Exploring the Outer Solar System through Citizen Science

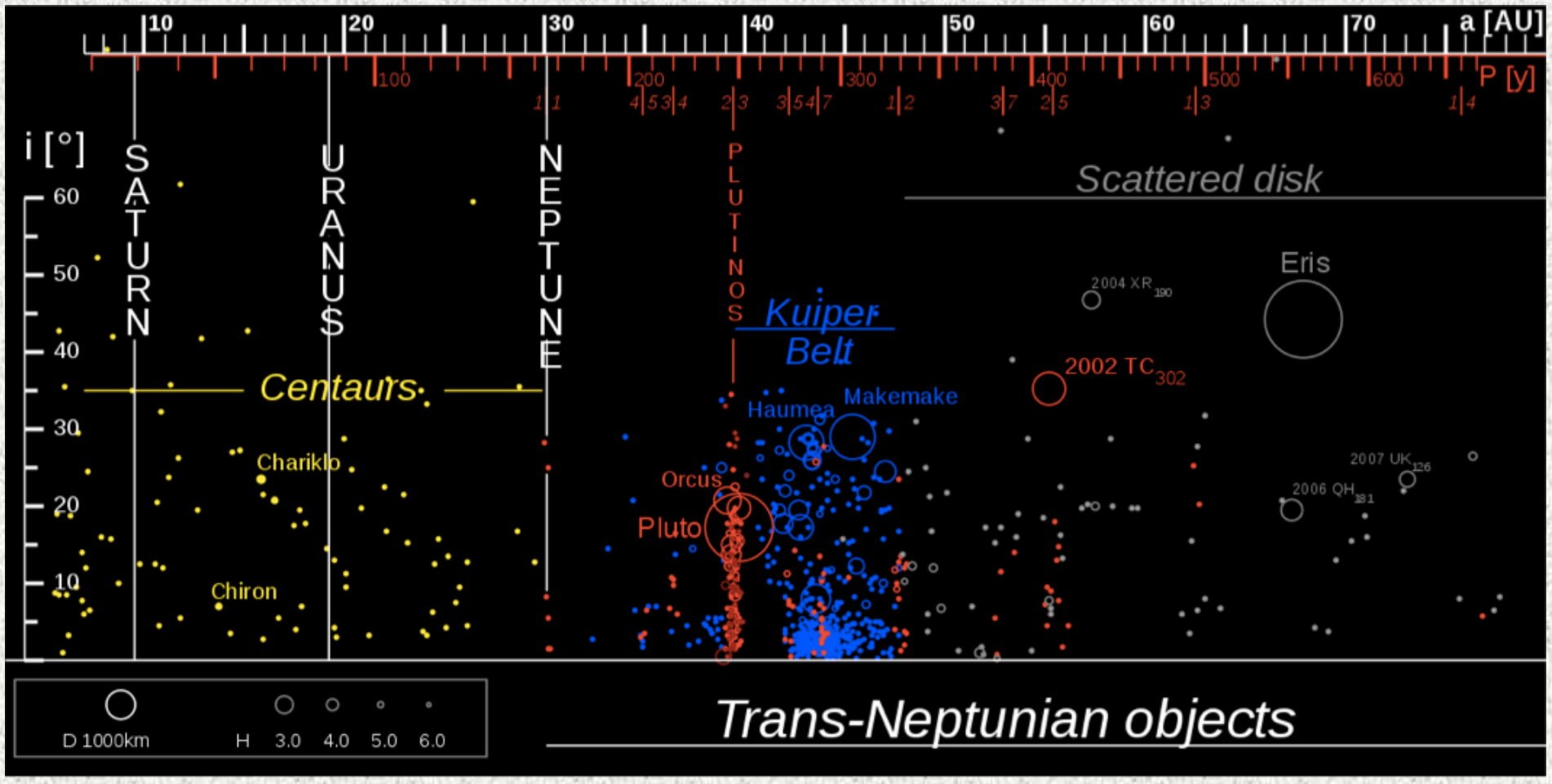
CanCON: Canadian Collaborative Occultation Network

