

Study of the Small Solar System Bodies with LSST

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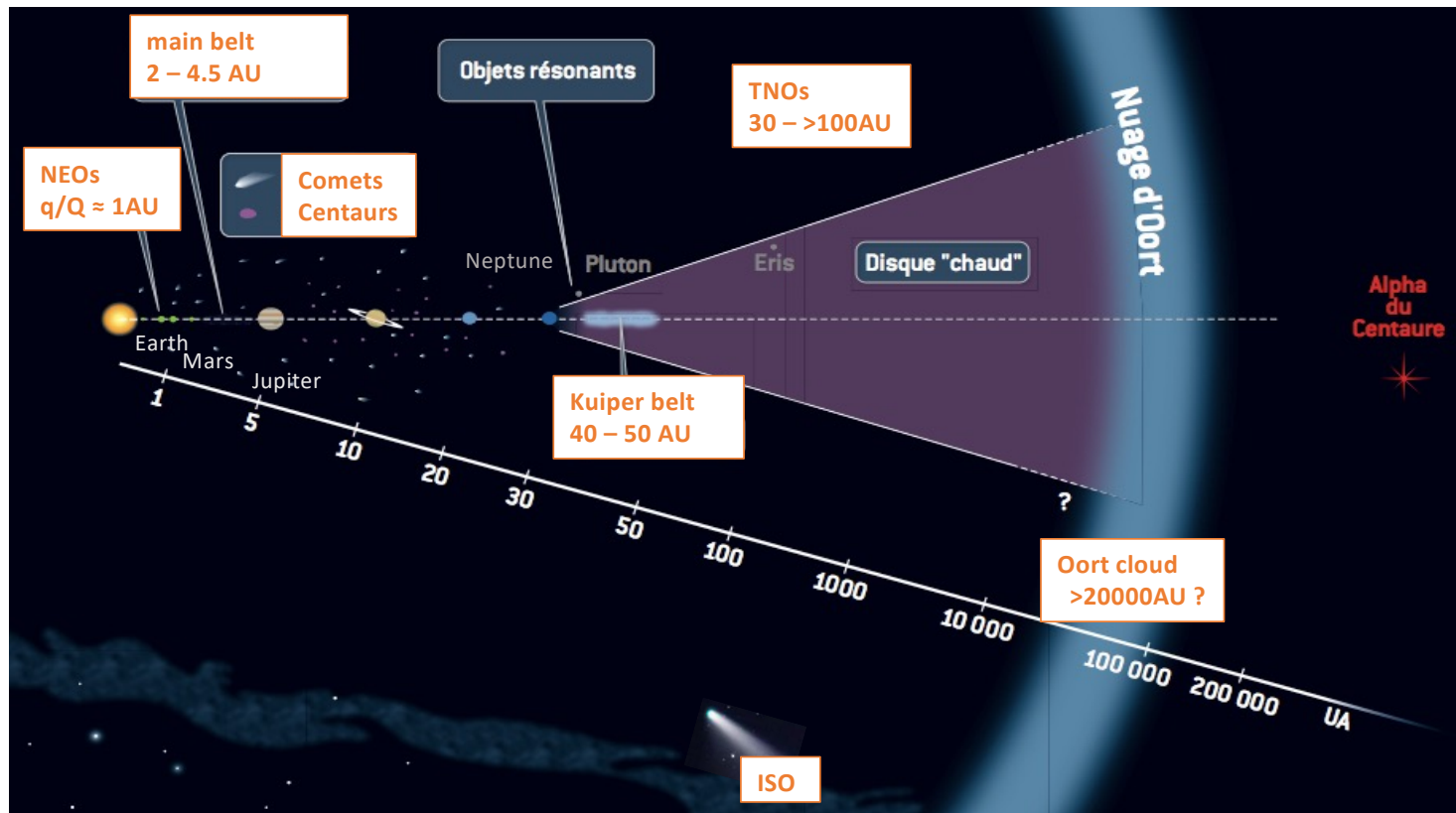
CNRS INSU-AA/PNP



LSST

Small Solar System Bodies (SSSBs)

