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Resonant Yarkovsky Effect

Families in Resonances with Jupiter

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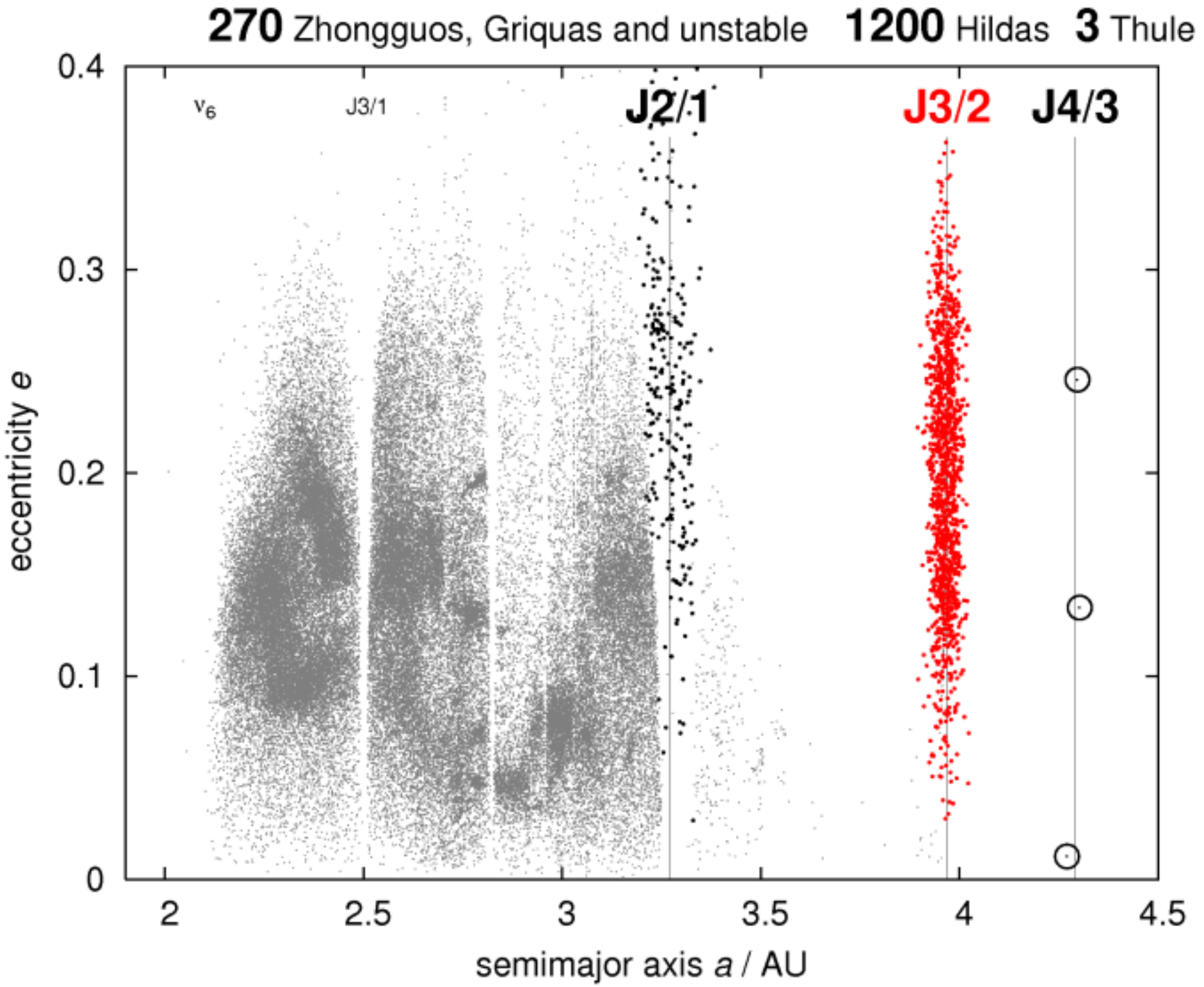
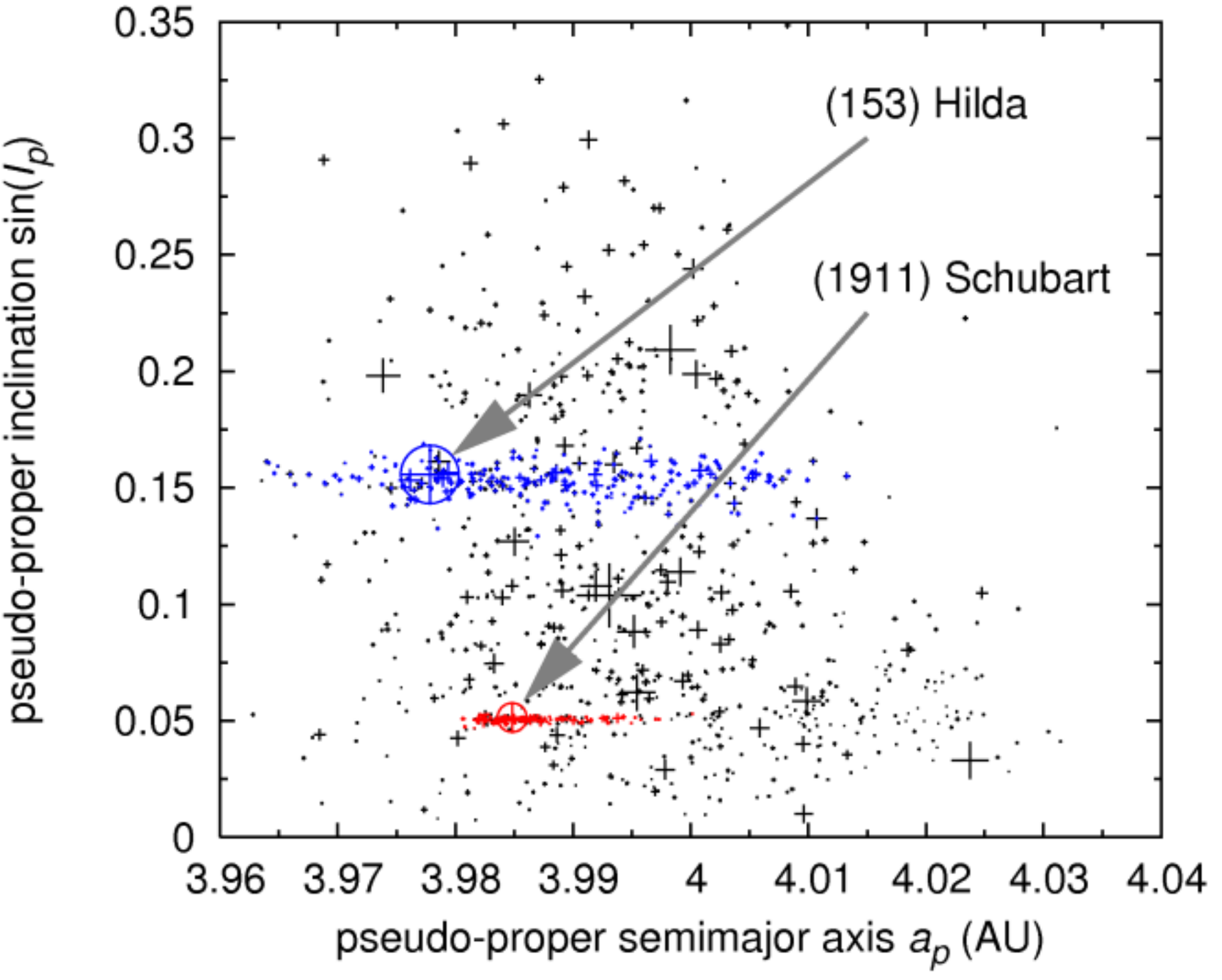
Update of resonant populations (Aug 2007):

