



©Quro/Hobunsha

# COIAS: Search Application for Small Solar System Bodies

<sup>1</sup>Seitaro Urakawa, <sup>2</sup>Keisuke Sugiura, <sup>3</sup>Kenichi Ito, <sup>4</sup>Takafumi Oostubo,  
<sup>5</sup>Kohei Kitazato, <sup>6</sup>Michitaro Koike, <sup>7</sup>Natsuho Maeda, <sup>8</sup>Shinsuke Uno,  
<sup>6</sup>Kumiko Usuda-Sato, <sup>9</sup>Daisuke Kinoshita, <sup>10</sup>Tomohiko Sekiguchi

<sup>1</sup>Japan Spaceguard Association, <sup>2</sup>Mitsubishi Electric Corporation, <sup>3</sup>Diver-X Inc,  
<sup>4</sup>University of Occupational and Environmental Health, <sup>5</sup>The University of Aizu,  
<sup>6</sup>NAOJ, <sup>7</sup>Kobe University, <sup>8</sup>RIKEN, <sup>9</sup>National Central University, <sup>10</sup>Hokkaido  
University of Education

<sup>1</sup>s\_urakawa@spaceguard.or.jp



# COIAS

Come On! Impacting Asteroids

HSC-SSP survey => Capture of a large number of solar system bodies (SSSBs)  
COIAS: A web-based application



# Aims of COIAS

## ► Mapping of the solar system bodies

Elucidation of the orbital and taxonomical distribution for small main belt asteroids (MBAs) and trans-Neptunian objects (TNOs)

## ► Planetary defense

Discovery of near-Earth objects and the orbit improvements

## ► Discovery of rare objects

TNOs • Comets • Active asteroids • Interstellar objects • Planet 9

## ► Citizen science (Community science)



# Concept behind COLIAS for Citizen Science

- ▶ **To create the environment where anyone can easily conduct research activity**

Installation-free and OS-independent.

- ▶ **To make the measurement accuracy of citizen scientists equivalent to that of researchers**

The created data can contribute to solar system sciences directly.

- ▶ **To inspire more people to be interested in science by introduction them to the wonders of astronomy**

Genuine research activity : Observation results are send to the IAU's Minor Planet Center.



## Collaboration with KOIAS ("Asteroids in Love")



KOIAS (K(C)OIsuru ASteroids):  
Japanese comic and animation work. The abbreviated name is KOIAS.

English title: Asteroid in Love.

Story: High school students attempt to discover and name an asteroid.

We have adopted the name "COIAS" for our application and aim to promote science education by encouraging the participation of young people in citizen science projects.



# Demonstration





Move

Area 1

Area 2

Area 3

Last

Image

Auto

x0



You measured 588 objects.



