Asteroid size determination from photometric/spectroscopic observations at the Instituto de Astrofísica de Canarias - IAC

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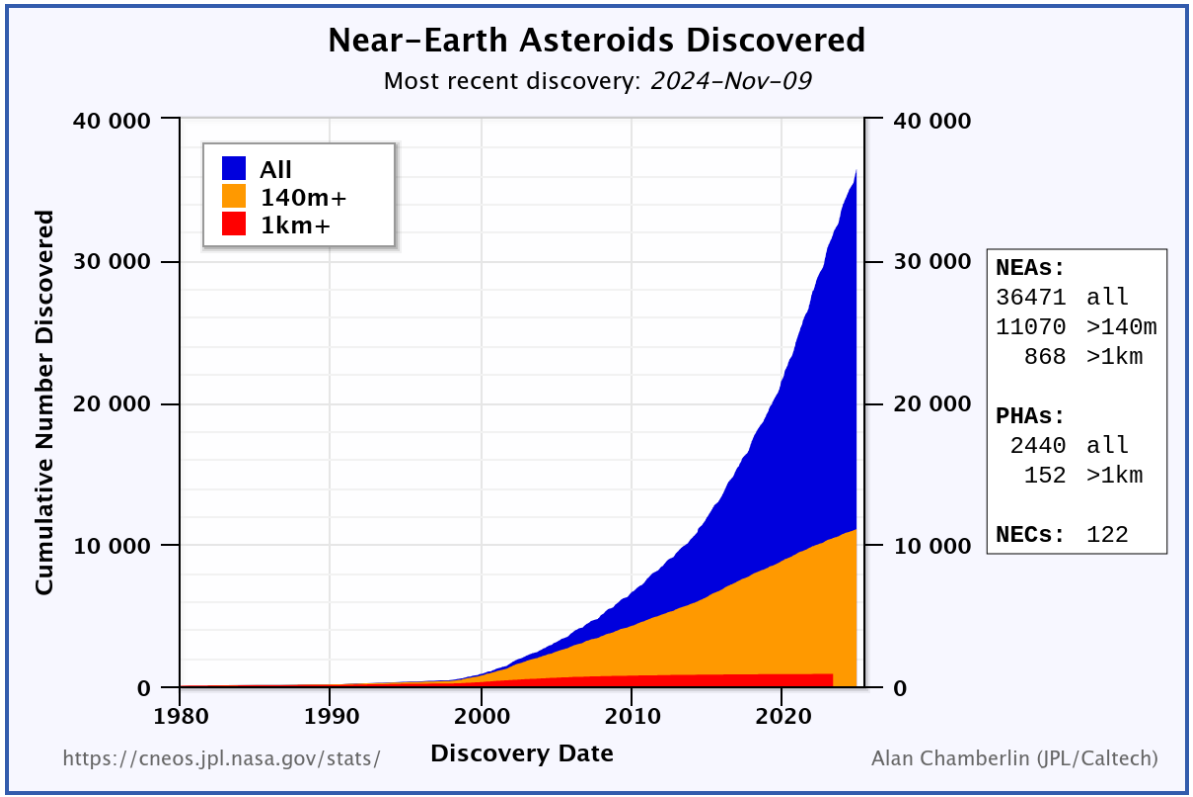
NEOs and PHAs



$$D\,(p_v)^{1/2}\,10^{\,H_V/5} = 1329 \pm 10 \text{ km}$$

D -- effective diameter (km)

p_v -- geometric albedo

H_V -- absolute magnitude

As of Nov. 9th, 2024:

36 471 NEAs

- < 10% with taxonomical information (either spectra or colors)
- < 5% with size estimation from termal modelling

NEOs observations @ IAC

SOLAR SYSTEM

Julia de León
(PI)

Javier Licandro
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Eri Tatsumi
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(Postdoc)

Full-time staff

Hector Socas

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Miguel Alarcón

George Prodan

Pre-doctorals

NEOs observations @ IAC

Canary Islands (Spain)

2 International Observatories
"*Observatorios de Canarias*" - OCAN

NEOs observations @ IAC

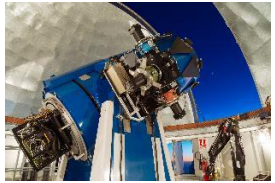
Time-series photometry

2x80cm TTT
(*managed by group members*)

80cm IAC80

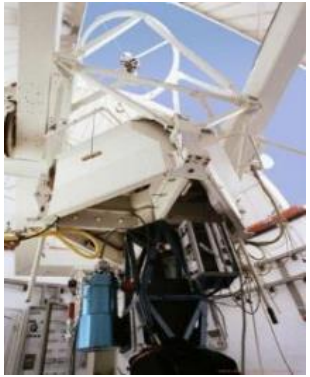
1m JKT

1.2m Mercator



Colors (*griz*)

1.5m TCS
(MuSCAT2)



Visible spectra

2.5m INT (IDS)

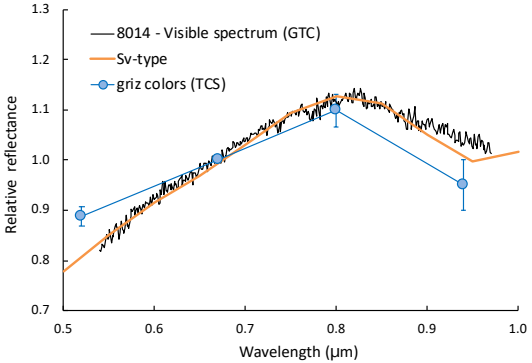
2.5m NOT (ALFOSC)

10.4m GTC (OSIRIS)

IAC-AIRA Joint Survey

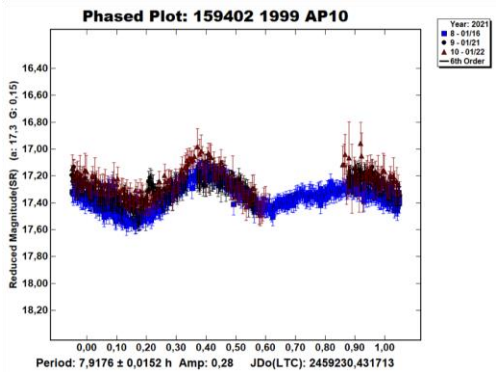
The **IAC** (Instituto de Astrofísica de Canarias) - **AIRA** (Astronomical Institute of the Romanian Academy) survey is a collaborative effort to obtain observational data of NEAs in the visible to near-infrared wavelengths, including time-series photometry, colors and spectra.