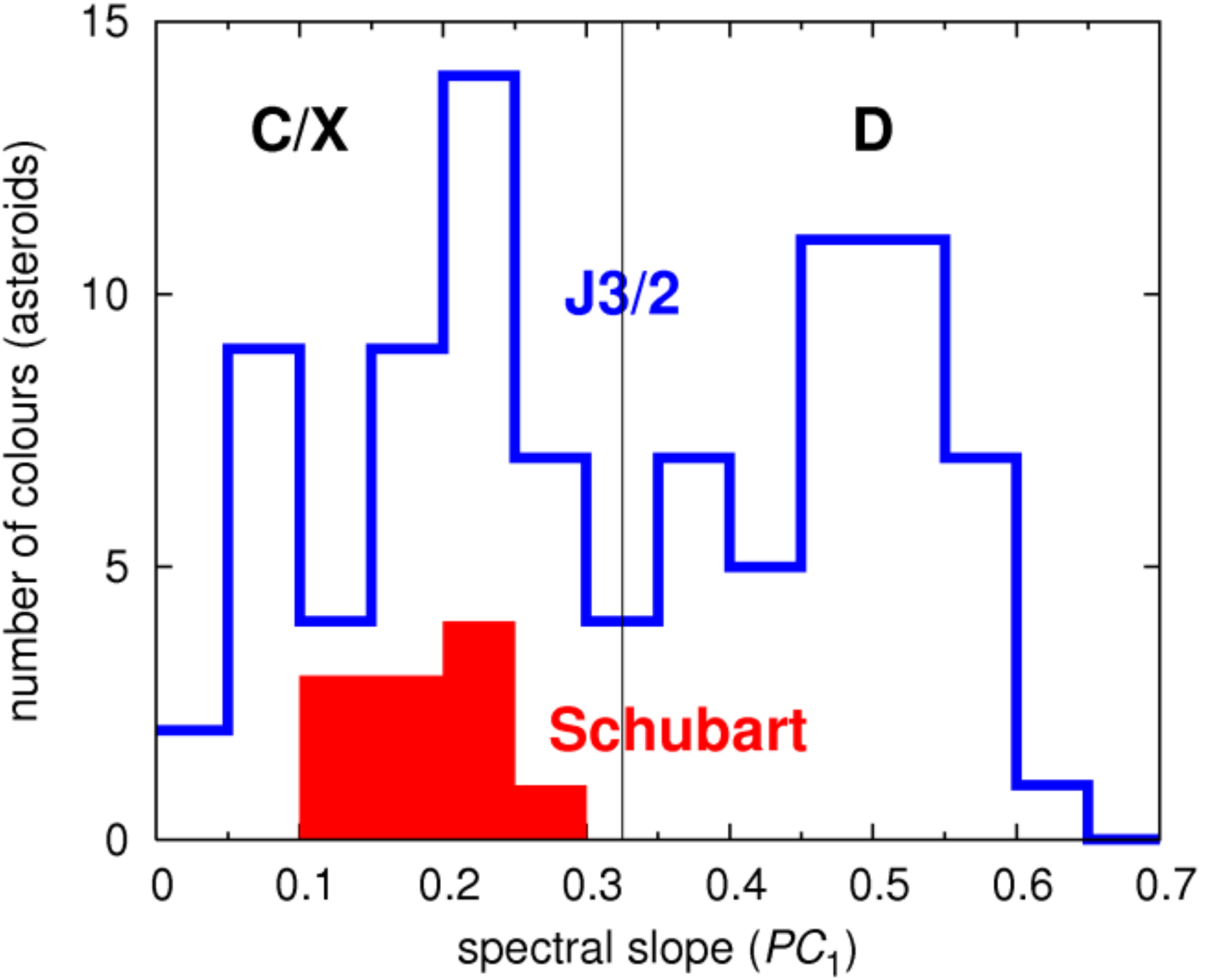


J3/2 — pseudo-proper elements:



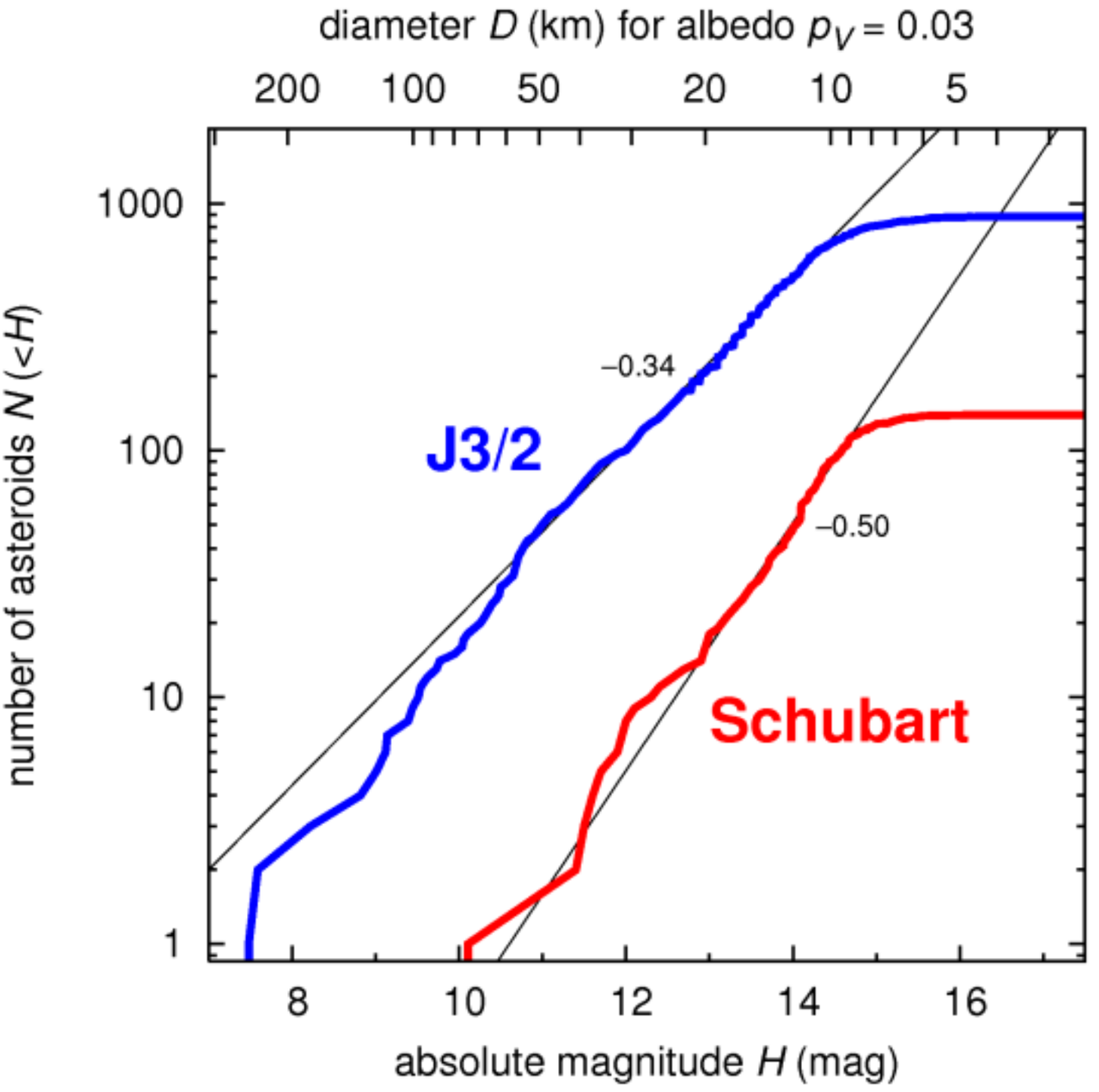
- a distinct collisional Schubart family (Schubart 1991); $v_{\rm cutoff} \simeq 60\,{\rm m/s}$, $\sim 100\,{\rm km}$ parent body, LF/PB $\simeq 0.25$
- Hilda family at higher inclinations; $\sim 200\,{\rm km}$ PB

