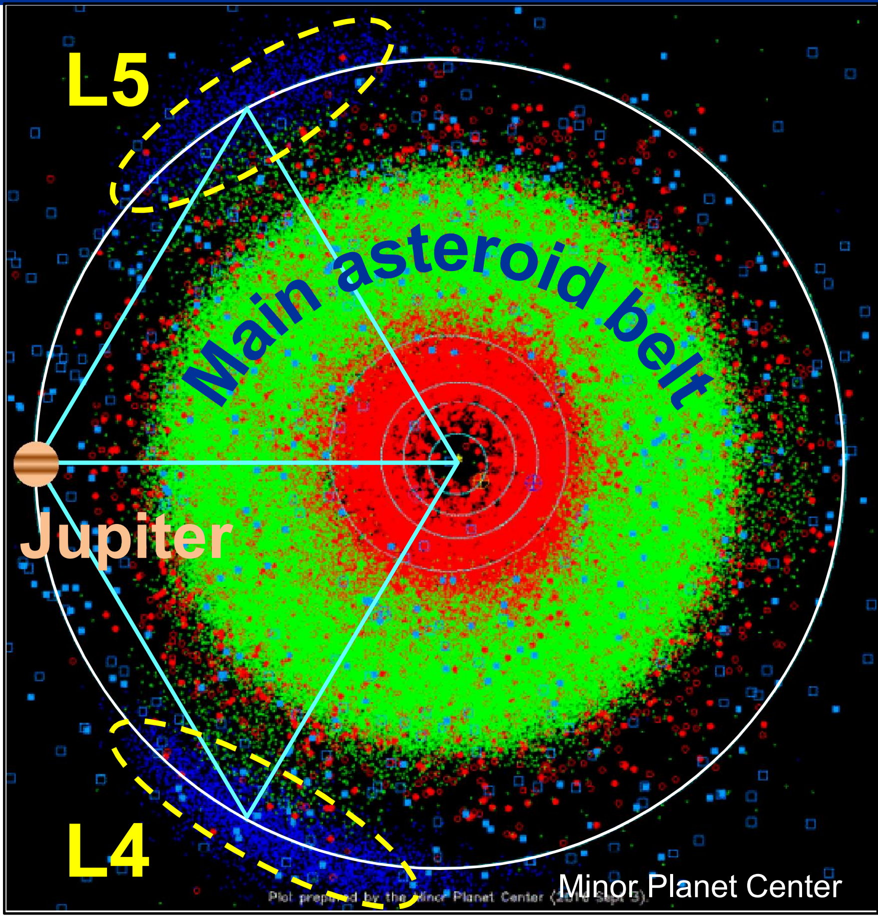
Jupiter Trojan Survey with Hyper Suprime-Cam

Tsuyoshi Terai (Subaru Telescope)

Fumi Yoshida (NAOJ)

Introduction : Jupiter Trojans

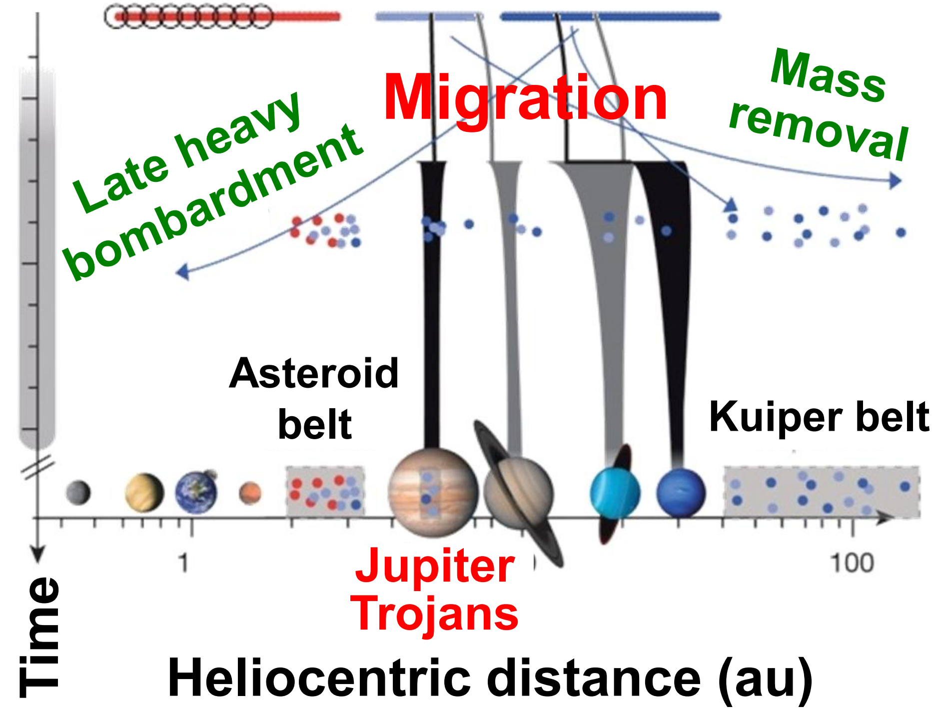
- Two asteroid swarms around the L4/L5 points of Jupiter's orbit
- The spectra are distinct from main-belt asteroids, but are similar to those of comets
- Still unknown from where and how they were captured into the Trojan regions



  - Formed near or beyond Jupiter's orbit ?
  - Gas drag? Collisions? Chaotic capture? Jumping Jupiter?