Auto

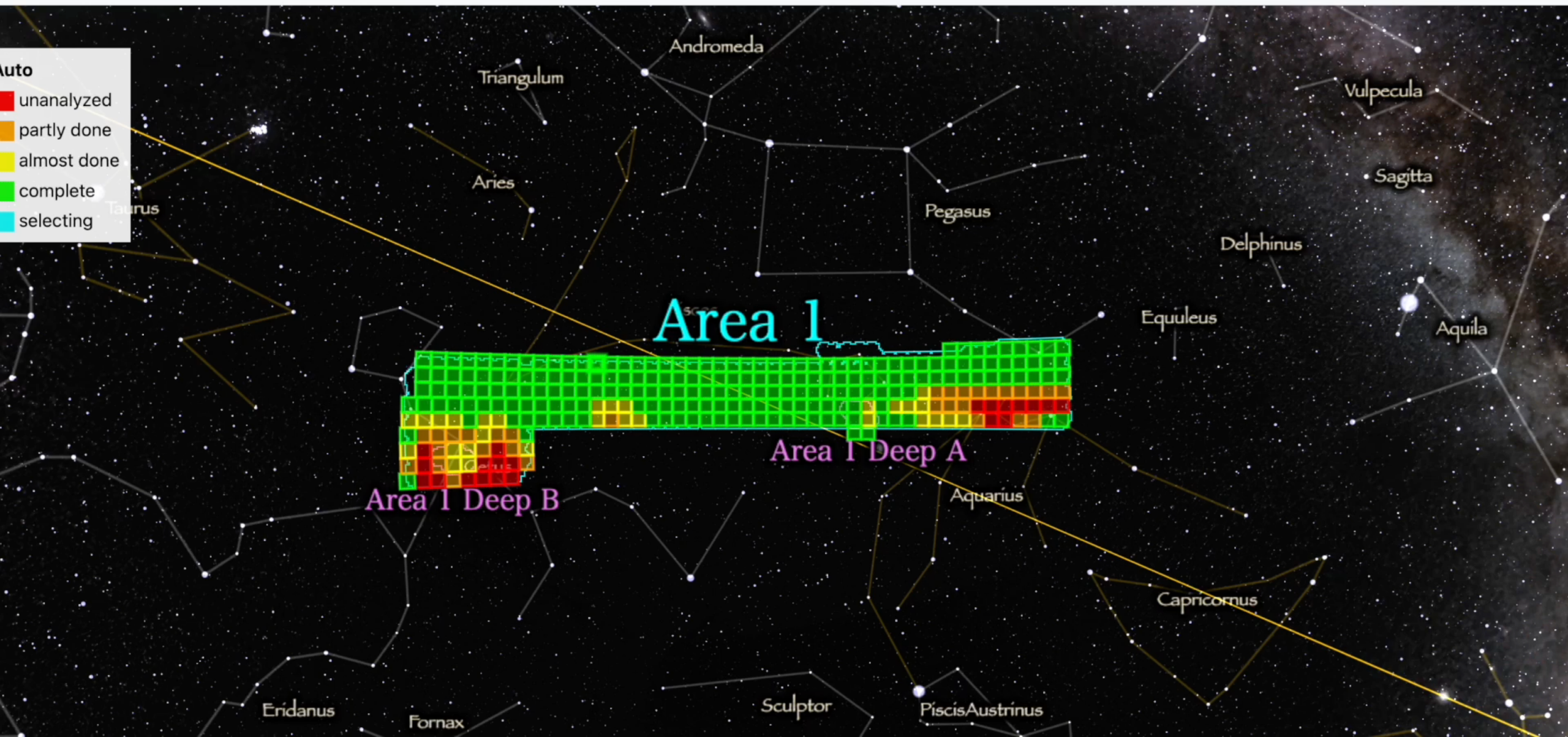
unanalyzed

partly done

almost done

complete

selecting

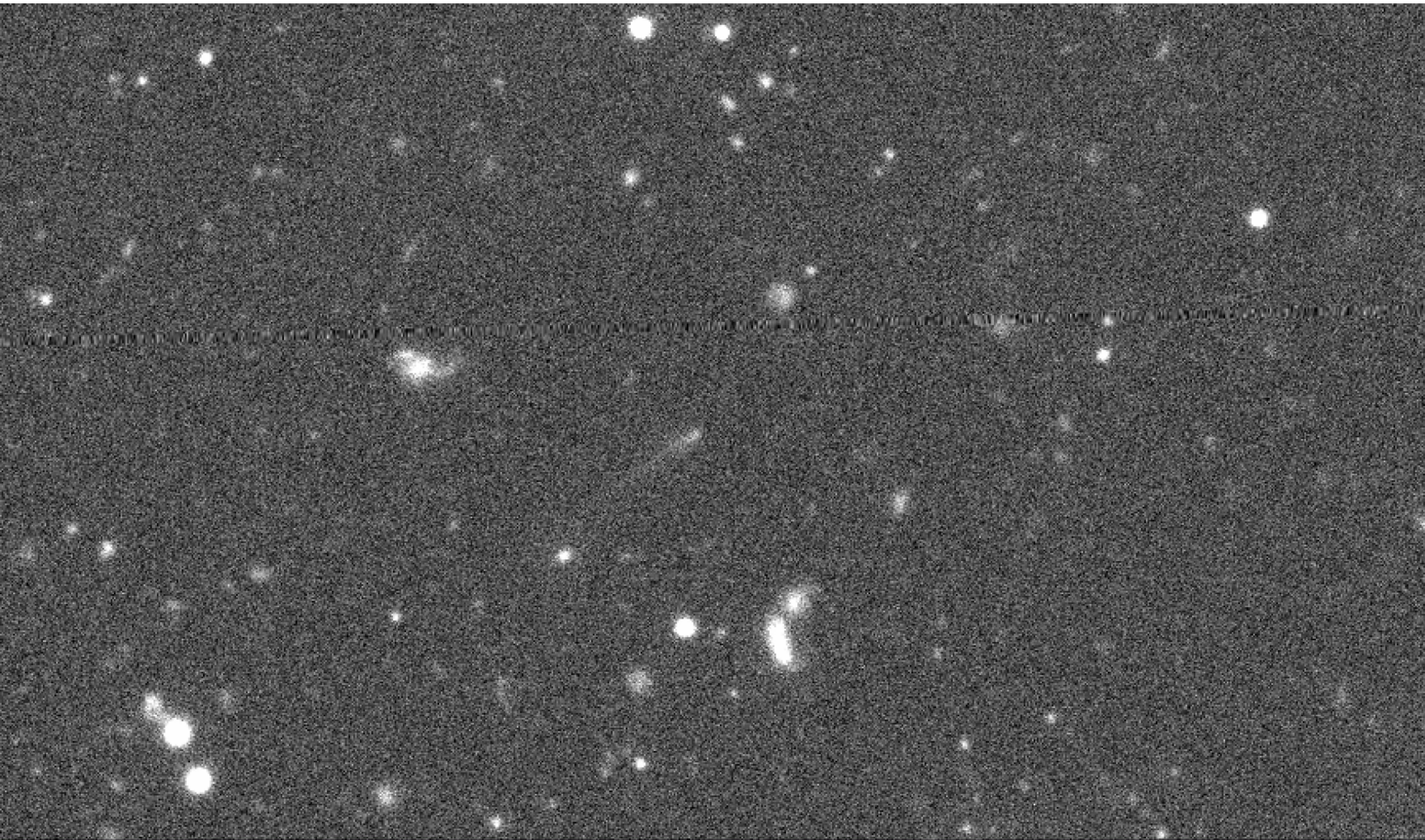


# Discovery Status



# C/2015 K7

## The Subaru telescope's first comet discovery



Observation date:  
May 17,21,26. 2014  
g:23.4 mag,i:23.0 mag  
y:23.7 mag

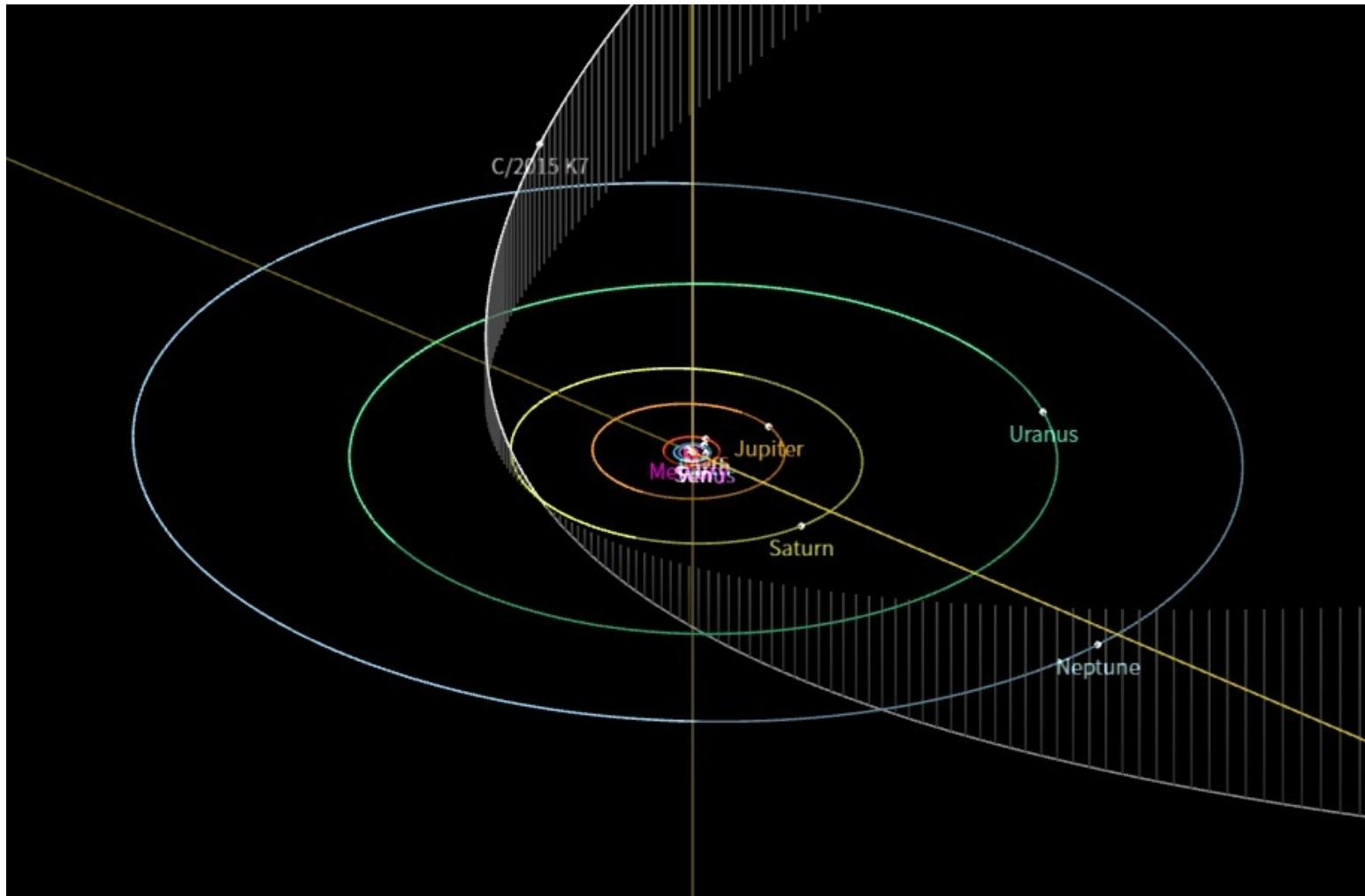
Measurer : A. Yamauchi  
(Report day : Nov.26 2024)

Orbital information  
 $e \approx 1$ ,  $i = 159.9^\circ$

Heliocentric distance in  
observation date:10.9 au  
Comet activity far from the  
Sun => CO sublimation