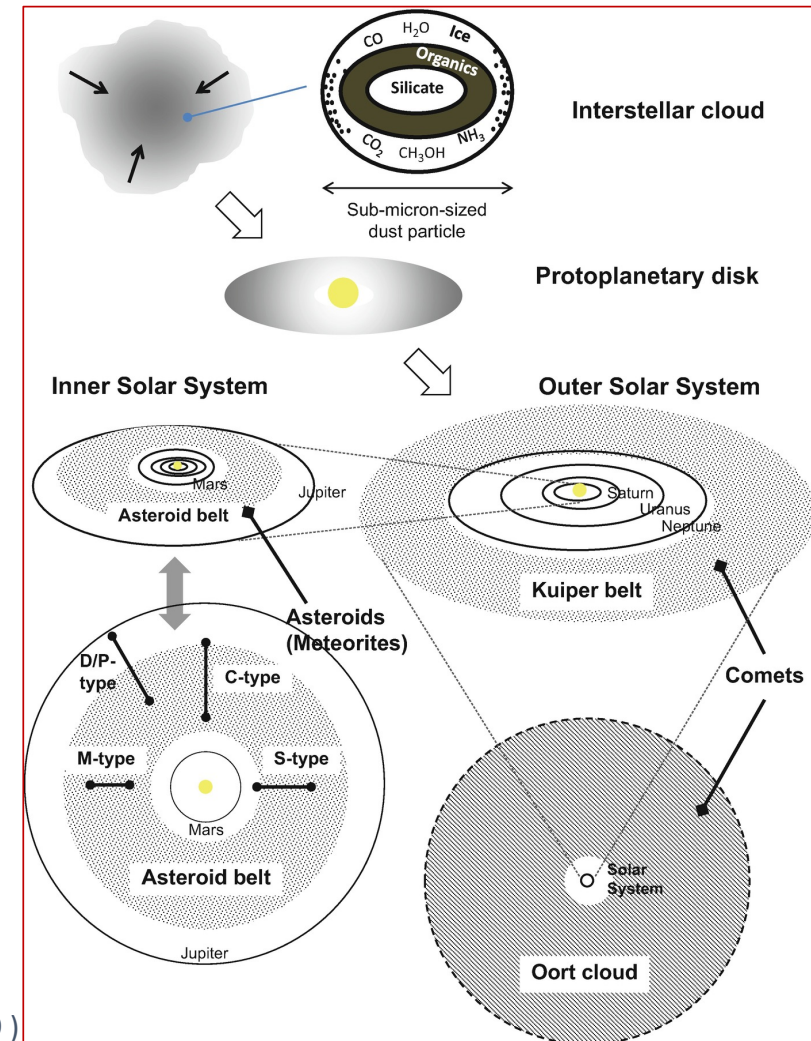
- Various populations in the Solar System – The targets



Small Solar System Bodies (SSSBs)

• Formation & Evolution the Solar System – The science –

- ± pristine objects – tracer of the chemistry at formation
 - formation of the Solar system / of planetary systems
 - mineralogy, aging, transport, water on Earth, ...
- dynamical structure – tracer of evolution over time
 - formation of Solar System / of planetary systems
 - dynamical interactions, migrations, ...