Terry Bridges, Okanagan College

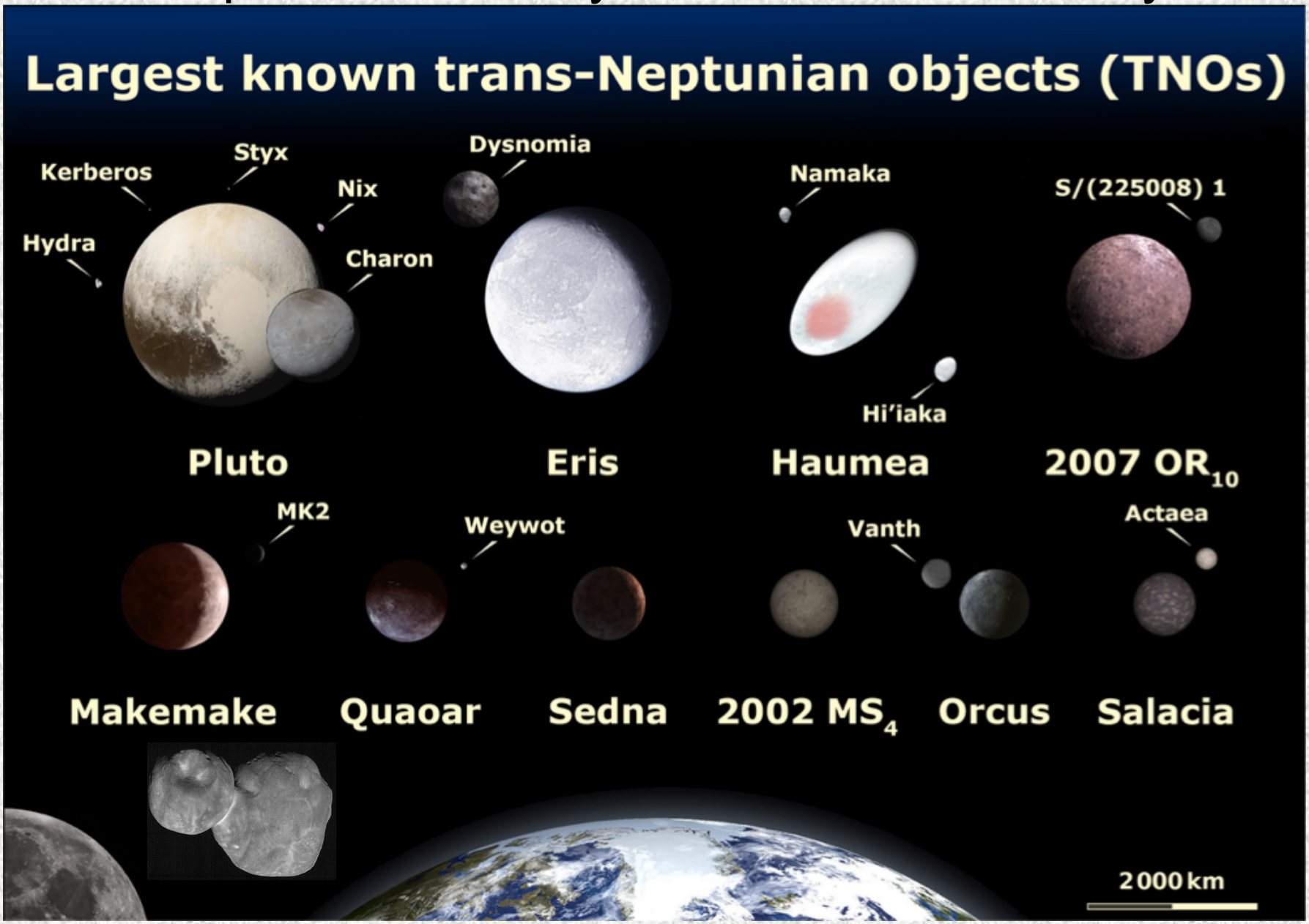
JJ Kavelaars, NRC Herzberg

+ Lots of high school teachers, students, and RASC members!

Trans-Neptunian Objects (TNOs)



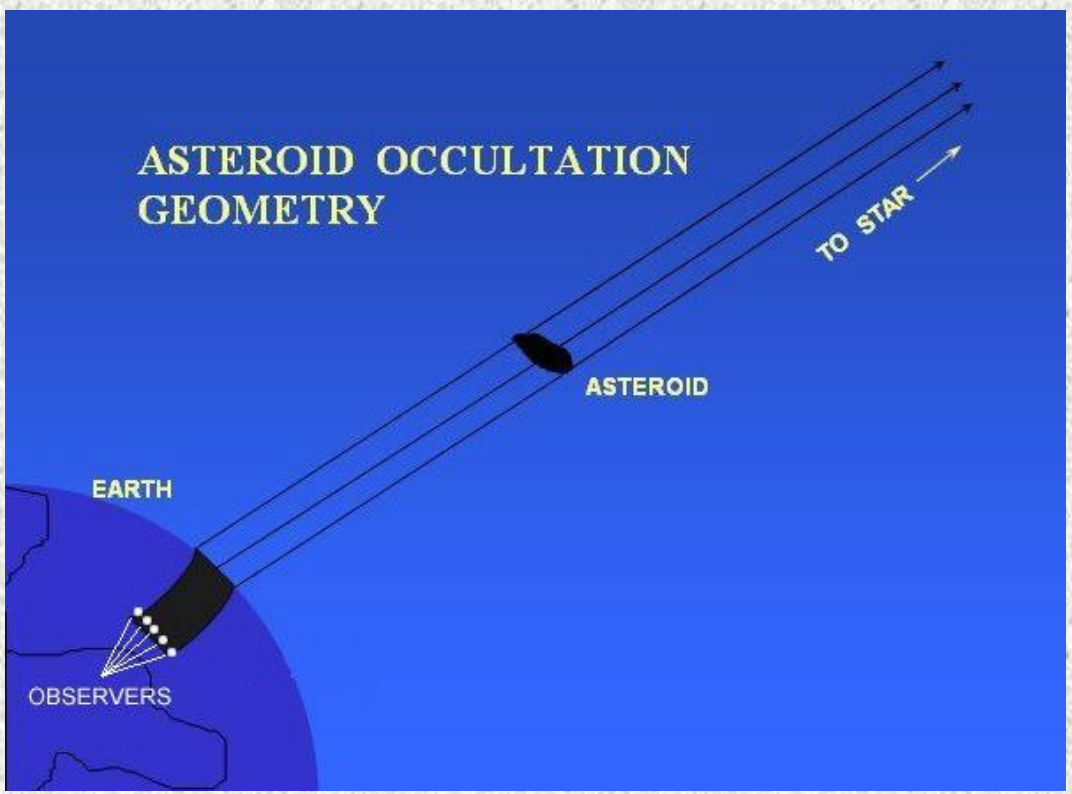
TNO sizes are needed to understand their composition, density, formation, and history.