Introduction : Jupiter Trojans

- **"*Nice*" model** :
  The outer planets migrated owing to interaction with the planetesimal disk
  (e.g. Tsiganis et al. 2005)



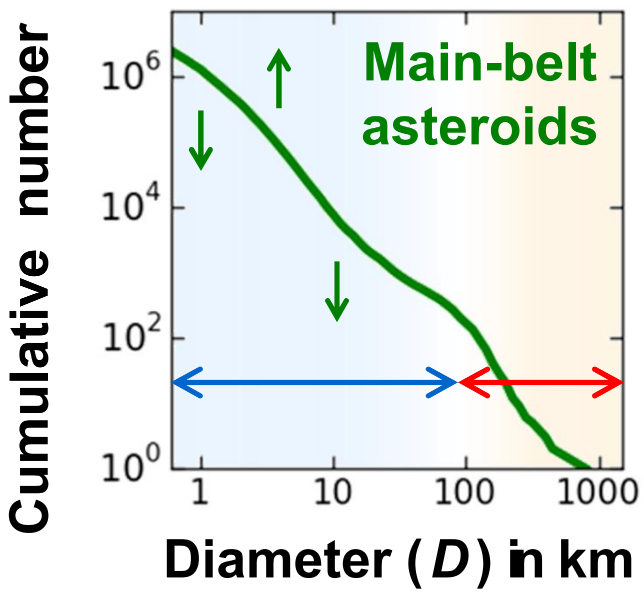
DeMeo & Carry (2014)

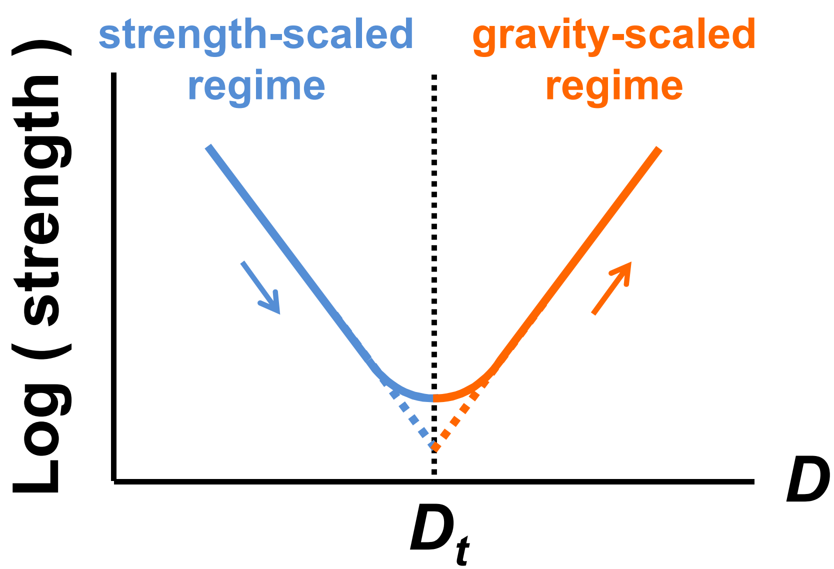
- Jupiter Trojans (JTs) could have been transported from distant regions during the planet migration
  (e.g. Morbidelli et al. 2005)

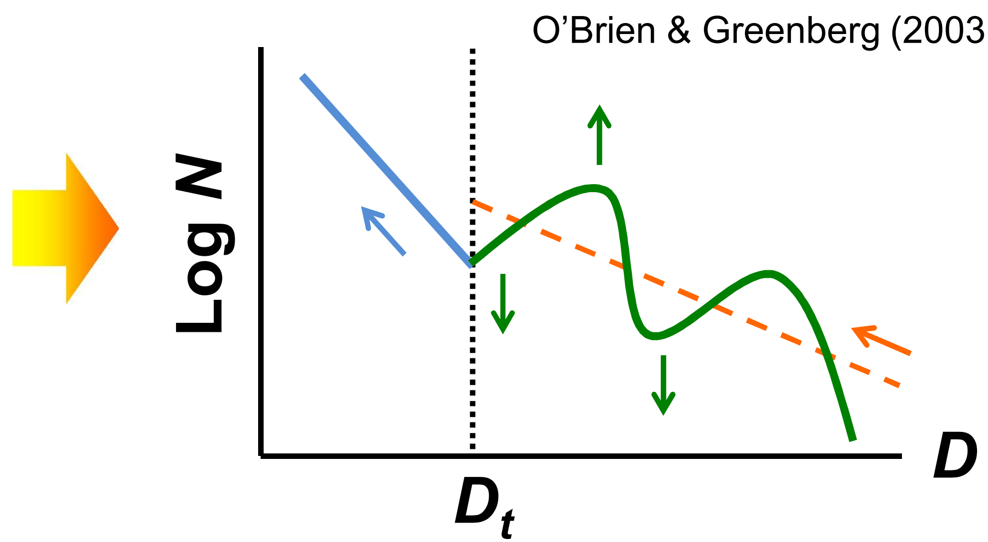
- JTs can provide constraints on the scenario of planet migration and dynamical evolution of small bodies