# C/2015 K7

## The Subaru telescope's first comet discovery



Observation date:  
May 17,21,26. 2014  
g:23.4 mag,i:23.0 mag  
y:23.7 mag

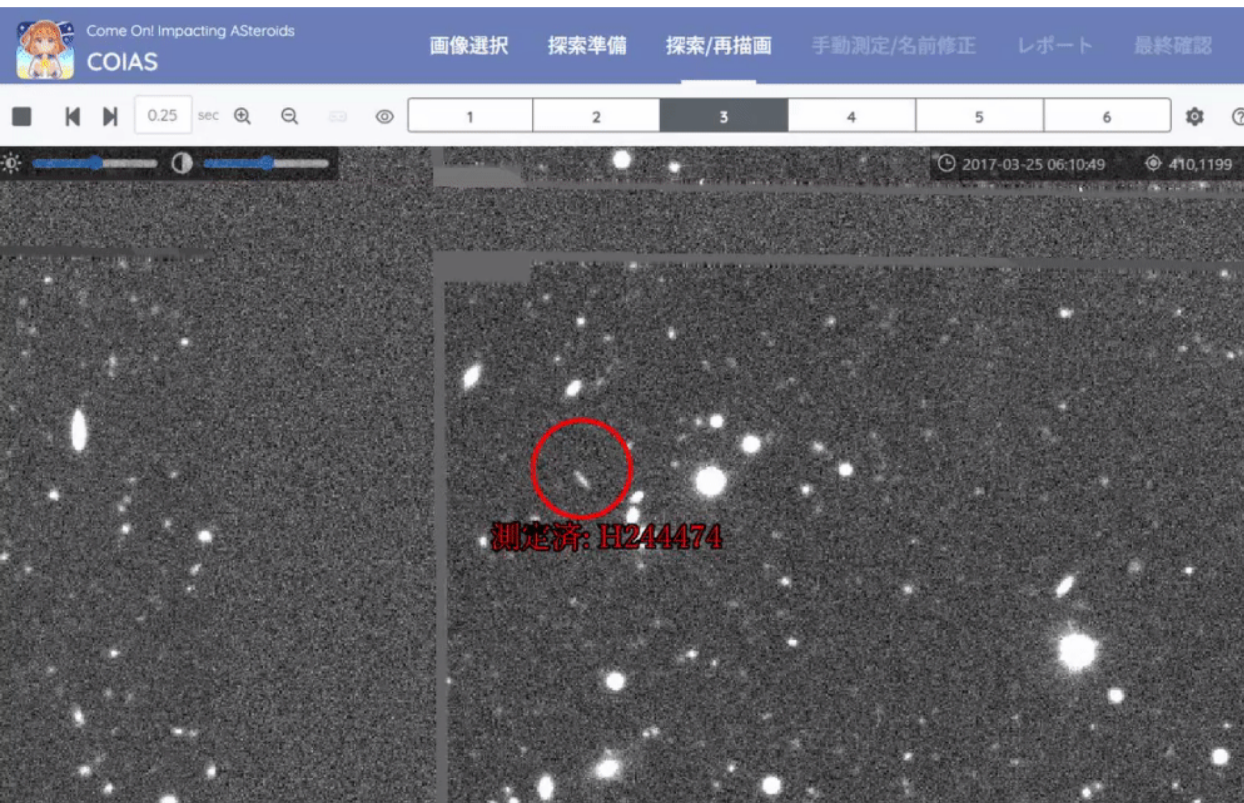
Measurer : A. Yamauchi  
(Report day : Nov.26 2024)

Orbital information  
 $e \approx 1$ ,  $i = 159.9^\circ$

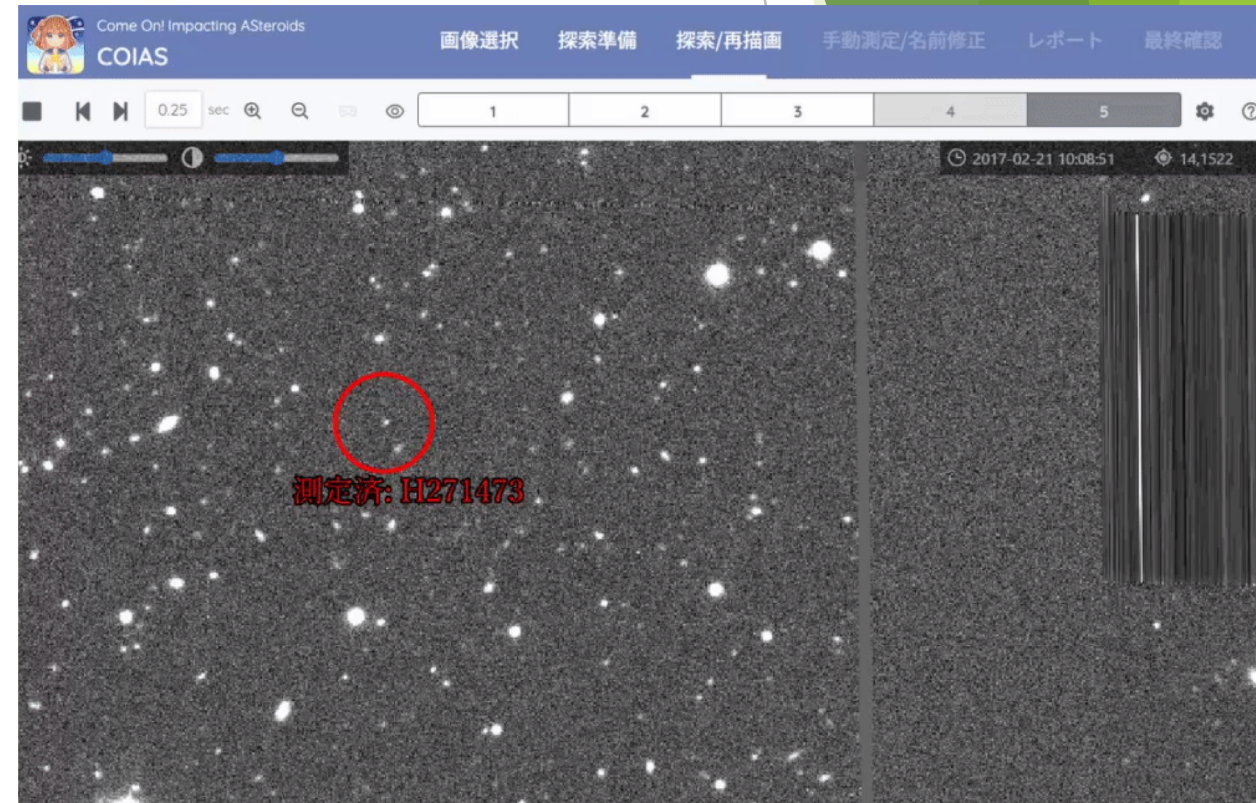
Heliocentric distance in  
observation date:10.9 au  
Comet activity far from the  
Sun => CO sublimation



# Discovery of NEOs and TNOs



NEO 2017 FC<sub>228</sub>  $a = 1.71$  au,  $e = 0.327$ , Diameter 30 m  
High moving velocity



TNO 2017 DE<sub>157</sub>  $a = 79.9$  au,  $e = 0.587$ , Diameter 75 km  
Slow moving velocity

# Search and Discovery Status by December 26, 2024

1. **ITF (Isolated Tracklet File) objects = Unknown candidates** : Objects reported to the MPC, but not followed by subsequence observations : **>200,000**
2. **Provisional designation objects** : Objects for which multiple observations have been made, allowing for a rough orbital estimation. (e.g., 2019 VC<sub>42</sub>): **4429**

**TNO (478) :**

**The world's leading number of discoveries in 2024**

NEO (6), Mars crosser (30), Hilda (33), Jupiter Trojan (139)

3. **Numbered (Named) objects** : Objects with well-determined orbits based on four to ten years of observations: **3**

