A glint in the eye: photographic plate archive searches for alien visitations

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ABSTRACT

An advanced extraterrestrial civilisation that has discovered the Earth might have sent probes here. In this paper, we present a simple strategy to identify Non-Terrestrial artefacts (NTAs) in geosynchronous Earth orbits (GEOs). We show that even the small pieces of reflective debris in orbit around the Earth can be identified through searches for multiple transients in old photographic plate material exposed before the launch of first human satellite in 1957. In order to separate between possible false point-like sources on photographic plates from real reflections, we include calculations to show that at least four or five point sources along a line within a 10°×10 arcmin² image box are a good indicator of NTAs, corresponding to significance levels of 2.5 and 3.9σ. The given methodology will be used to set an upper limit to the prevalence of NTAs with reflective surfaces in geosynchronous orbits.

Keywords: VASCO — transients — SETI — glints – probes

1. INTRODUCTION

The searches for technosignatures have never been more fashionable and received more attention than in recent years. The Searches for Extraterrestrial Intelligence (SETI) have been carried out in the radio band since the 1960s (Cocconi & Morrison 1959; Drake 1960), and since 2015, the Breakthrough Listen (see e.g. Lebofsky et al. 2019; Price et al. 2020) initiatives have deployed the world’s most capable radio telescopes in the most robust SETI effort undertaken to date. China’s FAST radio telescope is also conducting SETI observations. While most SETI searches have been carried out in the radio, there may be more reasons to believe that artefact searches and optical transient surveys will turn out more successful (Shostak 2020; Davenport 2020). Both targeted and untargeted laser searches are taking place (e.g. Tellis & Marcy 2017; Villarroel et al. 2020a; Isaacson et al. 2007; Marcy 2021). Meanwhile, alternative ideas for how to search for ET are flourishing, one after another (Singam 2020; Socas-Navarro 2021). Many of these ideas deal with searching for ET far away, in distant galaxies or around other star systems rather than our own.

Of the different research topics within SETI, solar system SETI has received far less attention than other topics. This is paradoxical, as humans have demonstrated capacities to send exploratory probes to other stellar systems. For example, the Breakthrough Starshot program plans to launch a probe to Alpha Centauri within twenty years. If humans have these capacities, it is thus natural to search for alien probes or other so-called “Non-Terrestrial Artifacts” (NTAs: Bracewell 1960; Haqq-Misra & Kopparapu 2012) inside our Solar System.

In this paper, we present an overlooked and, in terms of feasibility, simple SETI strategy. It attempts to answer the question whether any space-faring civilisation has surveilled the Earth by means of probes at any point in history. A space-faring civilisation in the distant past (> 100,000 years ago) may have sent probes to explore the Earth and under these circumstances, some of these probes are likely to have remained in high-altitude orbits around Earth. Of particular interest are the geosynchronous earth orbits (GEOs) used by communications satellites. GEO satellites nearly always remain over same spot on Earth. It is tenable that the GEOs were...
also used by another civilization to study Earth. A probe or spacecraft no longer in use, will disintegrate into space debris, that in principle survives for millions of years at the GEO, before gravity clears the orbits and collisions disintegrate eventual probes into minor pieces of only a few centimeters in size. It has been shown that radiation pressure (Socas-Navarro TechnoClimes 2020) does not remove debris at GEO orbits, at least not on Myr timescales.

Satellites that are uniformly illuminated at low- or medium altitude orbits leave clear streaks in the exposures from old photographic plates as they move at speeds of hundreds of arcseconds per second. At higher or GEO altitudes, the presence of satellites or space debris can be detected by fast, transient glints caused by the reflection of the Sun. When the reflective surface on the satellite coincides perfectly with the position of the observer and the Sun, a short but powerful glint can be observed. Despite the movement of the satellite, a short duration glint has a PSF-like shape – indistinguishable from fast astrophysical transients e.g. afterglows from GRBs or FRBs. Indeed, those who search for astrophysical transients know that most of the transients found in the automatized transient surveys today are just solar reflections from artificial objects in GEOs. These solar reflections usually happen on short time scales $t \sim 0.2$ or 0.4 seconds (Nir et al. 2020; Corbett et al. 2020; Karpov 2016) and with peak magnitudes ranging from 9 − 11 mag, corresponding to sizes of a few tens of centimeters. Sometimes, multiple transients happening within a few minutes from each other within the same field of view (Nir et al. 2020).