Approach of research

- Size distribution reflects accre-tional and collisional evolutions
- Transition of impact strength law creates “**wavy**” structure
  → depends on body properties
  → useful clues of the origin

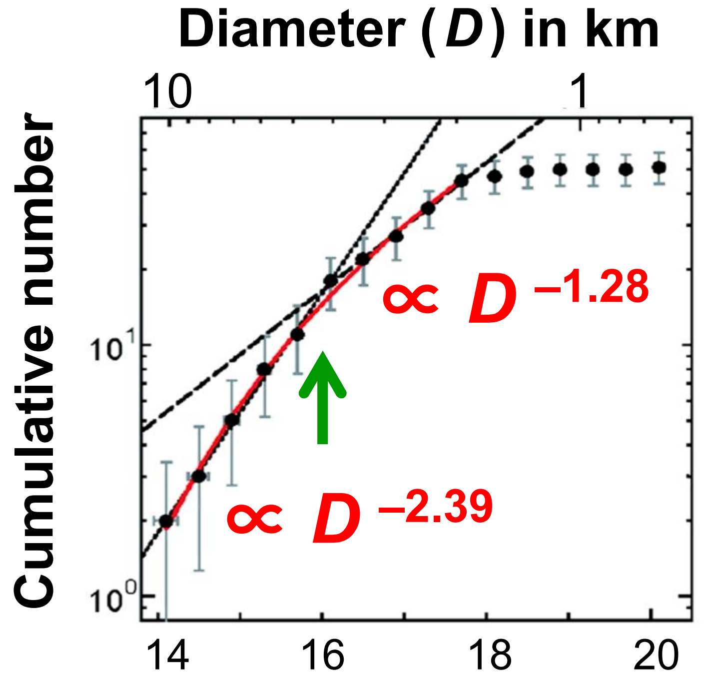


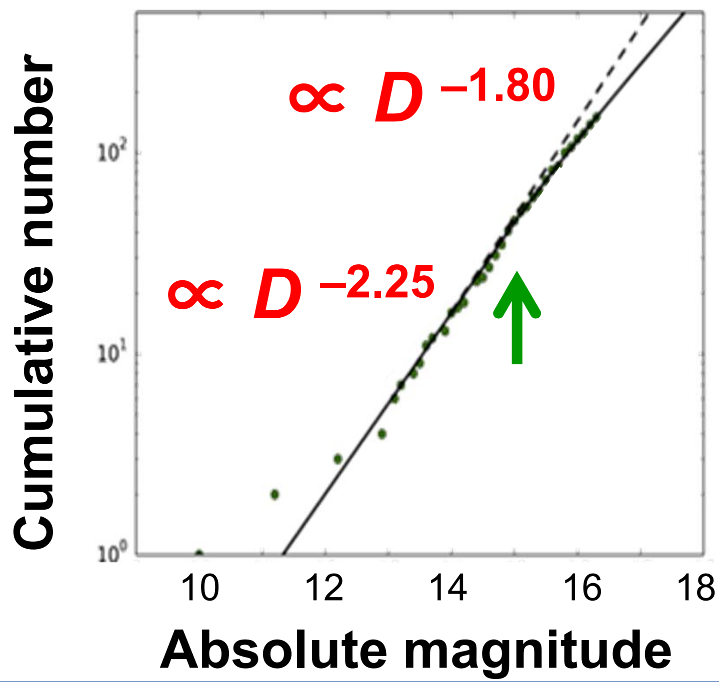




Previous surveys

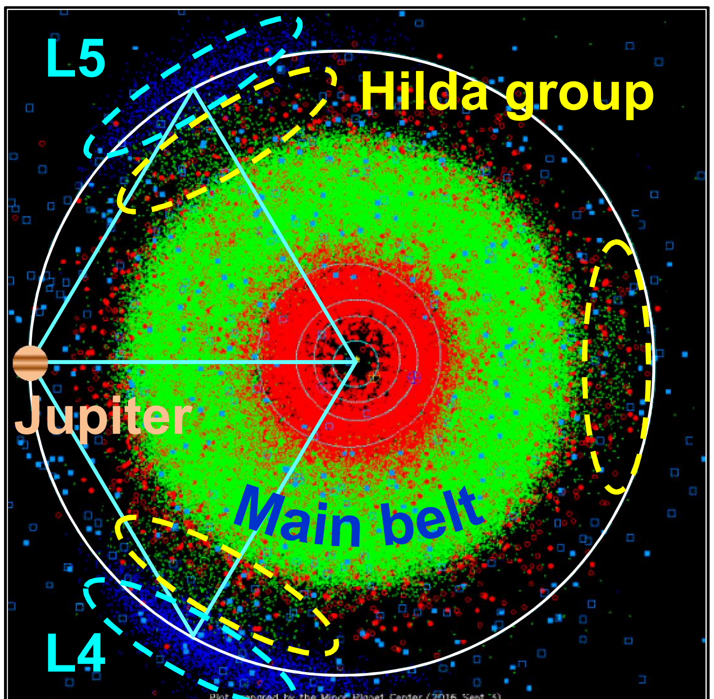
- Yoshida & Nakamura (2005)
  - Jupiter L4 survey by S-Cam
  - Detected 51 km-size JTs
  - **Power-law break** at $D \sim 5$ km
- Wong & Brown (2015)
  - Jupiter L4 survey by S-Cam
  - Detected 557 JTs with $D < 50$ km
  - Size distribution using 150 JTs
  - **Power-law break** at $D \sim 7$ km