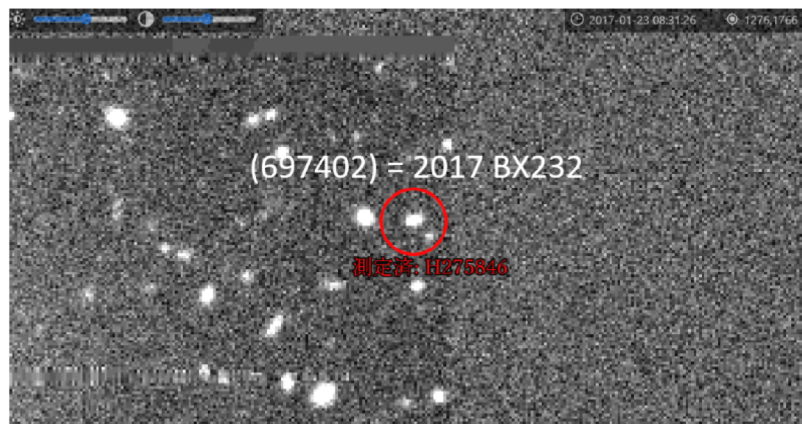


# Named Asteroids



- ▶ Congratulation! (697402) 「Ao」 : Character of “Asteroid in Love”
- ▶ Congratulation!! (718492) 「Quro」 : Author of “Asteroid in Love”
- ▶ (719612) 「Hoshizaki」 : High school name in “Asteroid in Love”

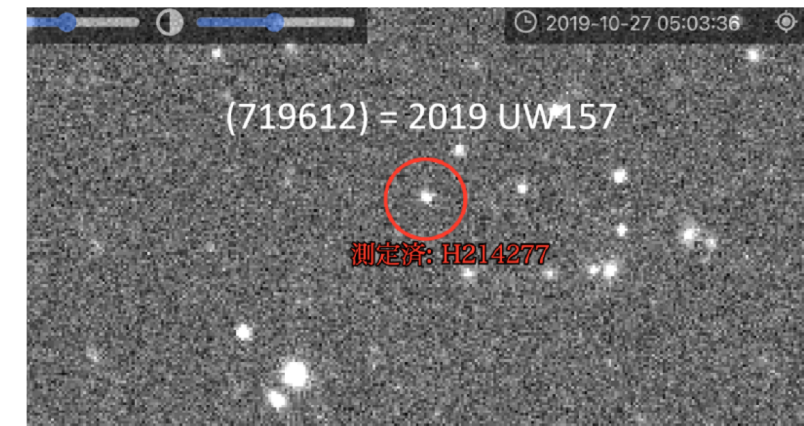
(697402) Ao = 2017 BX232



(718492) Quro = 2017 FZ233

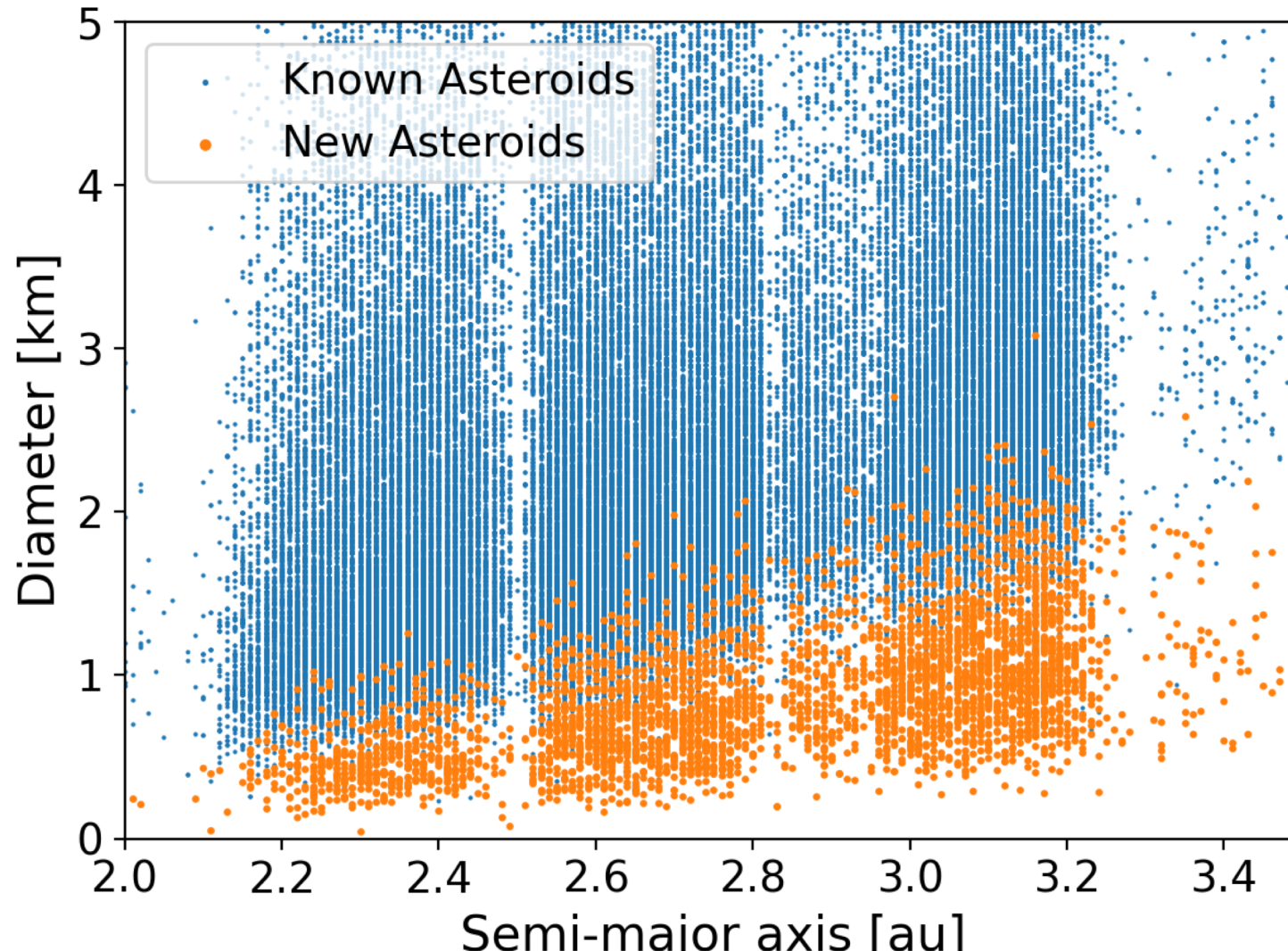


(719612) Hoshizaki = 2019 UW157





# Relationship between the orbit and diameter in the main belt asteroids region



COIAS has also measured more than 90,000 known objects.

Measurement results are stored in COIAS database.

Blue dot: Known objects measured by COIAS

Orange dot: Provisional designated objects discovered by COIAS

COIAS clarifies the orbits of a few hundred meter-class asteroids.

