Leiden-BNU Astronomy Summer School 2019: Computational Astrophysics projects

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Project 1: Colliding protoplanetary disks

Stars are not formed in isolation but in clustered environments, up to thousands at a time. Protoplanetary disks are a natural outcome of the star formation process. During their first stages of evolution they are immersed in an environment that is dense in gas and nearby stars. This ambient can be hostile for disk survival for many different reasons, such as the disks being exposed to photevaporation, supernovae explosions, ram pressure stripping, and close-by encounters with other stars. In this project the students will use an SPH code to study the interactions between two encountering protoplanetary disks.

Project 2: Finding the lost siblings of the Sun

Most stars are not born in isolation but in clustered environments, gravitationally tied to other stars. In time these clusters evolve and eventually dissolve, populating the field stars. Several processes contribute to this dissolution, such as the tidal field of the galaxy and the dynamical interactions of the stars inside the cluster. There is observational evidence that our Sun was born in such an environment. However, we do not know which stars belonged to the original cluster where the Sun was born. In this project the students will study how cluster evolution is affected by the tidal field of the galaxy and try to find the distribution of the solar siblings across the Milky Way.

Project 3: Dynamical modeling of the Milky Way-Andromeda merger

Galaxy mergers are among the most important dynamical processes in the evolution of galaxies. Depending on their speeds, impact angles, and mass ratios, galaxy mergers can produce irregular, lenticular, elliptical, or even spiral galaxies. Within the local group, the Andromeda galaxy (M31) is approaching the Milky Way at a speed of roughly 110 km/s. It is predicted that the two galaxies will eventually collide in about 4.5 Gyr from now, merging into an elliptical galaxy. In this project the students will develop a simulation of a galaxy merger using different N-body codes, and they will analyze how different initial conditions yield different merger results.

Project 4: Dynamics of a triple stellar system

The triple system θ Muscae comprises the WC5/6 Wolf-Rayet star WR48 on an inner orbit with period $P_{in} \approx 19$ days around an O6/7V star, with an O9.5/B0Iab companion on a much wider outer orbit. The other orbital parameters are not known, but each of the three stars has a strong stellar wind. In this project the students will integrate the equations of motion of such a triple

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system, taking the mass loss of each star into account, by coupling a stellar evolution code with an N-body integrator.

Sources

- Github repository for projects: https://github.com/franciscaconcha/LeidenBNU2019
- AMUSE repository: https://github.com/amusecode/amuse/
- AMUSE textbook examples: https://github.com/amusecode/amuse/examples/textbook
- AMUSE documentation: http://amusecode.org