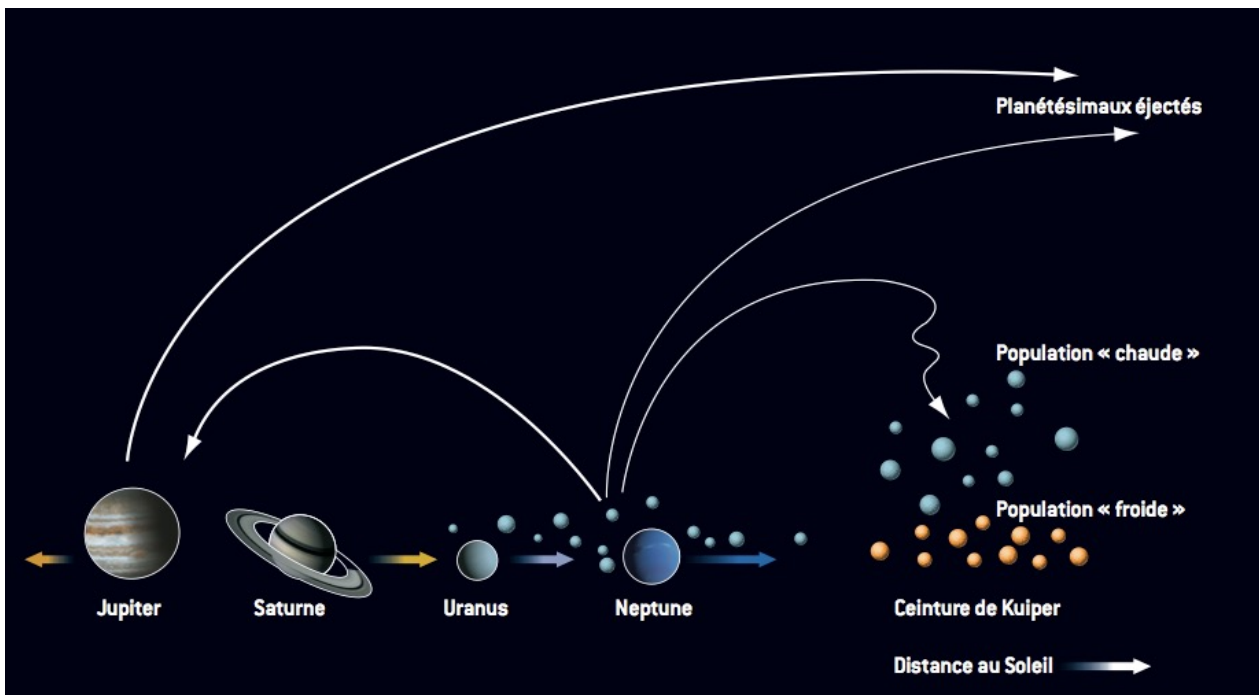


(H. Yabuta – Astrobiology, 2019)

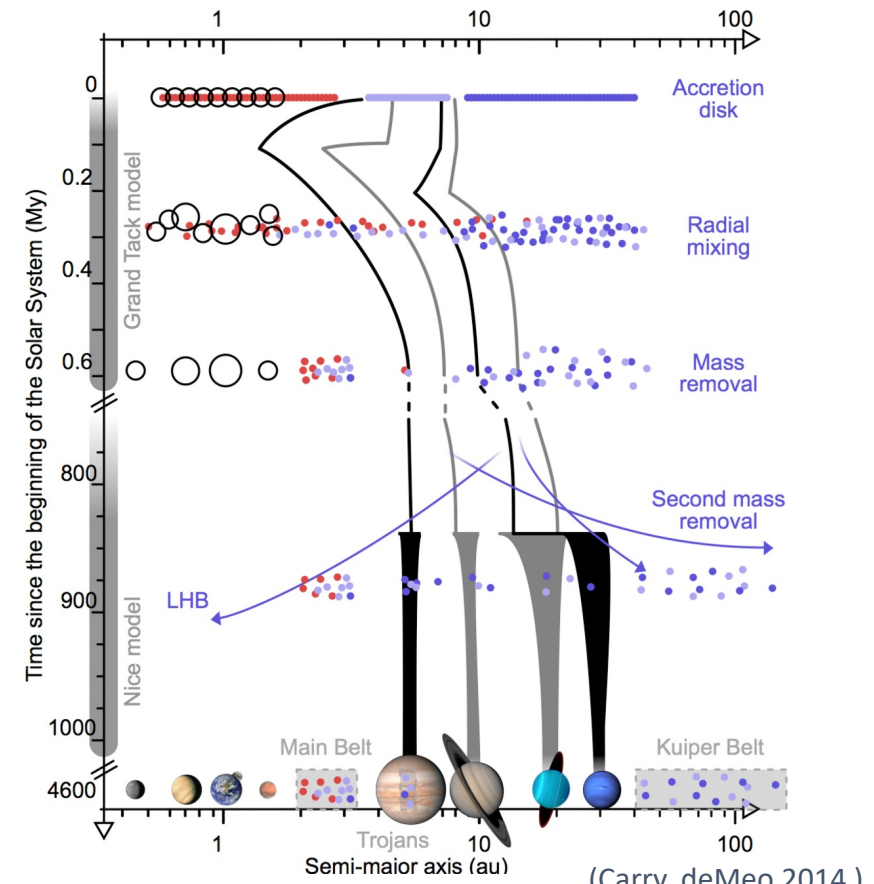
Small Solar System Bodies (SSSBs)