Schubart family — colours:



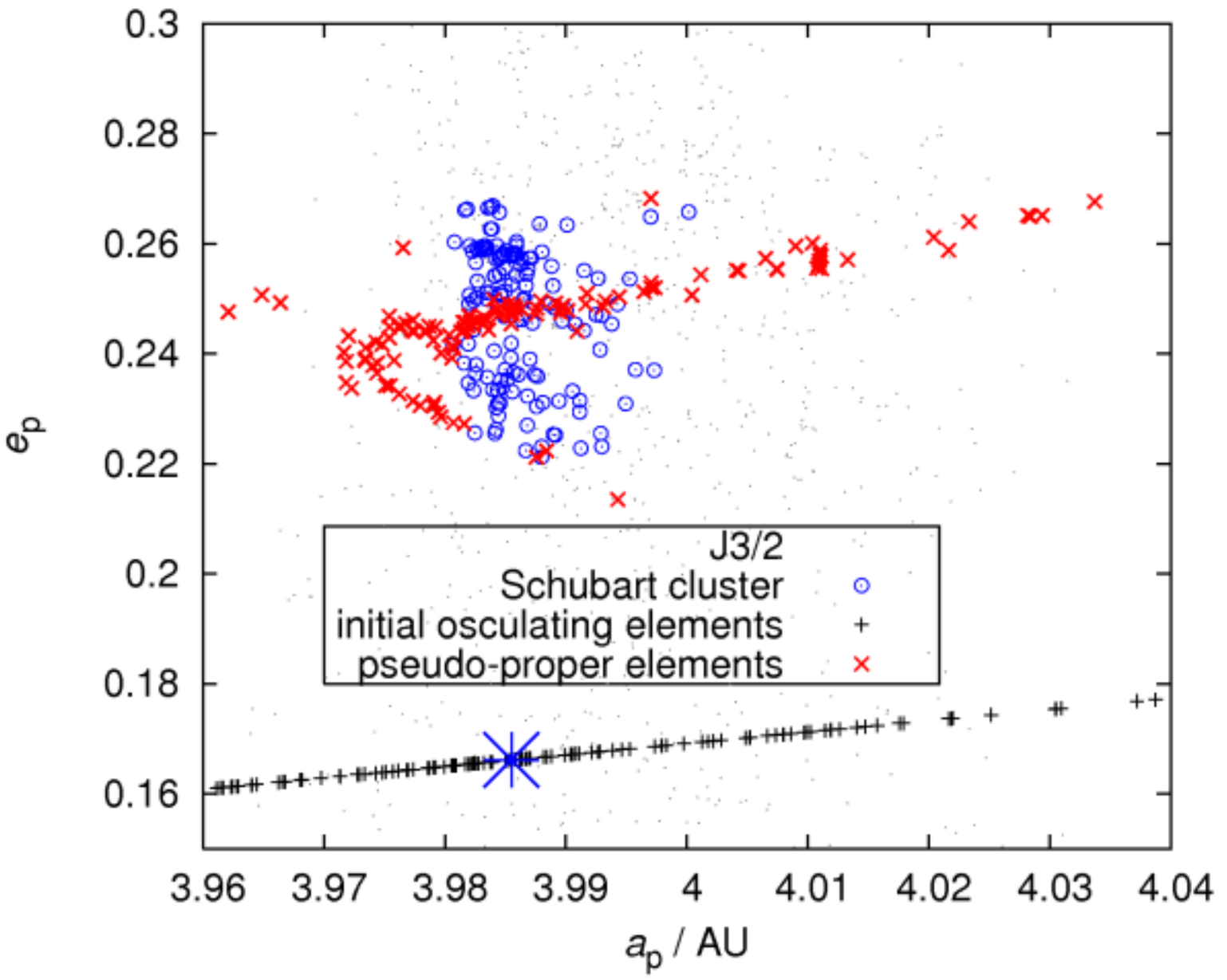
- SLOAN colours of J3/2 bimodal (C/X- and D-types)
- Schubart cluster only C/X-type ⇒ collisional origin

Schubart family — SFD:



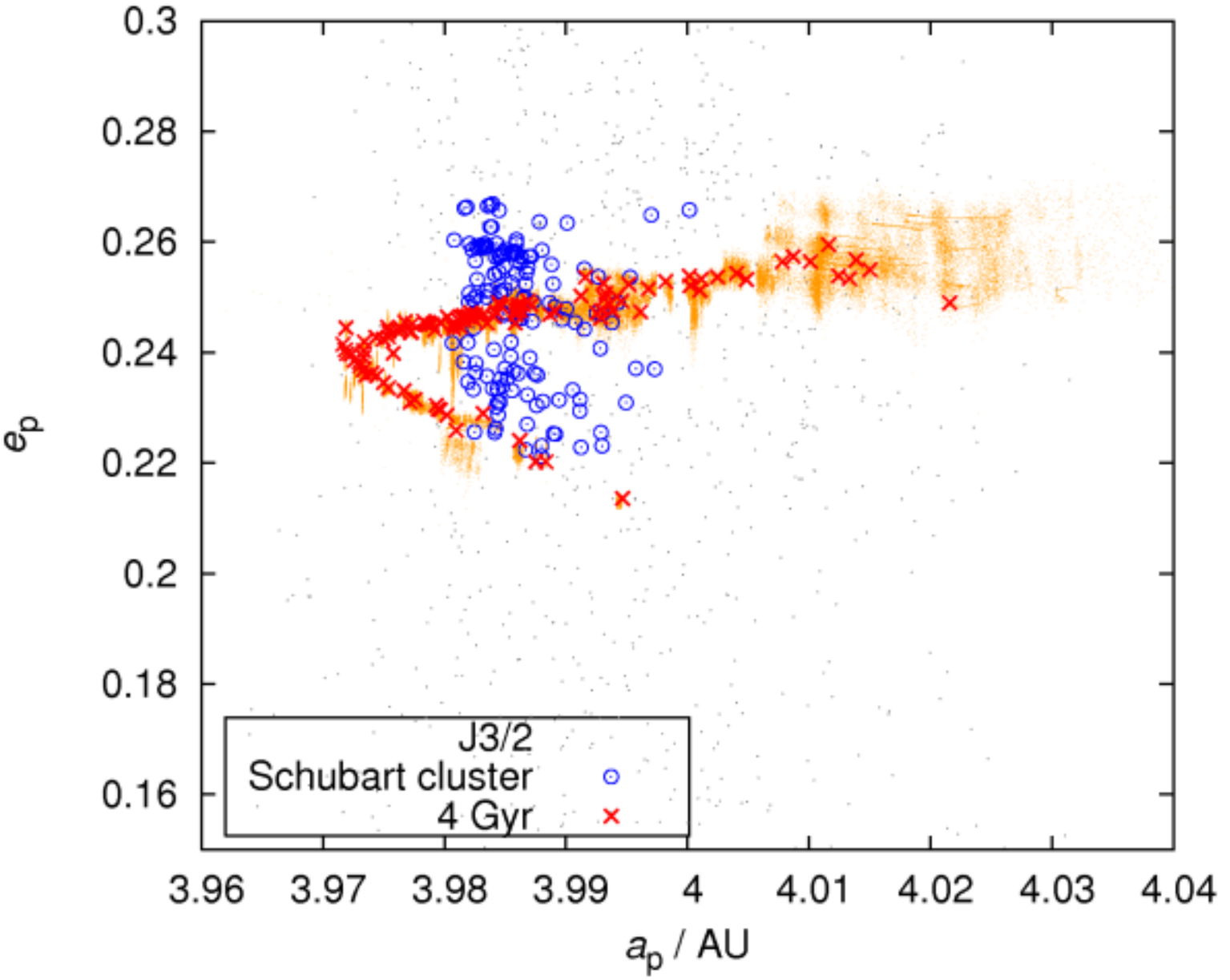
- Schubart family significantly steeper than the rest of J3/2 ⇒ collisional origin (but not as steep as MB families)