Visible and/or near-infrared spectra of ~200 NEAs



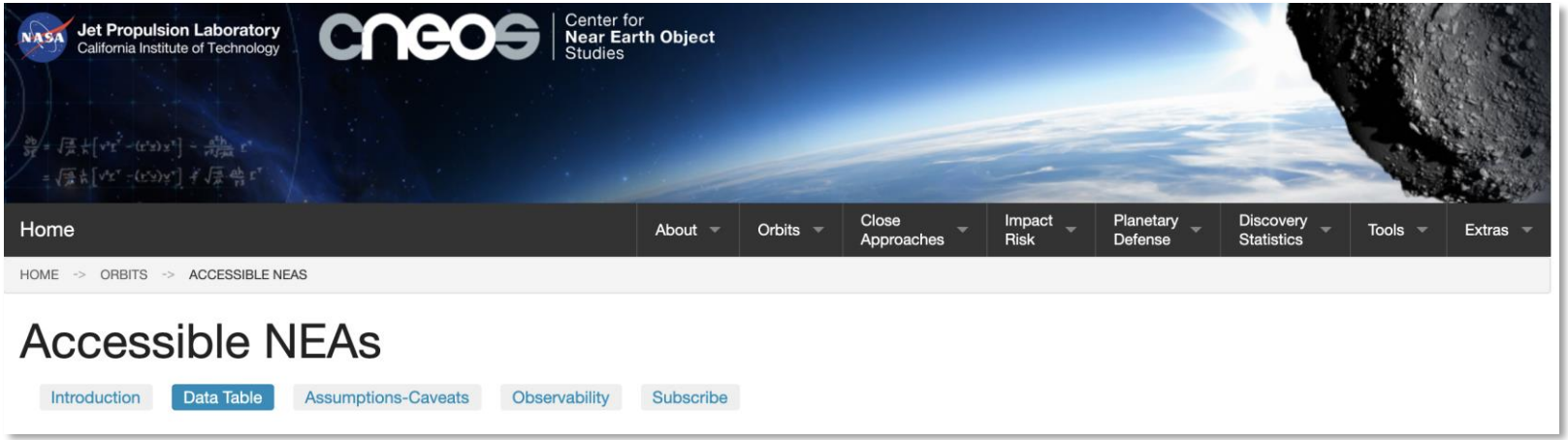
Visible colors (griz) of ~400 NEAs

Time-series photometry of ~150 NEAs



Spectra of NEAs (I)

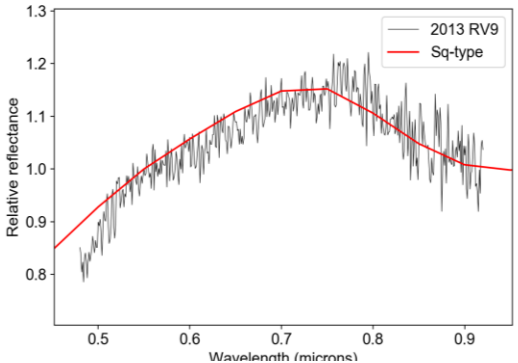
NASA Near-Earth Object Human Space Flight Accessible Targets Study: NHATS

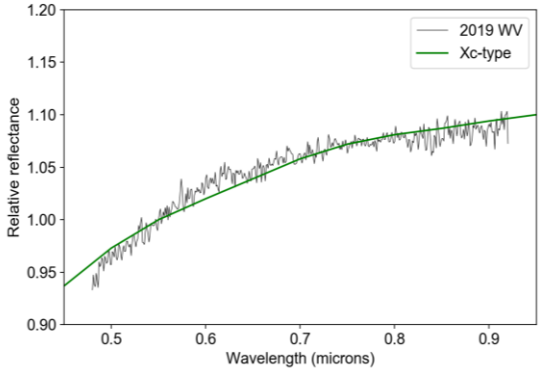


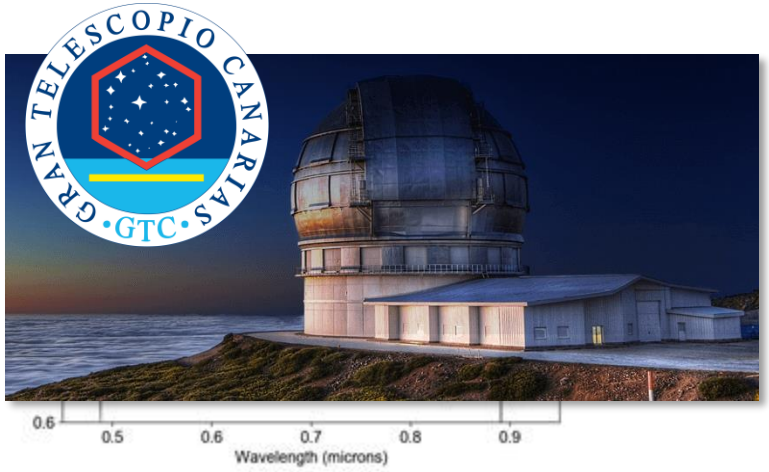
- NHATS began in September 2010 **to identify any known NEOs that might be accessible by future human space flight missions**.
- High-priority targets are identified and alerts are sent out to the observing community requesting observations.
- Best observed during discovery apparition --> need from fast response (in particular for small NEAs)
- Large aperture telescopes are best suited

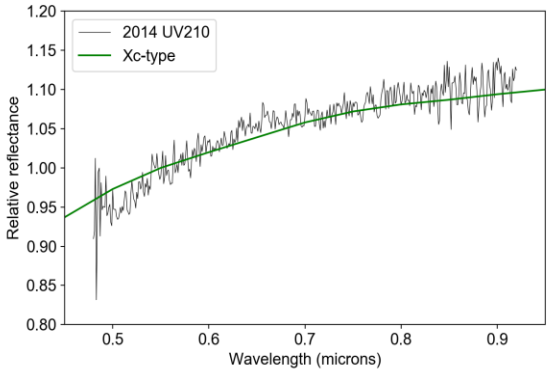
Spectra of NEAs (I)