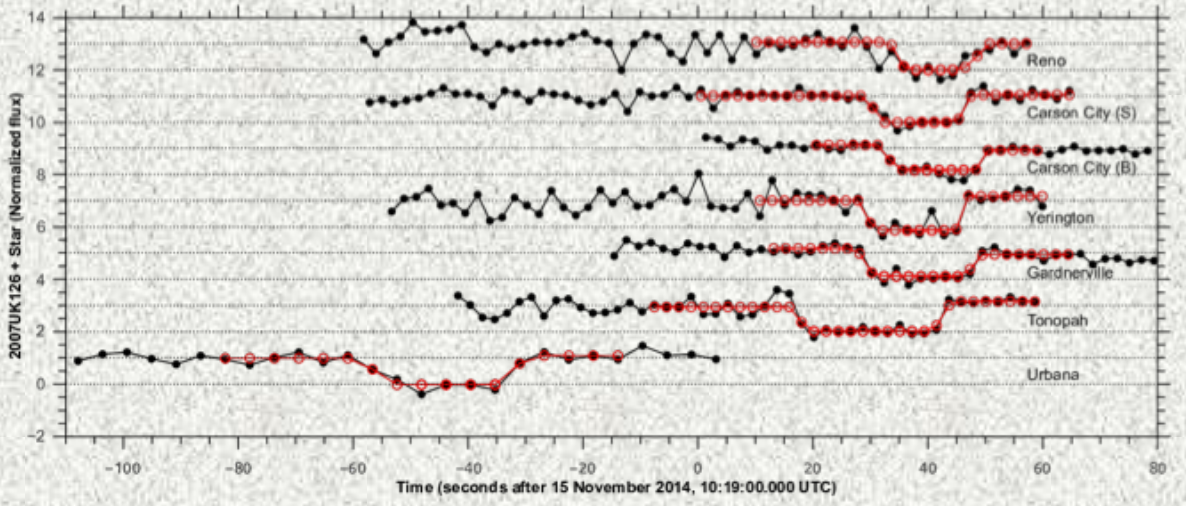


Occultation of a Star by a TNO

TNO passes between observer and star, casting shadow on Earth: *occultation*.

Duration of occultation + TNO speed → TNO size





RECON: Research & Education Collaborative Occulation Network

http://tnorecon.net

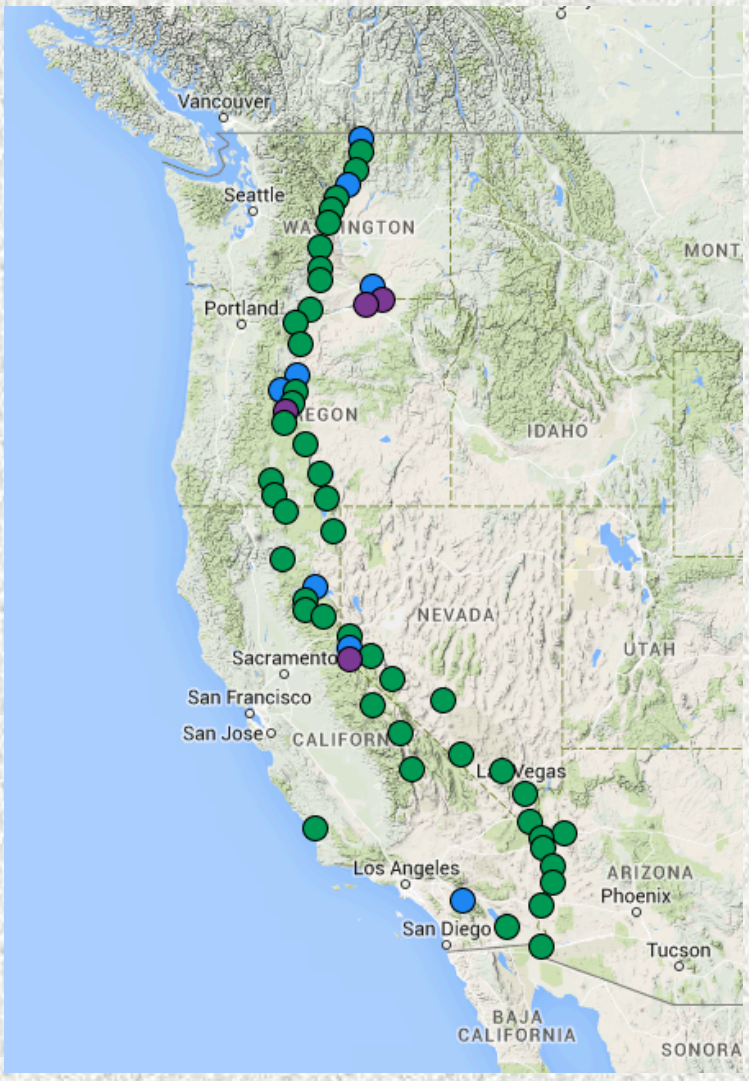
54 12” telescopes installed at high schools along the US west coast

Fully operational since Fall 2014

Each telescope comes with high-speed digital camera and timer.

