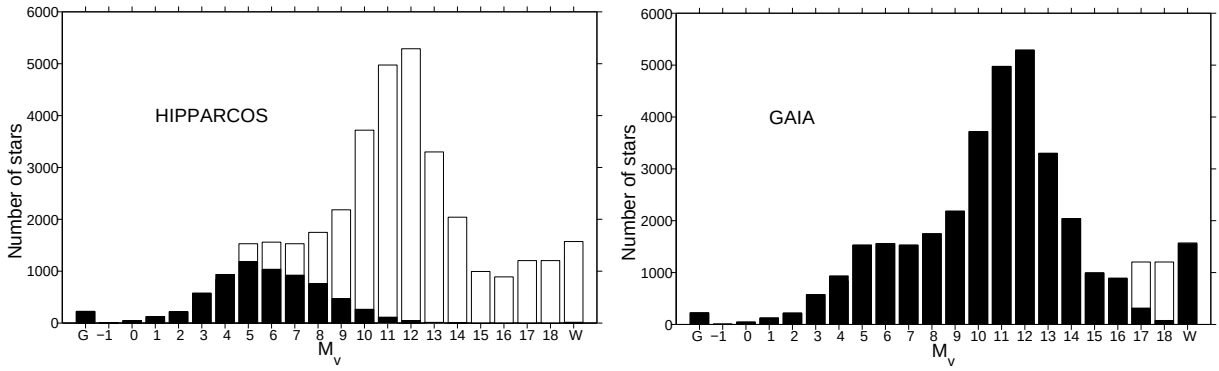

Comparison of the completeness from Hipparcos (left) with the expected completeness from Gaia (right). The plots show the number of star systems (individual stars or binary/multiple systems) within 50 pc of the Sun, as a function of absolute magnitude M_V, predicted by a systemic luminosity function based on data from the literature. The bar with the letter 'G' (at left) denotes giant stars, and with the letter 'W' (at right) denotes white dwarfs. The black parts of the bars give the number of star systems detected by Hipparcos or by Gaia. Figure courtesy Joan García-Sánchez.

Close or even penetrating passages of stars through the Oort Cloud can in principle deflect large numbers of comets into the inner planetary region, initiating Earth-crossing cometary showers and possible Earth impacts. Although the distribution of long-period cometary aphelia is largely isotropic, some non-random clusters of orbits do exist, and it has been suggested that these groupings record the tracks of recent stellar passages, with dynamical models suggesting typical decay times of around 2–3 Myr. Gaia's complete and accurate census of the distribution and space motions of the stars in the solar neighbourhood will allow a determination of the frequency of such close encounters, and will provide, for the first time, sufficiently accurate astrometric data for a large number of stars to carry out a reliable study of the link between comet showers and past impact events and mass extinctions on Earth.

García-Sánchez et al. (1999) used Hipparcos data to investigate close stellar encounters with the solar system, the consequences for cometary-cloud dynamics, and the evolution of the comet population over the history of the solar system. Effects of individual star passages on comet orbits were studied through dynamical simulations. Algol was the largest perturber in the recent past (although other stars have passed even closer), passing at a distance of about 2.5 pc about 7 Myr ago. Gliese 710 is the most significant known future perturber. At 19 pc from the Sun, and approaching at about 14 km s^{-1}, it will pass through the Oort Cloud, at about 69,000 AU from the Sun, in about 1 Myr. But the authors concluded that none of the predicted passages could have caused a significant disruption of the Oort Cloud, which supports the hypothesis that the currently observed flux of long-period comets corresponds to a steady-state value.

The figure above shows the number of star systems (individual stars or binary/multiple systems) within 50 pc of the Sun, as a function of the absolute magnitude. The black parts of the bars give the number of star systems detected by Hipparcos (left) or expected for Gaia (right). 'G' denotes giant stars and 'W' indicates white dwarfs. Hipparcos detected about 20 per cent of the nearby star systems, whereas Gaia will detect nearly all of them. Two explanations for an increased rate of impact events on Earth have been suggested: (i) a collisional breakup of a large asteroid in the asteroid belt that can deliver collision fragments to orbital resonances, resulting in large fragments ejected from the asteroid belt to Earth-crossing orbits; (ii) a comet shower caused by a close stellar passage, increasing significantly the number of comets with Earth-crossing orbits. The reliable determination of a close stellar encounter with the solar system during the time of the impact events would provide strong support to the cometary origin of such impacts, as opposed to the asteroid hypothesis. In particular, an extinction at the end of the Eocene period, 36 Myr ago, is identified with several large impact craters, multiple iridium layers, and other evidence of a prolonged period of increased cometary flux in the inner-planets region. Hipparcos data allowed the study of passages within a few million years. Gaia will enhance this time interval to a geologically interesting range. The encounters predicted by using Gaia data are expected to establish whether the currently observed comet flux corresponds to an enhanced or a steady-state flux, with implications for the size of the Oort-Cloud population. The prediction of future close or penetrating passages through the Oort Cloud may be used to estimate resulting enhancements in the inner-solar-system cometary flux.