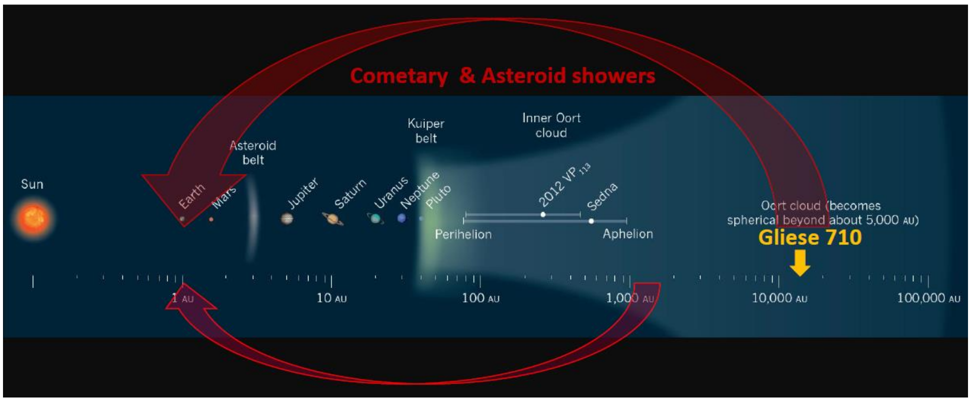
This proposal is inspired by recent results obtained by analyzing GAIA data. The European space craft GAIA was launched in December 2013 with the objective to create the largest and most precise 3D map of our Galaxy. In addition to the unique view of our Galaxy, GAIA predicts a spectacular flyby of a star named “Gliese 710”. It will have a close encounter with the solar system entering the Oort cloud in about 1.3 Myrs. The closest approach distance is somewhat difficult to determine as it sensitively depends on its current position and velocity as well as the assumed potential for the forward integration. So far, a minimum distance between 4300 and 13366 au has been determined, which puts Gliese 710’s trajectory well inside the Oort cloud.



Due to this event we expect intense perturbations especially of the Oort cloud objects and possibly major TNOs, which will result in observable comet showers. These comet showers have so far been studied by means of impulse approximation or N-body simulations using the simplified restricted 4 body problem. However, a fully interacting dynamical system of planets and planetesmial belts (all bodies gravitating) has not been simulated so far. Therefore, our N-body approach (using the fast GPU N-body code) by itself will be a first innovative improvement of former studies.

Our studies of perturbations in the outer solar system – involving not only large known TNOs but also a hypothetical Planet 9 – will constrain additional dynamical chaos induced by a close stellar flyby.

We are primarily interested in interaction of the inward-scattered comets with planetesimals in the outer and inner solar system. In the course of this interaction we expect a number of close encounters (and collisions) not only between small bodies and planets but also among the small bodies. In this context, in our group we studied and explained the activation of main belt comets by collisions of the parent bodies with meter-sized rocky asteroids. We will build on this by including collision outcomes in our dynamical studies. The novelty in our approach is to create one unified integrator which accurately calculates collision outcomes during N-body simulations of up to about a million bodies.

LSST will significantly contribute to completing the inventory of known asteroids by observing millions of new such bodies Considering the expected large number of small planetesimals and the fact that only a minuscule fraction of them has been observed so far, the LSST observations will help validating and fine-tuning the results of our proposed study.

The realization of this project will finally allow us to make statements about the probability of planet Earth experiencing stronger bombardments in the future and of the chaos in the outer solar system being enhanced due to stellar flybys. The technical tasks of this project comprise N-body computations, realistic collision simulations, and a combination of both. In addition, we will take into account new observations from GAIA and – as soon as available – LSST for verifying the conclusions drawn from our numerical investigations.