Funded by ~$1 million USD NSF research grant

The longer the network the more likely an event can be captured …



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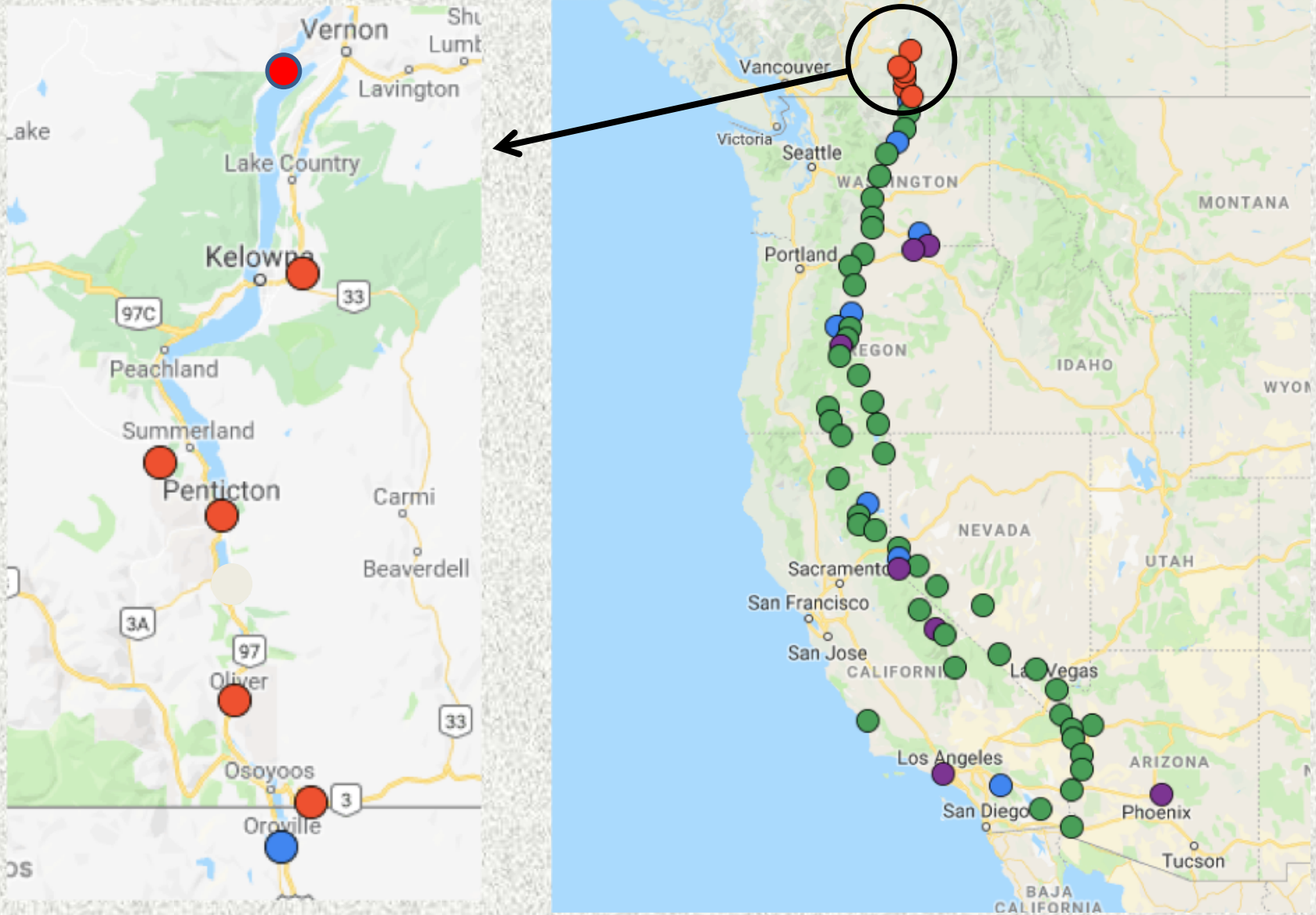