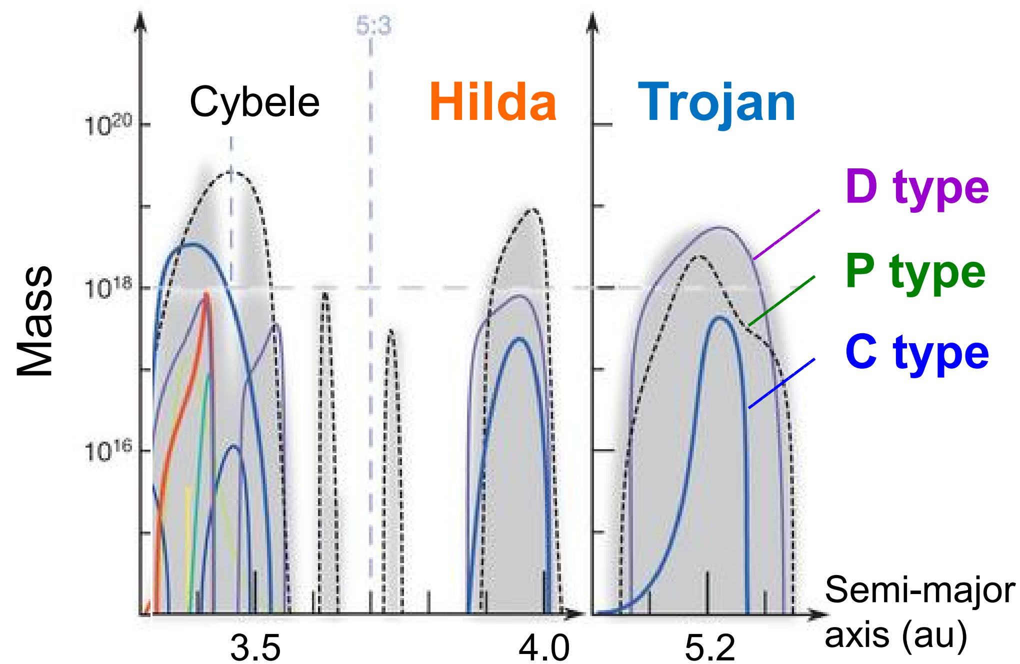




Another target : Hilda asteroids

- **Hilda group** : an asteroid population in the 3:2 mean motion resonance with Jupiter (semi-major axis ~ 4.0 au)
- Dominated by P type asteroids unlike JT population
- JTs and Hildas have the same origin or not ?

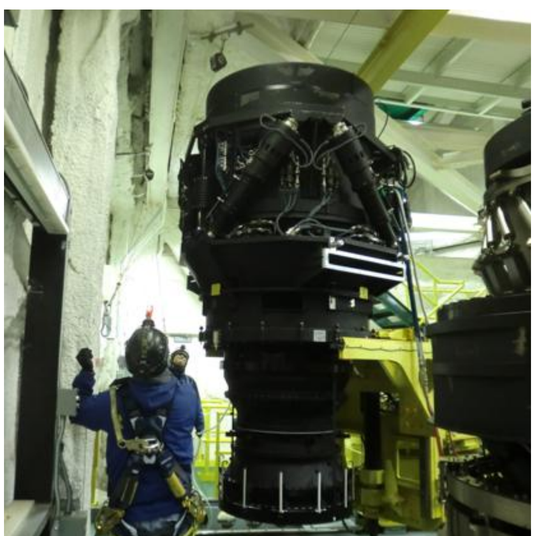


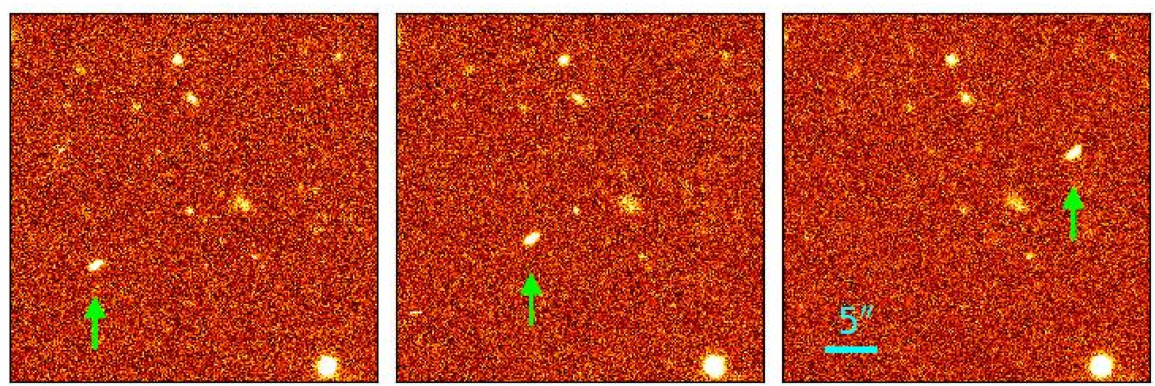


DeMeo & Carry (2014)

