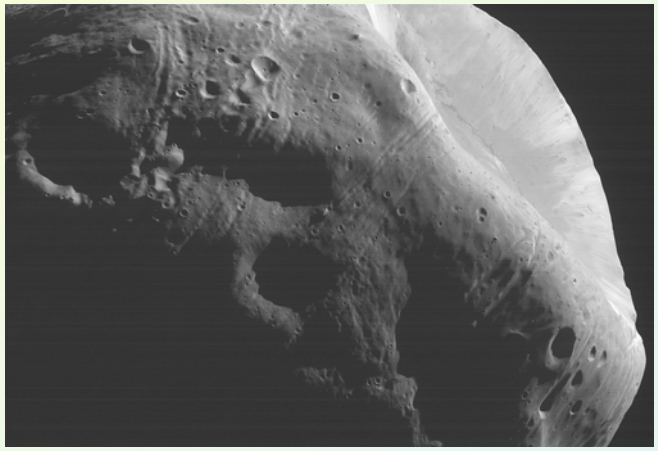
Gaia: les observations du Système Solaire



Paolo Tanga

Observatoire de la Côte d'Azur (France)

Observatoire de la Côte D'Azur

Gaia DPAC Data Processing & Analysis Consortium

Résume

- L’intérêt des observations du Système Solaire par Gaia
- Les traitement des données SSO
- Relation avec les observations au sol

Gaia will mainly observe…

- Asteroids (~250.000 – most known)
  - Remnants of Solar System formation
  - Altered/shattered by mutual collisions
  - Main Belt: source of Earth Crossers
  - Satellites

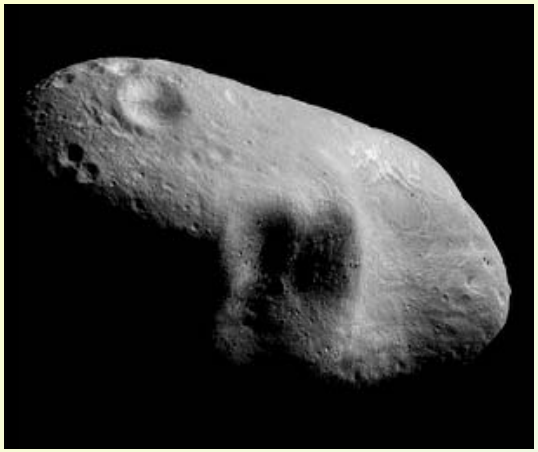
- Comets
  - Primitive material from the outer Solar System

- « Small » planetary satellites
  - « regular »
  - « irregular » (retrograde orbits)

- Gaia will probably NOT collect observations of « large » bodies (~200 mas?)
  - Main Planets, large satellites (Galilean, Titan..)
  - A few largest asteroids

The importance of asteroids…

The great issues:



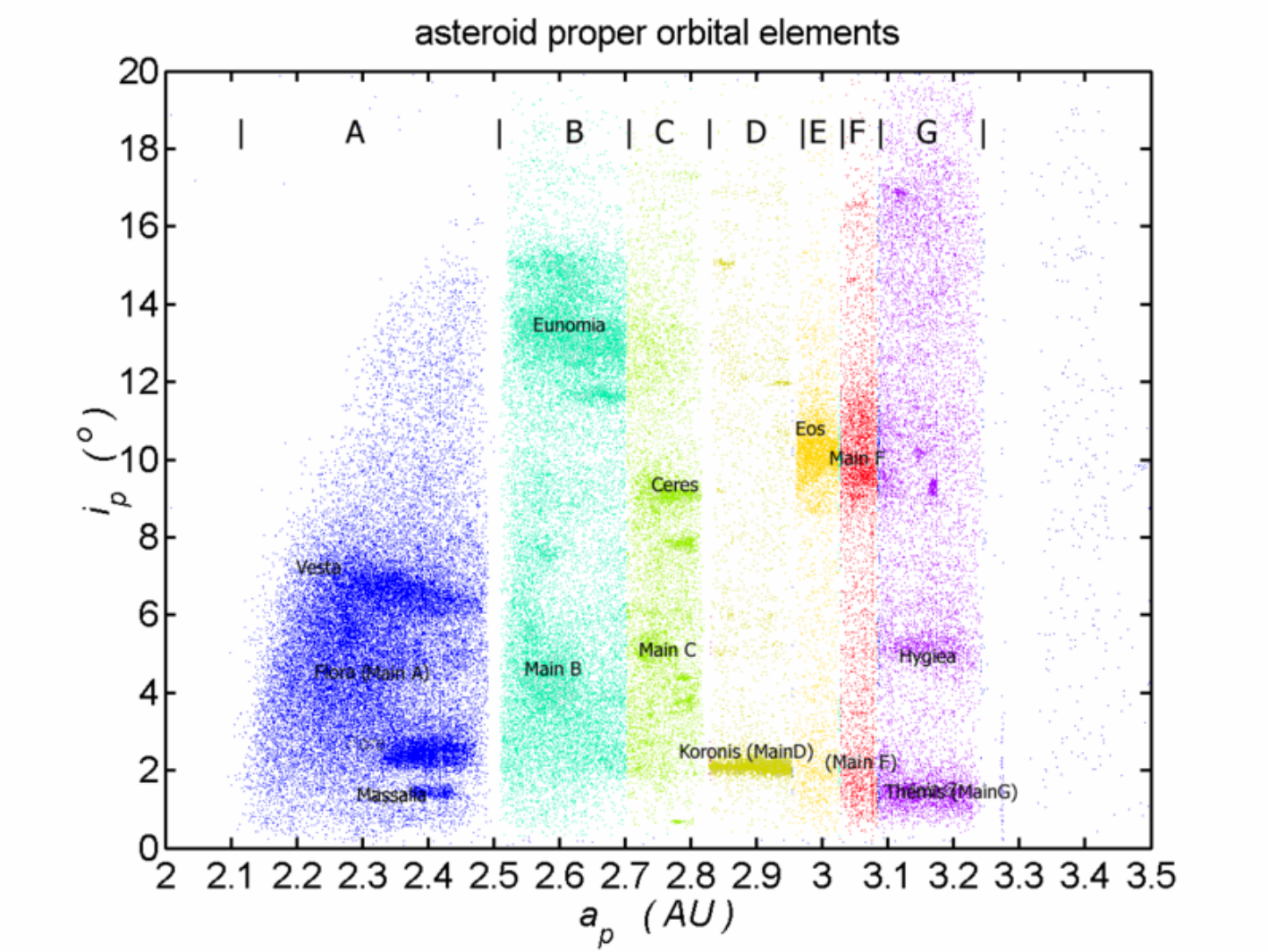
- Basic characteristics: density, porosity…
- Spectral types
- Shapes, satellites
- Size distribution
- Dynamical processes: transport, mixing, origin of meteorites