Searches for glints have indeed taught us a valuable lesson about space debris. We know now that the majority (75 %) of glints from the GEO are not associated with any known object listed in the USSTRATCOM catalogue and must be centimeter-sized space debris (Blake et al. 2020). This space debris, will not disappear tomorrow, nor the day after. The environmental damage done by more satellite launches, leaves a deleterious imprint on our close Earth environment that cannot be easily undone. All this together, demonstrates the need to carry out careful searches for non-human artificial objects at the GEOs.

To search for these structures in modern surveys as Pan-STARRS (Chambers 2016; Magnier et al. 2016a,b,c; Waters et al. 2016; Flewelling et al. 2016) or Evryscope (Law et al. 2016; Ratzloff et al. 2019) is a colossal challenge requiring fine modeling of tracks and surveys due to all the human contamination. Lacki (2019) proposes a program capable of detecting glints with large “spot size” from artificial, spinning objects located further than the Moon, where each glint could last for hours, rather than seconds, and leaving a “train” of glints in the eyes of the observer. While, in principle this is correct, dedicated search efforts in modern sky surveys are costly and time-consuming.

In this article, we show how open-ended programs such the Vanishing & Appearing Sources during a Century of Observations (VASCO; Villarroel et al. 2020a,b) are extraordinarily well suited to detect signs of artificial structures in the GEOs or even low-Earth orbits while comparing old photographic plate material of our sky, taken before the first satellite was launched in 1957, with modern imaging. While the VASCO program aims to search for vanishing stars, its methodology is capable of discovering other, unexpected features in the data. By piggybacking on VASCO’s “vanishing star” classifications, one has ample opportunity to collect glints from artificial objects.

In Section 2 we discuss the possible origin of reflective artefacts in GEOs. In Section 3 we discuss the lifetime of space debris in GEOs. In Section 4 we present specific signatures to be look for in photographic plate material, and include examples of what has been found so far. Finally, in Section 6 we discuss how the GEO satellites present the simplest, and most overlooked, technomarker in SETI and why programs such as the VASCO project (Villarroel et al. 2020a,b) has among the best probabilities of a first detection of artificial remains near our Earth – assuming their presence.

2. THE ORIGIN OF NON-TERRESTRIAL ARTEFACTS

The possibility of the presence of non-human technology, or NTAs, in our Solar System has been explored mildly and mostly on the theoretical level in the astronomical literature (Gertz 2016, 2020). Despite the strong arguments to run searches for Solar System artefacts, so far there have been too few observing programs to support the conclusion that the Solar System is devoid of NTAs (Haqq-Misra & Kopparapu 2012). In contrast, the prospect of NTAs has been indulged in with greed in the popular culture and science fiction literature.

If one considers NTAs, there could be two kinds. First, are objects that are operational or “active” which may appear as unpredictable transient events. The second category are objects that are non-operational or “passive” whose orbits could be predictable (and the glint timing, depending on the underlying geometry of the structure and if it spins).

Into the first category, enters both piloted and unpiloted exploratory probes from other civilisations.
Since we ourselves plan to send probes to another stellar system through *Breakthrough Starshot*, it is therefore natural to assume that another civilisation might be equally interested to explore our Solar System, provided the possibility (Bracewell 1960). Some of these probes could be in clear orbits around Earth or pass through the Solar System. Albeit heavily debated (see e.g. Curran 2020), it has been proposed that the *Oumuamua* interstellar visitor is a space-craft (Bialy & Loeb 2018) due to some of its anomalous features.