Observation

- Jupiter L4 survey with Hyper Suprime-Cam in 2015 Mar
  - Near ecliptic and opposition fields covering ~ 29 deg^2
  - *r* band 240-sec exposure x 3 visits in ~ 1 hour
  - Detection limit (50% efficiency) : 24.4 mag (*D* ~ 1 km)
- Extracting JT/Hilda candidates from the source catalogs created by HSC pipeline processing





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JT / Hilda samples

- Detected 761 objects

JTs: 631 objects

Hildas: 130 objects

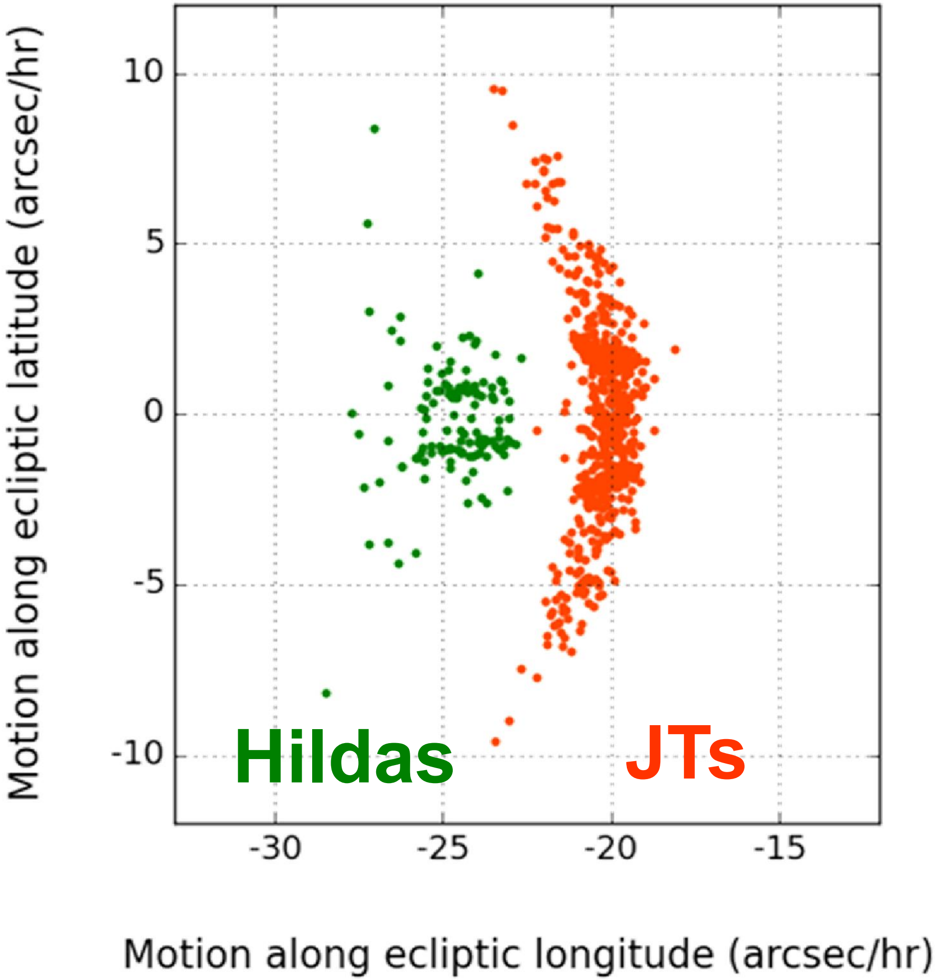
- Selection for obtaining unbiased samples :

