



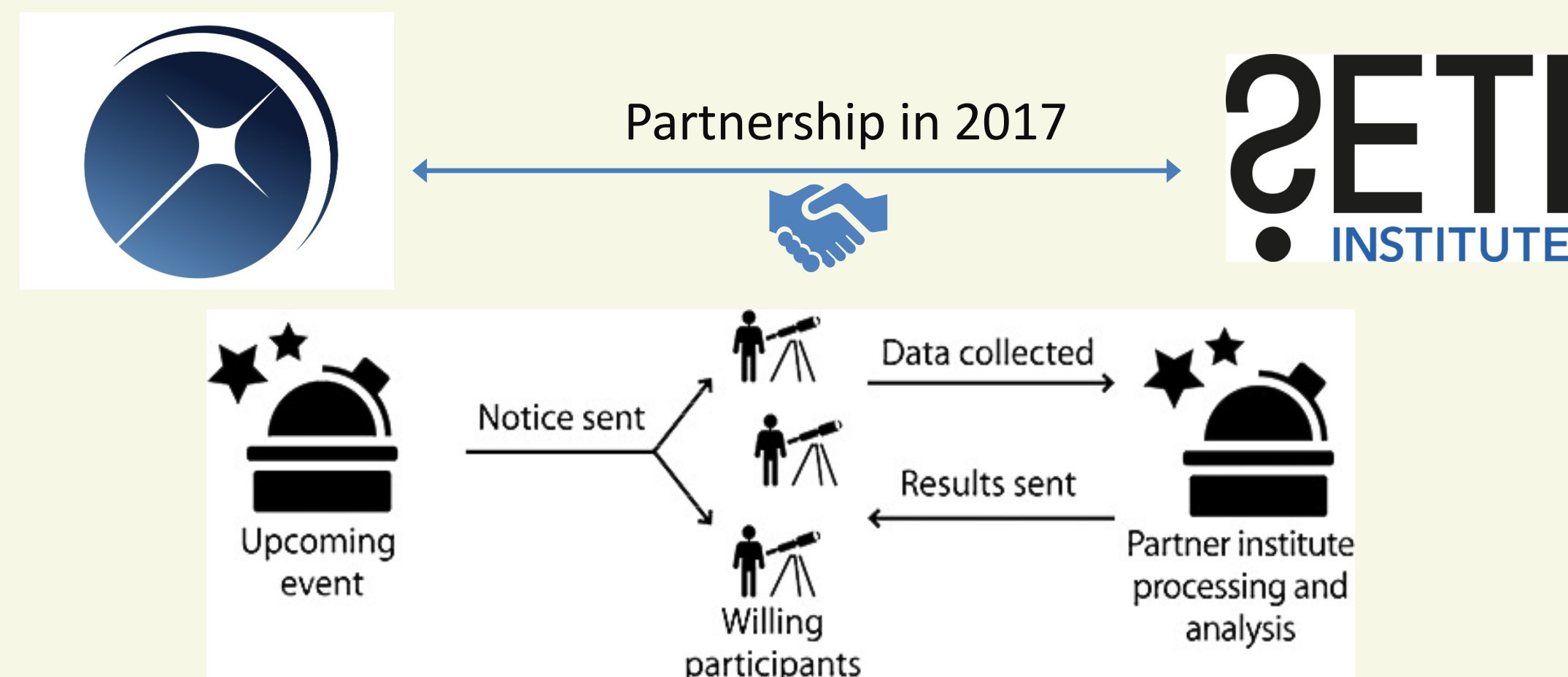
THE CONTRIBUTION OF THE UNISTELLAR NETWORK FOR PLANETARY DEFENSE: EMPOWERING CROWD-SOURCING ASTRONOMY



FRANCK MARCHIS^{1,2}, JOE ASECIO^{1,2}, DAN PELUSO², JOSEF HANUŠ³, JOSEF DURECH³, PETER VEREŠ⁴, GUILLAUME BLACLARD¹, LUDOVIC NACHURY¹