Simulated impact in J3/2:



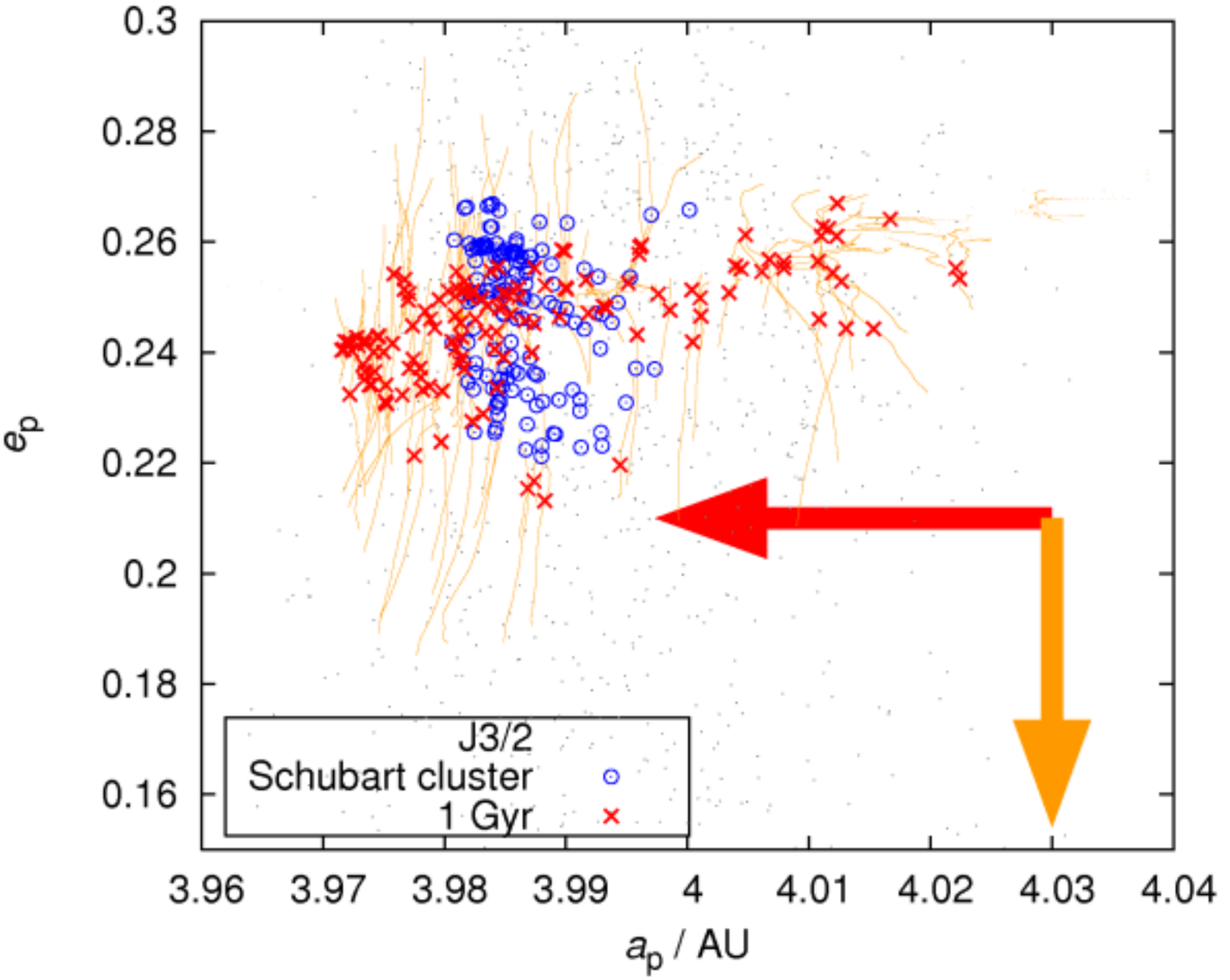
- a disruption of a 100 km PB; isotropic velocity field with $v_{\mathrm{mean}} = 50\,\mathrm{m/s}$, $f = 0$, $\omega + f = 180°$
- 'mapping' of the osculating elements into pseudo-proper

Impact in J3/2 — evolution over 4 Gyr:



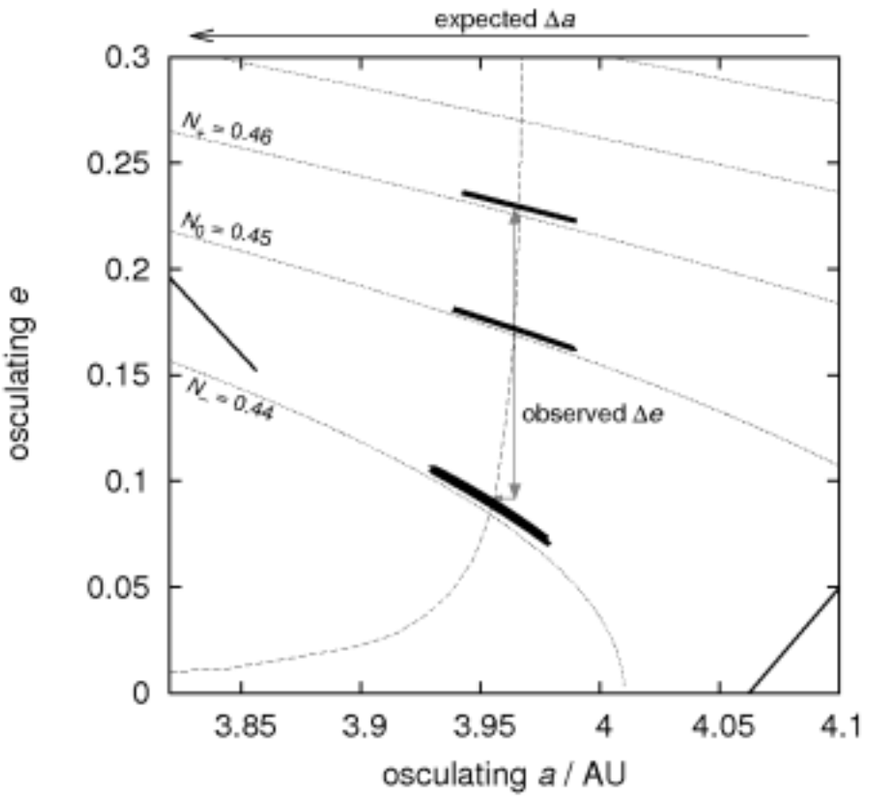
- N-body simulation, SWIFT integrator, 4 planets only
- the shape of the swarm is well preserved for 4 Gyr
- problem: observed Schubart family has larger spread in e