→ Origin: collisional life, related physics

→ Impact risks and mitigation strategy

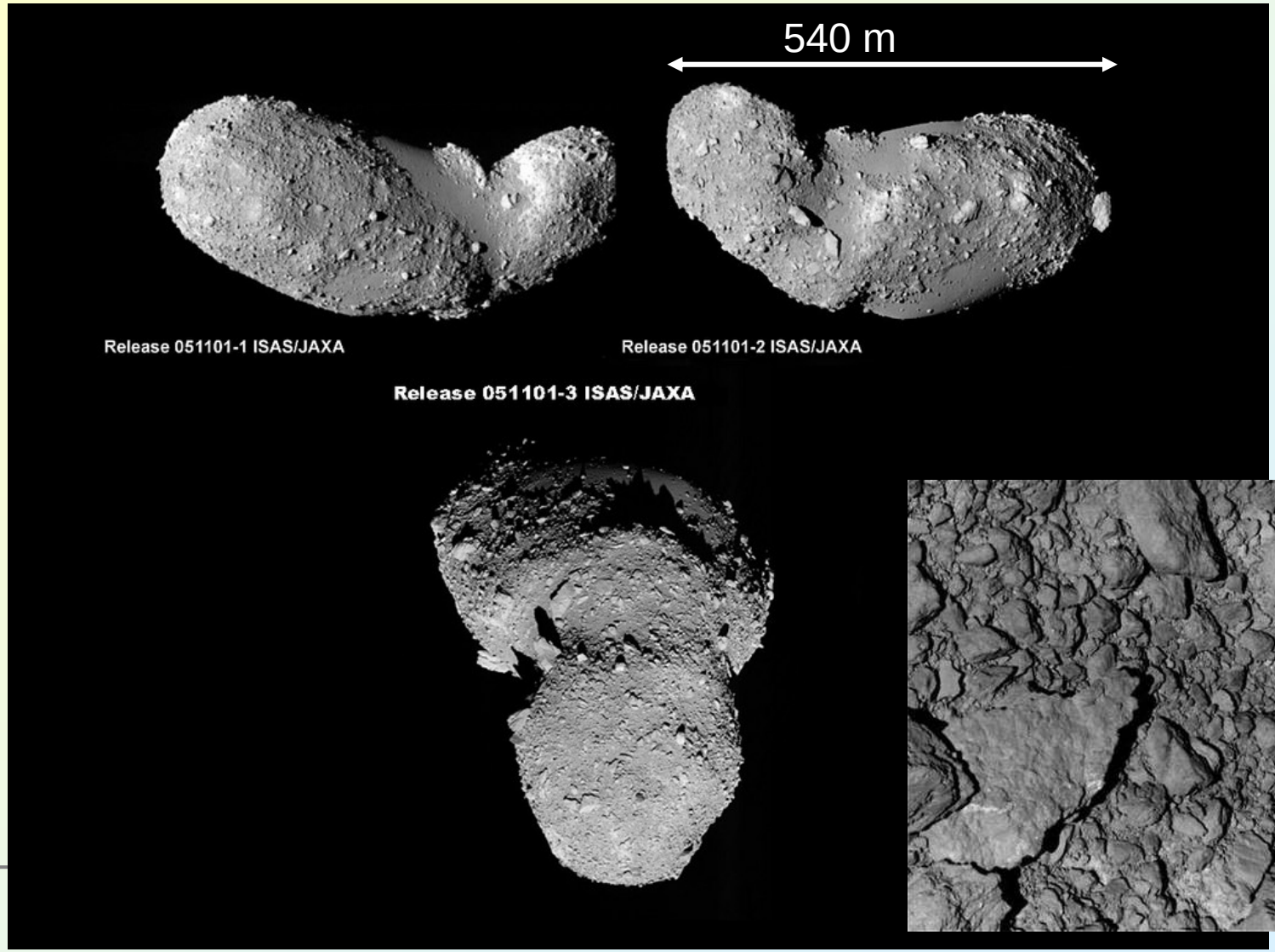
→ To understand Solar System formation and evolution