1. UNISTELLAR, MARSEILLE, FRANCE; 2. SETI INSTITUTE, CARL SAGAN CENTER, MOUNTAIN VIEW, CA, USA; 3. ASTRONOMICAL INSTITUTE, FACULTY OF MATHEMATICS AND PHYSICS, CHARLES UNIVERSITY 4. HARVARD & SMITHSONIAN CENTER FOR ASTROPHYSICS, MINOR PLANET CENTER

Citizen Science



Topics: Occultations, planetary defense, supernovae, comets, exoplanet transits, lightcurves of asteroids and novae,



A Networked Telescope

- Enhanced Vision technology**
Beautiful images
Light pollution compensation
- Automatic Field Detection**
Educative and Interactive
- Portable and autonomous**
Fits in an urban backpack
- Connected Science campaign**
Data Sharing

Future Campaigns

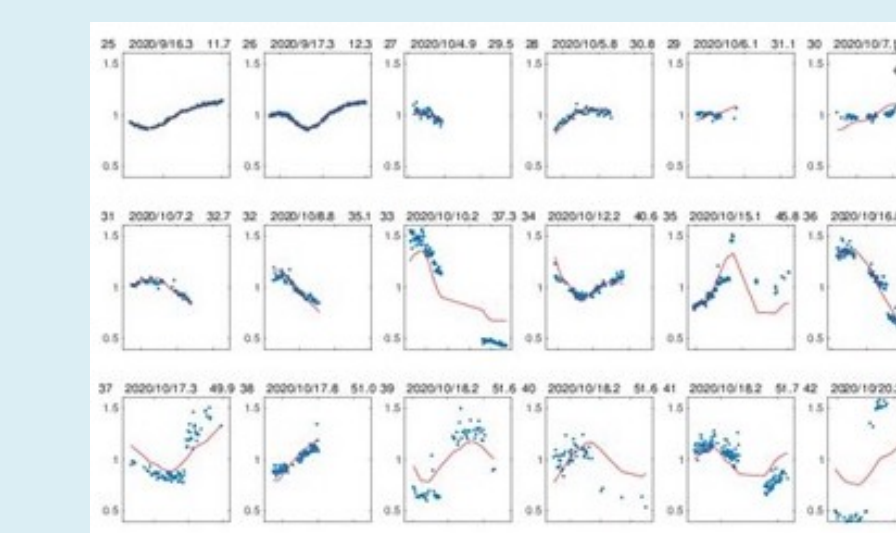
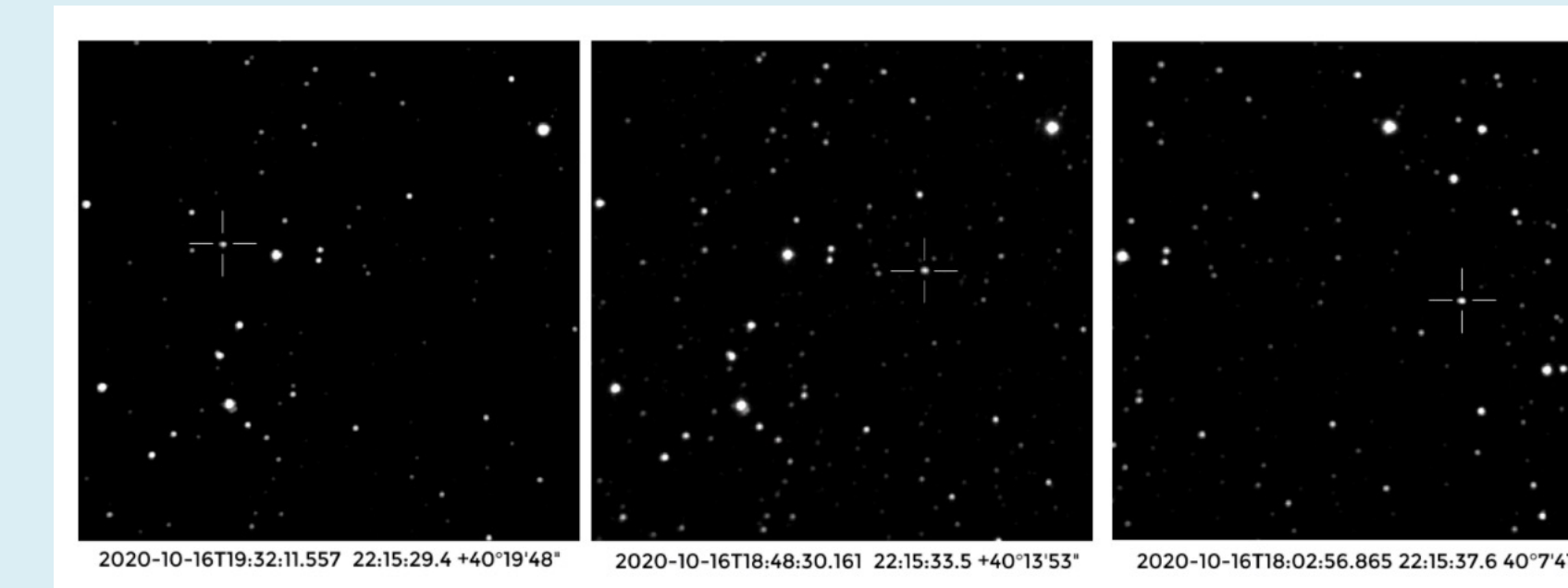
ID	NAME	Beg Date	End Date
450263	2003WD158	10-Jun-21	30-Jun-21
285571	2000PQ9	30-Jun-21	9-Aug-21
68063	2000YJ66	20-Jul-21	7-Nov-21
143649	2003QQ47	18-Sep-21	28-Sep-21
159857	2004LJ1	8-Oct-21	17-Dec-21
4660	Nereus	18-Oct-21	17-Nov-21
5143	Heracles	18-Oct-21	17-Nov-21
163899	2003SD220	17-Nov-21	17-Dec-21