Alien probes could reside in plain sight on the surface of the Moon, asteroids, trojans, minor planets or Mars (Haqq-Misra & Kopparapu 2012; Davies & Wagner 2013). Such objects might reveal themselves through radio or microwave or visible light emissions (Loeb & Turner 2012). While the main Lagrangian points have been investigated for probes to some degree without finding anything (Freitas & Valdes 1980; Valdes & Freitas 1983), lurking probes might discretely hide in co-orbitals (Benford 2019, 2021). A recent article (Socas-Navarro 2021) has proposed various missions using ultra-high resolution imaging in combination with machine learning techniques, that could help to investigate probes on other planets or bodies. An active effort in space archaeology today, is the newly launched *Galileo* project\(^1\) that looks for interstellar visitors and unexpected aerial objects within Earth’s atmosphere.

The second category of passive objects might seem more tricky to explore. Let us say, for example, that a long time ago (tens of thousands or even millions of years) a space-faring civilisation sent probes to the Earth. Having fulfilled its mission or run out of fuel, the advanced civilisation lost contact with its probes, leaving inert shells of the probes behind. These probes could still lie in orbit around the Earth (or further out in the Solar System). They could follow low orbits, moderate-height orbits, geosynchronous ones or even reside as high as the graveyard orbits, where we tend to place dead satellites. They could be alone or in groups. If any object has a surface made out of a reflective material, this surface may occasionally glint. Even a piece of metal that has broken off any of these machines, will glint. Other materials with high albedo, e.g. certain polymers, can also have the necessary reflective surface.

We can also consider some other scenarios. What if there previously existed a civilisation on Venus, Mars or even Earth itself, a so-called *prior indigenous technological species* (Wright 2017; Schmidt & Frank 2018)? Even if there are some technological signatures one expects a previous civilisation on the Earth to leave on the surface of the planet, plate tectonics wipes out the geological records on a time scale of million years on Earth. However, according to those who support the controversial concept of the Anthropocene, some evidence for any advanced long past technologically advanced civilisation on Earth might persist despite plate tectonics, for example if they launched objects into orbit. For Venus, we already know that liquid water was on the surface of the planet for about 3 billion of years during its habitable period during which complex life might have emerged (Way 2020), until 700 million years ago. Mars, appears to have been too cold, although surprises can still emerge. Plate tectonics would destroy many signs of previous civilisations. The advantage of searching for NTAs of previous civilisations in space itself, is that there is no plate tectonics in space. We could potentially see leftovers from previous civilisations – provided that the civilisation did not exist too long time ago (several billion years ago) as the orbits are likely to have been cleared from artefacts during such a long time period.

### 3. LIFE-TIME OF JUNK IN SPACE

The amount of space debris in orbit around Earth is huge. It is estimated that about 34,000 objects larger than 10 cm are known to exist; small objects ranging between 1 to 10 cm in diameter is approximately 900,000, and there are 128 million (!) particles that are even smaller (ESA 2021). Among all this space debris, an alien probe might hide.

Assuming that another civilisation has left NTAs at the geosynchronous orbits, how long could reflective pieces of e.g. metal or glass (or other reflective materials) actually stay in orbit? The determining factors here are (1) gravity: debris at too low altitude, will fall back to Earth within a few years. (2) collisions with natural objects will break the objects into many smaller ones, but also push some out of orbit, and (3) radiation pressure from the sun. Wright (2017) argues that these natural factors can make the artefacts survive less than a few Gyr in orbit. The orbits might further drift over long time scales.

The question of how long objects can stay in a geosynchronous orbit around the Earth was approached by Socas-Navarro (TechnoClimes 2020), that sought to estimate how long a “Clarke exobelt” around another star could be visible from Earth. A Clarke exobelt is a thick belt of debris at a geosynchronous orbit seen in the transit light curves of exoplanets, which makes it useful as a technomarker (Socas-Navarro 2018). The author estimated that given the currently accelerated rate of satel-