- Evolution the Solar System – The science

- dynamical structure – tracer of evolution amplitude and speed of planet migration



(Doressoundiram & Lellouch 2008)

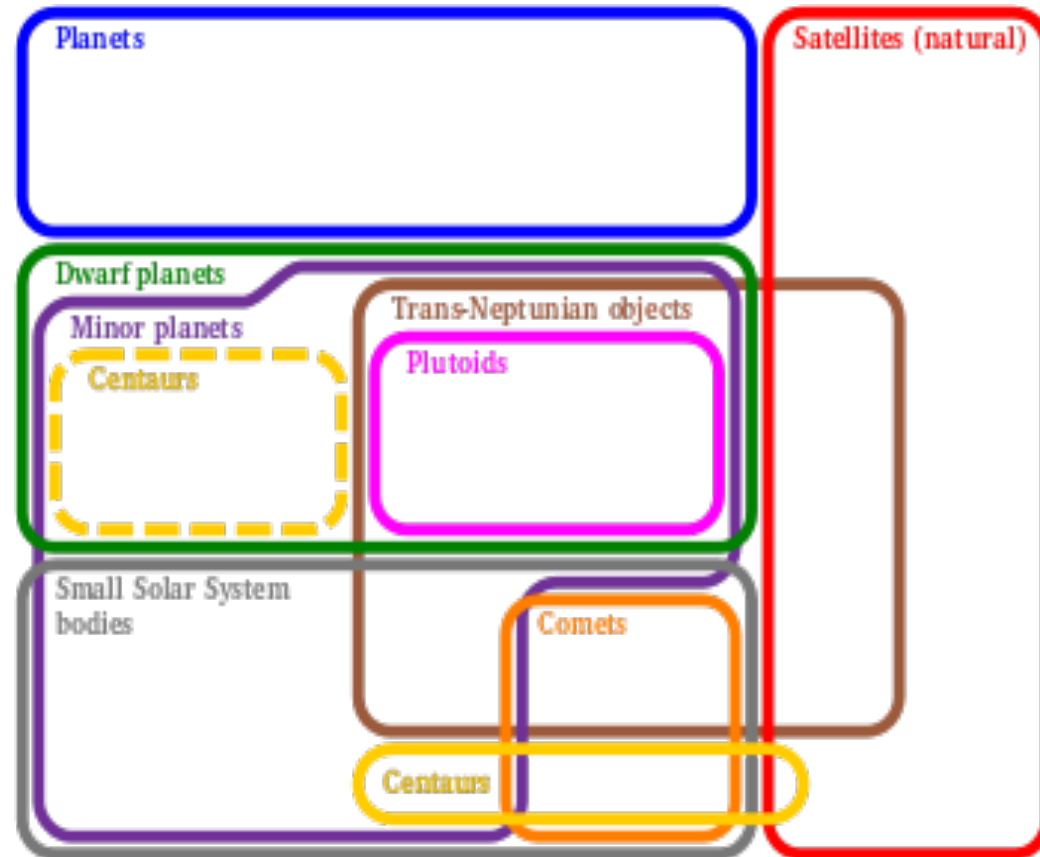


Small Solar System Bodies (SSSBs)

- Taking an inventory of the solar system

- Asteroids: NEOs, MBAs, Trojans (of Jupiter, Neptune, ...), Centaurs, TNOs (different populations), ...
- Comets: SPC, JFC, LPC, DNC, ... Oort cloud
- Planetary satellites: regular and irregular
- Dwarf planets
- ISOs

- Peculiar objects or state: Active asteroids (MBA Centaurs), main-belt comets (MBC), fast rotators, tumbling, multiple, bilobated, rings, ...