CanCON Equipment

BK DOB 12" SynScan GPS

QHY174M CMOS IMAGER WITH BUILT-IN GPS AND TIMER

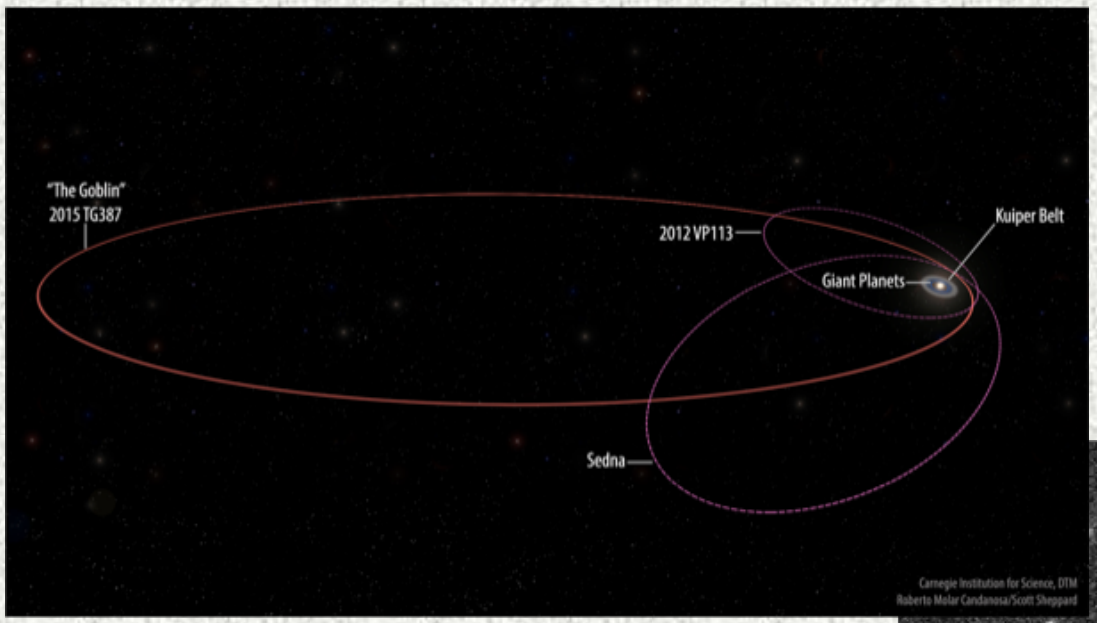
CanCON Successes and Benefits

- **CanCON** has taken part in 8 events since Fall 2018, with 2-4 teachers and 5-15 students at each event
- Lots of enthusiasm, even when it's cloudy at 3:00 am …!
- We have had a detection and a paper submitted! More below …
- Strong partnership between Okanagan College; NRC; Okanagan teachers and students; RASC; and the US RECON program.
- Students and teachers take part in astronomical research, and get their names on refereed scientific papers
- Students inspired to pursue STEM fields in post-secondary

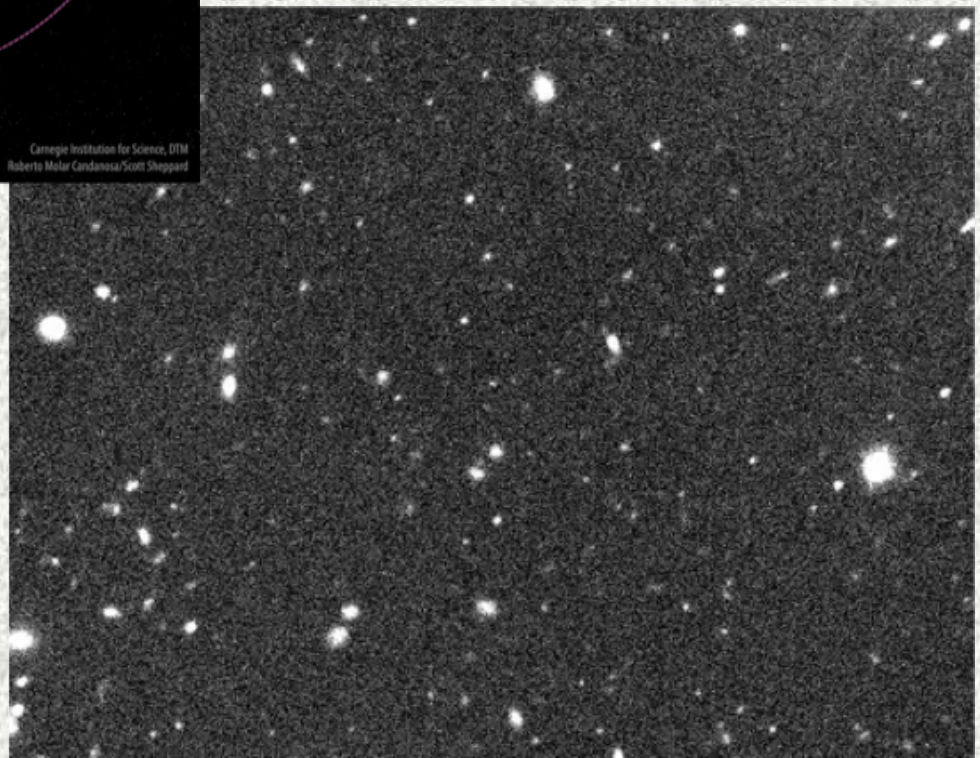
"*I've found that it has really spiked some students' interest in astronomy and given them some practical experience with what research is actually like. The students have been very excited about participating/contributing to something big like the RECON project*." (Sabra McIntyre, teacher at South Okanagan Secondary, Oliver)

2015 TG387: AKA "The Goblin"

Small dwarf planet discovered in Oct 2015, most distant yet found!