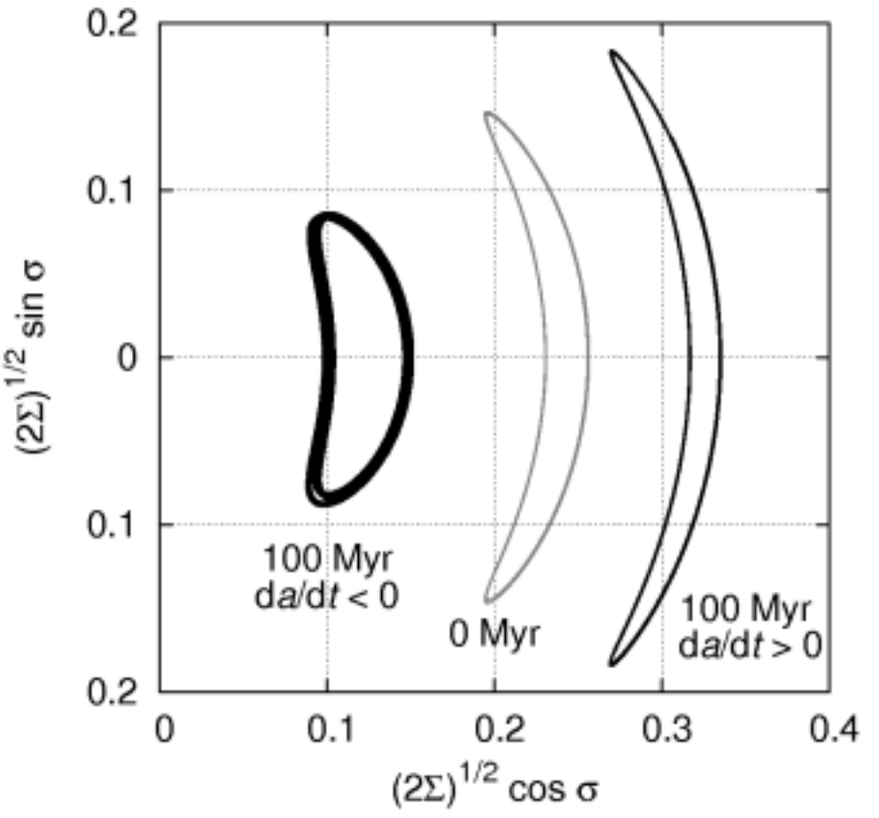
Impact in J3/2 — Yarkovsky effect:



- the Yarkovsky enhances the diffusion in eccentricity
  → different mechanism than for Main Belt families!

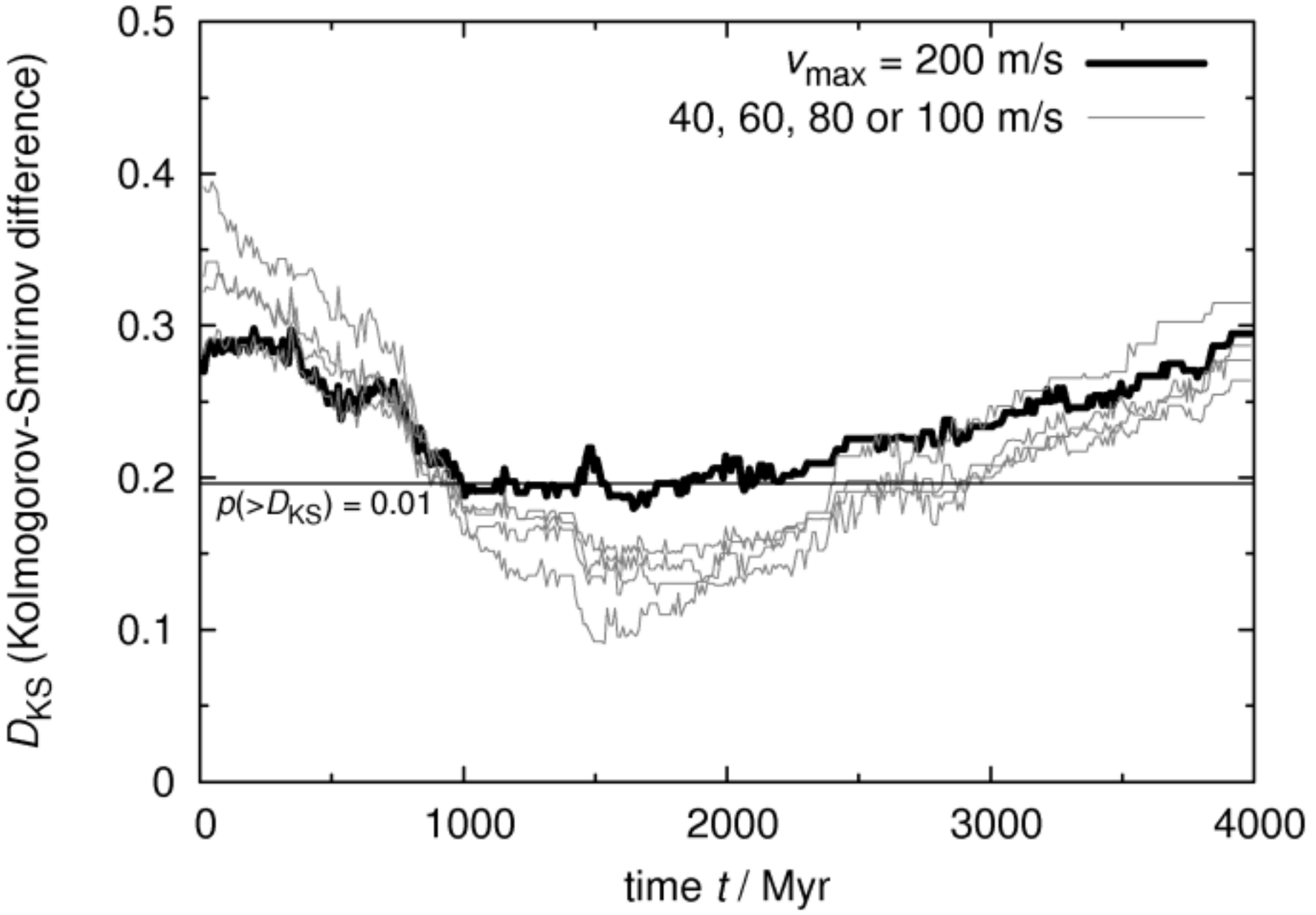
Yarkovsky drift in e (RTBP):