- Close Approaches for MPC (typically 2-3 per months)
- Photometric study for shapes. 8 selected targets

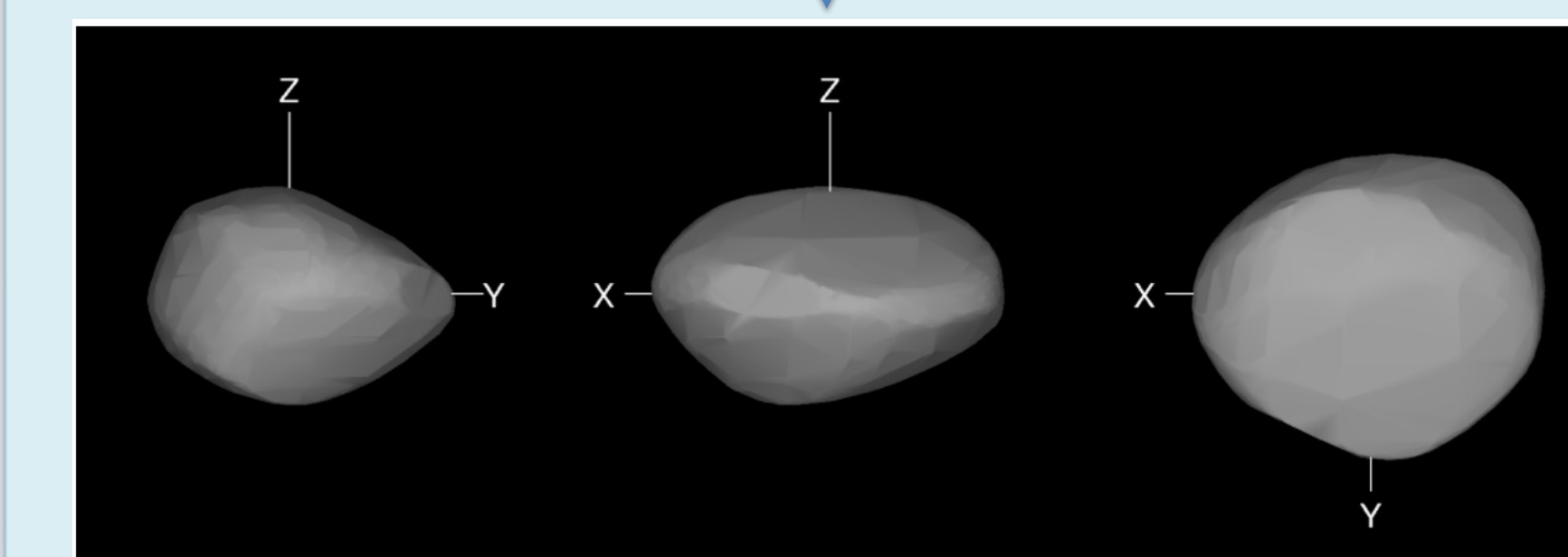


1999AP10 Campaign

Campaign from Nov 2020 to Dec 2020 (V<15.4)