## Summary and additional information

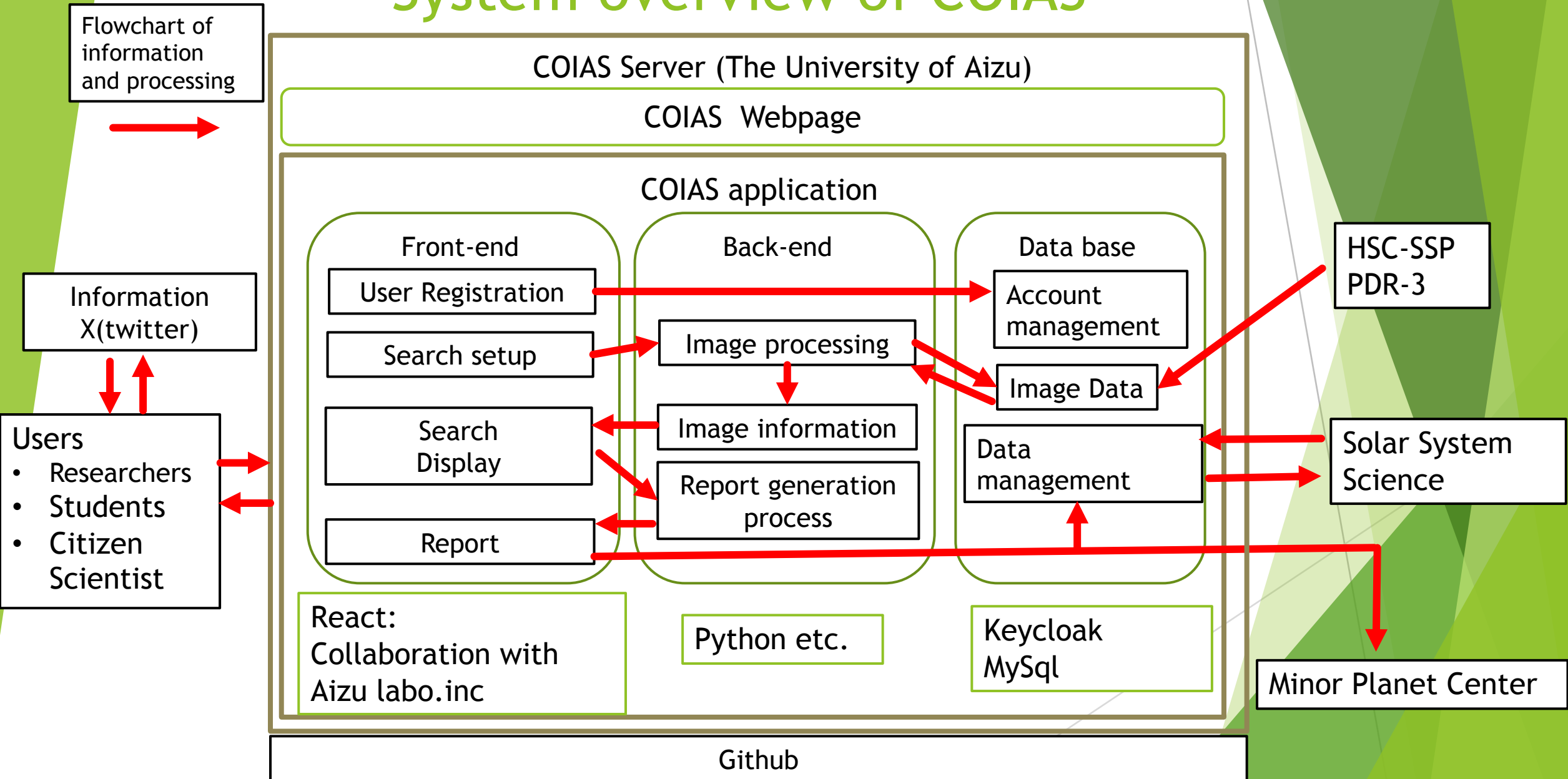
- ▶ COIAS: World's deepest SSSBs search web-based application
- ▶ Number of citizen scientist: >1000
- ▶ Our operations and management are entirely volunteer-based, covering system maintenance, user support, and information dissemination.
- ▶ We anticipate that the LSST will enable our ITF objects to be provisionally designated.

# Acknowledgements

- ▶ The author, Quro, along with publisher Hobunsha, and animation distributor KADOKAWA, have kindly provided design assistance for this work. Unauthorized use of images related to “Asteroid in Love” in this presentation is prohibited.
- ▶ This work was supported by MEXT Promotion of Distinctive Joint Research Center Program Grant Number JPMXP0619217839/JPMXP0622717003 and JSPS KAKENHI JP16K05310/JP20K0401.
- ▶ The production of the front-end in COLIAS was supported by Aizu laboratory, Inc.



# System overview of COIAS

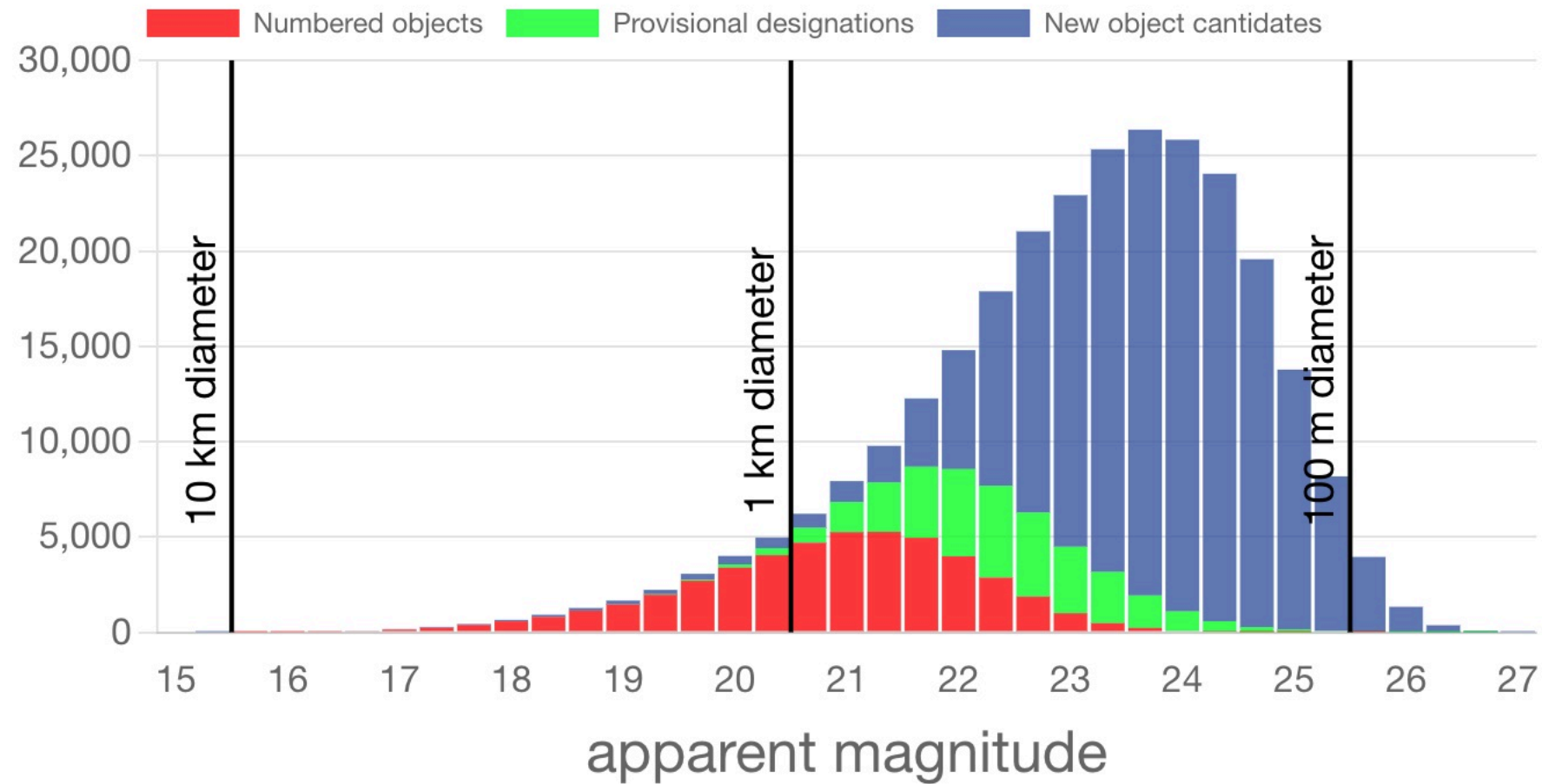


# Public information

- Max impression number in X :124,000 (Discovery of asteroid “Ao”)
- Japanese news paper
- Web on NAOJ
- Collaboration with VTuber