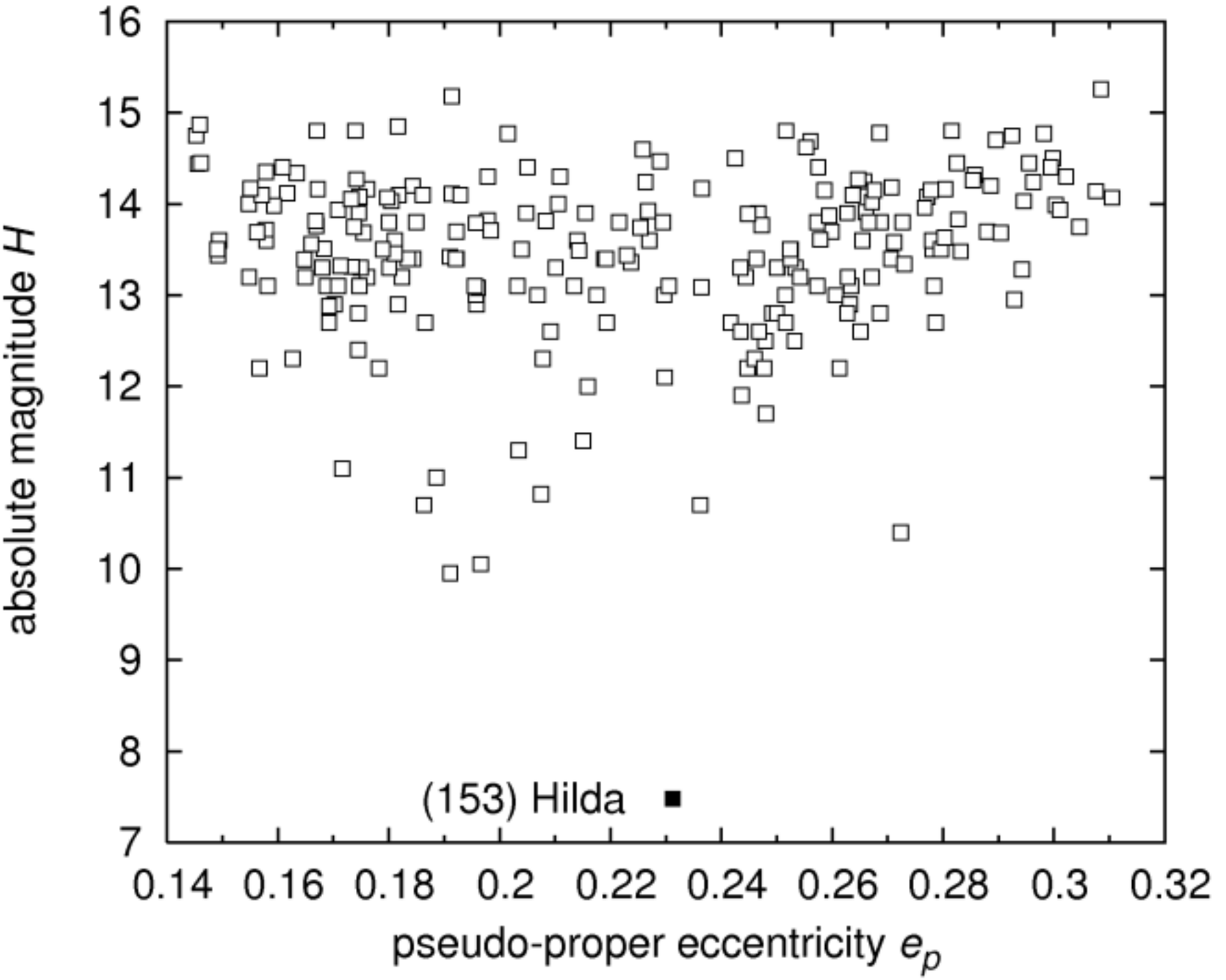
- object is locked in the libration centre
- adiabatic invariant $N = \sqrt{a}\left(\frac{p+1}{p} - \sqrt{1-e^2}\cos i\right)$ evolves linearly

Schubart and Hilda families — ages:



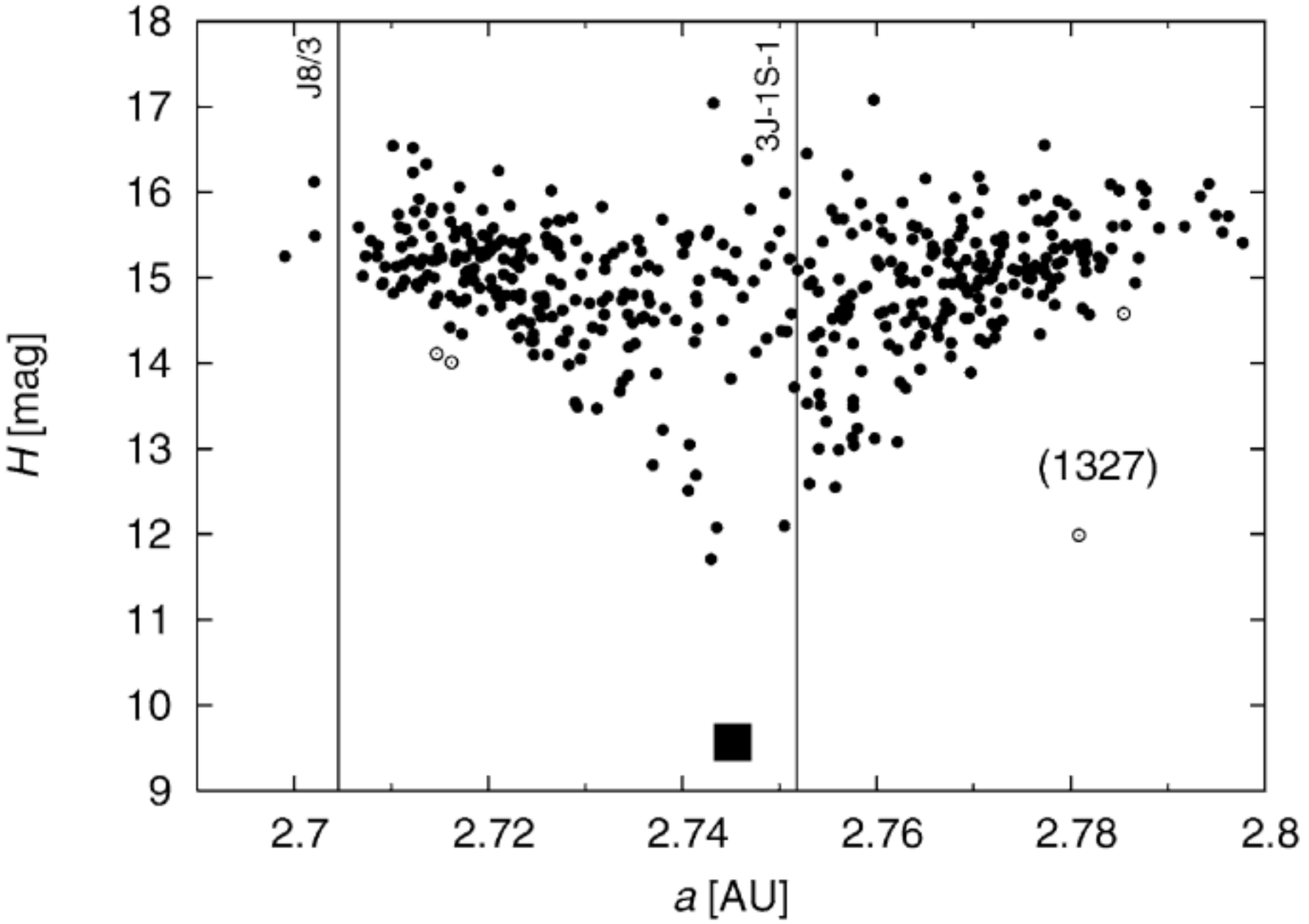
- K-S test for Schubart $\Rightarrow$ 1–2.5 Gyr old
- $\gtrsim$ 4 Gyr for Hilda (LHB origin?)