Inversion by Kaasalainen et al. 2001



First shape model of 1999AP10
Pole: $\lambda=19$ deg, $\beta=-69$ deg, shape: $a/c=1.7$ & $b/c=1.4$
 $P=7.9219$ h

Conclusion: Today 24,298 NEAs are known and only 69 have a shape model. Our network can observe D>1 km NEAs so 406 of them in the future. We will organize more campaign in 2021 to provide more shape models and important first step to understand the formation and potential mitigation for PHAs

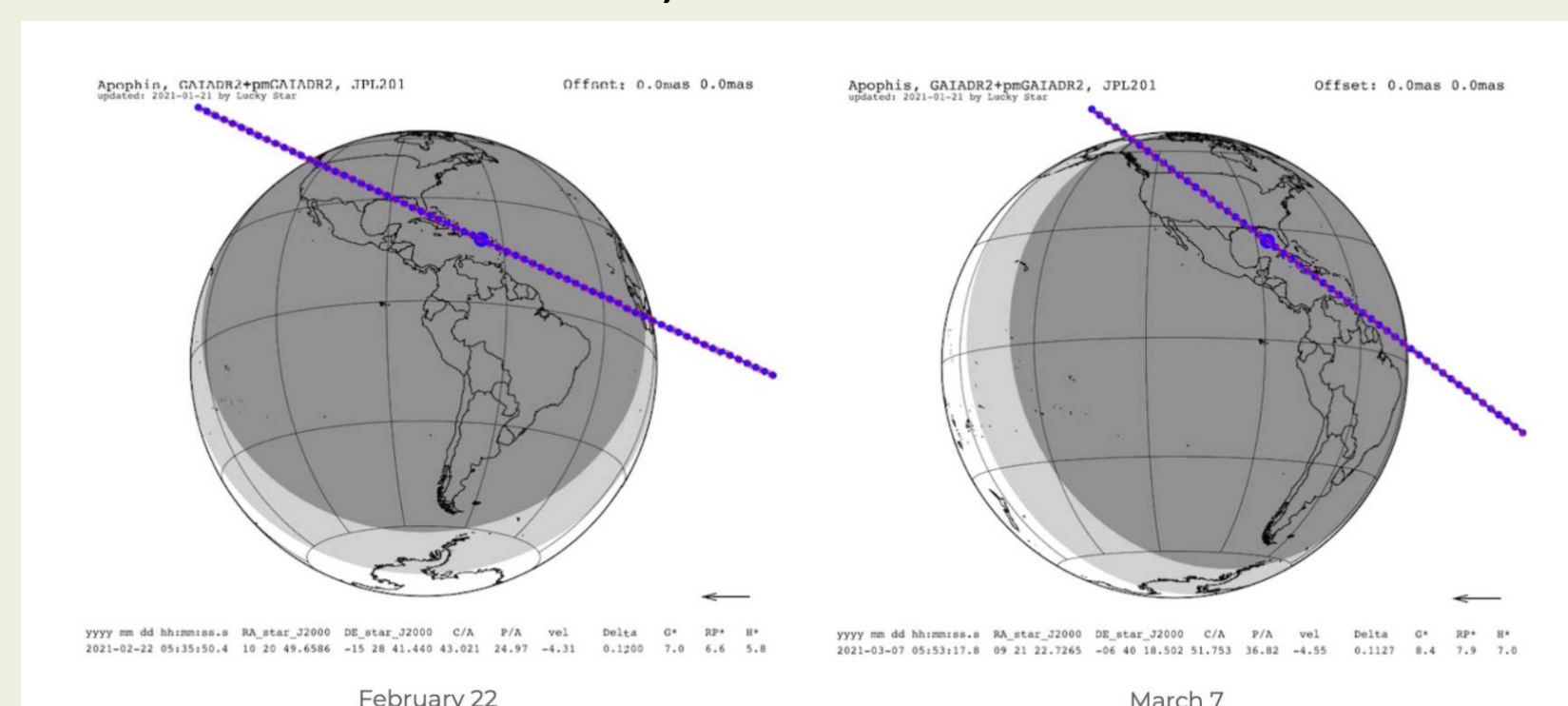
With almost 5,000 eVscopes (digital enhanced vision telescopes) sold in North America, Europe, Japan, Oceania and now Asia and South American, the Unistellar network has become the largest network of backyard astronomers. 5% of those astronomers became citizen scientists meaning that they participate to scientific campaigns of observations proposed by the SETI Institute, the scientific partner of Unistellar.