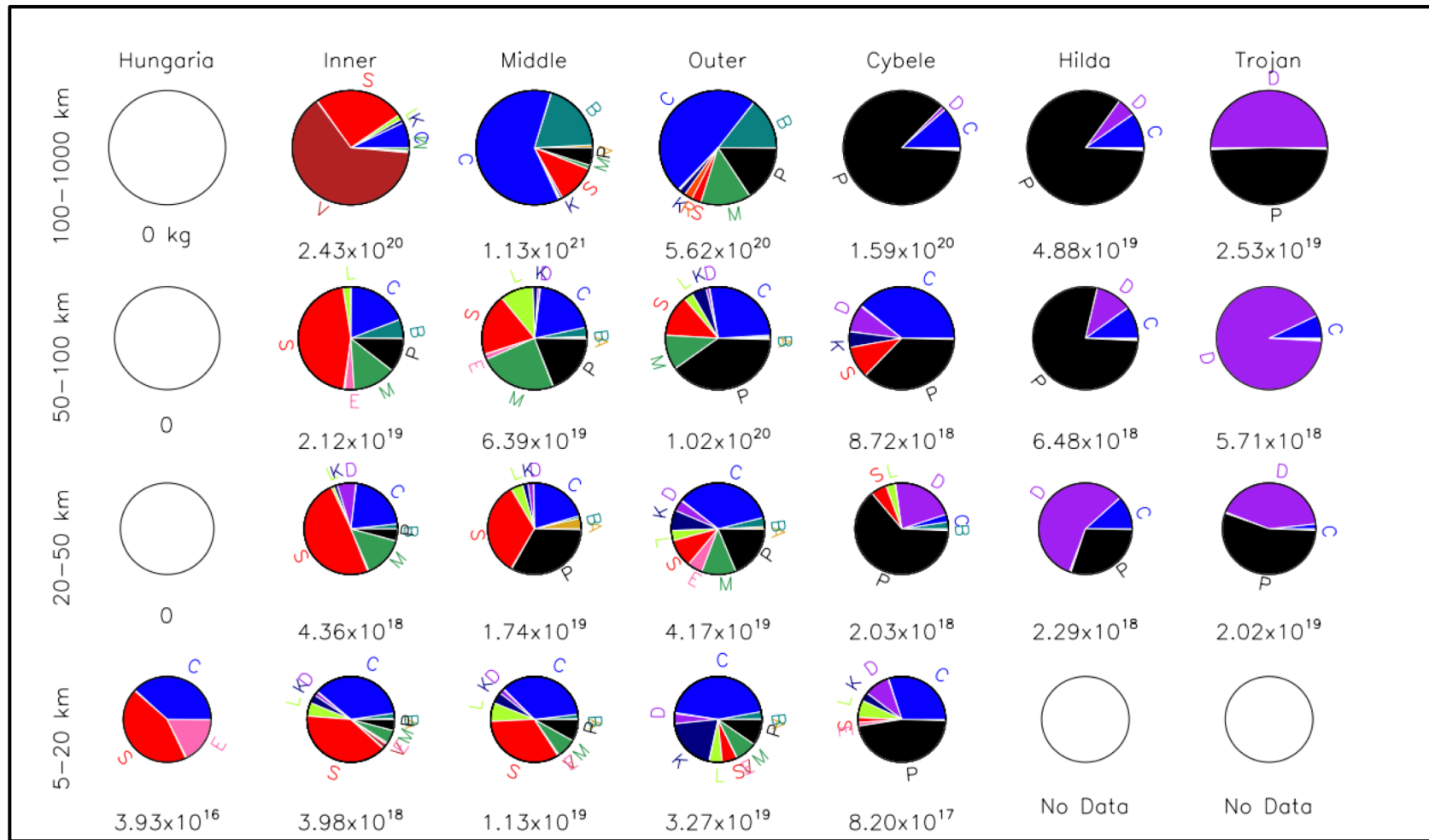


# Magnitudes distribution





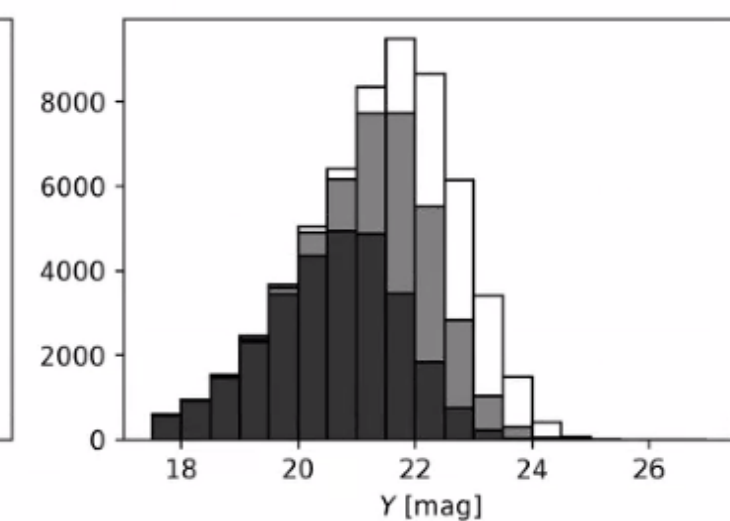
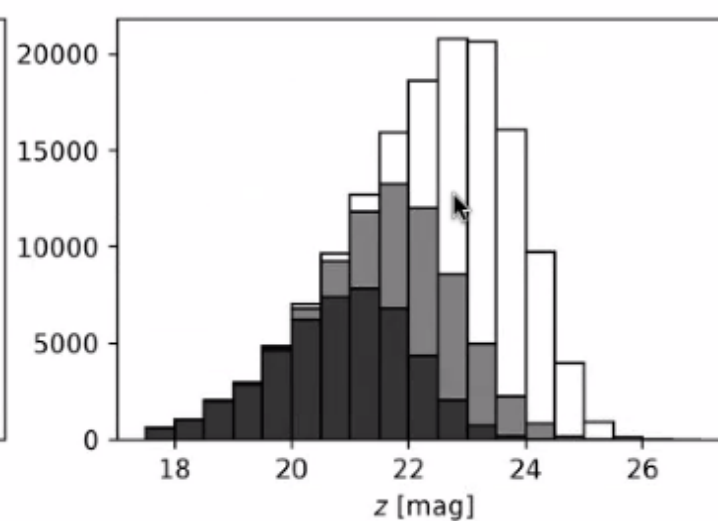
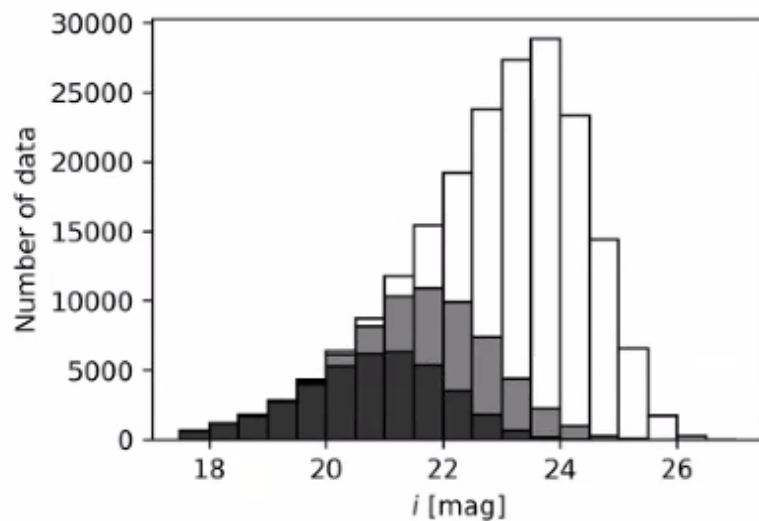
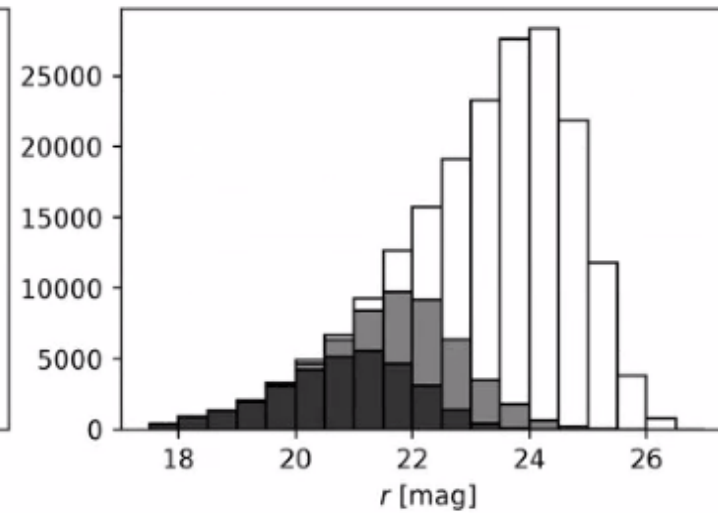
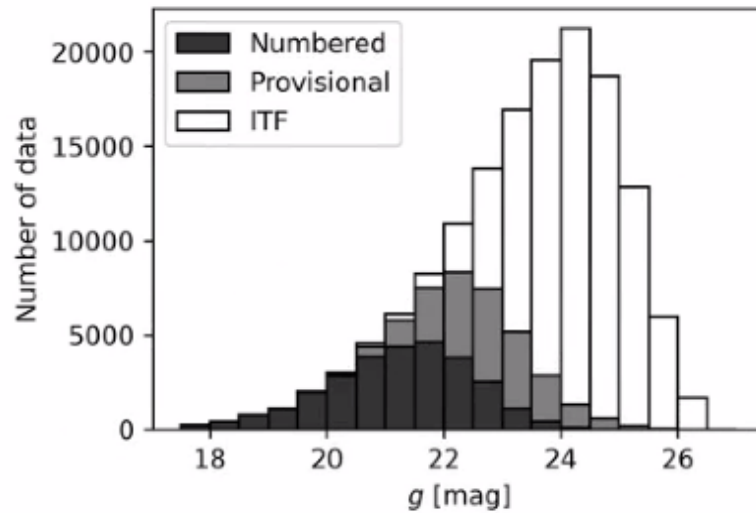
# Taxonomy for small asteroids