Group	R	H_r	N
JTs	< 5.5 au	< 17.4	481
Hildas	< 4.9 au	< 18.0	91

R : heliocentric distance

H_r : r band absolute magnitude

Motion distribution



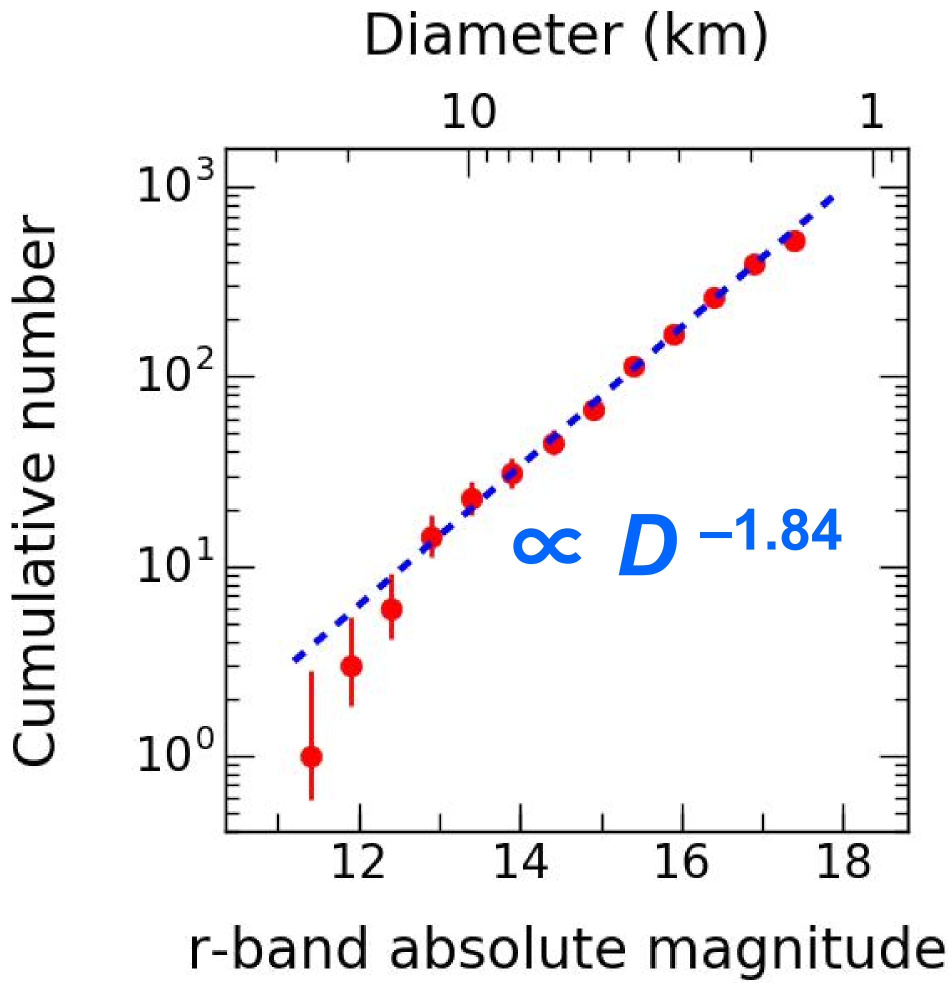
Size distribution : Trojans

- Assuming a geometric albedo of 0.07 (Grav+ 2011)
- Well approximated by a single-slope power law

$$N(<D) = N(<1\,\text{km})\, D^{-b}$$

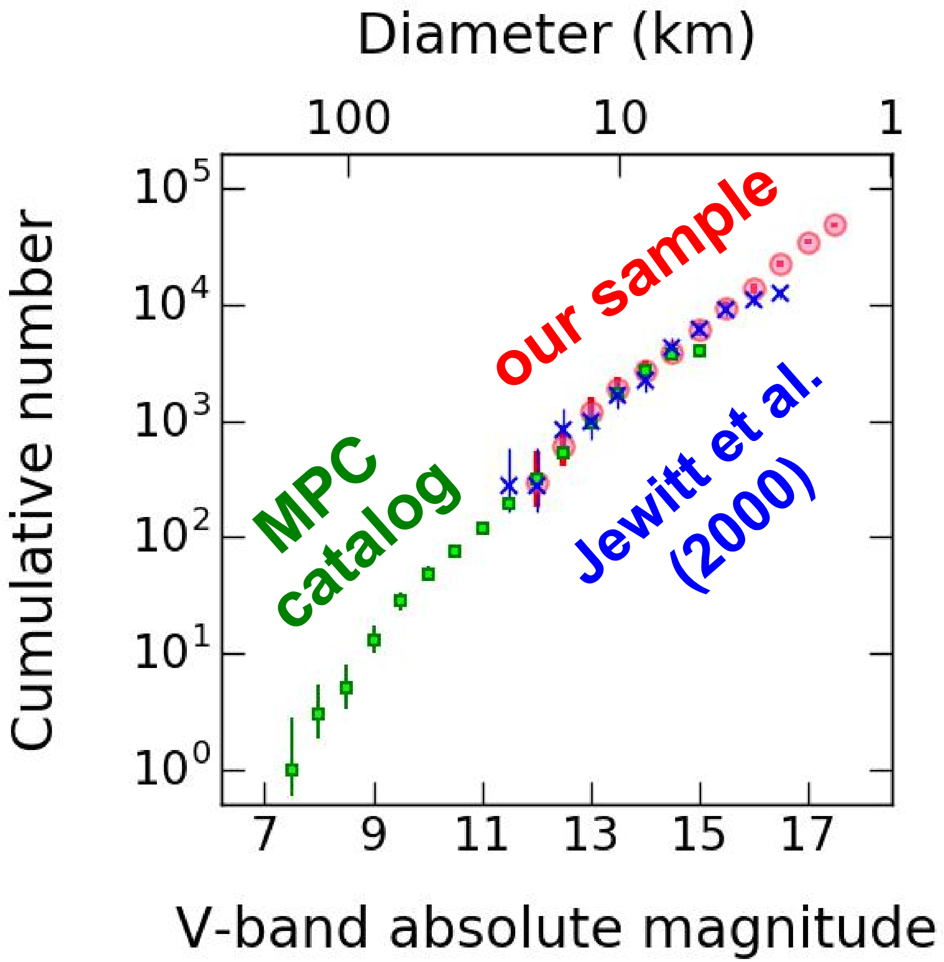
$$\rightarrow\ \boldsymbol{b = 1.84 \pm 0.05}$$

- No feature such as break or roll-over was found in D < ~10 km



Size distribution : Trojans

- Size distribution of L4 JTs combined with cataloged objects and our sample
- Likely to have a power law break around 10 km in diameter
- No significant wavy structure compared to main-belt asteroids

