disturbed the standard model and was later found to be a new phenomenon, such as the cosmic background radiation. Almost all payloads of satellites, interplanetary probes or rovers have very specific instruments. Thus, they are by far not able to detect something unusual beyond their planned specific measurements. The interpretation of the resulting data is mostly done by humans, who may or may not detect something unusual, If not searching for it by intention.

HYPER-SETI tries to find such anomalies by intention. As mentioned above, as a side effect, also

new natural phenomena could be discovered, even if they have nothing to do with extraterrestrial communications.

So, still the question is how exactly could we search for anomalies by intention?

First, we need to think about how exactly anomalies could be characterized. Because characterizing something unknown could be very difficult as we don't know what it looks like. But nevertheless, this is absolutely necessary because otherwise we will not be able to develop sensors that are aimed at a specific target. In the design of space-based remote sensing missions, for example, one of the first steps is to characterize the objects to be observed in order to then design the sensors in such a way that the observation succeeds as well as possible. Observing forest fires from satellites places completely different demands on the sensors than, for example, measuring the composition of the atmosphere.

To answer the question of how anomalies might look and how we might become aware of them, the following strategy is proposed here that processes multiple paths simultaneously and in parallel. On the one hand, we can look at examples of anomalies from the present and the past and then search for similar features. On the other hand, we can develop intelligent sensor systems, with the ability to learn how the environment normally looks like and react, if something unusual occurs.

To summarize some of the concrete proposals, which type of signs would be unusual and for which we should look at:

I. Sudden, short-term unexpected occurring iluminous phenomena such as the ones observed in Hessdalen, Norway [9], sprites, known to us since the 90's, Fast Radio Burst (FRB) from deep space, or terrestrial gamma radiation bursts. The technical difficulty in this type of search, is that we don't know, when and where such a phenomenon occurs and the very short duration of the phenomena.

II. We can search for geometric formations, features, objects or phenomena, such as the holes on the surface of Mars, which were discovered from satellite imagery shown in Fig. 2, the Fairy circles in Namibia or Saturn's hexagon. These are all interesting geometric forms that rarely occur in nature, unknown before and their discovery was a surprise, so they were "anomalies".

III. On the other hand, we can build unsupervised self-learning systems that would independently observe the environment and learn its normal appearance or behavior. This is especially useful, as such a system could be used on different locations, planets and environments. Also, the environment can change slowly, such as the change of seasons on Earth. As a simple example we can imagine a person who walks through a desert and learns independently over days and weeks how the environment in the desert normally looks like. A branch, which suddenly appears in the otherwise only sand desert, would immediately attract the attention of everyone and would be interesting. Of course, it becomes more difficult if the environment is more complex, but the principle is the same.

It is almost superfluous to say that most of the phenomena observed in this way, after a thorough scientific investigation, will turn out to be known phenomena. But it offers the potential to discover something really new, which does not necessarily have anything to do with extraterrestrial communication.

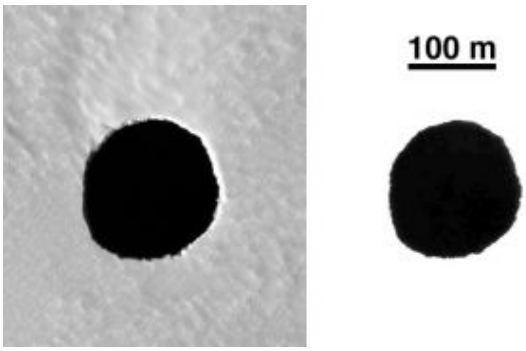

Fig. 2 Deep hole on Mars [10]

These new to be discovered anomalies on Earth, on planets or in space could be previously unknow natural phenomenon but there is also a chance, that they could be signatures or side effects of any kind of extraterrestrial intelligent communication or transportation. In contrast to SETA, with HYPER-SETI the search is open to any kind of signature, not only probes of some kind.

4.2 Main objectives and needs

Main objective of a system, which follows the HYPER-SETI strategy, would be to continuously observe the environment with the intention to detect anomalies.

Based on the previously discussed examples of how anomalies could look like, the system must be able to autonomously detect, record and report such observations. Observations should be done in different wavelengths but especially in shorter wavelengths such as the ultraviolet, since we can expect, that side effects of communication could be related to high energy levels for very short durations.

The system must also ignore all types of known objects and phenomena's in the sensor data to reduce the false alarm rate, so that human interaction could be as low as possible. There are many examples for known natural or artificial objects or features such as insects, birds, planes, satellites, planets, stars, etc., which could be learned by the system to differentiate using a set of rules and modern data processing algorithms such as neural networks. Of course, depending on the location of the observatory, disturbing natural or artificial objects will be different in kind and number.

There is already some relevant technical experience within the professorship of space technologies of the author. Three examples can be mentioned here. A system to detect meteors and other transient luminous phenomena's using an all sky camera and a neural network system to support the research of the Hessdalen lights. Another similar sensor system is used to detect transient lunar phenomena (TLP) on the moon using a telescope on Earth. With SONATE, a nanosatellite (3-U Cubesat) has been launched in July 2019 as a technology demonstrator for on board autonomy and autonomous sensor systems into an Earth Orbit [11]. Larger and more intelligent next versions of SONATE, equipped with a couple of sensors for different wavelengths, including neural network processors, could be an example of how to search for short, luminous anomalies in space or on the surface of celestial objects such as the Moon.