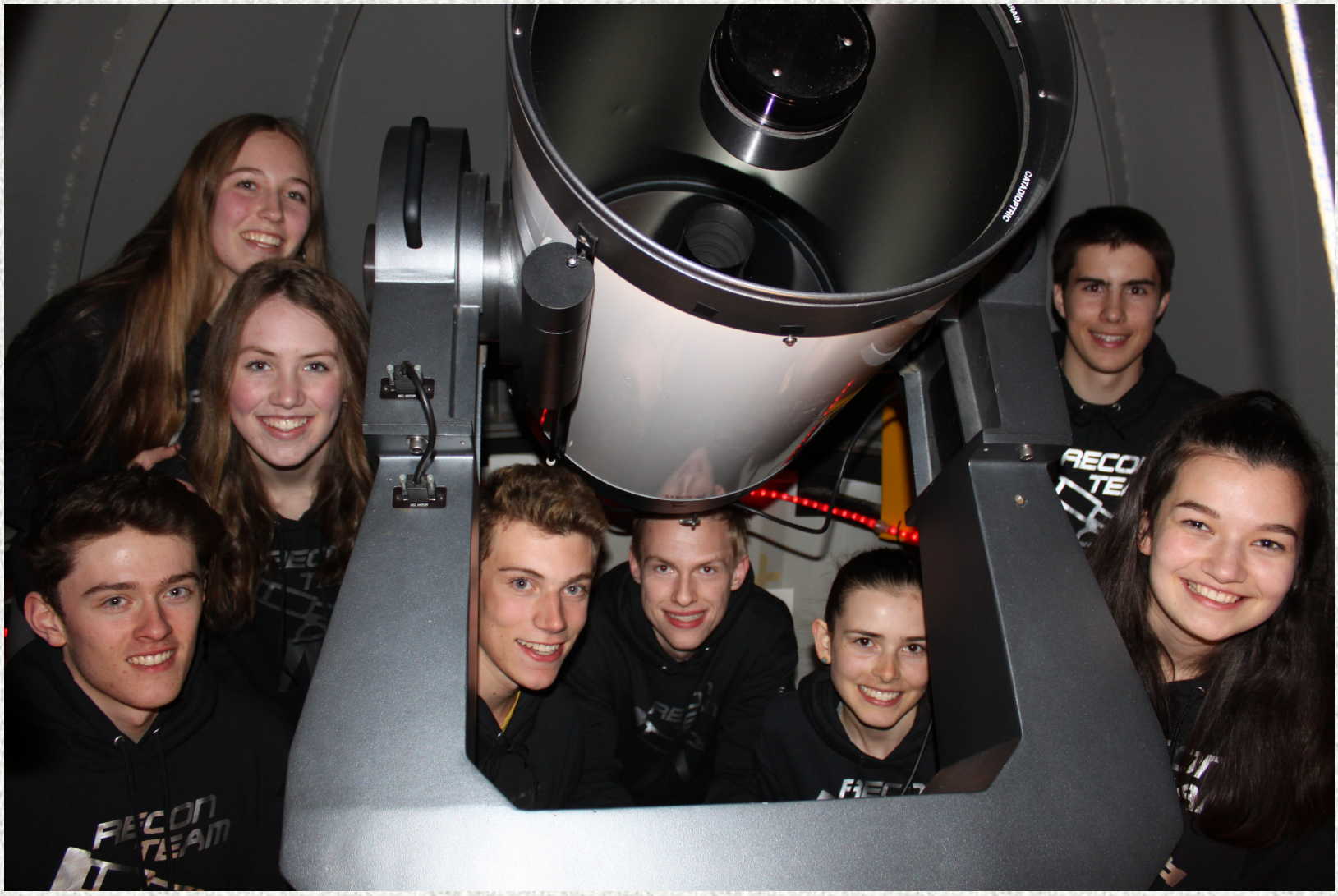
Currently ~80 AU: 2.5X Pluto's distance from Sun



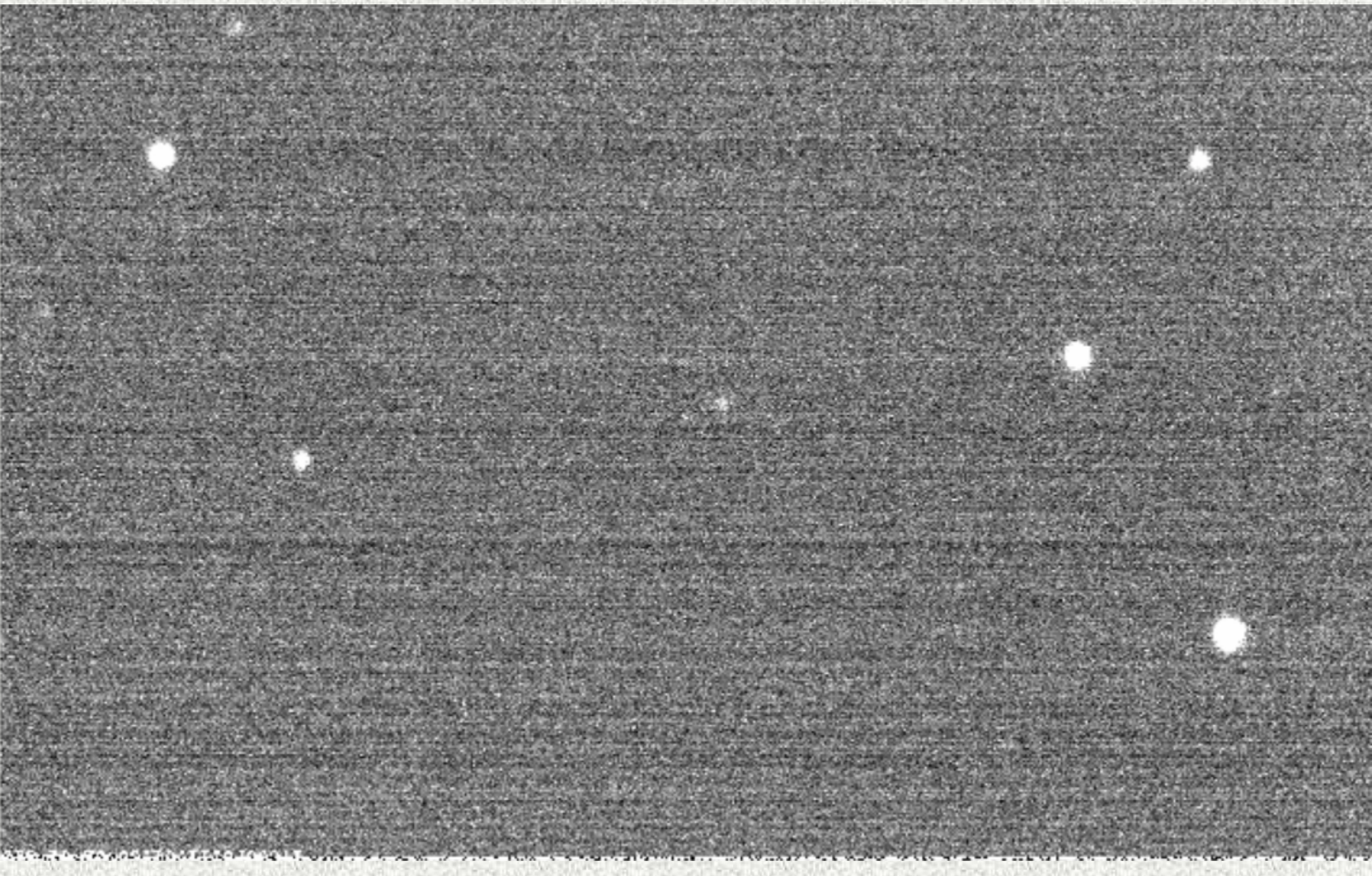
Orbital radius: 65-2300 AU
Orbital period: ~32,000 years
Orbital eccentricity: 0.94

