LUND UNIVERSITY

Faculty of Science

ASTM28, Astronomy: Dynamical Astronomy, 7.5 credits

Astronomi: Dynamisk astronomi, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2021-01-31 and was last revised on 2021-02-19. The revised syllabus comes into effect 2021-02-19 and is valid from the autumn semester 2021.

General information

The course is a compulsory course for second-cycle studies for a Degree of Master of Science (120 credits) in astrophysics.

Language of instruction: English

Main field of study	*Specialisation*
Physics	A1N, Second cycle, has only first-cycle course/s as entry requirements
Astrophysics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Learning outcomes

The overall aims of this course is to give the student knowledge and understanding of a number of basic concepts that are used to describe gravitationally dominated dynamic systems within astronomy (for example star clusters, galaxies and galaxy groups), and the ability to apply the concepts by analysing such systems by means of observational data.

References to aims target the intended learning outcomes in the programme syllabus of Degree of Master in Astrophysics at Lund University, as given in the list below:

Aims 1-6 target the intended learning outcomes 1a.I and 1a.II in the programme syllabus.
Aims 7, 8, 10, and 11 target the intended learning outcome 1b in the programme syllabus.
Aims 5, 9, 17 target the intended learning outcome 2 in the programme syllabus.
Aims 9 target the intended learning outcome 3.I in the programme syllabus.

Aims 13 target the intended learning outcome 3.II in the programme syllabus.
Aims 12, 15, and 16 target the intended learning outcomes 4.I in the programme syllabus.

Knowledge and understanding

On completion of the course, the student shall be able to:

1. From basic astrometric and other observational data calculate the three-dimensional positions of objects and their velocities.
2. Calculate statistical kinematic properties such as the average velocity and the velocity dispersion for a selection of objects.
3. Describe observed correlations between statistical properties and how these vary depending on the physical properties of the objects and explain the most important mechanisms behind these variations.
4. Explain and apply the principles of dynamic determination of the mass or the mass densities in a dynamic system.
5. Describe the consequences from limitations in the amount of data used and the errors in measurement data.
6. Use and interpret a Hertzsprung-Russel diagram.

Competence and skills

On completion of the course, the student shall be able to:

7. Numerically calculate orbits for particles in a given potential.
8. Use a structured programming language to implement a project in a clear and efficient manner.
9. Formulate and apply selection criteria for observational data so that these are suitable for statistical studies.
10. Carry out statistical calculations on different selections of objects.
11. Integrate ordinary differential equations numerically.
12. Present project work in written reports.
13. Conduct a defined computational project on a given time-scale.

Judgement and approach

On completion of the course, the student shall be able to:

14. Evaluate when and how to reference the work of others.
15. Give clear arguments for what constitutes a well structured scientific report.
16. Critically discuss the uncertainty in achieved results.

Course content

The course contains the following parts:

1. Newtonian gravitation and dynamics.
2. Reference systems and units.
3. Galactic coordinates.
4. Astrometry and the determination of the distance, the motion and distribution of stars.
5. The HR-diagram and the stellar colours, luminosities and ages of stars.
6. Stellar kinematics.
7. Circular motions.
8. The motion of the sun and the local velocity standard.

9. The rotation curve, differential galactic rotation and Oort's constants.
10. Force, potential, and Poisson’s equation.
11. Non-circular motion in the galactic plane.
12. The potential of the galaxy and galactic orbits.
13. Statistical description of distributions and motions.
14. The phase space, the collision free Boltzmann equation and Jeans's equations.
15. Applications of the Jeans equations to dynamical determination of masses and mass density.

Course design

The teaching consists of lectures and group work in the form of three related projects. The projects include planning and writing a computer program to analyse observational data and carry out simulations using a model. The results of the projects are discussed in groups but are presented individually in written form. Participation in group work and project work and thereto integrated teaching is compulsory.

Assessment

The examination consists of project work during the course, including a written report for each project, which in the first hand assesses intended learning outcomes 7-16 but also aspects of learning outcomes 1-6, as well as a written take home examination at the end of the course, which assesses intended learning outcomes 1-6.

Students who do not pass an assessment will be offered another opportunity for assessment soon thereafter.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Grades

Grading scale includes the grades: Fail, Pass, Pass with distinction
To pass the entire course, approved examination and passed project reports and participation in all compulsory parts are required. The final grade is determined by combining the results in the different parts of the examination, whereby the reports account for 3/4 of the final result and the written examination 1/4.

The grading of the reports is based on answering a number of questions with the simulations. The quality of the results is reflected in the grades and the scientific results must be correct - the examiner is guided by prepared solutions which are used to assess the student solutions. The solutions can be different depending on the quality of data used and must be assessed.

The grading of the take home examination is made from a series of questions with well defined answers.

The pass mark is 50% and the mark for pass with distinction is 75%.

Entry requirements

To be admitted to the course, students must have 75 credits in Physics and 45 credits in Mathematics, or a Bachelor of Science in Physics, in both cases including knowledge corresponding to FYSB24 Atomic and Molecular Physics, 7.5 credits, FYSC22 Nuclear Physics, 7.5 credits, and English 6/B.

Further information

The course may not be included in a higher education qualification together with ASTM13 Dynamical Astronomy 7.5 hp.