Collisional life: dynamical families

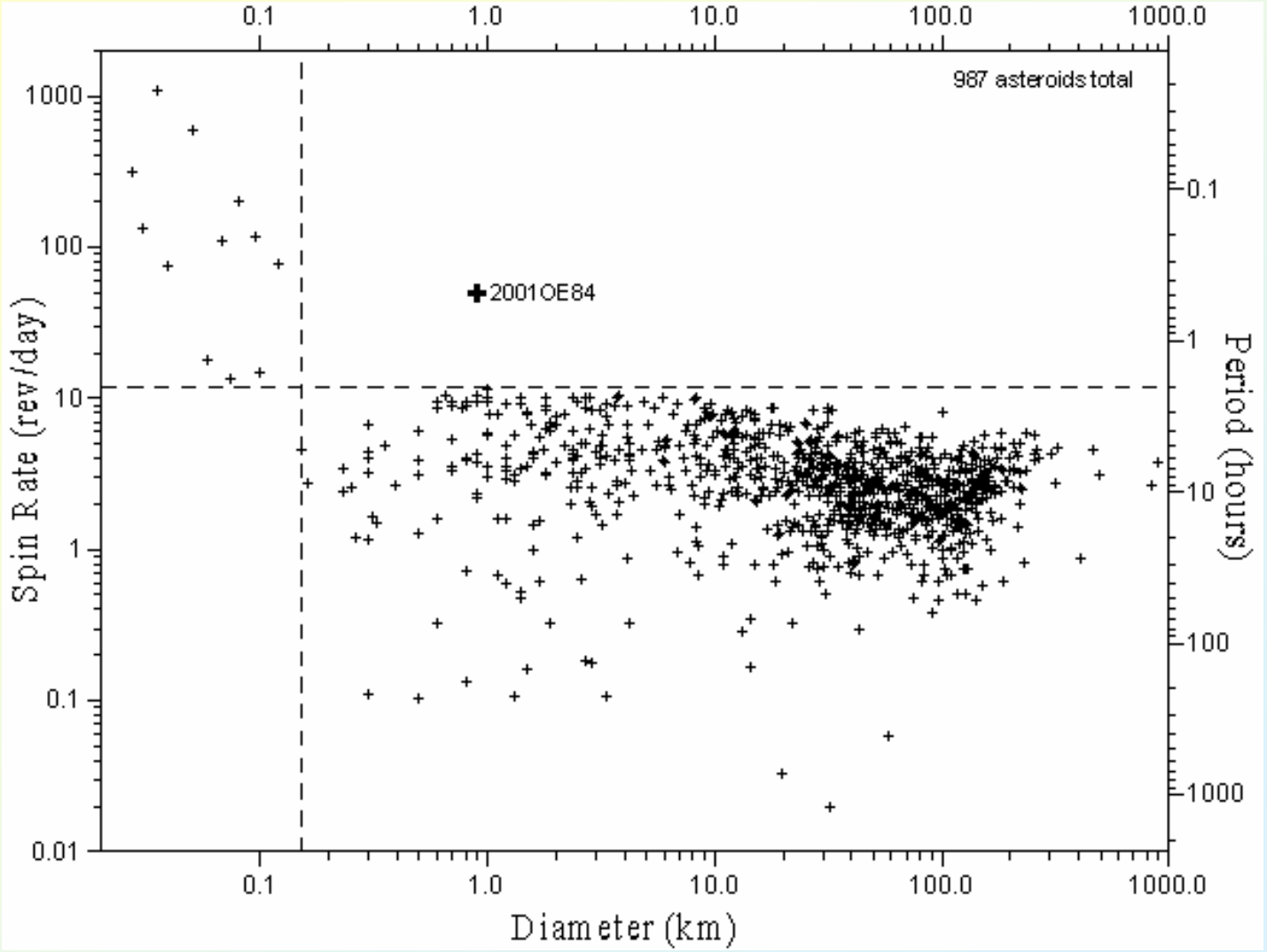


Itokawa by the Hayabusa mission

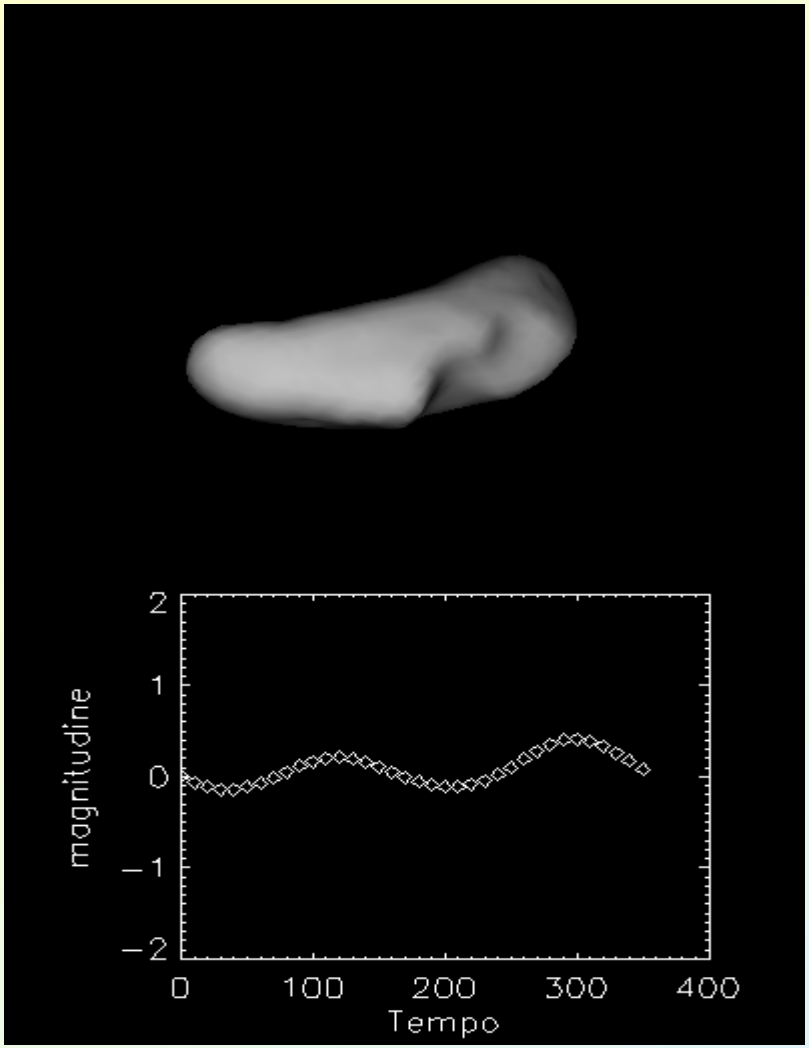
Is this a gravitational aggregate?