To date, the network has contributed to the shape of the near Earth asteroid 1999 AP10 from ~80 lightcurves collected by the network in November 2020, plus the contribution of other observers. We also regularly alert our network so they can contribute to planetary defense by observing asteroid or MPC candidate flyby-s like 2020 SO in Dec 2020 and Feb 2021, 2021 BC in Feb 2021 and more... The astrometric positions are sent and validated by MPC. Finally, we also use the network to observe asteroid occultation involving in some cases NEAs like 1036 Ganymed (January 25 2021) and the Apophis occultations predicted by Lucky Stars (February 22 & March 7).

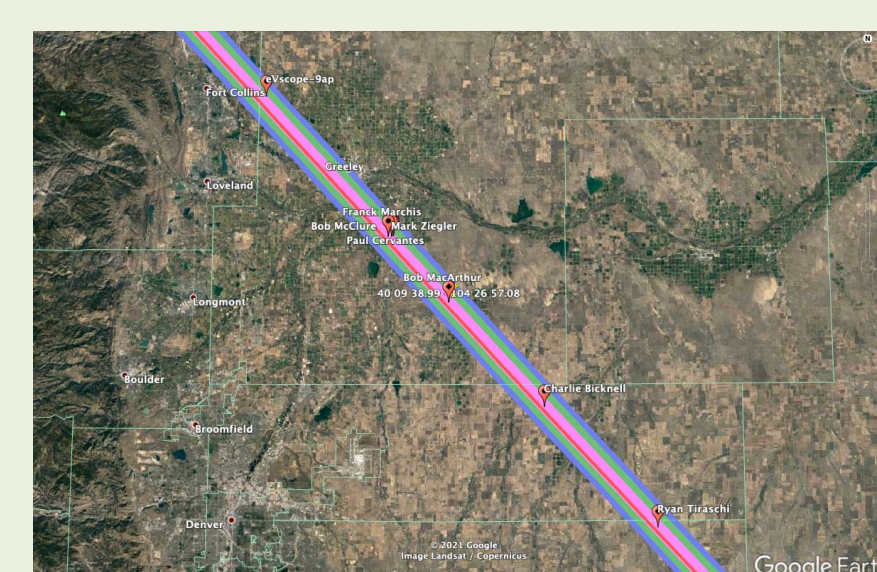
The scientific network is growing with the contributions of schools, community colleges, universities and engineering schools in the US and Europe, but also informal education centers like the Girl Scouts of America. Our goals for the year 2021 are to ease the use of the telescopes for scientific events, while providing the tools as well to process them, and bring more Citizen Astronomers by offering more introduction materials for the classrooms and education centers (museum, ...).

Apophis Occultation Campaign

Occultation events predicted by Josselin Desmars (Obs. de Paris) In collaboration with M. Buie, IOTA



Refined with radar observations 2 days before the event. Uncertainty 6 km at the time for a 200 m shadow!