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\(^1\) https://projects.iq.harvard.edu/galileo/activities
lite launches, within 200 years the Earth will have a detectable exobelt. He also estimated that these satellites can survive on orbit for Myrs, making the technomarker extensive in time. The satellites will be subjected to collisions among each other, that will cause the pieces to break into smaller fragments, that will cause a larger spread over the belt. Some objects might have high density, while others have lower, which means that they too have different ballistic coefficients and not all of them will be equally prone to stay in orbit. Another consequence of the collisions, is that the cross-section of the fragments is larger than of a single object, making it more likely to detect both a “glint” from Earth, or a Clarke exobelt around another planet, if collisions have taken place to a large degree. Socas-Navarro (Techno-Climes 2020) therefore assesses that the survival of objects on the GEO is at minimum $\sim 10^5 - 10^7$ years if only considering the collisions, and likely on $\sim$ Gyrs time scale.

An entirely different problem, not touched upon in this work, is how long a piece of flat metal or glass might stay in space and remain reflective, given collisions with dust grains and possible radiation damage.

4. SIGNATURES IN PHOTOGRAPHIC PLATES

So how do we actually, in practice, recognize signs of artificial objects in the pre-satellite images? At low orbits, one could look for satellite streaks. Figure 1 shows how the illumination of satellites make them visible. The typical low-orbit satellites that we normally see with naked-eye do not emit any light themselves, but are visible through the reflection of sunlight. They cannot be observed during daytime because of the brightness of the sky, and in the night they are mostly in Earth’s shadow (most of the night). That means, they are mostly visible before the sunrise or after the sunset. We see them as fast-moving point sources, giving rise to long, continuous streaks in images of long exposure. A satellite whose reflective surface is spinning gives rise to dashed or broken lines. Continuous streaks may often be confused with natural objects e.g. meteors or asteroids. Small signs can help to distinguish between meteors and satellites, for example fainting edges. Another signature is that if one has images of the entire sky, one knows that the satellites that are bound to Earth follow an arch, while meteors go along straight lines. Asteroids often tumble, and moreover, can be identified through the JPL Horizon list of known asteroids. Also they have fainting edges in their streaks, as seen in Figure 2.

At the geosynchronous orbits, what one may see is a glint, when the Sun, the observer and the reflective surface are in perfect alignment. Of course, this is provided that the satellite is not residing in the Earth’s shadow, as the sunlight will not make it glint here (although, satellite lasers could). At the higher altitudes, the shadow cone of the Earth is much smaller. Two years ago, the glint rate of human satellites (McDowell et al. 2020) observed from Earth was 340 glints $h^{-1}sky^{-1}$ with $V < 4$ mag or 740 $h^{-1}sky^{-1}$ in dark places with a visibility reaching $V \sim 6$ mag, where $h$ is hour and $sky$ means the whole sky. Around the equator where many telescopes are located, about 1800 glints $h^{-1}sky^{-1}$ are expected as many satellites follow geostationary orbits and cluster near the equator.
From a single glint on an astronomical image, it is nearly impossible (if not impossible) to guess whether it is a real, short-lived transient or a satellite glint from just the PSF. For example, a recent paper (Jiang et al. 2020b) reported an extremely unlikely GRB flash from the highest redshift galaxy we know of, at $z \sim 11$ (Jiang et al. 2020a). It did not take many weeks until several new groups showed that the observation was not a real transient, but a satellite glint, see e.g. Steinhardt et al. (2021). Therefore, what we actually need for our searches is an indicator that cannot be confused with any natural phenomenon and is unlikely to be an instrumental defect. We examine the ways satellite glints manifest themselves observationally in data. Beyond the presence of a single glint, the VASCO citizen science project could discover such artificial objects in additional ways:

- **Multiple glints with PSFs.** Especially, this should be seen in the Kodak 103-aE emulsions (red plates) that more easily captured reflected sunlight (Fig. 3). A variation on the theme, is a streak that seems to have embedded glints, caused by a variation in brightness that is shorter than the exposure time.

- **Repeating glints.** Repeating glints with typical PSFs along a straight line, cannot be caused by any natural object nor by any type of plate defect (Fig. 4). They arise when one single fragment of an object on a particular orbit reflect the sunlight. These glints can be, although they do not have to be, equidistantly distributed along the line.