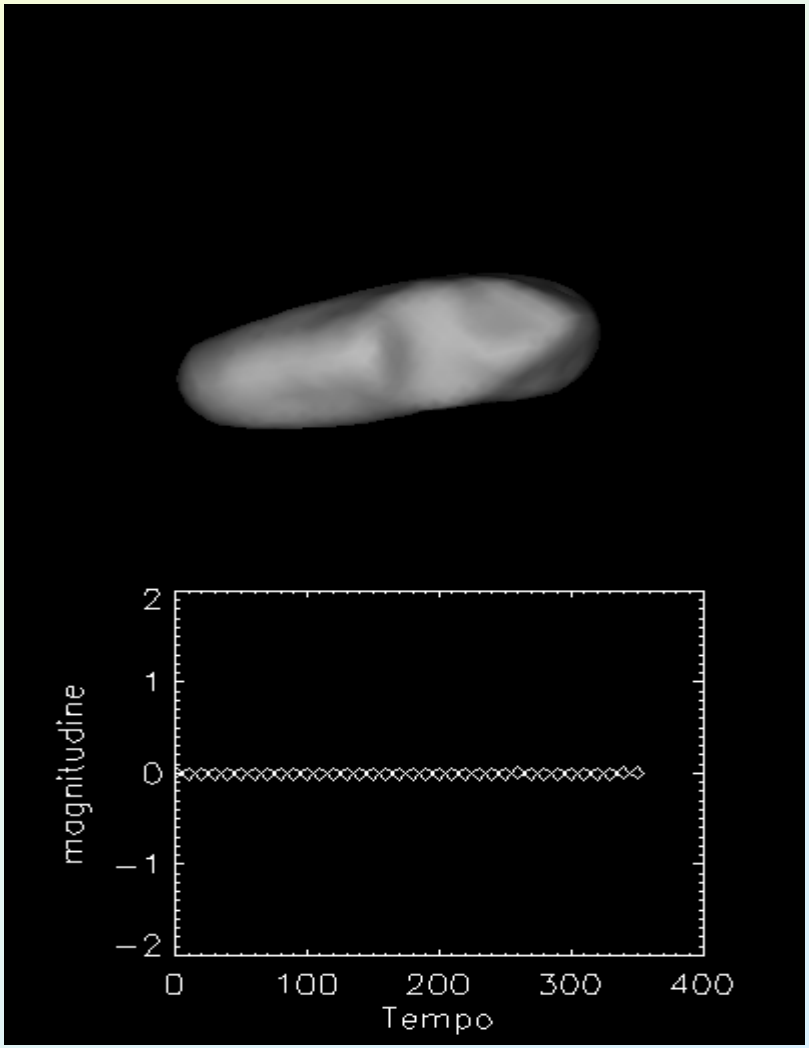


Rotation periods



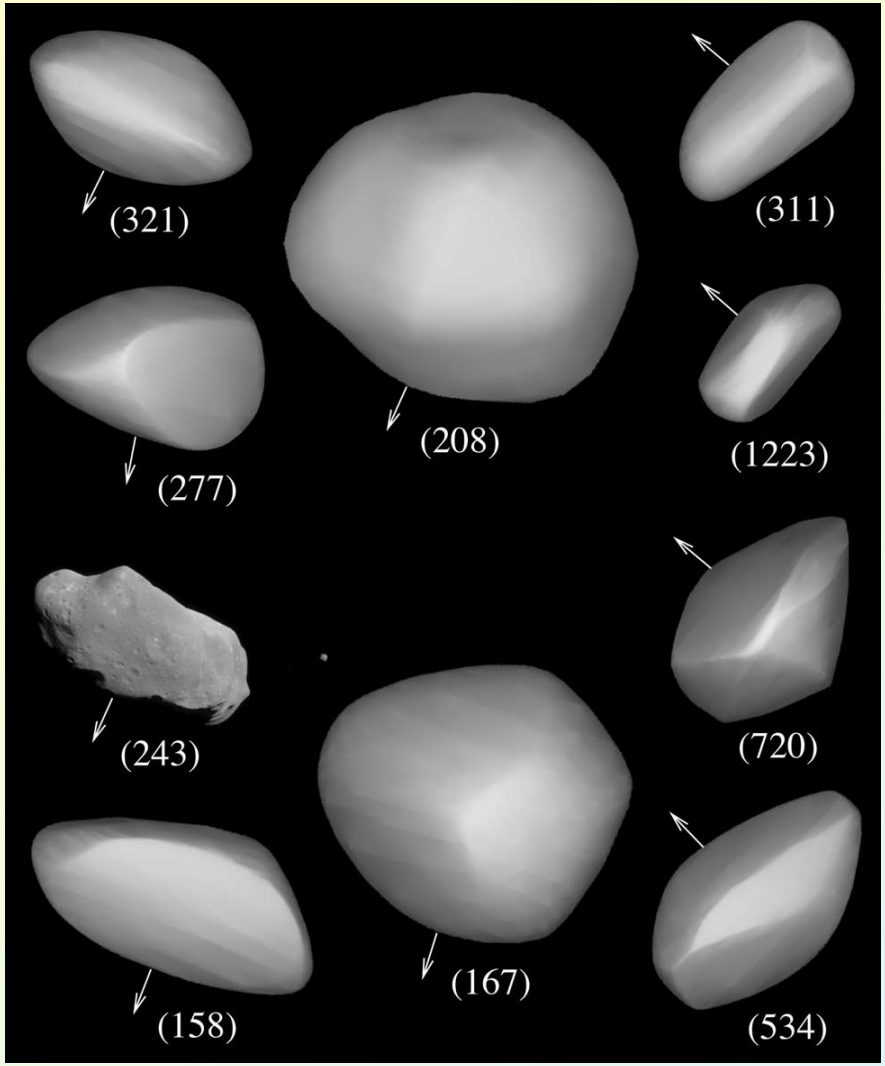
From photometry to shapes…





Courtesy of Marco Delbò

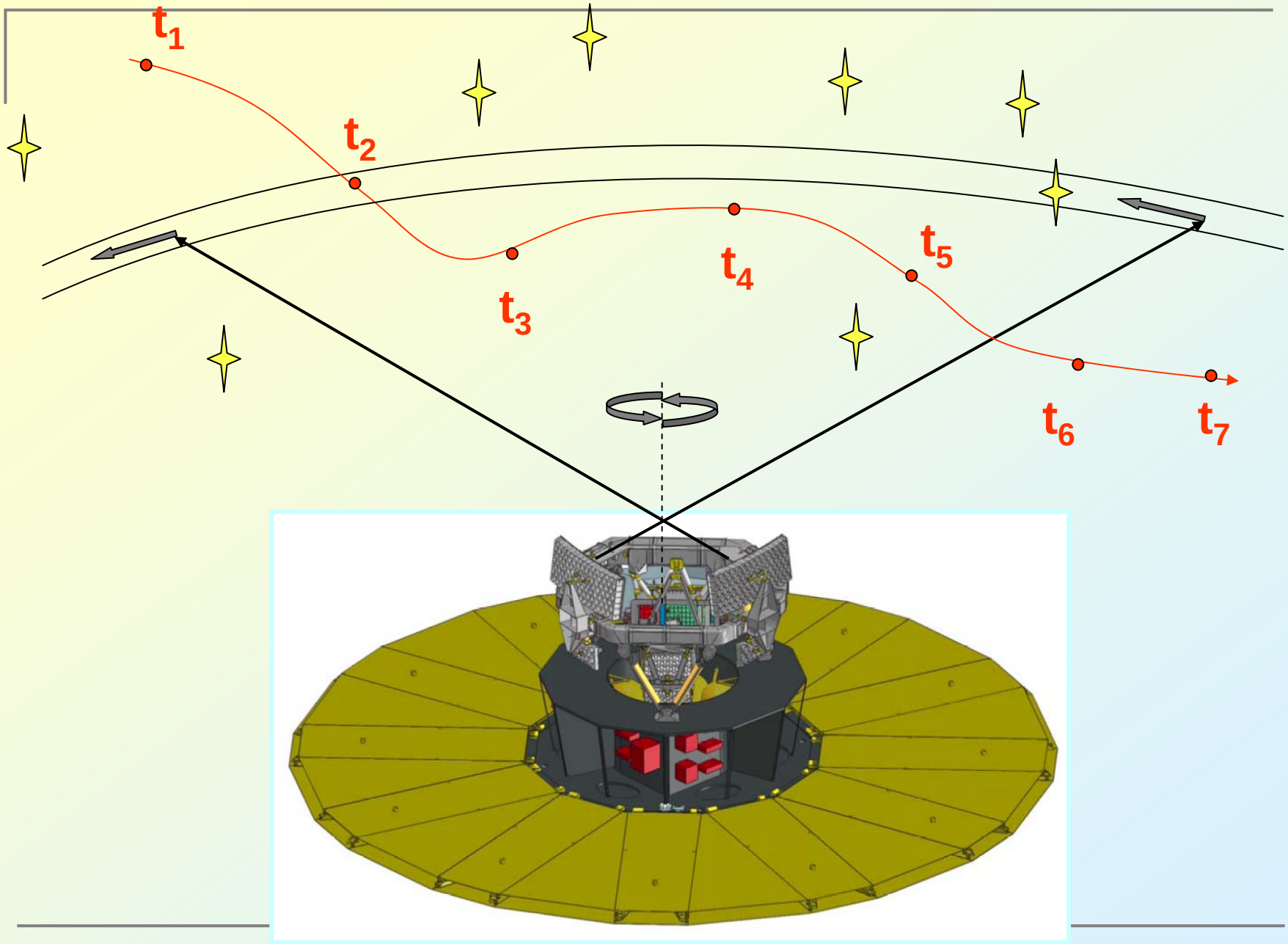
Implications



Spin properties: important constraint to modern models of the collisional evolution of Main Belt asteroids.

Tests of preferential alignments of family members, or the effectiveness of the Yarkovsky-YORP effects.

Gaia:
expected contribution and data reduction


t1
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What we need, what we will get

	Today	with Gaia
■ Photometry → shapes, poles rotation periods	~100 ~1000	>10000
■ Satellites	~20 (MBA)	?
■ Low-res spectroscopy: surface composition	~1500	>10000 new taxonomy
■ Astrometry, better orbit determination → masses	~40, σ<60%	« new families » ~1000, σ<50% (~30, σ<10%)
■ Size / albedos	~200, σ<10% (*very* indirect)	~1000

CU4/Solar System Objects en France

- **Besançon**
  - **J.-M. Petit** • • •
- **Nice**
  - O. Michel •
  - **F. Mignard** • • •
  - Ph. Bendjoya •
  - N. Rambaux → Post-doc JPL •
  - A. Minussi
  - **P. Tanga** • • •
  - Post-doc: M. Delbò • • •
- **Paris** (IMMCE)
  - **J.-E. Arlot** •
  - **J. Berthier** •
  - F. Colas •
  - A. Fienga → Besançon •
  - **D. Hestroffer** • • •
  - S. Mouret • •
    → post-doc a l'Obs. de Helsinki (K. Muinonen)
  - **W. Thuillot** •
  - F. Vachier •
  - J. Vaubaillon •
    → post-doc au CalTech
- **Lilles** (IMCCE)
  - M. Fouchard • •
  - V. Lainey • •
- **Toulouse (**CNES)
  - B. Frezouls •

- • **coordination**
- • **analyse du signal, prétraitement**
- • **bases de données, identification**
- • **propriétés dynamique**
- • **propriétés physiques**
- • **classification**