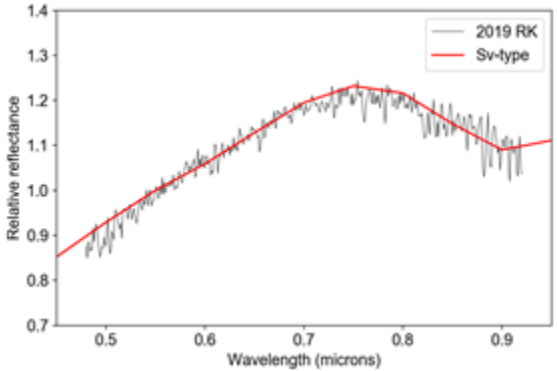
10.4-m Gran Telescopio Canarias - GTC

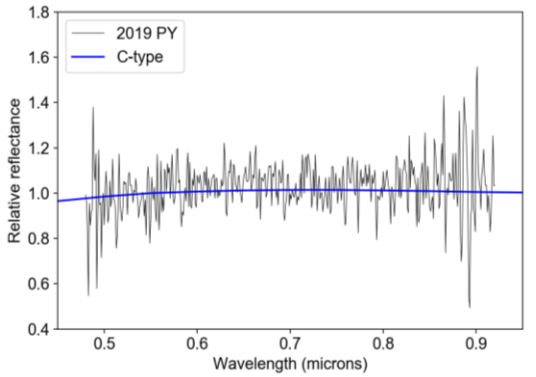












Spectra of NEAs (I)

Asteroid	Discovery date[1]	Observation date	m_V	α (°)	H^1	p_V^2	Tax[3]	D (km)	Notes
350523	Mar 3, 2000	Jun 1, 2019	20.5	23.1	21.0	0.148	R	0.218	
2013 RV9	Sep 3, 2013	Mar 9, 2019	20.7	33.6	23.6	0.211	S	0.055	
2014 UV210	Oct 25, 2014	Dec 16, 2014	18.7	5.8	26.9	0.047	X	0.025	Fast rotator (< 1 h)
2015 BG92	Jan 19, 2015	Jan 26, 2015	18.6	25.6	25.1	0.048	D	0.058	Fast rotaror (< 0.2 h)
2015 DU	Feb 17, 2015	Feb 28, 2015	19.1	19.5	26.6	0.211	S	0.014	Fast rotator (< 0.1 h)
2017 PV25	Jul 24, 2017	Mar 10, 2019	20.7	18.0	24.7	0.129	Xc	0.042	
2019 UO1	Oct 19, 2019	Oct 28, 2019	21.0	15.5	25.0	0.050	C	0.059	
2019 WV	Nov 21, 2019	Nov 25, 2019	19.2	27.8	24.9	0.129	Xc	0.038	P_{rot} = 1.25 h
2019 YV	Dec 19, 2019	Dec 27, 2019	18.9	39.7	23.6	0.042	T	0.123	
…	…	…	…	…	…	…	…	…	

[1] *JPL Small-Body Database Browser (https://ssd.jpl.nasa.gov/sbdb.cgi#top) and IAU Minor Planet Center*

[2] *When no albedo information is available, we use the average albedo for the taxonomical class from Mainzer et al. (2011)*

[3] *Taxonomical classification is done using the M4AST on-line tool (http://spectre.imcce.fr/m4ast/index.php/index/home, Popescu et al. 2012)*

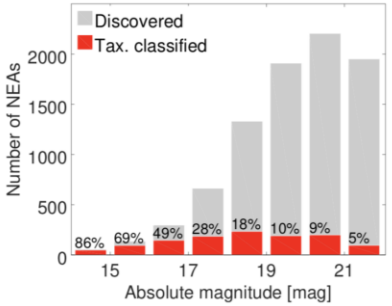
Spectra of NEAs (II)

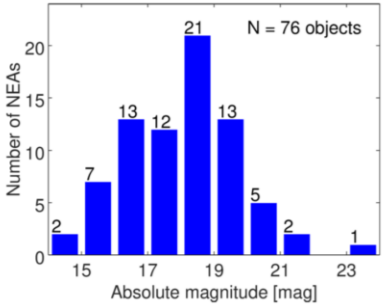
A&A 627, A124 (2019)
https://doi.org/10.1051/0004-6361/201935006

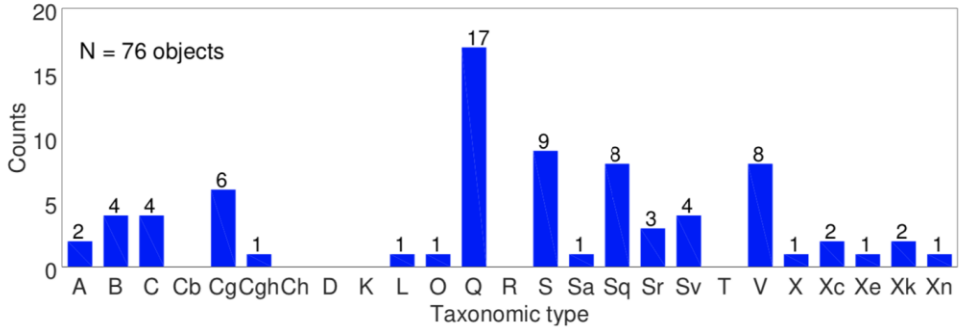
Astronomy & Astrophysics

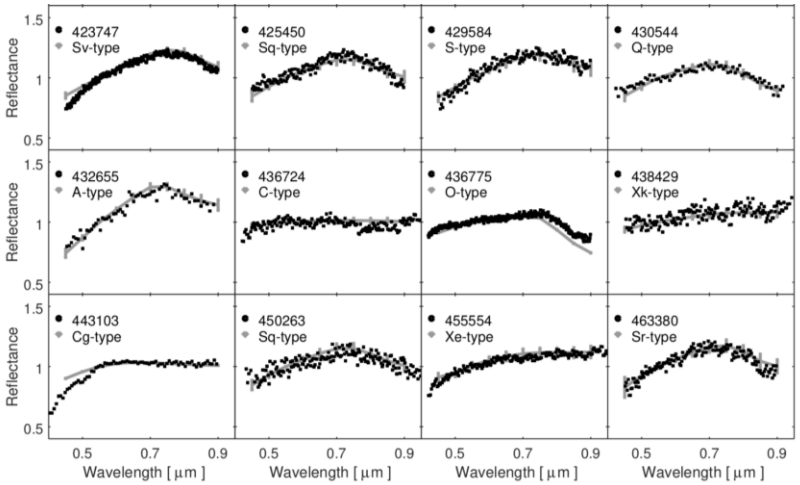
Near-Earth asteroids spectroscopic survey at *Isaac Newton* Telescope*