- **Triple glint.** A triple glint could be indicative of a rotating dish (Fig. 5).

On top of this, any object moving relative to the geostationary, will leave trails. These trails might look like streaks, either continuous or with brightness variations depending on the shape of the object. When the variation in brightness is longer than the exposure time, a line of varying thickness will result. These streaks, may however be easily confused with an asteroid.
It is premature to argue that simultaneous transients represent alien artefacts even if they were observed years before Sputnik I was launched. For instance, contamination or emulsion defects maybe could create false imprints on old photographic plates, only discernible with a microscope. We need therefore another indicator. The smoking-gun observation that settles the question unequivocally, is the one of repeating glints with perfect PSFs along a straight line in a long-exposure image.

When an object spins fast around itself and when its reflective surface faces the Earth, some of its parts could reflect sunlight. That results in multiple glints following a trail in an image. The number of glints might depend on the geometry and the speed of the rotation of the object. An object with only one single reflective surface that spins slowly will produce fewer glints than an object with several reflective surfaces that, moreover, spins...
Figure 5. Triple glints. An example of repeating glints in a red POSS-I image from 1950s. The left column shows the POSS-I image, and the right column the Pan-STARRS image (> year 2015). The example is from Villarroel et al. (2021) and uses the VASCO citizen science web interface.

fast. From the period one can also determine the shape of the glinting object.

The exciting aspect of these suggestions is that precisely this type of objects are expected to be found during the course of the VASCO project (Villarroel et al. 2020a,b). Among the many objects classified as “Vanished”, we expect to find both single and multiple glint objects. Also through automatized methods, we hope to identify every case of multiple glints within a small area of $10 \times 10$ arcmin$^2$, and see if any of these represent cases where the glints follow a straight line.

The estimated number of “multiple transients”, real or false, expected in, e.g., the POSS-I image data was estimated to about $\sim 0.07 \ h^{-1}sky^{-1}$ Villarroel et al. (2021). That is negligible in comparison to the current number of satellite glints an astronomer at a telescope near the equator sees today, $\sim 1800 \ h^{-1}sky^{-1}$ (McDowell et al. 2020). Of these, we expect that less than half will show at least three transients following a straight line.

In general, the method may lead to some cases being lost. An object covered in dark material, or an object that has been subjected to harmful radiation over a very long time while in orbit, may be significantly less reflective. Also objects having only one small, reflective surface, might only give off one single glint.

5. ESTIMATED PROBABILITIES

To quantitatively grasp the likelihood of how multiple transients along a line represent satellite glints, we need to estimate the expectation value for the number of such alignments that would occur by pure chance. We do so by investigating $r$-point alignments, where $r$ is the number of transients along a straight line within a given field.

The simultaneous transients presented by Villarroel et al. (2021) appear to have three 3-point alignments in a cluster of just nine transients located in a $10 \times 10$ arcmin$^2$ region. This may seem very improbable, but 3-point alignments are more easily created by chance than one might think. Following Edmunds (1981); Edmunds & George (1985) we have that the expected number of 3-point alignments in a population of $N$ points (transients) defined by a strip of length $d$ and width $2p_{\text{max}}$ located within an area $A$ on a plate is

$$\mu = \frac{2\pi}{3} \frac{p_{\text{max}} d_{\text{max}}}{A^2} N (N - 1)(N - 2), \quad (1)$$

where $d_{\text{max}}$ is the maximal length of the strip/alignment, so that $d \leq d_{\text{max}}$. If $N = 9$, $A = 100$ arcmin$^2$, $d_{\text{max}} = 10$ arcmin, $p_{\text{max}} = 1.7$ arcsec (equal to image resolution) we get $\mu \approx 3$. If we assume $A$ is a circular-disc domain with an diameter 10 arcsec instead of $A = 10' \times 10' = 100$ arcmin$^2$, the expectation value reduces to $\mu \approx 1$. Thus, we conclude that $\mu \sim 2$ is a reasonable estimate. In the image from Villarroel et al. (2021) the actual number of 3-point alignments is 3.