(wikipedia SSSBs)

Physics & Dynamics

• Current

- Several surveys for detection of NEOs (Space Safety, Planetary Defence)
- Science programmes legacy

• SDSS (2MASS)

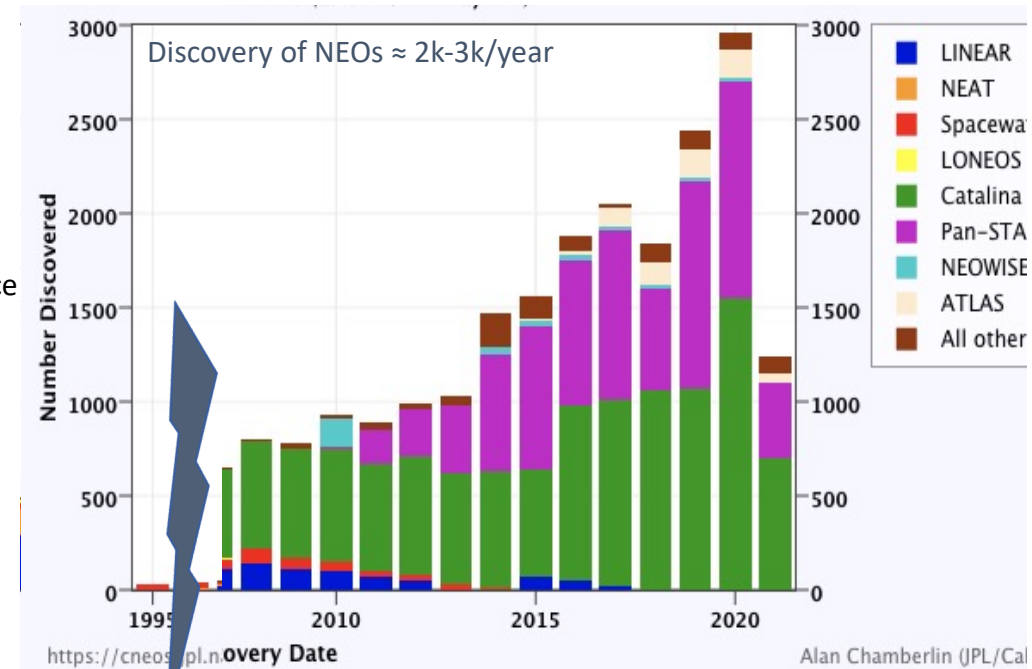
- ugriz images of about a quarter of the sky to $r \approx 22.5$
- colour-photometry
- color-based asteroid taxonomy

• CFHT

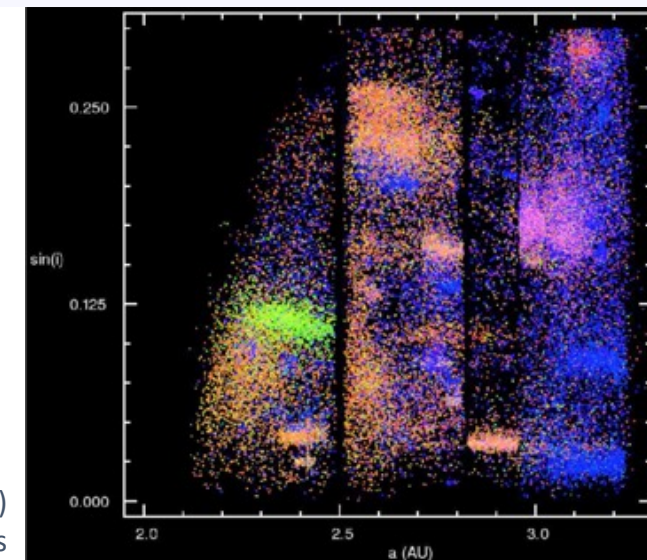
- large programmes on TNOs (mag $R \approx 24$) CFEPS, OSSOS, CoLOSSOS, ...
- survey along ecliptic down to $r \approx 24$
- about 1000 targets observed in astrometry & colour-photometry
- discoveries, orbits, colours, resonant and discs, dyn. models, Neptune's migration, ...
- <http://www.ossos-survey.org/>

• Gaia

- about 350.000 asteroids (+satellites, comets) observed – mostly known ($V \approx 20.7$)
- over 10 years (in progress, 2014.5 – 2024.5)
- high precision astrometry & spectro-photometry (visible)
- direct or indirect science of SSOs

