Cologne Courses in Astrophysics -

Module No.
Category
Credit Points (CP)
Semester

Module: Cologne Courses in Astrophysics

Module Elements:

Nr	Course	Course No.	CP	Type	Teaching hours	Semester
1	Astrophysics II (MA)	Astrophysics II	8	Lect. + ex.	4+1	WT
2	Star Formation (MA)	Star Formation	3	Lect. + ex.	2	WT
3	Galaxy Dynamics (MA)	Galaxy Dynamics	4	Lect. + ex.	2+1	WT
4	Active Galactic Nuclei (OA)	AGN	4	Lect. + ex.	2+1	ST
5	Methods of Experimental Astrophysics (OA)	MethExpAstro	4	Lect. + ex.	2+1	ST
6	The Fourier-Transform and its Applications (OA)	FTA	4	Lect. + ex.	2+1	ST

Requirements:

Preparation:

Content:

Aims/Skills:

Form of Testing and Examination:

Length of Module:

Maximum Number of Participants:

Registration Procedure:

Note:

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Astrophysics II (MA) - Astrophysics II

Course	**Astrophysics II (MA)**
Course No.	Astrophysics II

Category	Type	Language	Teaching hours	CP	Semester
Elective	Lecture with exercises	English	4+1	8	WT

Requirements:

Preparation: Astrophysics I

Form of Testing and Examination: written test

Length of Course: 1 semester

Aims of the Course: The student will gain the ability to apply fundamental concepts of physics to describe astrophysical phenomena and will obtain an overview of the experimental foundations of our knowledge about the cosmos. The courses will enable him to understand the fundamental principles of the universe and its history. The courses also give an introduction to topics of active research in astrophysics and thus prepares the students towards their own research activity within the master thesis.

Contents of the Course:

Based on the introductory course 'Astrophysics I' in the Bachelor program this course deepens the understanding in selected topical areas of relevance. These are:

Interstellar medium: molecular clouds, HII regions, photon dominated regions, shock waves, radiation processes, radiative transfer, astrochemistry

Star formation (low mass and high mass), planetary system formation

Galaxies: galactic structure, morphology, dynamics, chemical evolution, nuclei of active galaxies

Large scale structure of the universe: intergalactic distance ladder, galaxy clusters, dark matter, gravitational lenses, experimental cosmology

Recommended Literature:

Binney and Merryfield, Galactic Astronomy (Princeton University Press)

Binney and Tremaine, Galactic Dynamics (Princeton University Press)

Carroll and Ostlie, An Introduction to Modern Astrophysics (Addison-Wesley)

Schneider, Einfhrung in die extragalaktische Astronomie & Kosmologie (Springer, Berlin)

Shu, The Physics of Astrophysics I & II (University Science Books, Mill Valley)

Tielens, The Physics and Chemistry of the Interstellar Medium (Cambridge University Press)

Unsöld and Baschek, Der neue Kosmos (Springer, Berlin)

Weigert and Wendker, Astronomie und Astrophysik (VCH Verlag)

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Star Formation (MA) - Star Formation

Course	**Star Formation (MA)**
Course No.	Star Formation

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

Requirements:

Preparation: Astrophysics I (Astrophysics II recommended)

Form of Testing and Examination: Oral examination

Length of Course: 1 semester

Aims of the Course: Understanding of fundamental concepts of star formation in a variety of environments.

Contents of the Course:

The lecture introduces the basic aspects of Star Formation:

Physical Processes in the ISM, Interstellar Chemistry, ISM and Molecular Clouds, Equilibrium Configurations and Collapse, Protostars, Formation of High Mass Stars, Jets, Outflows, Disks, Pre-main sequence stars, Initial Mass Function, Structure of the Galaxy, Starburst Galaxies, Star Formation in the early Universe

Recommended Literature:

Palla and Stahler, Formation of Stars (Wiley)

Carroll and Ostlie, An Introduction to Modern Astrophysics (Addison-Wesley)

Shu, The Physics of Astrophysics I & II (University Science Books, Mill Valley)

Tielens, The Physics and Chemistry of the Interstellar Medium (Cambridge University Press)

Spitzer, Physical Processes in the Interstellar Medium (Wiley)

Unsöld and Baschek, Der neue Kosmos (Springer, Berlin)

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Galaxy Dynamics (MA) - Galaxy Dynamics

Course	**Galaxy Dynamics (MA)**
Course No.	Galaxy Dynamics

Category	Type	Language	Teaching hours	CP	Semester
Elective	Lecture with exercises	English	2+1	4	WT

Requirements:

Preparation: Astrophysics I (Astrophysics II recommended)

Form of Testing and Examination: Oral examination

Length of Course: 1 semester

Aims of the Course: Understanding of fundamental concepts of stellar and galaxy dynamics.

