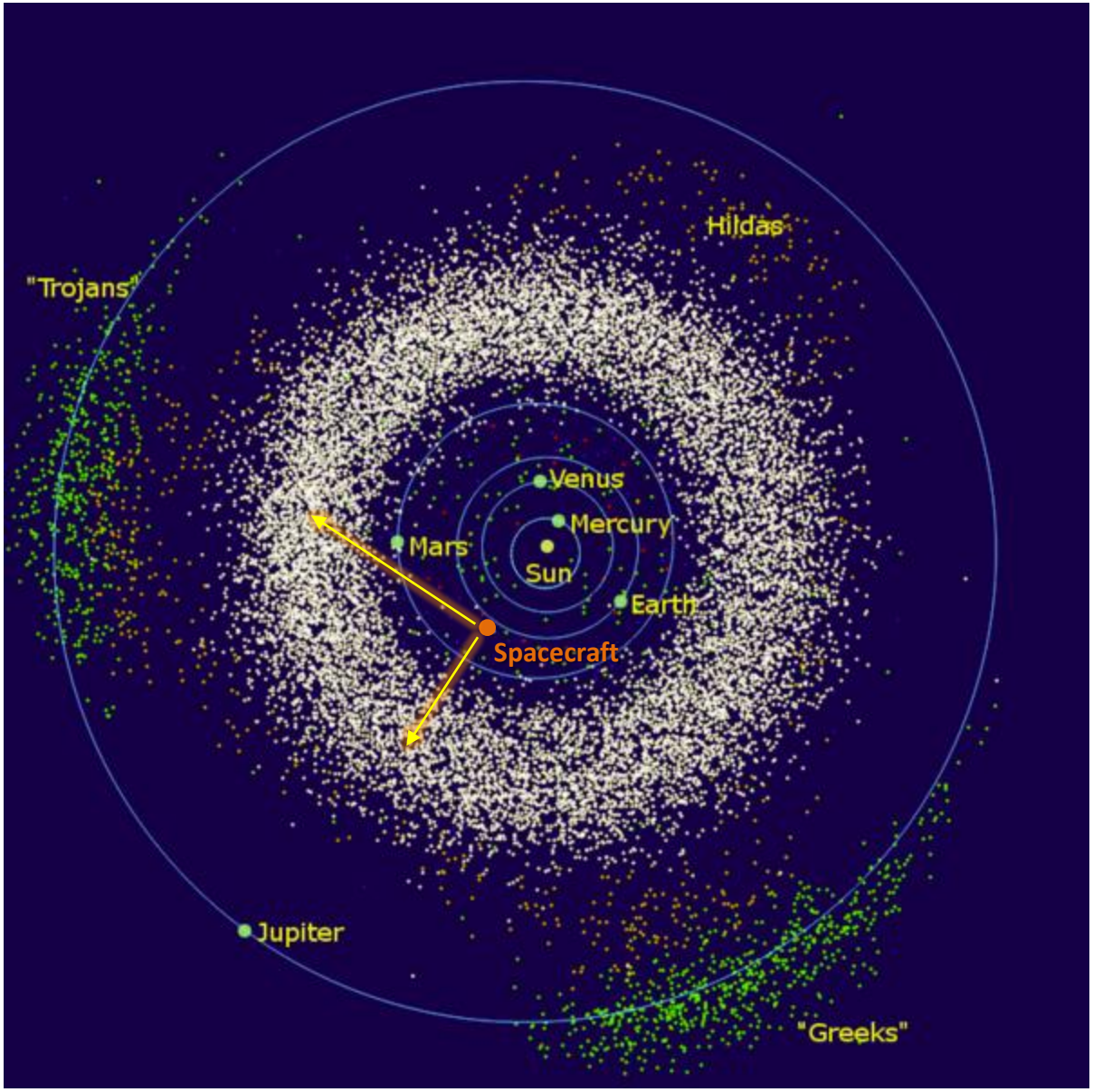
Another Application of uas Astrometry of Asteroids