M. Popescu[1,2,3], O. Vaduvescu[4,1], J. de León[1,2], R. M. Gherase[3,5], J. Licandro[1,2], I. L. Boacă[3], A. B. Şonka[3,6], R. P. Ashley[4], T. Močnik[4,7], D. Morate[8,1], M. Predatu[9], M. De Prá[10], C. Fariña[4,1], H. Stoev[4,11], M. Díaz Alfaro[4,12], I. Ordonez-Etxeberria[4,13], F. López-Martínez[4], and R. Errmann[4]

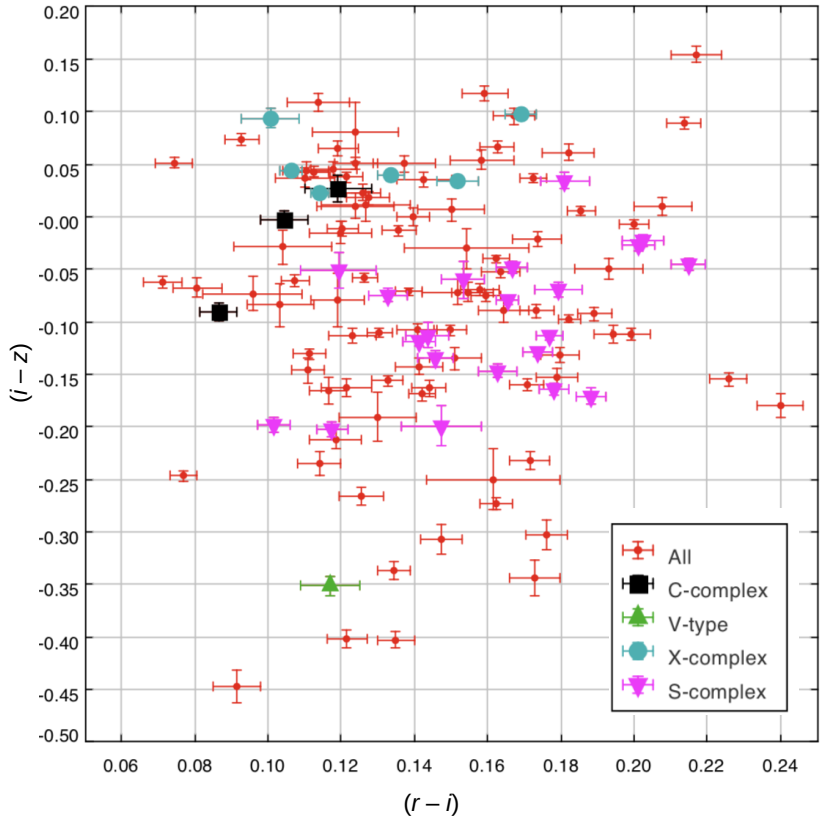


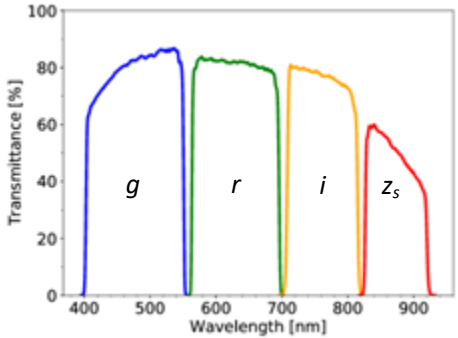






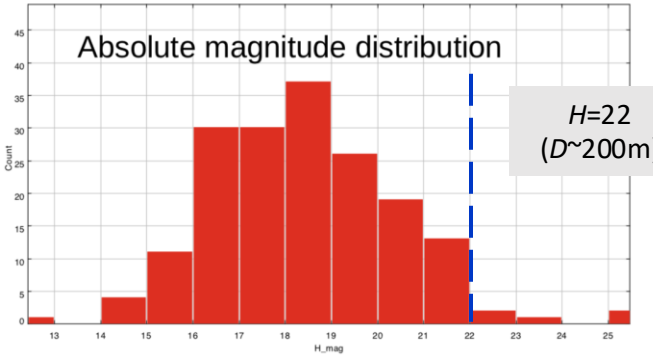
Visible colors with MuSCAT2





MuSCAT2: 4-color Simultaneous Camera

~400 NEAs observed so far



H=22 (*D*~200m)

H2020: NEOROCKS

NEOROCKS is a EU H2020 funded project, led by the Istituto Nazionale di Astrofisica, in Italy, and with the participation of 14 European institutions. The main goal of the this project is to study the near-Earth asteroid population, including their dynamical, physical and compositional properties