As the search locations, the field of view of the sensors and type of sensors can be very different, what is in fact needed is a "system of systems", which is able to cover a large observation area. As an example, it could be a satellite constellation with a number of satellites observing the Earth's near space and atmosphere, combined with a network of multispectral all-sky observatories on Earth, all connected to appropriate data processing centers. This could be done in a similar way on the Moon or Mars and could be combined.

One important aspect of such a search strategy is, that it must be interdisciplinary. Thinking of the examples from the previous chapter, it is clear, that to decide whether an observed phenomenon is new or not, multiply experts from different areas must be included in the analysis of detected signatures as the phenomenon might for instance have a astronomical, chemical, physical, meteorological, biological or technical explanation. The Interdisciplinary Research Center for Extraterrestrial Studies (IFEX) has been founded with this idea in mind at the Faculty of Mathematics and Computer Science, University Würzburg in September 2016. One of the activities of IFEX was a feasibility study for a Nanosatellite Mission Concept for Optical SETI already mentioned before [6].

4.3 System architecture

Having the main objectives and needs in mind, the system architecture would involve an intelligent multisensory system (IMS) as a key element. Although such IMS's may contain different types of sensors, depending on their mission, one common characteristic of all of them would be the intelligent sensor processing system using artificial intelligence techniques. It is essential that these IMS's must operate in a highly autonomous way because of the long transmission delays, when placed at the planets or moons of the solar system and to reduce operational costs.

Fig. 3 show the basic principal function blocks of such an autonomous IMS with multiply sensors and an intelligent data processing system.

The IMS's could be placed on board of satellite constellations, planetary rovers or observation stations on asteroids, moons and planets in our solar system or on Earth. Fig. 4 demonstrates a possible system architecture using a number of planet and space based IMS.

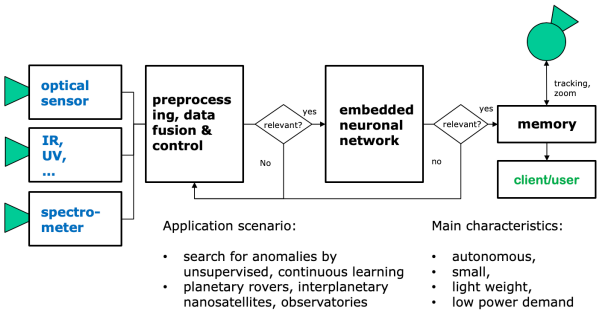

Fig. 3 Intelligent multisensory system

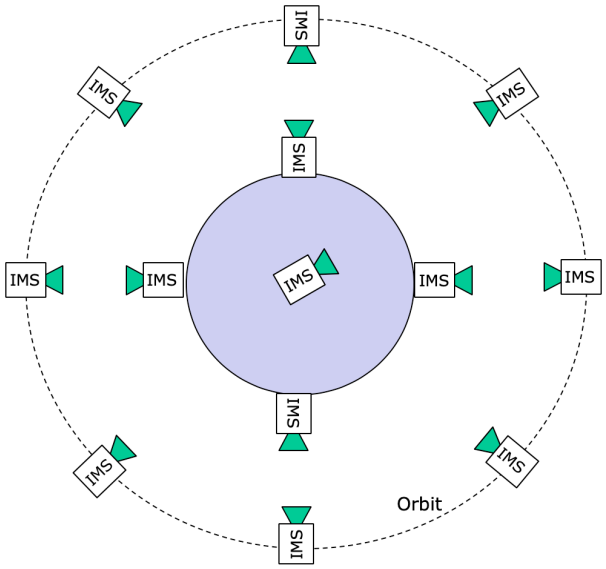

Fig. 3 A possible system architecture

5. Conclusions

In this paper a new search strategy for extraterrestrial intelligence, called HYPER-SETI, is proposed. The main idea of HYPER-SETI is to overcome the possible "more of the same" problem in classical SETI by assuming hypothetically, much more advanced civilizations, who have already answered several very fundamental, simply still unanswered questions of today's cosmology and physics mentioned in 4.1. and managed to communicate or even travel at speeds faster than light.

This assumption, like many other assumptions, with which new theories start and are further developed before they are proved, does not involve any non-scientific consideration. The basic reason why we should assume such a far-reaching assumption is, that today we simply still make observations in space and on Earth, which cannot be explained by existing models in several scientific disciplines, so that there is still much room for improvement in science and technology.

By seriously accepting such an attitude, we can use existing strict scientific methods and technological tools to search for intelligent, extraterrestrial signatures of *any* kind and would not limit ourselves unnecessarily to the level of our today's knowledge and technology. Such signatures do not necessarily have to be the decodable communication itself. It could also be side effects, which might appear in the interaction process from an unknown source or origin. But they would possibly be observable by conventional, advanced, autonomous sensors, which are capable of distinguishing known phenomena from the unknown as much as possible. New technologies such as methods of artificial intelligence would help in this context a lot for the automatization of such a search.

The key point is, that these signatures *must* appear as unknown phenomena to us and that we should expand our search for such signatures by intention.

The following conclusion of Carl Sagan and the group of authors in their "Extraterrestrial Intelligence: An International Petition" [12]:

"We are unanimous in our conviction that the only significant test of the existence of extraterrestrial intelligence is an experimental one. No a priori arguments on this subject can be compelling or should be used as a substitute for an observational program. We urge the organization of a coordinated, worldwide, and systematic search for extraterrestrial intelligence"

is still accurate and applicable. But we must significantly extend our search strategies as proposed in this paper and go beyond the classical way, for which the term "hyper" in HYPER-SETI stands for.

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