Clearly, we cannot argue that finding a 3-point alignment is indicating anything. Not even two 3-point alignments in nine data points rises to the level of statistical significance. But what if we look for 4-point alignments? How likely is it that the above example would include a random 4-point alignment? Generalisation to an $r$-point
alignment gives the formula (Edmunds & George 1985),

$$\mu = \frac{\pi^{r-2} n^r p_{\max}^{-2} A}{\Gamma(r-1)} \int_0^{d_{\max}} x^{r-1} e^{-2x n p_{\max}} \, dx,$$

(2)

where \( n = N/A \). For \( 2d_{\max} p_{\max} n \ll 1 \) (which is applicable here for the most part) this formula reduces to

$$\mu \approx \frac{\pi^{r-2} n^r p_{\max}^{-2} d_{\max} A}{r (r-2)!}.$$

(3)

Using the above, we see that \( \mu \sim 10^{-2} \) if \( r = 4 \) and \( \mu \sim 10^{-4} \) if \( r = 5 \). Thus, a multiple transient event showing a 4-point alignment is perhaps sufficiently improbable to be a trustworthy indicator of a repeatedly glinting reflective material.

Using the equation (2) above we can also explore the number of expected \( r \)-point alignments from a more general point of view. In Fig. 6 we show expectation value for the number of \( r \)-point alignments within an area \( A \) containing \( N \) points (transients/whatever), assuming \( d_{\max}/p_{\max} = 353 \) for consistency with the case considered above. The blue zone corresponds to alignments that we can expect to occur by chance in almost any set of points distributed in a plane. The red and yellow zones are more interesting as the expectation value is very low and such alignments, of 5 or more points, are so extremely improbable to happen by chance that the only reasonable explanation is a series of glints from a near GEO object. As we have already pointed out, even a 4-point alignment is an unlikely event, but a 1/100 probability (\( \sim 2.5 \sigma \)) is not enough to completely rule out a random alignment. A five-point alignment is much better with a 1/10000 probability is much better (\( \sim 3.9 \sigma \)). We note also that the number density of points/objects is a key parameter: already at \( n = 20 \) a 5-point alignment can easily happen by pure chance.

6. DISCUSSION

In this paper, we have discussed a variety of signatures of artificial objects near Earth and how they can be detected in pre-satellite imaging data. We demonstrate that the cleanest signature are fast glints from reflective pieces at geosynchronous orbits. As described in the Introduction, glints happen when the observer, the sun and the object are perfectly aligned so that the observer sees the sunlight reflected off the objects’ reflective surface. Particularly bright and fast glints, happen when the objects are small and flat and mirror-like, e.g. artificial structures found on satellites and space debris. A rocky surface as one of an asteroid, does neither have the shape nor the necessary reflectivity to create the strong subsecond glints an artificial object can create.

![Figure 6. Number of expected occurrences s of r-point alignments within an area A containing N points.](image)

A glint seen from a satellite or space debris is often point source-like, with a PSF similar to a natural transient, even when the object is moving. This is a consequence of that the glint is very fast while the seeing of the observation is imperfect with FWHMs > 1.5 arcsec. For example, objects that move at geosynchronous orbits at typical speeds of e.g. 15" per second in images with a seeing around \( \sim 1.5 \) seconds, will acquire a PSF-like shape if they glint faster than 0.1 seconds. In old photographic plates such as the First Palomar Sky Survey (POSS-1) plates, the seeing is sometimes significantly worse than what is typical in CCD-based observations (\( \sim 1 - 1.5 \) arcsec).