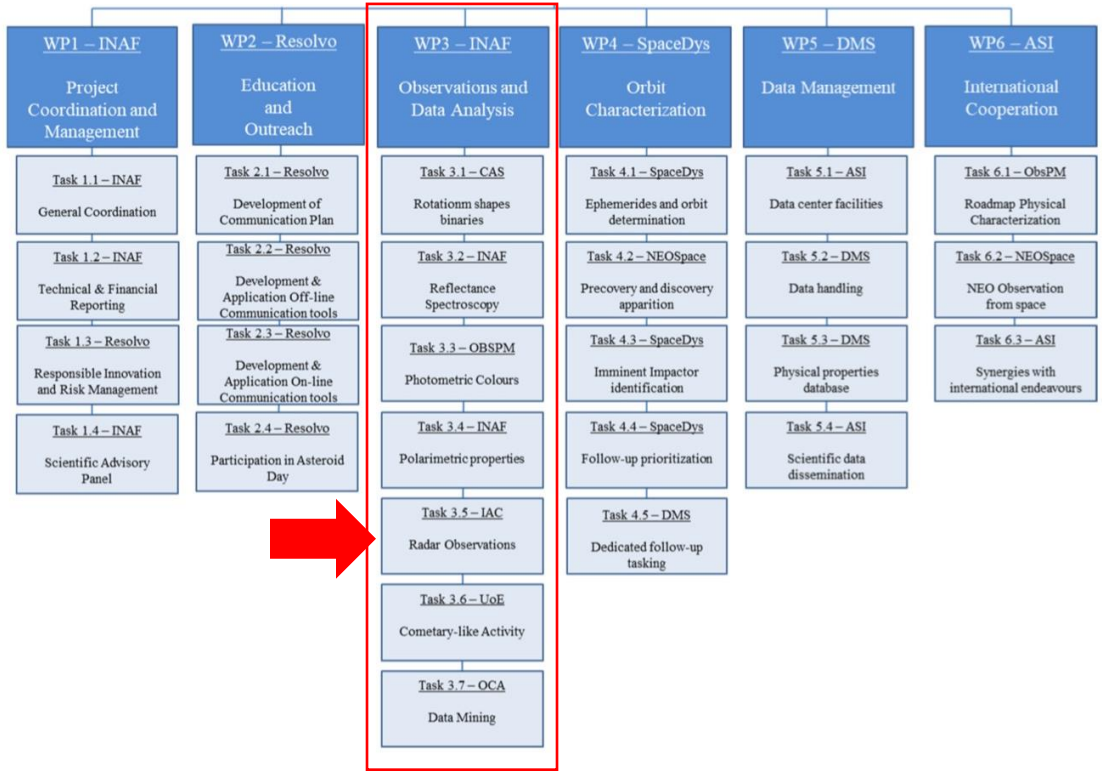
NEO ROCKS

Near Earth Object Rapid Observation, Characterization and Key Simulations

@H2020NEOROCKS

SCAN ME

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870403. This leaflet reflects only the author's view and the Commission is not responsible for any use that may be made of the information it contains.



H2020: NEOROCKS

Task 3.5 – Observational support to the Arecibo Planetary Radar Program

The IAC group is responsible for providing access, through regular calls and target-of-opportunity (ToO) mode, to visible/near-infrared photometric and spectroscopic observations from a range of 1- to 10.4-m telescopes located at the "*Observatorios de Canarias*" (OOCC). The main tasks of the IAC:

- To participate on the planning, execution, and full characterization of the targets and the publications produced by the Arecibo Planetary Radar Program.
- To prepare and send observational proposals to the corresponding Time Allocation Committees of each observatory, either as regular or ToO mode. This is done every 6 months.
- To acquire photometric, spectro-photometric, and/or spectroscopic data of the NEOs (the PHOs having higher observational priority) already observed by the Arecibo radar system, in the visible (0.4 – 0.9 µm) and/or the near-infrared (0.8 – 2.5 µm).

H2020: NEOROCKS

Task 3.5 – Observational support to the Arecibo Planetary Radar Program

The IAC group is responsible for providing access, through regular calls and target-of-opportunity (ToO) mode, to visible/near-infrared photometric and spectroscopic observations from a range of 1- to 10.4-m telescopes located at the "*Observatorios de Canarias*" (OOCC). The main tasks of the IAC:

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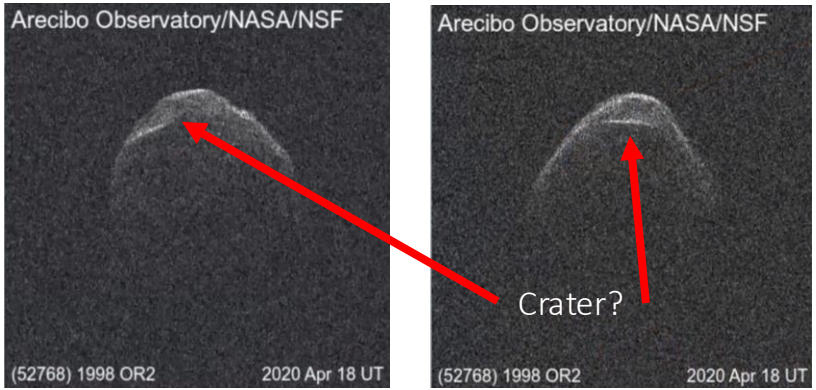
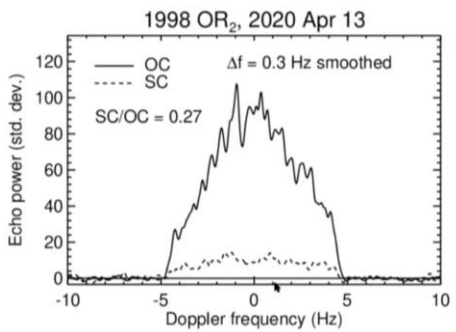
- To prepare and send observational proposals to the corresponding Time Allocation Committees of each observatory, either as regular or ToO mode. This is done every 6 months.
- To acquire photometric and spectroscopic data of NEAs and PHOs having higher observational priority) already observed by the Arecibo radar system, in the visible (0.4 – 0.9 μm) and/or the near-infrared (0.8 – 2.5 μm).

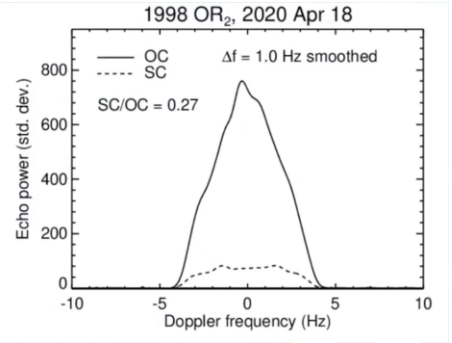
After the Arecibo collapse in December 2020, we focused in observing those targets that had been observed in the past by the Arecibo radar, having good SNR radar data.