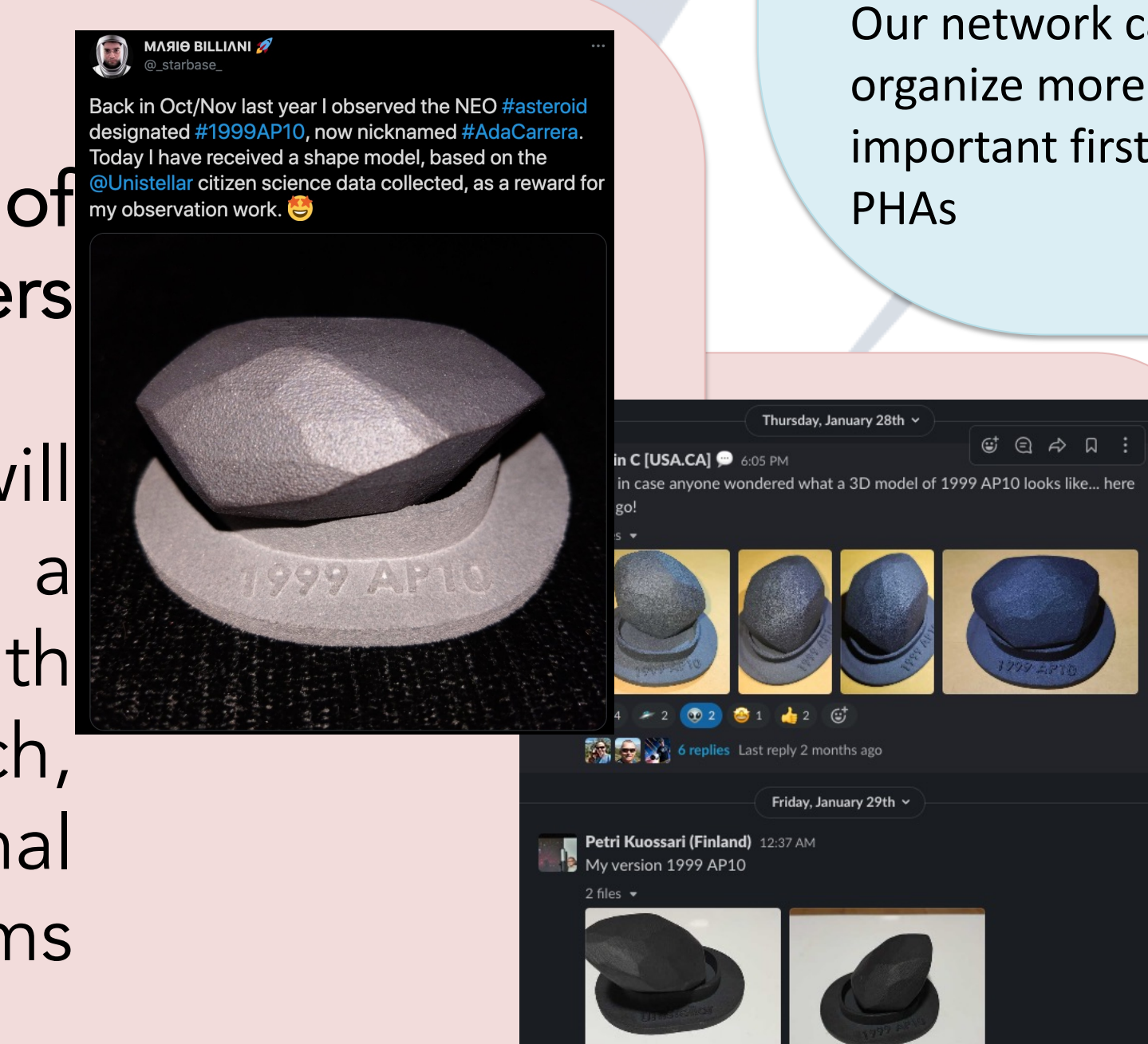


All negative but only 650m from it, three positive from IOTA stations. See <https://www.seti.org/we-got-it>

Outreach & Education

In 2020, we have demonstrated that eVscope users can experience the thrill of scientific discovery and be part of an active community of citizen astronomers able to find and track asteroids.

The eVscope is more than a telescope, it's a window to the universe that will connect this diverse international community of citizen astronomers into a network of thousands of users. By empowering crowd-sourcing astronomy with the eVscope, we give people the opportunity to contribute to scientific research, observe, and learn together. This transformation will also be relevant for formal education, where we envision modern project-based education programs ushering students, teachers and aspiring astronomers into the 21st century.



Contact:

Franck Marchis, Chief Scientific Officer
franck.marchis@unistellaroptics.com
Senior Astronomer, fmarchis@seti.org
To learn more, check our web site:
<http://www.unistellar.com>



In memory of our colleague Mikko Kaasalainen