

Detecting the Yarkovsky effect with Gaia

An astronomical clock to understand the collisional history of our Solar System



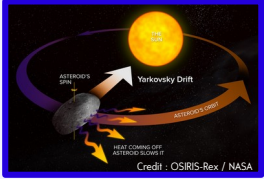
F. Spoto¹, P. Tanga¹, B. Carry^{1,2}

¹Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, Laboratoire Lagrange, FR
²IMCCE, Observatoire de Paris, Université PSL, CNRS, Sorbonne Université, FR



Chapter 1. The Yarkovsky effect : a clock to unveil the collisional history of our Solar System

The Yarkovsky effect



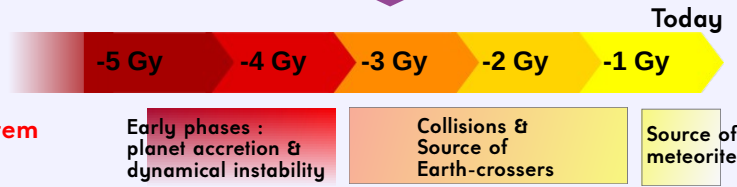
Description

- Subtle **non-gravitational** perturbation
- Dependence on **physical parameter** usually unknown
- Detected from **very accurate astrometry**

Thanks to the **Yarkovsky** detections we can identify the **main collisional events in the Solar System** and create a completely **new timeline** :

Consequences

- **Changes asteroid orbits**
- Necessary to **understand the evolution of our Solar System**
 - **Collisional history**
 - **Delivery of Earth-crossers from the Main Belt**



Chapter 2. The ESA Gaia mission vs ground-based astrometry



Gaia is a mission to **chart a three-dimensional map of our Milky Way**, in the process revealing the composition, formation and evolution of the Galaxy. **Gaia will provide unprecedented positional and radial velocity measurements** with the accuracies needed to produce a stereoscopic and kinematic census of about one billion stars in our Galaxy and throughout the Local Group.

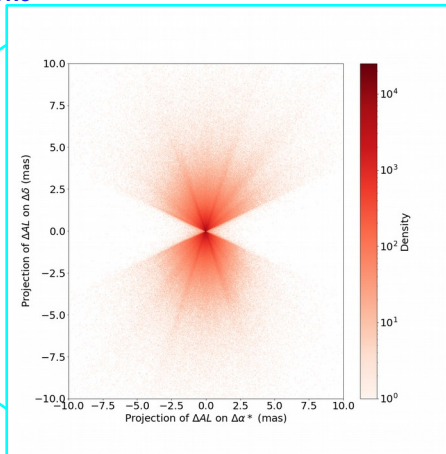
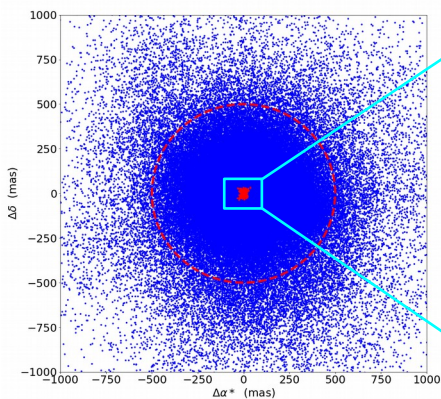


While surveying the sky, Gaia also provides **Solar System Object astrometry (positions on the sky)** with **unprecedented accuracy**.

Take a tour of our Solar System with Gaia



Post-fit residuals on the sky:
Blue – ground based asteroid observations
Red – Gaia asteroid observations



Available ground-based astrometry

- **200 millions** of observations (mid Feb. 2019)
- Typical accuracy: between **400 and 500 mas**
- **2 000** accurate observations (mostly radar)

Gaia Data Release 2

- **1 977 702** observations of Solar System Objects
- Accuracy : between **2 and 5 mas** ($V \sim 20.5$)
- Accuracy : **sub-mas level** (bright objects)

(Gaia Collaboration, Spoto et al. 2018, A&A)

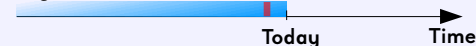
Chapter 3. Results : new Yarkovsky detections with Gaia DR2

(Spoto et al. 2019, A&A submitted)

Method :

- Combination of ground-based and extremely accurate Gaia observations with a **completely new debiasing of old stellar catalogs and weighting scheme**

Tens of years of observations **22 months of Gaia**



Conclusion & future perspectives

- **We found 10 new detections** and we are moving towards the first detections in the Main Belt
- **We are ready** for the next Gaia data release to unveil the main evolution mechanisms of our Solar System