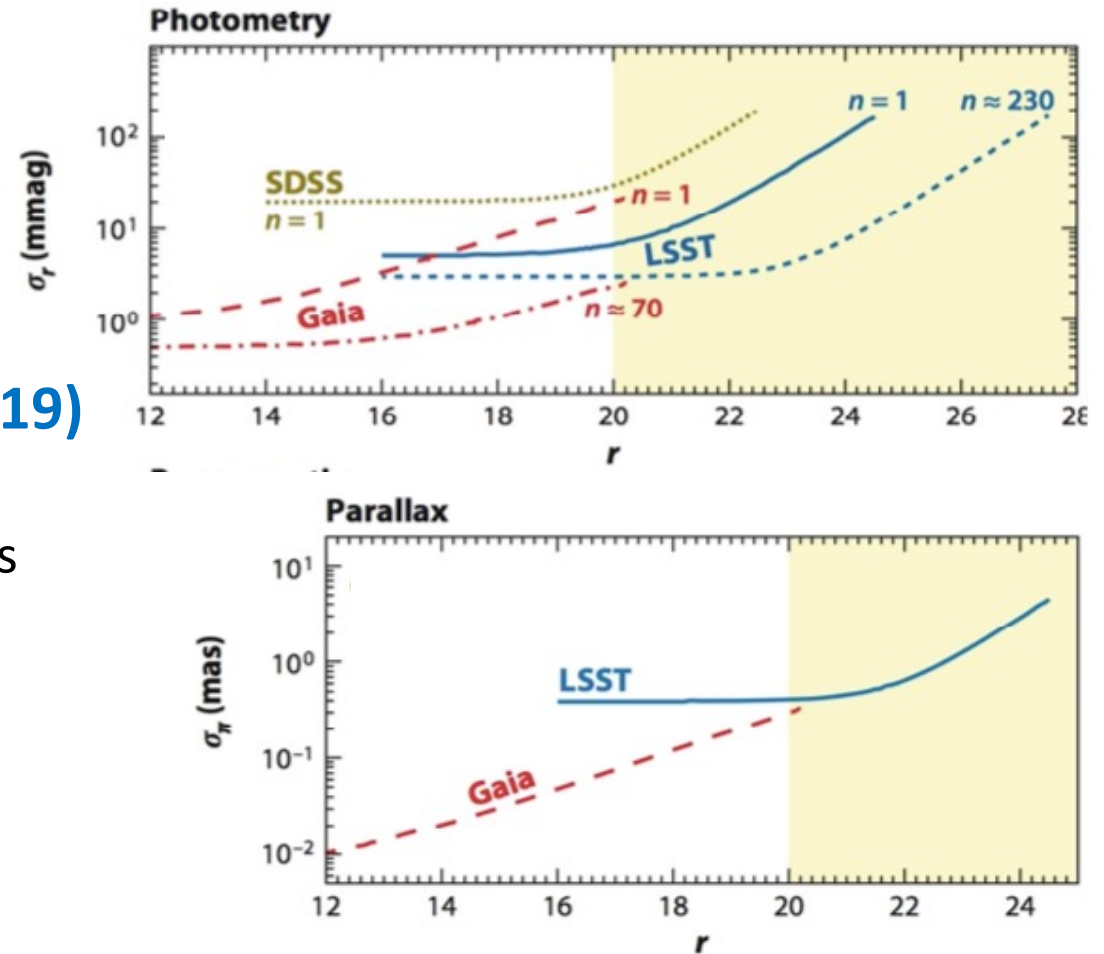


Taxonomy (SDSS Parker *et al.* 2008)
+ proper elements



LSST - SSSBs

- Science case
- Gaia-LSST synergy (Ivezic 2015, 2019)
 - calibration and astrometric catalogue
 - extends Gaia survey by ≈ 4 magnitudes+ OSSOS-LSST synergy
- Dynamical and physical properties
- Population characterisation
- Testing of formation models
- Predictions of events (occultations)