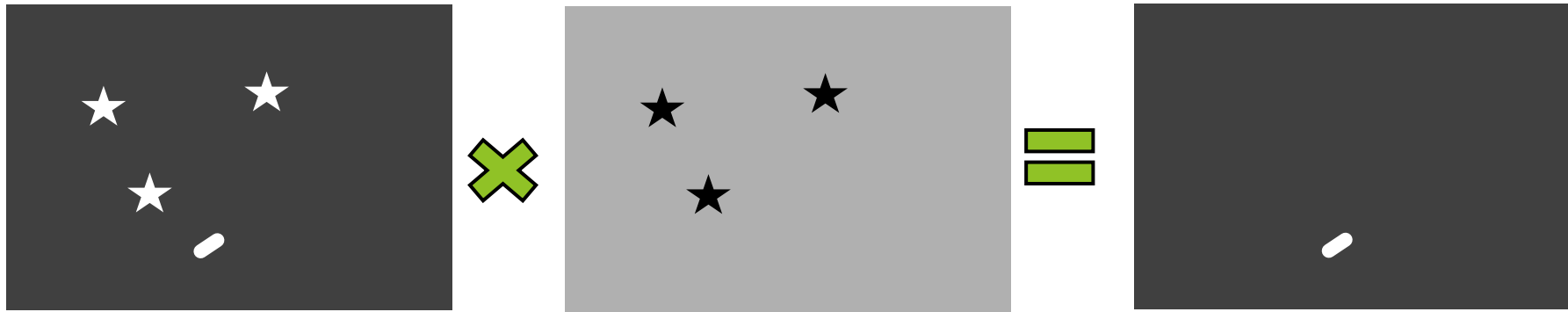
DeMeo & Carry 2014

COIAS clarifies taxonomy for 0.1- 5km asteroids in diameter.