Hilda family — (e, H) plot:

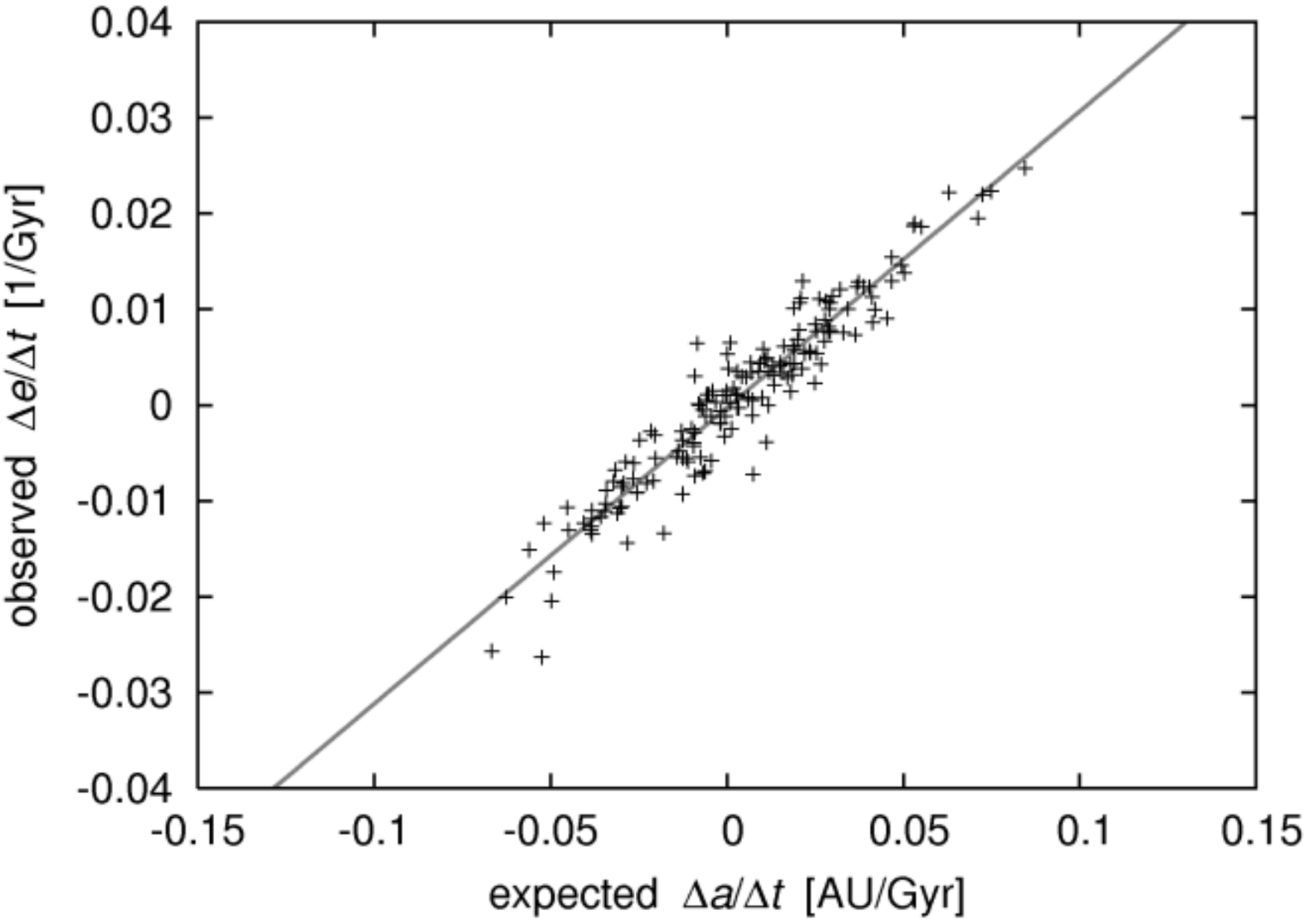


- 'ears' like in (a, H) for Eos, Erigone, Massalia, Merxia, ...
- YORP effect changes spins $\Rightarrow$ more precise age!

A comparison with Merxia family (a, H):

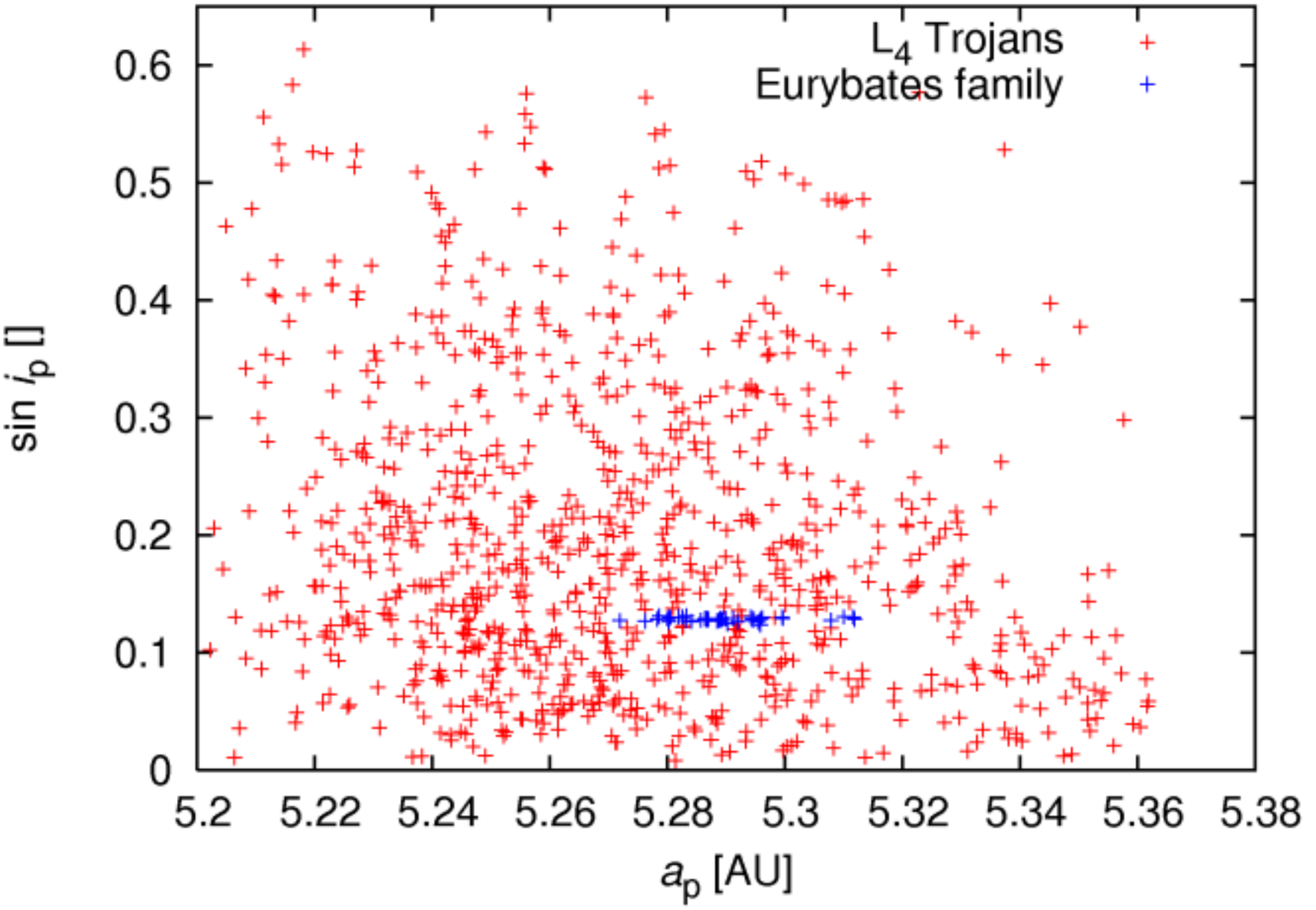


Hilda — expected Δa vs observed Δe:



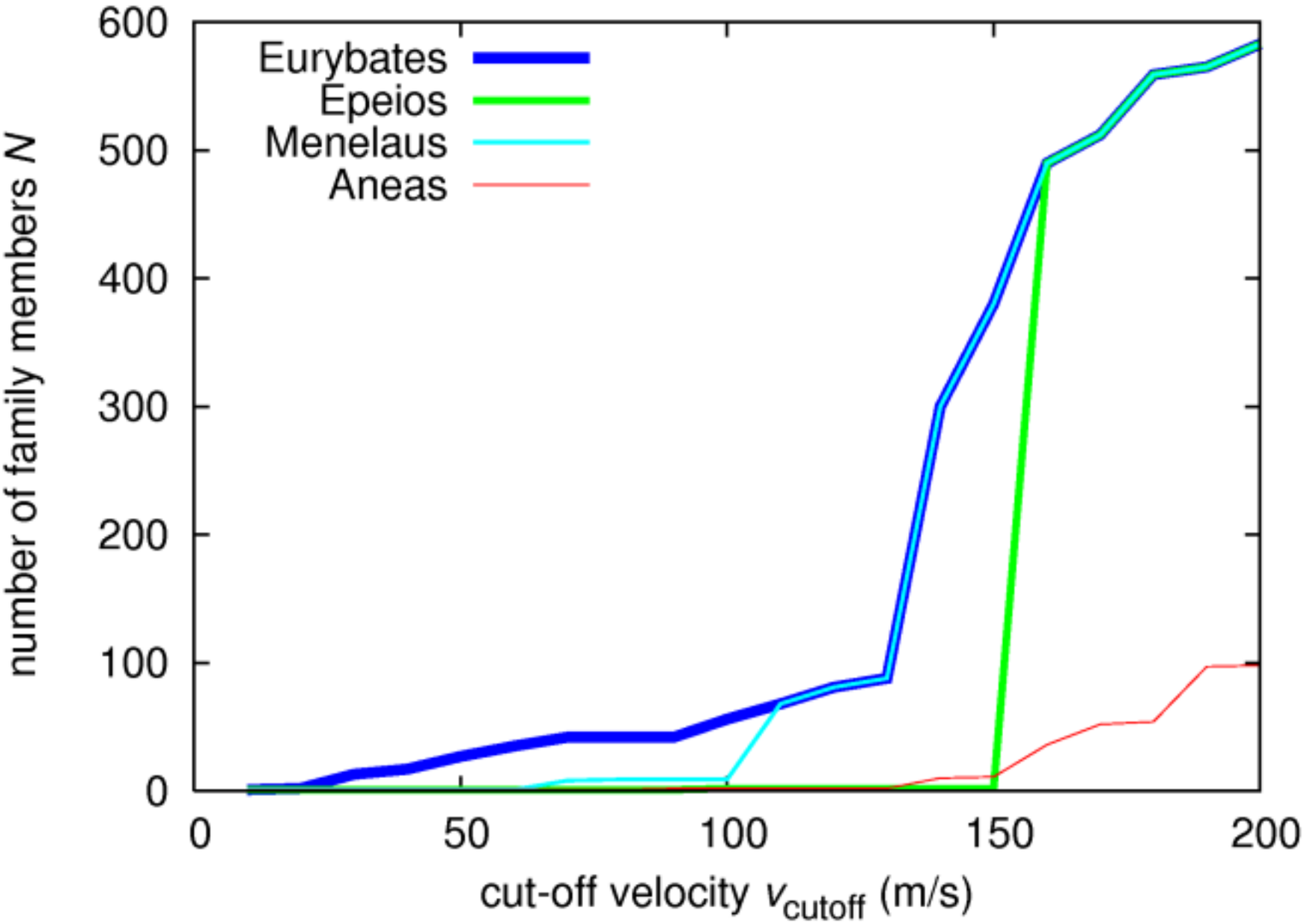
- linear dependence $\Rightarrow$ the same code as for (a, H)

Trojans — how many families?:



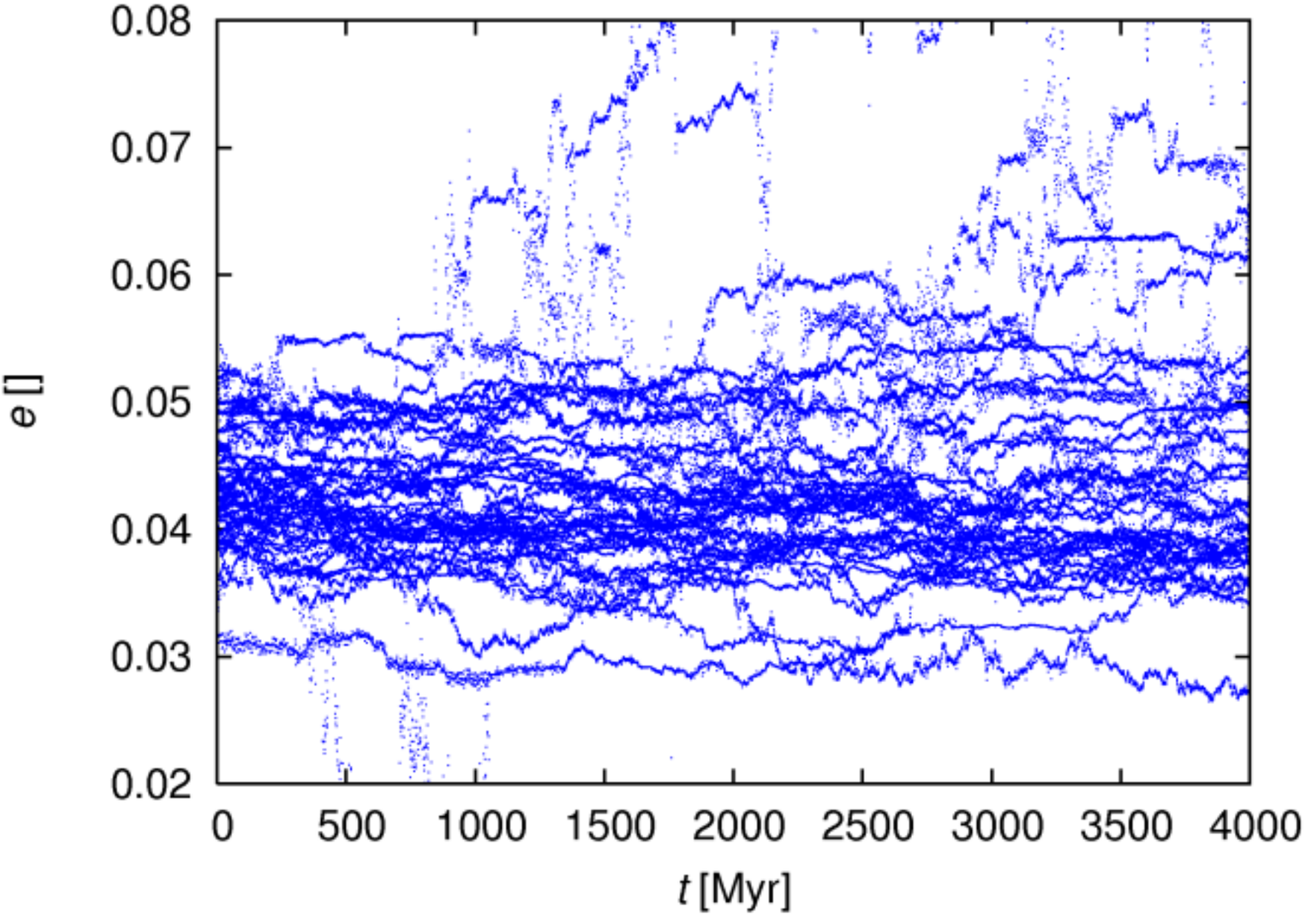
- $\sim$1000 bodies in each L_4 and L_5 cloud
- not many prominent clusters!

Trojans — only 1 family?!:



- $N(v_{\mathrm{cutoff}})$ to be compared with (random) background
- Eurybates family is the most robust case

Eurybates family:



- evolution with/without Yarkovsky effect is the same
- different dynamics $\Rightarrow$ no systematic drift in e

Conclusions:

- resonant Yarkovsky effect operates
- two collisional families in the J3/2 resonance (probably old, different from MB families)

Future work:

- (e, H) method $\Rightarrow$ more precise ages of resonant families
- also limits for thermal parametres of outer MB bodies?