Module: Elective Advanced Lectures: Modern Astrophysics

Module No.: astro850

Course: The Physics of Dense Stellar Systems as the Building Blocks of Galaxies

Course No.: astro8531

Category	Type	Language	Teaching hours	CP	Semester
Elective	Lecture with exercises	English	3+2	6	WT

Requirements for Participation:

Preparation:
Participation in the lecture course and in the exercise classes and reading

Form of Testing and Examination:
A final two hour written exam on the contents of the course

Length of Course:
1 semester

Aims of the Course:
The students are taught the fundamentals of collisional stellar dynamics and of the emergence of stellar populations from galactic building blocks

Contents of the Course:
Fundamentals of stellar dynamics: distribution functions, generating functions, collisionless Boltzmann equation, Jeans equations, Fokker-Planck equation, dynamical states, collisional dynamics and relaxation, formal differentiation between star clusters and galaxies, mass segregation, evaporation, ejection, star-cluster evolution, the form, variation and origin of the stellar initial mass function, stellar populations, their evolution and their properties, binary stars as energy sinks and sources, the distribution functions of binary stars and the evolution of these distribution functions, star-cluster birth, violent relaxation, birth of dwarf galaxies.

The lecture course covers a broad range of topics related to the emergence of stellar populations from their molecular cloud cores. It provides a Bonn-unique synthesis on the one hand side between observationally and theoretically derived distribution functions, which describe stellar populations, and on the other hand side the temporal evolution of these distribution functions, such that a comprehensive mathematical formulation of stellar populations in galaxies becomes possible with this knowledge.

Recommended Literature:
Lecture notes
Galactic Dynamics by J.Binney and S.Tremaine (1987, Princeton University Press)
Dynamics and Evolution of Galactic Nuclei by D.Merritt (2013, Princeton University Press)
Dynamical Evolution of Globular Clusters by Lyman Spitzer, Jr. (1987, Princeton University Press)
The Gravitational Million-Body Problem by Douglas Heggie and Piet Hut (2003, Cambridge University Press)
Gravitational N-body Simulations: Tools and Algorithms by Sverre Aarseth (2003, Cambridge University Press)
Initial Conditions for Star Clusters by Pavel Kroupa (2008, Lecture Notes in Physics, Springer)

The stellar and sub-stellar IMF of simple and composite populations by Pavel Kroupa (2013, Stars and Stellar Systems Vol.5, Springer)
The universality hypothesis: binary and stellar populations in star clusters and galaxies by Pavel Kroupa (2011, IAUS 270, p.141)