H2020: NEOROCKS

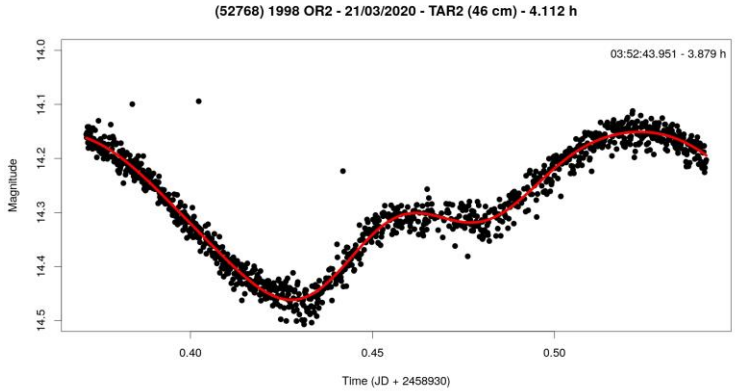
(52768) 1998 OR2 Flew-by the Earth on April 29th 2020. Closest approach: 0.042 au





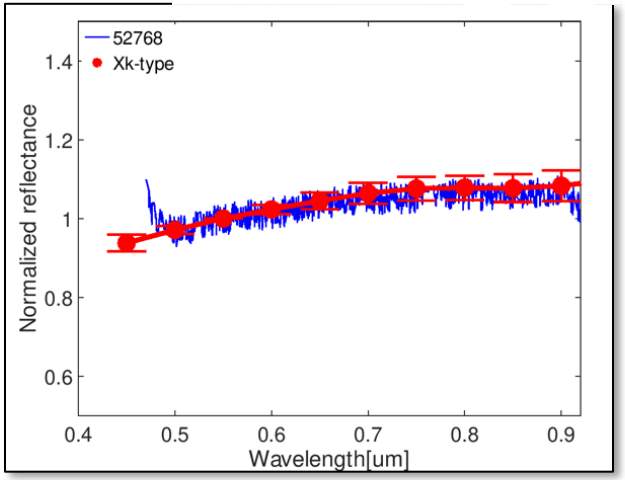


Devogele et al. (2024), PSJ 5(2), 44.



- 1998 OR2 - 8 nights with 46cm TAR2 telescope (Mar 17 – Apr 29 2020)
- Colors with MuSCAT2

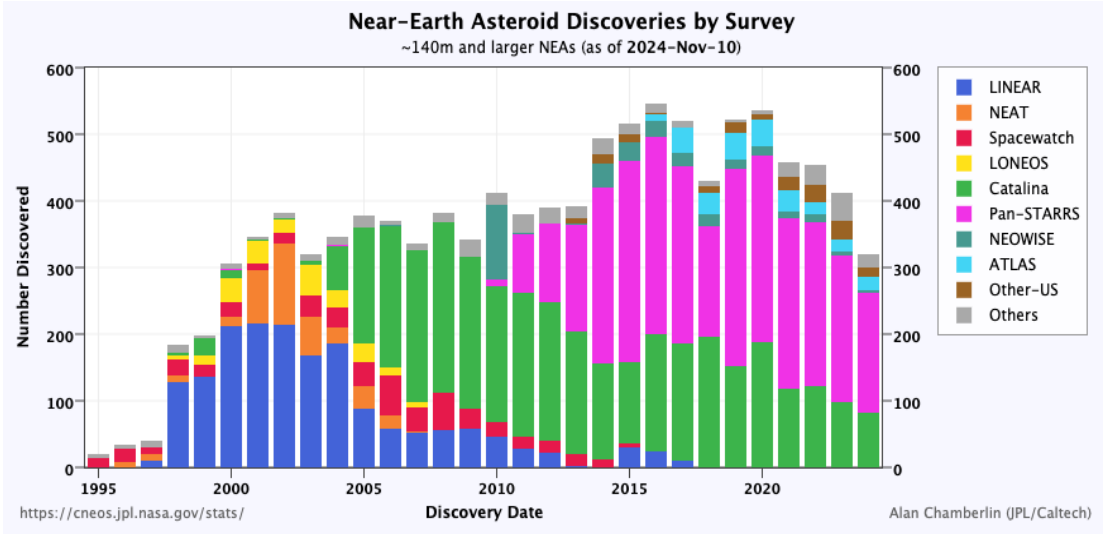
$(g\text{-}r) = 0.499 \pm 0.006$
$(r\text{-}i) = 0.118 \pm 0.005$
$(i\text{-}z) = 0.015 \pm 0.005$



ATLAS-Teide

ATLAS-Teide: project funded by Spanish Ministry of Science to acquire and built an ATLAS unit at the Teide Observatory (OT) to integrate the IAC Solar System Group in one of the most important surveys of NEOs. ATLAS is an early detections system for objects that can collide with the Earth, composed of a network of 50 cm telescopes and a wide FOV (30 deg^2). It has two telescopes in Hawaii, and another 2 under construction in South Africa and Chile.

ATLAS Discovery Totals	
Near-Earth Asteroids	1119
Potentially Hazardous Asteroids	104
Comets	96
Supernovae	4,272



ATLAS-Teide

ATLAS modules based on COTS :

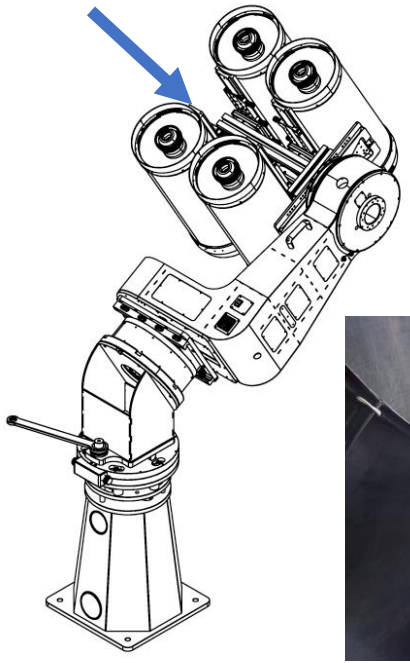
- Optics: 4 x RASA11 OTAs.
- Cameras: QHY600PRO back-illuminated CMOS
- Mounts: improved Planewave L-500

4 RASA 11 mounted on a Planewave L-550, aligned to observe the same field

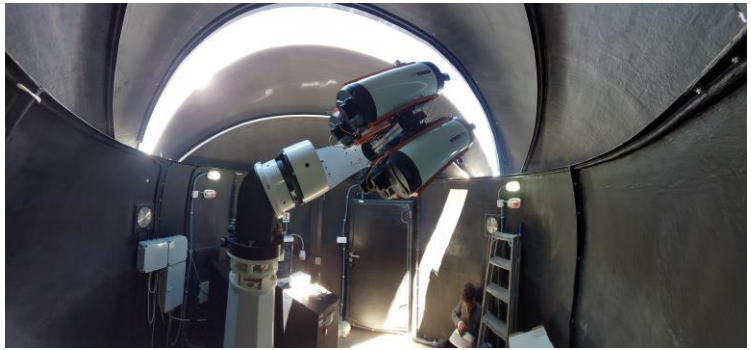
- Effective aperture combining the 4 images = 56cm
- Field of view ~7 deg^2
- V_{lim} = 20.2 in 30s (r+g filter)

With 4 ATLAS modules we can cover the same field of view of the actual ATLAS telescopes, with similar sensitivity allowing to cover ¼ of the night sky 4 times / night. Cheaper, easier to install and maintain and allows more observing modes.