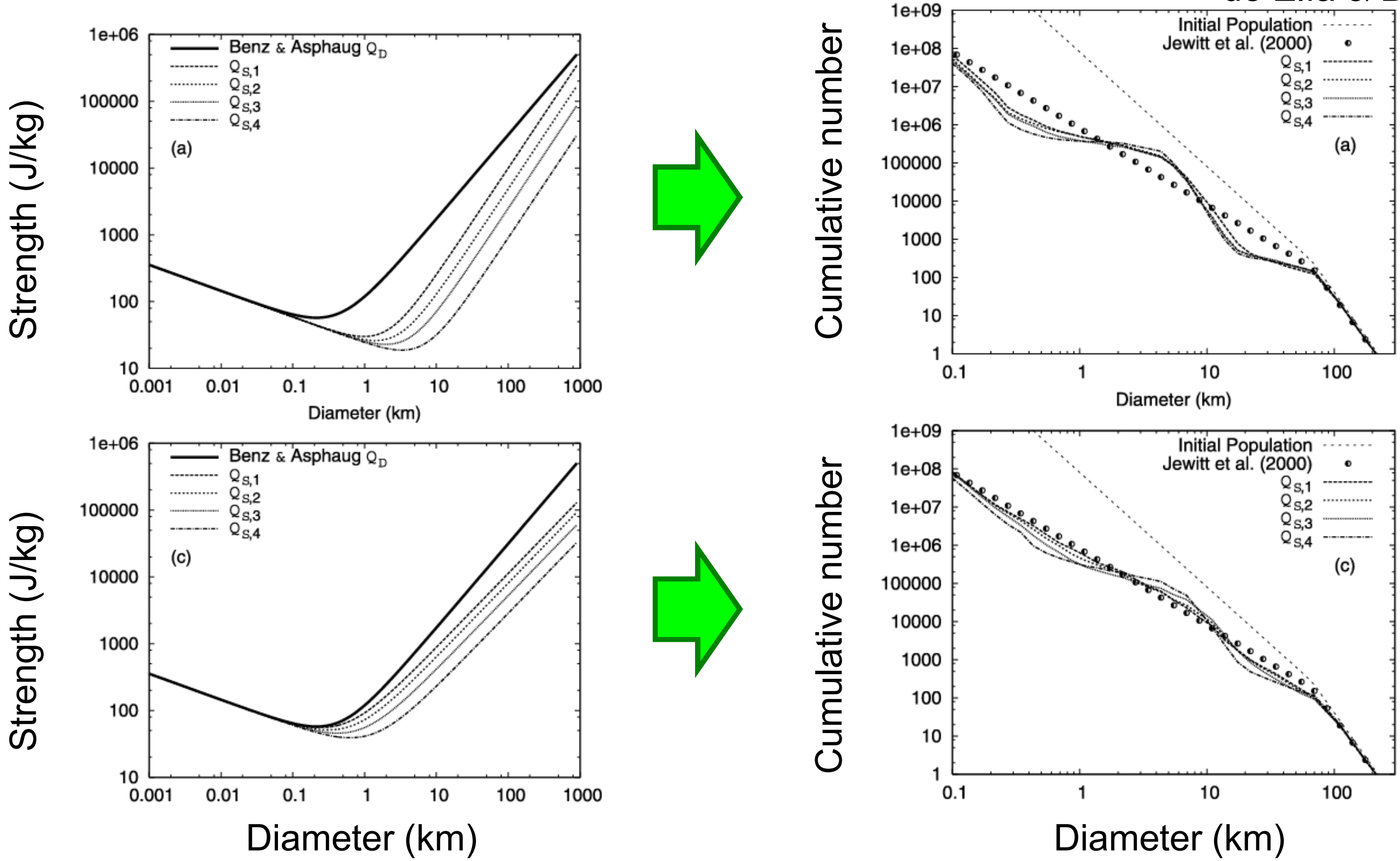


Note: assuming $V - r = 0.25$ mag (Szabo et al. 2007)

Size distribution： Trojans

- Wave amplitude depends on the shape of strength law
- Indicating different composition and/or internal structure between JTs and main-belt asteroids

de Elía & Brunini (2007)



