Module Name **Computational Astrophysics**						
Type of Module Advanced Module				**Module Code** AM-CompAstro		
Identification Number MN-CS-CompAstro	**Workload** 180 Hours	**Credit Points** 6 CP	**Term** 1. – 3. Semester	**Offered Every** WiSe	**Start** Winter Term Only	**Duration** 1 Semester

1	**Course Types**	**Contact Time**	**Private Study**	**Planned Group Size**
	a) Lecture	30 h	60 h	Students
	b) Tutorial	30 h	60 h	

2	**Module Objectives and Skills to be Acquired** This course is highly complementary to the Advanced Astrophysics MSc course and is oriented towards students who are interested in how to simulate stellar and gaseous astrophysical systems. It provides an overview over the commonly used numerical methods in modern astrophysics, from the modelling of N-body dynamics, to (magneto-)hydrodynamics, and radiative transfer. Project work in the tutorials will give an introduction to these numerical techniques following the principle of "learning-by-doing".
3	**Module Content** The lecture covers three different physical processes that are essential for astrophysical systems: - Gravity: The gravitational force calculations are needed to model different astrophysical systems, from planetary systems, stellar clusters, stellar dynamics in galaxies, to the dark matter content of the Universe. Here, we will discuss N-body techniques. Next, we briefly discuss how to develop methods to model the self-gravity of gas in galaxies. - (Magneto-)hydrodynamics: The gas in galaxies, which forms the so-called interstellar medium, mostly follows the equations of fluid dynamics. Here we discuss Smoothed Particle Hydrodynamics as well as finite-volume methods. - Radiative Transfer: Radiation is ubiquitous in the Universe. The structure of the radiative transfer equation is simple but its multi-dimensionality, e.g. describing radiation emitted throughout a significant part of the electromagnetic spectrum (From gamma-rays and X-rays down to the radio regime), makes it a challenging task. We will discuss Monte Carlo as well as different field-based methods to solve the radiative transfer problem.
4	**Teaching Methods** Lectures and exercises
5	**Prerequisites (for the Module)** Formally: none Regarding the content: Good bachelor level knowledge of theoretical physics and astrophysics
6	**Type of Examination** Successful and active participation in the exercises One oral examination at the end of the module

7	**Credits Awarded** The module is passed by passing a oral examination. The grade given for the module is equal to the grade of the oral examination.
8	**Compatibility with other Curricula** The module is part of the Master of Science in Physics.
9	**Proportion of Final Grade** 6/114
10	**Module Coordinator** Prof. Dr. Stefanie Walch-Gassner
11	**Further Information** **Recommended literature:** Bodenheimer, Laughlin,Rozyczka, Yorke, Numerical methods in astrophysics (Taylor & Francis, 2006)