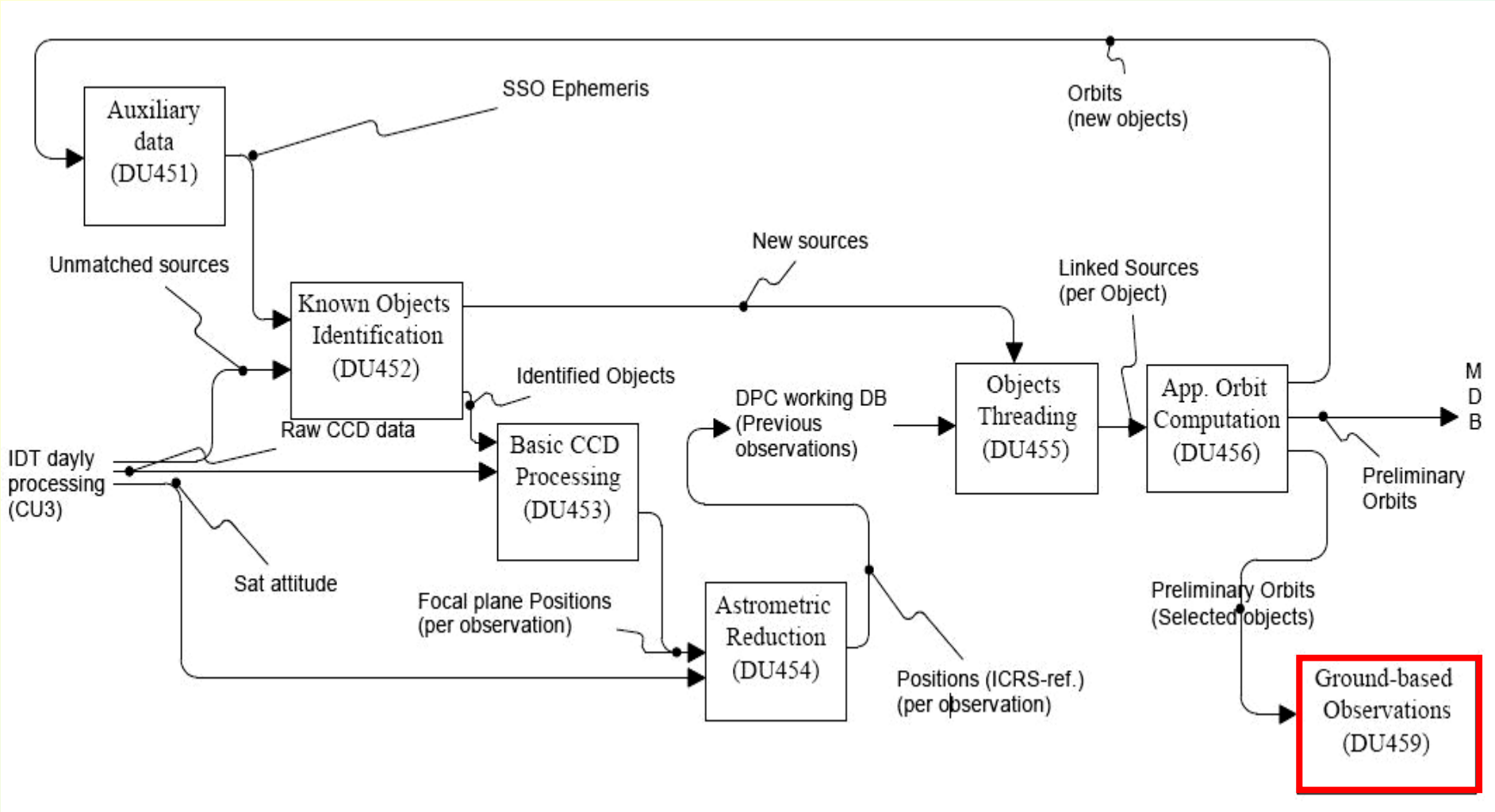
Critical aspects

- Data reduction
  - Object motion (windowing, smearing…)
  - Finite size
  - CTI – radiation damage
  - Identification (threading, parasites…)
  - Tracking accuracy of Gaia

- Completeness and interpretation
  - NEO orbit sampling – new objects
  - photometric parameters
  - « missing » objects
  - other evolution-relevant quantities: sizes

Future ground based support

CU4 SSO: data flow



Earth based support …before, during, after…

