

# Stellar encounters with the Sun in Gaia DR3

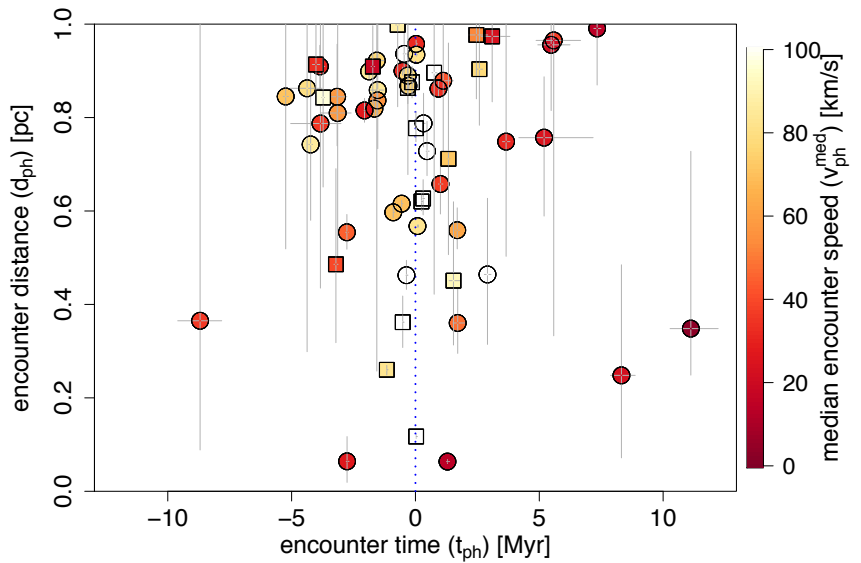
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## Motivation

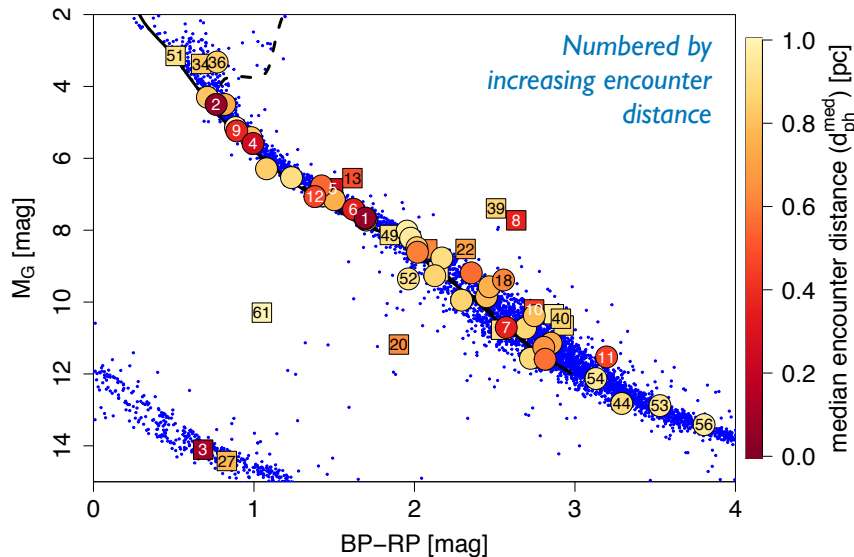
Close encounters between stars can influence their evolution, for example by disrupting planet-forming disks. For the Sun, the gravitational perturbations of passing stars can inject Oort cloud comets into the inner solar system, where they could impact the Earth, with implications for biological evolution.

## Goal and method

Using 6D phase space data for 33 million stars from Gaia DR3, I integrate their orbits and those of the Sun through a Galactic potential to identify which stars come close to the Sun. Uncertainties are propagated by resampling from the 6D covariance, and these are summarized using confidence intervals on the encounter time, distance, and speed.



Encounter parameters of the 61 stars that approach within 1 pc. The error bars show the 5th and 95th percentiles. Circles denote good encounters; squares denote the questionable encounters (e.g. due to binarity). The colours indicate the encounter speed (unfilled shapes have  $v_{ph} > 100$  km/s): slower is more disruptive for the Oort cloud.



Colour-absolute magnitude diagram for the encounters. For orientation, the small blue dots are a random subset of all sources in GDR3 with parallax  $> 50$  mas and RUWE  $< 1.2$  and the black lines are solar metallicity PARSEC isochrones for 1 Gyr (solid) and 10 Gyr (dashed).

## Results

- 61 stars have median encounter distances below 1 pc, of which 42 have high confidence.
- The closest encounter is the K7 dwarf Gl 710: its median encounter distance is 0.064 pc in 1.3 Myr (90% confidence interval 12 000 -14 000 au), bringing it well within our Oort cloud.
- The closest past encounter is also the second closest encounter: the G3 dwarf HD 7977, which 2.8 Myr ago approached within less than 0.05 pc of the Sun with a probability of 1/3.
- Earlier work based on Gaia DR2 (Bailer-Jones et al. 2018) showed that after correcting for incompleteness, the overall rate of encounters within 1 pc is  $19.7 \pm 2.2$  stars per Myr. This rate scales quadratically with the encounter distance out to several pc.

## Looking ahead

- Looking for encounters beyond 10-20 Myr is difficult, due to uncertainties in the Galactic potential, its evolution, and the short lifetimes of undetectable perturbers of orbits such as molecular clouds.
- Correcting for incompleteness remains a challenging problem. It will be readdressed using the larger data set (more radial velocities and more accurate astrometry) coming in Gaia DR4.