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Citizen Science Astronomy with the Unistellar Network: From Planetary Defence to Exoplanet Transits

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Abstract

Thousands of Unistellar telescopes (light-amplifying, user-friendly devices made for the general public) will soon be sent to people around the world who are eager to observe the universe, from downtown or the countryside, in unprecedented clarity and detail. Every user will also be able to join a global network of observers conducting coordinated, worldwide viewing campaigns under the aegis of professional astronomers. We will describe the potential of the SETI/Unistellar network to do citizen science astronomy, coordinated campaigns conducted with the network, and our key scientific objectives in planetary defense, occultations, and exoplanet transits.

1. Introduction

Unistellar proposes to reinvent popular astronomy through the development of the Enhanced Vision Telescope (eVscope), a compact mass-market device. (Figure 1). The company's main goal is to make observational astronomy far more fun, exciting, and easy to do than it is today, while fostering a strong, growing interest in astronomical research and citizen science.

Figure 1: Five unique features of the eVscope.

1.1 Public Participation and Partnership

There is much to be gained from continuous observations of the night sky using telescopes spread around the globe, and by coordinating observations and sending alerts to users to study faint objects like asteroids or supernovae. Several groups of amateur and professional astronomers, including the International Occultation Timing Association (IOTA) and the American Association of Variable Star Observers (AAVSO), have for decades understood the value of those astronomy networks and the collaborative efforts they make possible.

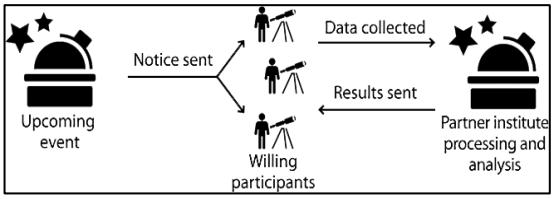

Figure 2: Alert system for citizen science.

In July 2017, the SETI Institute and Unistellar partnered to develop scientific applications for the eVscope network (Figure 2). Because of its sensitivity and ease of use, the eVscope can play a major role in a wide range of research topics linked to planetary defense, exoplanets, and the study of many transient astronomical events. This partnership was also a natural match because the SETI Institute has robust, world-class outreach and education programs.

2. Citizen Science Network

All eVscope owners will be able to receive notifications on their smartphones of transient events visible in the sky, such as occultations by asteroids, the flyby of a NEA, or transits by Jupiter-sized exoplanets (See Figure 3)

- If a campaign is predicted a few days or weeks ahead of time (a.k.a. an occultation or transit) and eVscope owners accept the request from the SETI Institute, they will get instructions on how to conduct observations (location, time, sky quality) along with regular updates from astronomers leading the event.

- If the event happens while they are observing (i.e., a small asteroid flyby), the telescope will interrupt the observation and automatically point to the correct field of view.

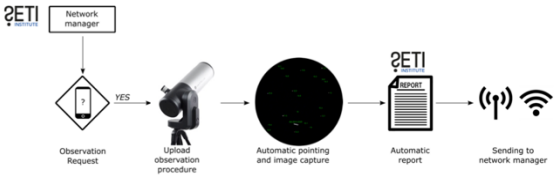

Figure 3: Campaign Mode schematic as designed by Unistellar. In this case, the flyby of the 650m NEA 2014 JO25 was observed in April 2017.

In both cases, the data will be collected while the citizen astronomer observes the event in the eyepiece. After the observations are complete, the data will be sent to the SETI/Unistellar database for processing, analysis, and publication.

3. First Results

3.1 Occultation Events

On January 27 2018, the International Occultation Timing Association (IOTA) predicted that asteroid (175) Andromache would occult TYC 1399-01064-1, a V=11.3 star. Centrality (i.e., the path of the shadow) was predicted to be a few-km-width line that passed near our headquarters in Marseille, France. We designed a fast-frame recording capability for the eVscope with an individual exposure time of 100 ms (which gives us ten images per second). At 18:37 UT, our team saw the disappearance of the star for about eight seconds, at very close to the predicted time.

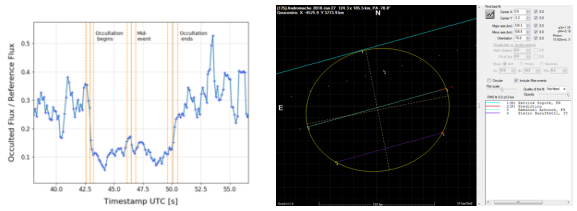

Figure 4: Occultation by the large asteroid (175) Andromache observed with the eVscope. Additional chords were recorded from other observers and the shape of Andromache can be approximated with an ellipse of 124 x 105 km.

The lightcurve clearly shows the occultation event (Figure 4). We measured the timing of the ingress and egress of the event and filled out a report for EURASTER.

Since then we have observed additional occultations involving main-belt asteroids and Pluto.

3.2 Exoplanet Transits

We have recently observed several transits of Jupiter-sized exoplanets, such as WASP-43 b, from Fuveau, France. The transit signature was detected using our pipeline for one telescope (see Figure 5). We propose to build coordinated campaigns of observations with the Unistellar network to support the NASA TESS mission and future ESA missions (KEOPS, PLATO).

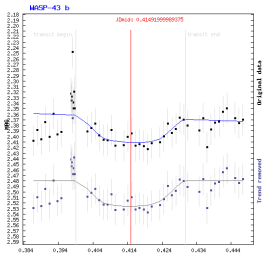

Figure 5: Transit of WASP-43b observed with one eVscope.

We have identified several scientific areas where the Unistellar/SETI network can make important contributions to scientific research:

- Repetitive and coordinated observations of short-period Jupiter-sized exoplanets to accurately measure their size and orbit shortly after their discovery.

- Coordinated observations of transits involving, for example, rare long-period Jupiter-sized exoplanets to confirm their existence, measure their TTV effect, and inspect the areas surrounding these exoplanets (disks, large moons).

4. Conclusion

Thanks to citizen science campaigns such as these, Unistellar users will contribute to astronomy and experience the thrill of astronomical discovery. This project will stimulate interest, curiosity, and dedication to astronomy and to science at large.