M. Shao

Asteroid Masses

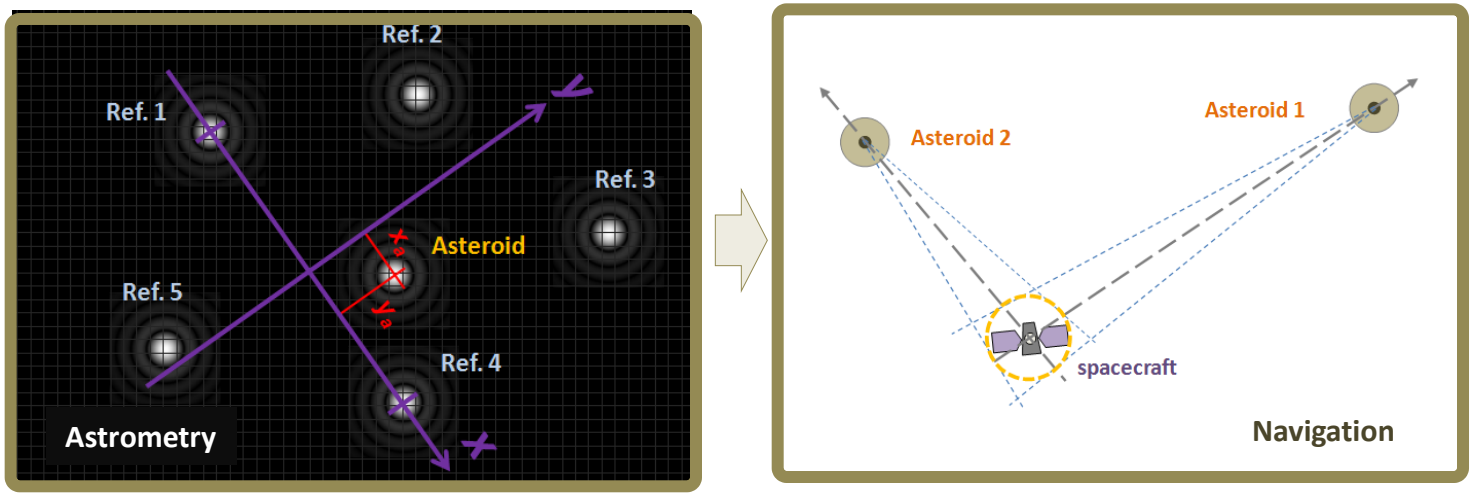
- Use GAIA data to survey asteroid oribts to determine, which asteroids will have close encounters.
- Use NEAT to measure the change in the orbits of the two asteroids after the close encounters, to measure the masses of the two asteroids.
- Haven't done the homework on how many encounters might be found. But asteroids will in general be bright, 14mag and allow 5~10uas accuracy with "short" observing time for NEAT. (~10X higher accuracy per epoch then GAIA)
  - Very little observing time needed. (6~8 epochs, 1000sec)
  - Higher precsion (vs GAIA) means "close" encounter can be relaxed. (1/r^2) 100X larger cross section for detectable orbit change.



Basic Concept is very simple

Measure the position of at least 2 asteroids, against background stars.

Star positions from GAIA ~10uas, Asteroid positions initially from GAIA ~ 10uas.



We know the positions (x,y,z) of the asteroids. When we measure their angular position wrt background stars, we know where the spacecraft is along a line from the asteroid. Doing this with 2 or more asteroids lets us determine the XYZ position of the spacecraft.

10uas ~50 picoradian * 2AU = ~ 1.6e-2 KM ~ 16 meters. Potentially GPS accuracy anywhere in the solar system.

Besides 10uas astrometry, the major challenge is the orbit of the asteroid. An asteroid is not a sphere and the center of light is not at the center of mass to within 16m. GAIA will observe each object 80~150 times over 5 years, it may or may not be able to model the CL-CM offset with sufficient accuracy.
For interplanetary navigation, the DSN has ~ 1km accuracy. It's highly likely that proper analysis of the GAIA data will enable 1km navigation in the solar system.