Leiden-BNU Astronomy Summer School 2019: Computational Astrophysics projects

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July 7, 2019

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 an N-body code, and they will analyze how different initial conditions yield different merger results.

Project 4: Protoplanetary disks in the Trapezium cluster

The Trapezium cluster (M42, NGC1976) is one of the closest young star forming regions. The close proximity of the Trapezium cluster allows detailed observations of circum- stellar disk sizes. This size distribution is well described by a power law, but the origin of this distribution is not well understood. In this project the students will simulate star clusters with initial conditions similar

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to the Trapezium, where the stars have protoplanetary disks around them. They will use N-body codes to simulate the cluster dynamicls and a parametrized model for disk encounters, to try to reproduce the observed disk size distribution.

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/tree/master/examples/textbook
- AMUSE documentation: http://amusecode.org