Support of 4 RASA11 is the only ad-hoc part



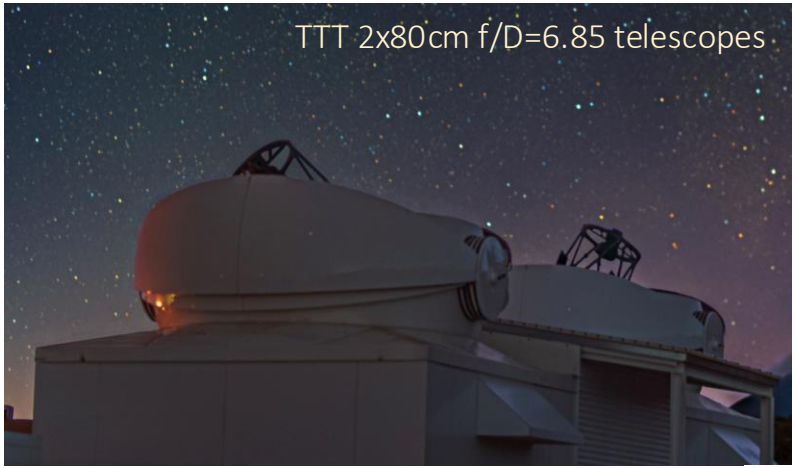
Phase 1– built a prototype that operated at Teide Obs. during 2023
Phase 2 – building of the 4 modules of ATLAS-Teide and installation in the Roll-off structure (early 2025)
Phase 3 – complete integration of ATLAS-Teide in the ATLAS network (2025)

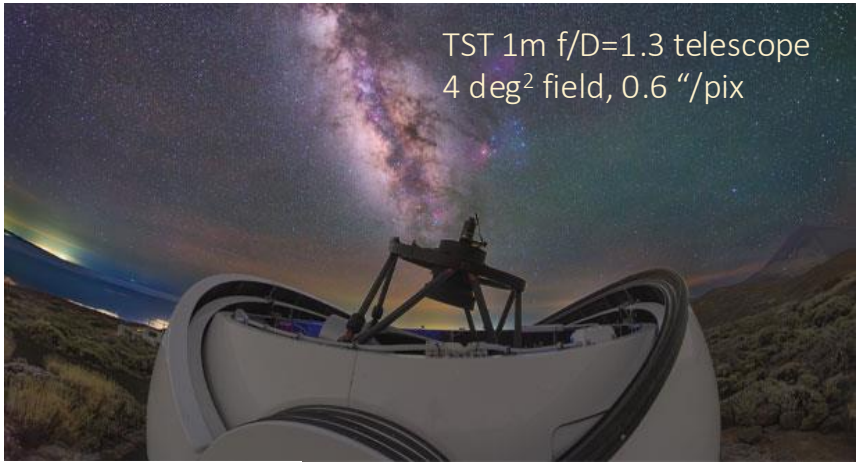


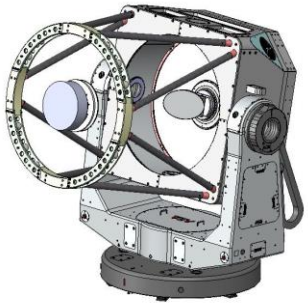
atlas TEIDE

- Builing & dome finished
- Instrument assembled at Baader's workshop. Soon on its way to the Observatory
- Start of operations: early 2025