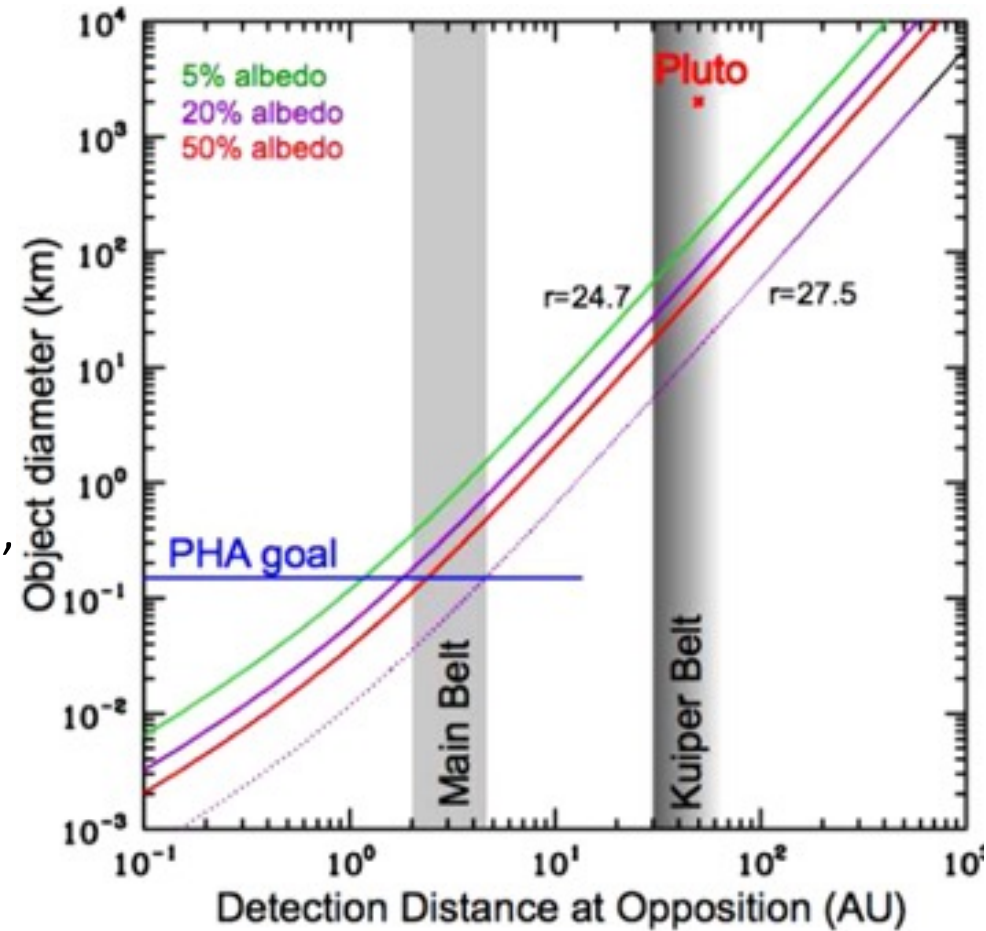


Gaia-LSST synergy (Ivezic *et al.* 2015)

LSST - SSSBs

- **Survey strategy, Cadence, Discoveries, Astrometry, Photometry**
 - *need to adapt cadence to apparent motion for proper detection and linking*
 - *time-data $f(t)$ over 10 years*
 - *ugrizy colour-photometry - taxonomy, lightcurves, size distribution, ...*
 - *imaging - peculiar objects, active, binaries, MBC*
 - *astrometry - good orbits, dynamics, proper elements, families, masses, non grav. effects, ISOs, ...*
- **Major Extension of populations**
 - *from $r \approx 21$ to $r \approx 24$ mag. - population extension XXL**
 - *faint and small objects – in particular for TNOs, MBAs, NEOs*

(*OSSOS isn't complete)



(Ivecic 2015)

LSST – France

- **INSU-PNP demande ANR** :-(

- *Survey characterisation*
- Detection for specific objets
- Imminent impactors, binaries, active bodies
- Taxonomy, albedo, debiased size distribution
- Orbit determination (\neq MPC)
- Techniques/algorithms for big data treatment
- Combination with other surveys (Euclid, PanSTARRs, Gaia)

(* LSST PI ticket \neq research team in France)

- **Fink broker (Peloton et al.)**

- Detection – Identification – Alert

- **PS : IAU/UAI Aug. 2022**

- Focus Meeting FM10 <https://iaufm10.org/>
“Synergy of Small Telescopes and Large Surveys for Solar System and Exoplanetary Bodies Research”
- Focus Meeting FM8 <http://www.iauga2022.org/>
“Planetary Astronomy via Telescopic and Microscopic Approaches”