Event between 15TG387 and star GA1020:00020858, Oct 20, 2018

The Penticton Secondary RECON Team!



15TG387: Occultation Detection!!!



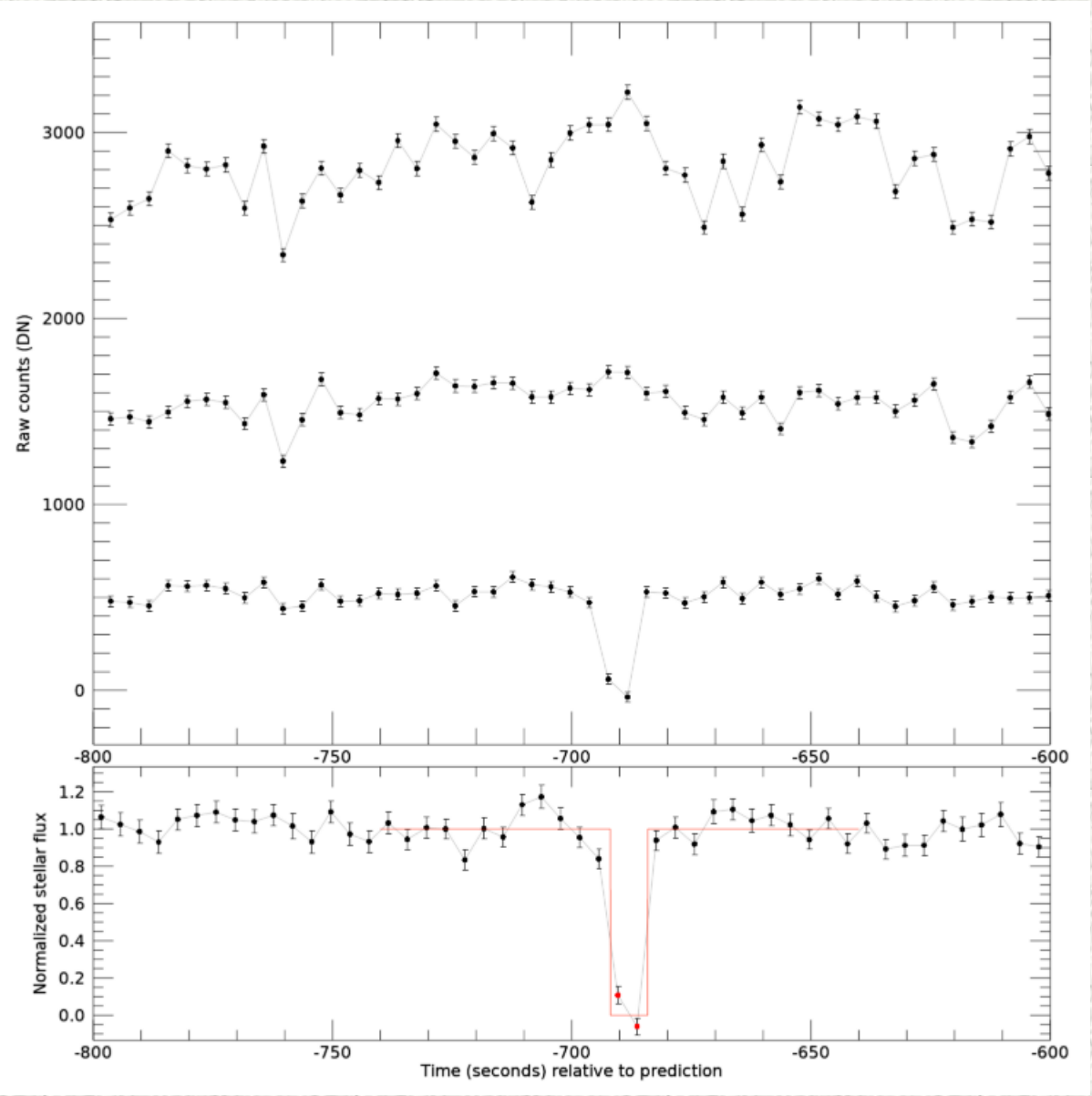
15TG387 Light Curve and Properties

Occultation Duration: 7.8 s

Velocity: 24.0 km/s

Radius: 110^{+14}_{-10} km

Albedo: $0.21^{+0.03}_{-0.05}$




RECON
TEAM

CanCON Challenges

Funding

- Maintaining existing sites
- Adding additional sites to the network

Time

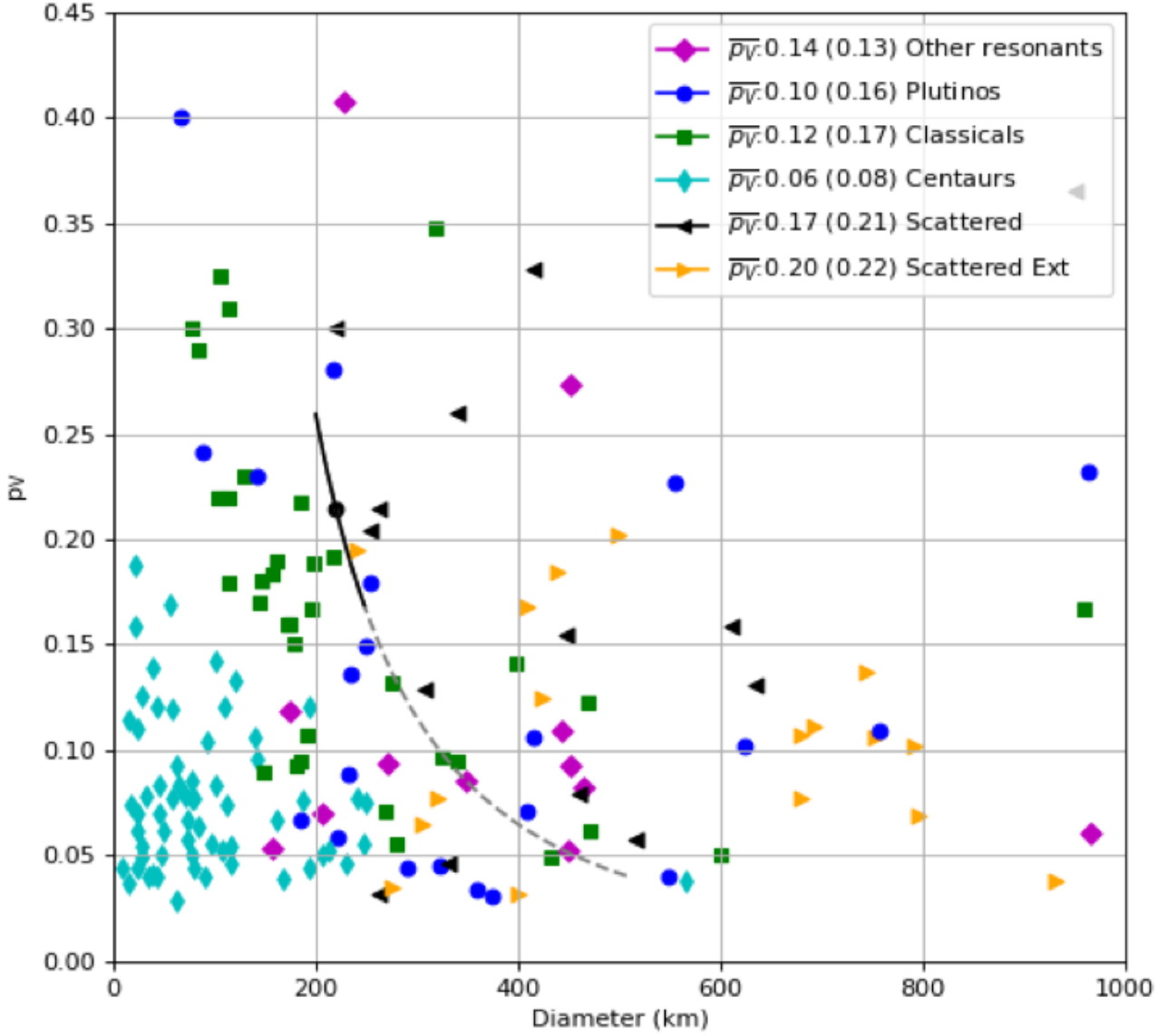
- Coordination of network
- Travel to network sites
- Writing funding proposals

Demands on busy teachers

- Often starting with little astronomy background
- Recruiting students, fundraising, working with administration
- Taking part in events at any time of year and time of night

CanCON Future Opportunities

- Getting **high school students more involved** in data analysis, research, and publications
- **Involvement of Okanagan College science, engineering, and trades students**: training, website, preparing curricular materials, taking part in research
- **Filling in gaps** in existing network, and extending further north
- **RECON 2**: fully robotic observatories at existing RECON/CanCON sites
  - *Funding Sources*:
    - NSERC PromoScience, community foundations, OC grants
    - School boards
    - NSERC College and Community Innovation program; CFI College-Industry Innovation Fund: (e.g. dome fabrication and machine learning data processing).


0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
pv
0
200
400
600
800
1000
Diameter (km)
$\overline{pv}$:0.14 (0.13) Other resonants
$\overline{pv}$:0.10 (0.16) Plutinos
$\overline{pv}$:0.12 (0.17) Classicals
$\overline{pv}$:0.06 (0.08) Centaurs
$\overline{pv}$:0.17 (0.21) Scattered
$\overline{pv}$:0.20 (0.22) Scattered Ext