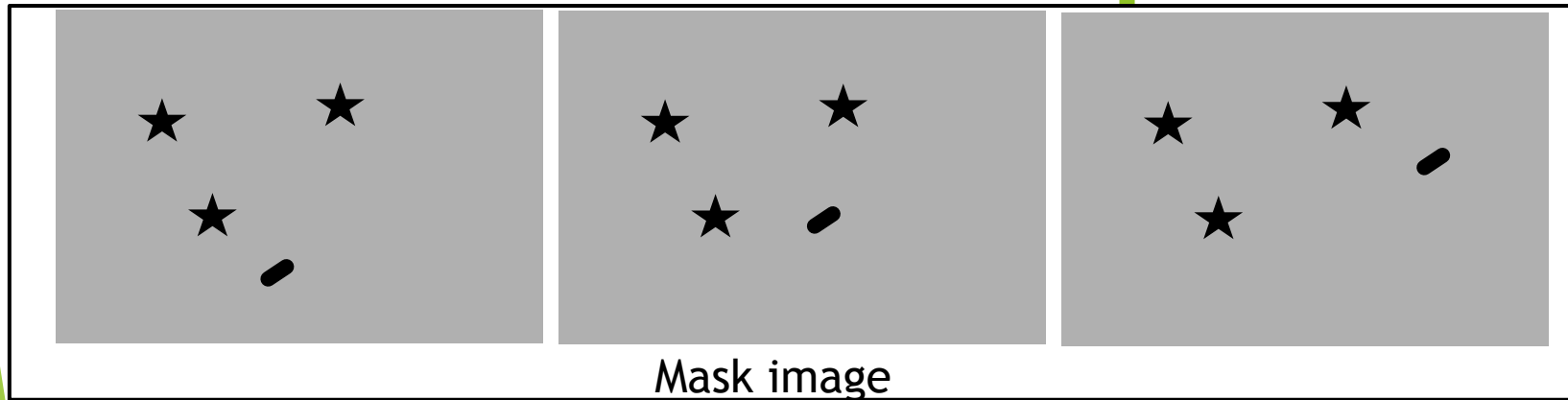
# Magnitudes distribution for each band



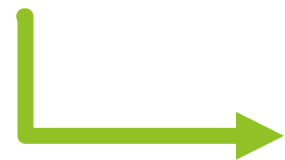
# Star removing



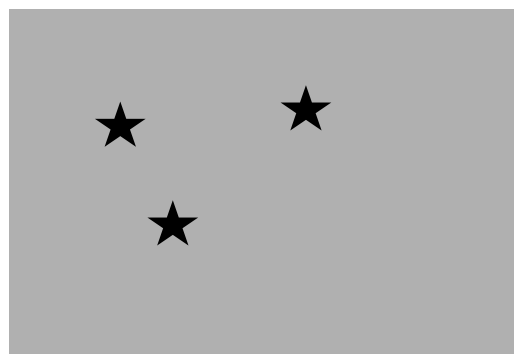
Original image



Mask image



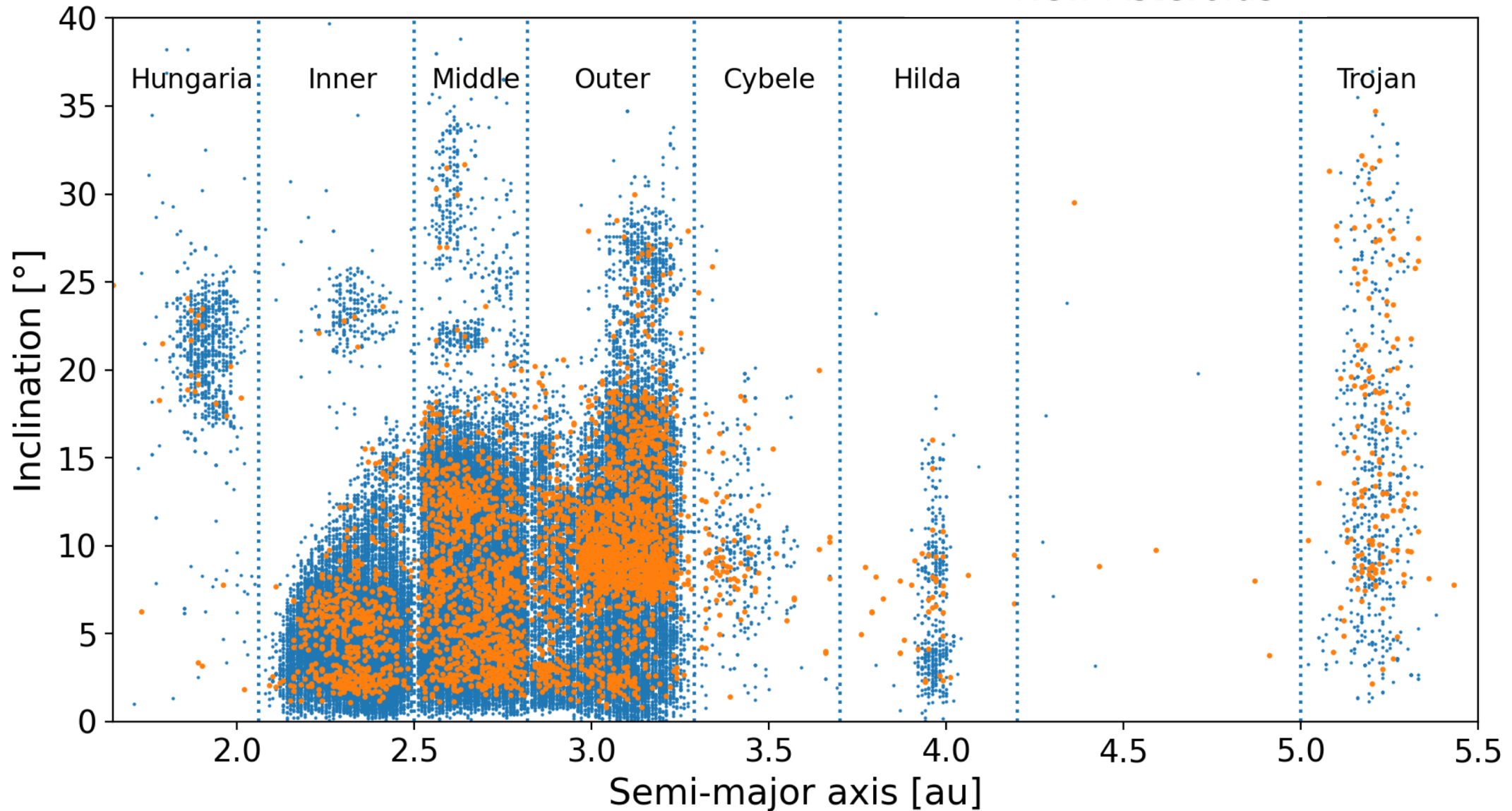
Median  
Binarization



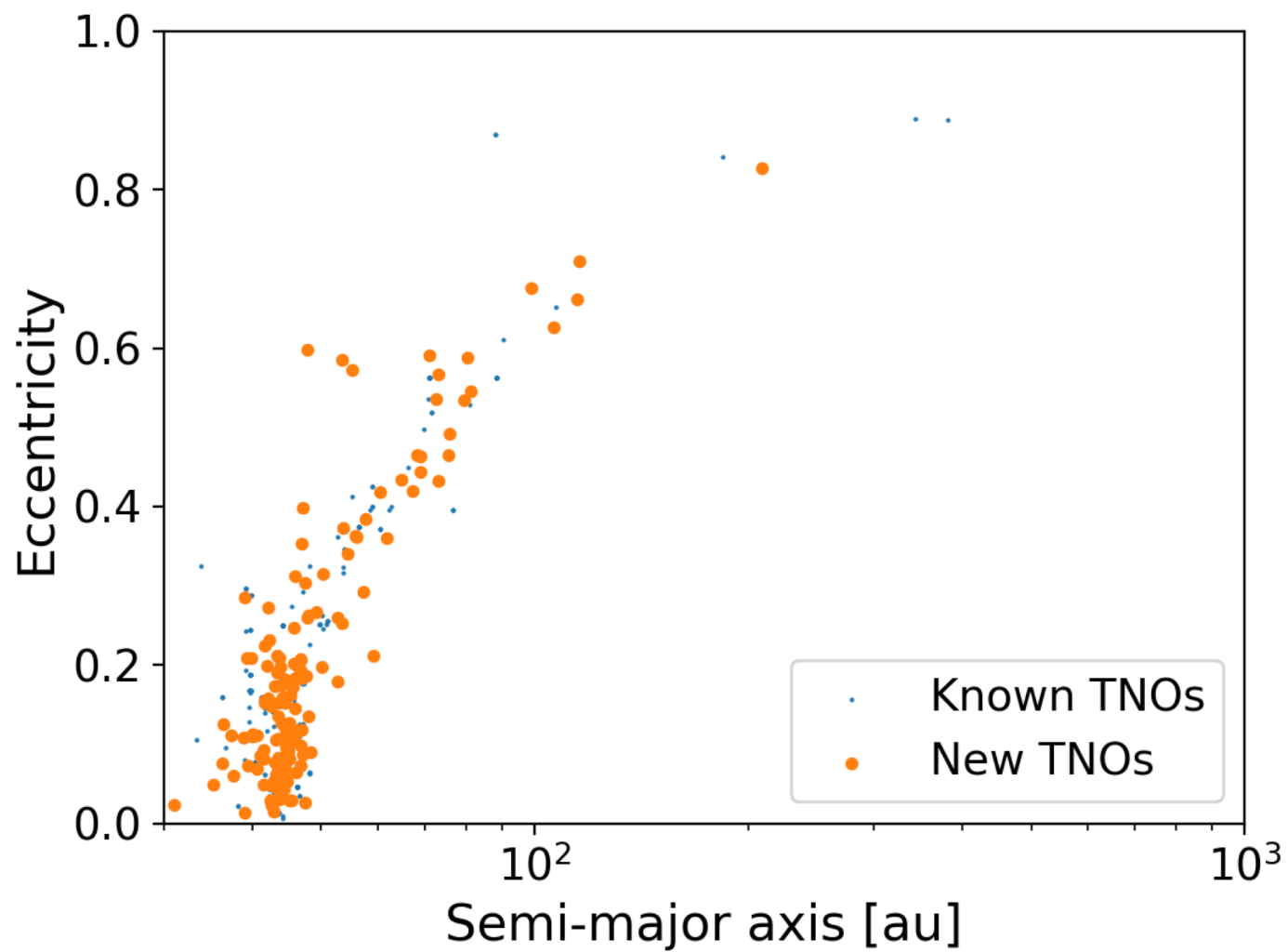


# Orbital distribution by COIAS's measurement objects

- Known Asteroids
- New Asteroids



# Orbital distribution of TNOs



# Orbital distribution by COIAS's measurement objects