TTT & TST telescopes







TTT 2x2m f/D=6.85 telescopes

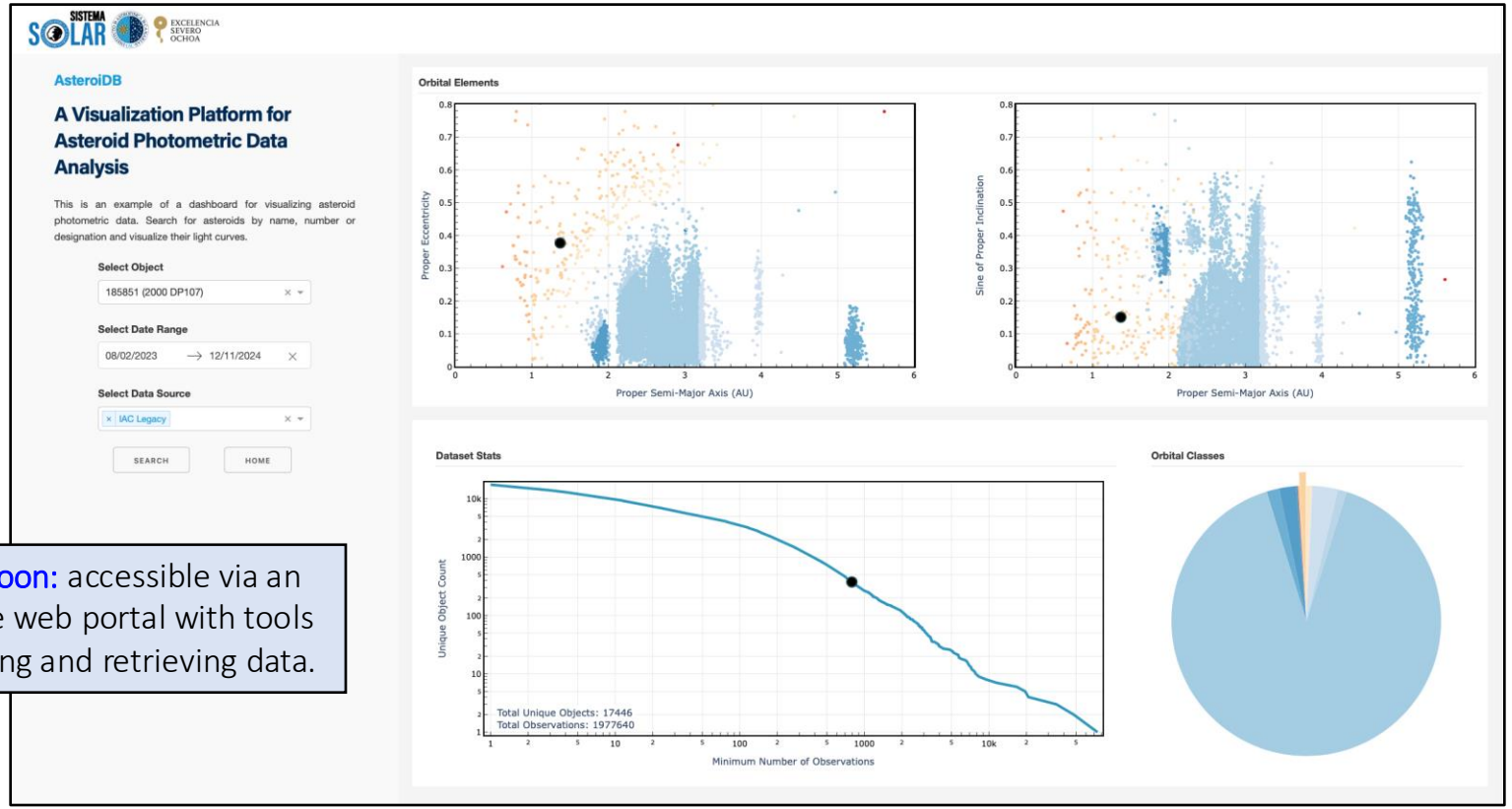
Starting operations 1st half of 2025

AsteroiDB

AsteroiDB: The Asteroid Legacy Archive of the Canary Islands Observatories is a pilot initiative to standardise, index and massively process images from different telescopes to extract photometric data of known asteroids. The open-access images are being processed in real time to complete an asteroid photometric database, accessible through a web portal. This portal will provide tools for selecting, visualising, downloading and analysing data and image stamps. It will also allow the calculation of derived variables such as rotation period, amplitude and HG/HG1G2 parameters.

Telescope	⌀ (m)	Instrument	FOV (')	Scale ("/px)	Filter	# images	Volume (TB)
TTT-1	0.80	iKon936-L BEX2-DD	17.3 x 17.3	0.50	Lum ugriz	101,306	1.6
TTT-1	0.80	sCMOS QHY411	52 x 39	0.22	Lum gri	58,195	33.6
TTT-2	0.80	sCMOS QHY411	52 x 39	0.22	Lum gri	363,842	209.9
TST	1.0	sCMOS QHY411	144 x 106	0.6	Lum gr	27,172	15.7
To be processed…							
ATLAS-Teide	16 x 0.28	sCMOS QHY600	99 x 66	1.2	Lum		
IAC80	0.82	CAMELOT-2	11.8 x 11.8	0.3	gri UBVRI		

AsteroiDB



Coming soon: accessible via an interactive web portal with tools for analysing and retrieving data.

AsteroiDB

Number of processed images: 550 515

Asteroid observations: 2 038 921

Unique objects: 21 255

Unique Near-Earth-Asteroids: 307

with more than 300 points: 140

Goldstone targets: 29

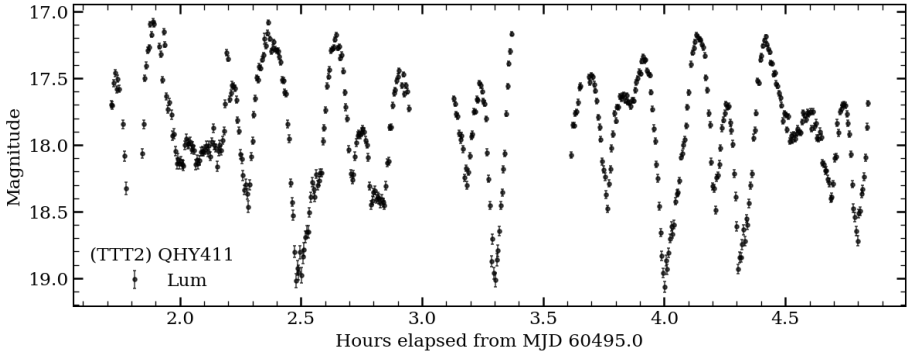
with more than 1000 points: 73

On-going characterization projects:

- Goldstone targets
- Newly discovered NEAs
- Potential mission targets
- Fast-rotator candidates

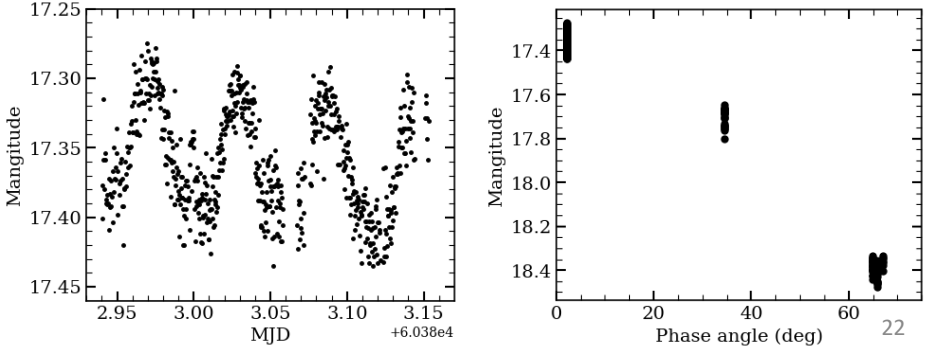
2024 MK

Newly discovered NEAs are observed as soon as possible and the resulting photometry is automatically retrieved on the fly.



185851

Extensive follow-up campaigns of NEAs are carried out to determine their physical and rotational properties.



EXCELENCIA SEVERO OCHOA

SOLAR SYSTEM

THANKS!!!!

You can contact us at:

jmlc@iac.es (Julia)

jlicandr@iac.es (Javier)