In the curious case of simultaneous transients described in (Villarroel et al. 2021), the seeing was as high as \( \sim 7 \) arcseconds. A seeing of 7 arcseconds, means that a glint from an object that travels 15"/second during the exposure time has to be faster than < 0.5 seconds in order to look like a PSF. For the curious case of the simultaneous transients, they were found on long-exposure red emulsion images of 50 minutes. Such a long exposure, will necessarily dilute the observed flux. Under the assumptions that these transients represent real observations, the observed POSS-1 magnitudes of the simultaneous transients must have been diluted with the long exposure time. We can estimate how much, by us-
ing the exposure time of the POSS-1 plate – about 50 minutes (or 3000 seconds) – and assume the 0.5 seconds long glint of a geosynchronous satellite. This leads to a flux dilution by a factor of 3000/0.5s ∼ 6000, which corresponds to a reduction of about 9.4 magnitudes to the actual glint. We apply the correction to the simultaneous transients listed in Table 1 of Villarroel et al. (2021). Only 5 out of 9 transients have their POSS-I magnitudes listed: three were not included as they did not have follow-up observations, and one was in an overcrowded area. Nevertheless, we show the histogram of the 5 listed sources with and without correction for exposure time dilution, see Fig 7. All sources fall perfectly into the expectations of typical apparent magnitudes of glints of Nir et al. (2020).

Provided these are the actual apparent magnitudes of the glints, the sizes of such possible objects must therefore be similar to those observed by Nir et al. (2020), that deduce the actual physical objects to be around a few tens of centimeters if the reflective surface is some type of transparent material, or even smaller of cm scale if perfectly reflective and mirror-like.

As a single occurrence, a case of simultaneously occurring transients in an image should not be taken as an evidence of satellites glinting at GEOs, due to that a single piece of evidence might be the result of some unusual type of contamination or defects. However, their presence supports a controversial question being asked: can we find any signs of potential junk and satellites in orbits around Earth? The best way to search them, is obviously by looking at images taken before human-made objects were sent to orbit the GEOs.

This paper represents a call to the SETI community to use pre-satellite image data to engage in time pressing searches for artificial objects in orbit around Earth, in particular highly reflective ones at high altitude. An object residing in a geosynchronous orbit around our planet may have been there for many millions of years. Intact alien probes or debris from degraded probes can easily be detected even if they might have experienced multiple collisions during this time period. The new Galileo project is preparing to systematically search for these non-human, artificial structures in our modern sky the coming years. However, pre-1957 archival photographic plates turn out to be particularly powerful tools for this science, as the sky was free from human-made contamination in those times.

The clearest signature of solar reflections from artificial, reflective materials in geosynchronous orbits displaying multiple (n > 4) glints along a line in 10 ∗ 10 arcmin² images. Finding a single such case, merits on-site searches. Given the always ongoing satellite launches and human space debris in place at the GEOs, our time window is extremely short, even from a human perspective. We thus urge SETI researchers to perform the searches for glints in photographic plate material and assist in VASCO’s searches for these unusual technosignatures. VASCO’s searches at the moment only target POSS-I data. The same investigations should be conducted with all photographic plate material, including digitized plates from the Lick and Sonneberg observatories and the Cartes du Ciel.

7. ACKNOWLEDGMENTS

The authors wish to thank Geoff Marcy, John Gertz, Ravi Kopparapu, Jacob Haqq-Misra and Hector Socas-Navarro for helpful and constructive comments on the manuscript. B.V. is funded by the Swedish Research Council (Vetenskapsrådet, grant no. 2017-06372) and is also supported by the The L’Oréal - UNESCO For Women in Science Sweden Prize with support of the Young Academy of Sweden. She is also supported by Märta och Erik Holmbergs donation.

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Figure 7. Exposure-time corrected magnitudes. We show the POSS-1 r magnitudes of 5 of the simultaneous transients listed in Villarroel et al. (2021). In the left panel, we show the actual observed POSS-1 magnitudes. In the right panel, we correct for an eventual dilution with 9.4 magnitudes due to a 50 minutes exposure time. All of the exposure-time corrected magnitudes fall into the peak magnitudes of satellite glints from Figure 3 in Nir et al. (2020). In case the transients are shorter than 0.5 seconds, the histogram transforms into one of upper limit for the magnitude, as the effect of dilution will be even greater.