Adding astrometric measurements before and after Gaia, on specific objects:

- For the determination of masses (→ S. Mouret)
- For non-gravitational effects (Yarkovsky thermal acceleration on ~50 asteroids – simulations by M. Delbo)
  - NEO transfer toward the inner Solar System
  - Thermal properties of asteroids
- During the mission:
  - simultaneous observations of selected targets
  - direct Gaia astrometry

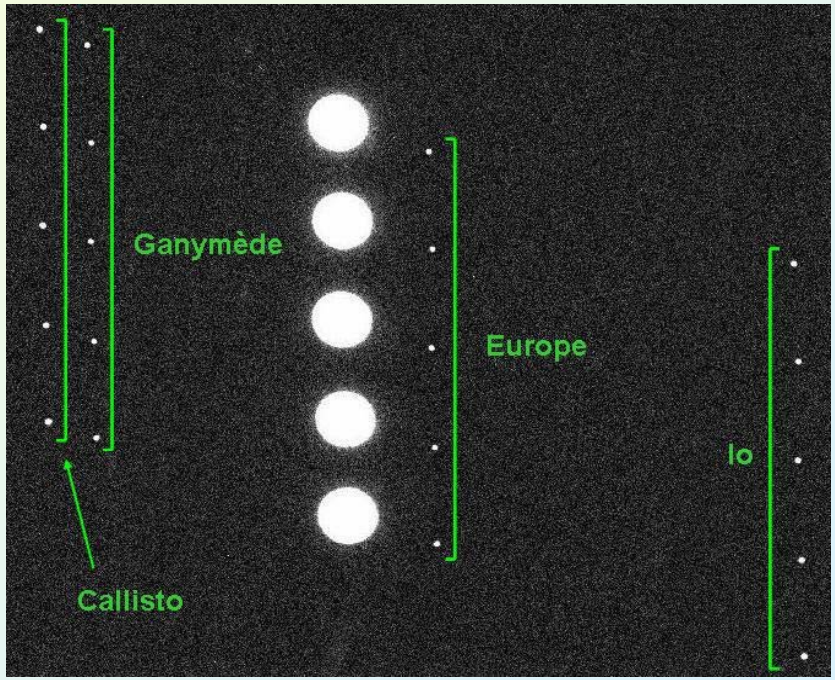
Remeasuring old plates

J.E. Arlot

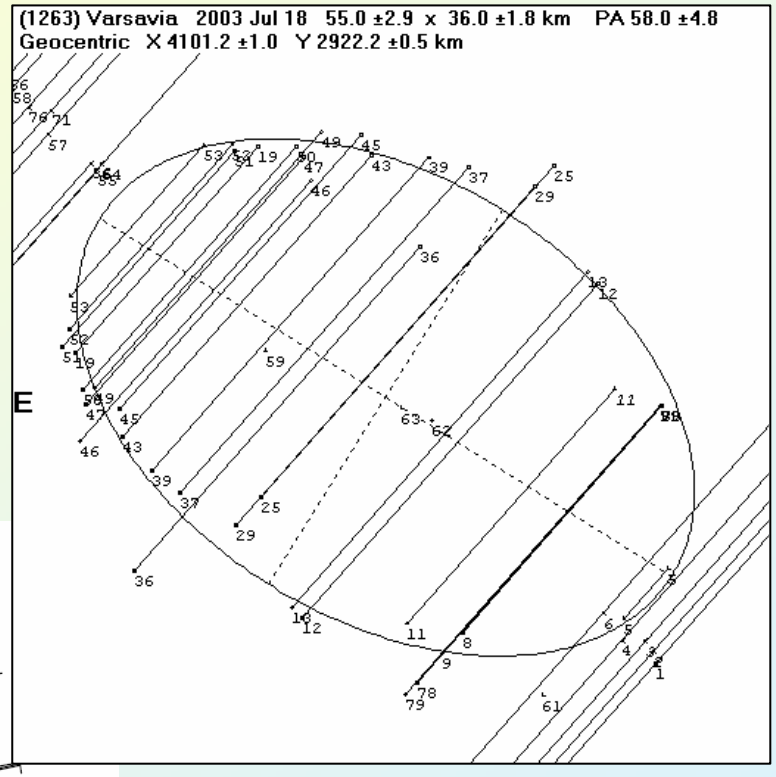
example: USNO Galilean plates (D. Pascu)