Size distribution : Hildas

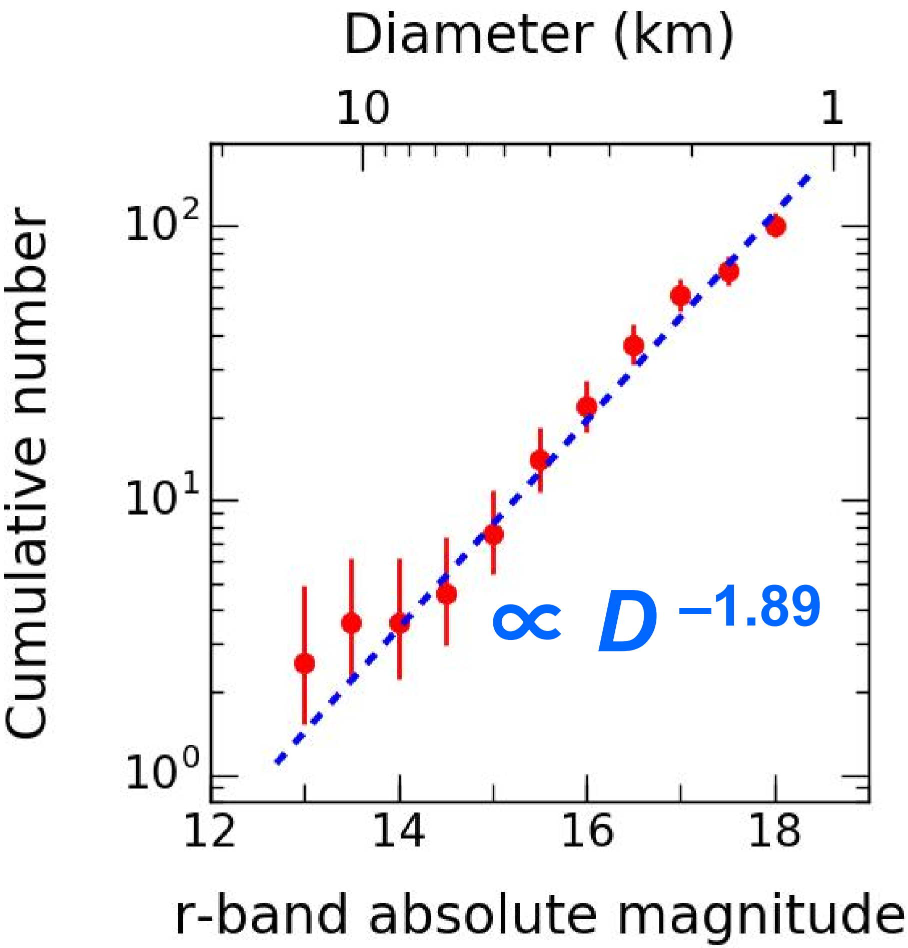
- Assuming a geometric albedo of 0.055 (Grav+ 2012)

- Can be approximated by a single-slope power law

$$N(<D) = N(<1\,\mathrm{km})\, D^{-b}$$

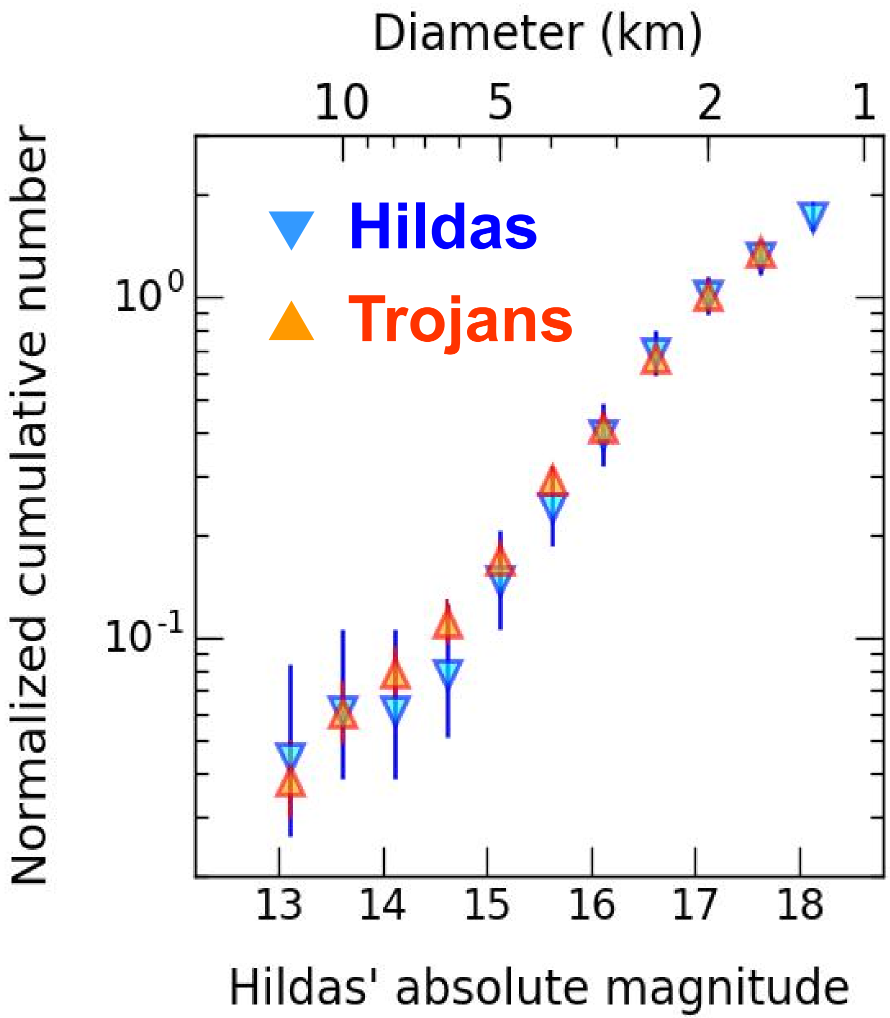
$$\rightarrow \boldsymbol{b} = \mathbf{1.89 \pm 0.11}$$

- The best-fit power-law slope is similar to that of JTs



Comparison

- Size distributions of JTs and Hildas normalized at D = 2 km
- The two curves agree well with each other through km size range
- JTs and Hildas have the same/similar impact strength parameters



(Normalized at D = 2 km)

Summary

- Size distribution of JTs shows a single-slope power law without a slope break in km size range

- No significant wavy structure has been found on JTs' size distribution, indicating different impact strength parameters from main-belt asteroids

- Size distribution of Hildas well agrees with that of JTs in km size range, suggesting the same origin between the two populations