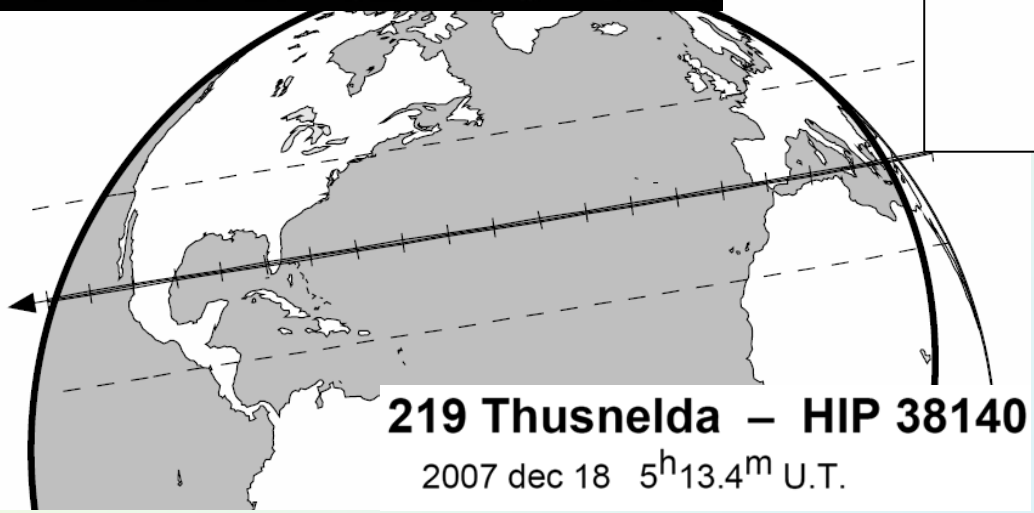
Accurate absolute positions useful for both the satellites and for the planet dynamics (not observed by Gaia)

- from 4 to 7 observations per plate
- from 1 to 17 stars per plate never used because of the poor catalogs available at the time of the observations.



A possible solution to the problem of sizes





Today: poor predictability for objects < 40 km

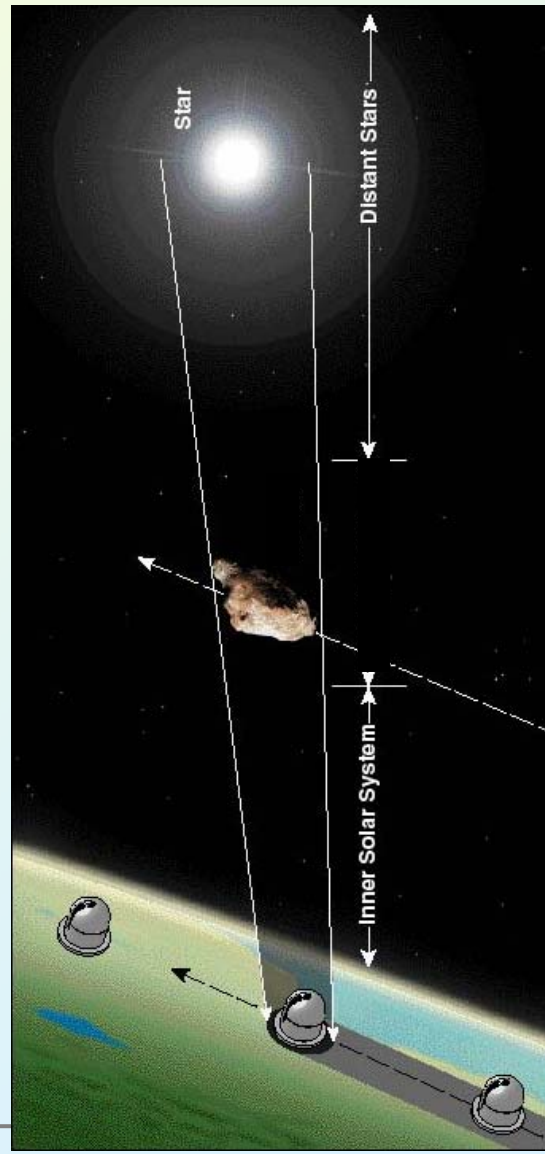
After Gaia : the occultation revival

Today

- poor predictability for objects <50 km
- bright Hipparcos/Tycho stars favoured
- ~0.1 events/objects/year
- Current practical limit: 100 km at 10% accuracy

After Gaia (100 X orbit improvement):

- Uncertainty smaller than the asteroid at >20 km
- 1-m automated telescope(s):
  - Single site: 20-40 events/yr for an object of ~20 km
  - Network: completeness of diameters > 20 km in a few yr
- Projected shape known



Tanga, Delbo A&A 2007

The End