Contents of the Course: The lecture introduces to basic aspects of stellar and galaxy dynamics: Multiple stellar systems, dynamics of open and compact stellar clusters, elliptical, disk and barred spiral galaxies, gas kinematics, galaxy evolution in galaxy clusters, gravitational friction, violent relaxation, the Hubble fork, galaxy collisions and mergers, cosmological evolution of stellar systems.

Recommended Literature:

Binney and Merryfield, Galactic Astronomy (Princeton University Press)

Binney and Tremaine, Galactic Dynamics (Princeton University Press)

Carroll and Ostlie, An Introduction to Modern Astrophysics (Addison-Wesley)

Schneider, Einführung in die extragalaktische Astronomie & Kosmologie (Springer, Berlin)

Weigert and Wendker, Astronomie und Astrophysik (VCH Verlag)

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Active Galactic Nuclei (OA) - AGN

Course	**Active Galactic Nuclei (OA)**
Course No.	AGN

Category	**Type**	**Language**	**Teaching hours**	**CP**	**Semester**
Elective	Lecture with exercises	English	2+1	4	ST

Requirements:

Preparation: Astrophysics I (Astrophysics II recommended)

Form of Testing and Examination: Oral examination

Length of Course: 1 semester

Aims of the Course:

Understanding of fundamental concepts and physical radiation mechanisms for active galactic nuclei

Like Seyfert-galaxies, QSOs, quasars, and violently variable objects.

Contents of the Course:

The lecture introduces to basic aspects of active galactic nuclei:

Types of sources HII-galaxies, LINERs, Seyfert I, Seyfert II, QSO I , QSO II, BLLac /OVV-sources

Structure of an active nucleus: Broad line region (BLR), Narrow line region (NLR) and extended narrow line region (ionization cone).

Forbidden and permitted line transitions as density and temperature probes

Continuum emission processes: free-free and synchrotron radiation

Radio galaxies, jets and lobes as well as super luminal motion in jets.

Recommended Literature:

Binney and Merryfield, Galactic Astronomy (Princeton University Press)

Binney and Tremaine, Galactic Dynamics (Princeton University Press)

Carroll and Ostlie, An Introduction to Modern Astrophysics (Addison-Wesley)

Schneider, Einführung in die extragalaktische Astronomie & Kosmologie (Springer, Berlin)

Shu, The Physics of Astrophysics I & II (University Science Books, Mill Valley)

Tielens, The Physics and Chemistry of the Interstellar Medium (Cambridge University Press)

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Weigert and Wendker, Astronomie und Astrophysik (VCH Verlag)

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Methods of Experimental Astrophysics (OA) - MethExpAstro

Course	**Methods of Experimental Astrophysics (OA)**
Course No.	MethExpAstro

Category	**Type**	**Language**	**Teaching hours**	**CP**	**Semester**
Elective	Lecture with exercises	English	2+1	4	ST

Requirements:

Preparation: Elementary Physics (Bachelor level); Astrophysics I (and II)

Form of Testing and Examination: Exercise and written test; or oral examination

Length of Course: 1 semester

Aims of the Course: Gain insight into which type of instrumentation, based on which principles, is employed for particular astronomical and astrophysical applications; and learn about their practical and fundamental limitations in resolution and sensitivity

Contents of the Course:

- detection of radiation: direct and coherent detection
- Signal/Noise ratio: fundamental and practical limits
- principles of optical instruments: imaging
- principles of optical instruments: spectroscopy
- radio receivers: Local Oscillator, Mixer and Backend-Spectrometers
- calibration: theory and measurement startegies

Recommended Literature:

Rieke: Detection of Light

Kraus: Radioastronomy

Bracewell: The Fourier Transform and its Applications

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The Fourier-Transform and its Applications (OA) - FTA

Course	**The Fourier-Transform and its Applications (OA)**
Course No.	FTA

Category	**Type**	**Language**	**Teaching hours**	**CP**	**Semester**
Elective	Lecture with exercises	English	2+1	4	ST

Requirements:

Preparation: Elementary Physics (Bachelor level); Elementary QM

Form of Testing and Examination: Exercise and written test; or oral examination

Length of Course: 1 semester

Aims of the Course: Strengthen insight into how the mathematical principles of Fourier Theory as a common principle affect many areas of physics (optics: diffraction/interference; QM: Heisenberg principle; statistics of noise and drifts; data acquisition: sampling) and other applications (data compression, signal processing).

Contents of the Course:

- introduction to the principles of Fourier Transform mathematics
- Delta-function and more general distributions
- diffraction optics and interferometry
- uncertainty principle in QM as application of FT
- theory of noise, drifts and their statistics
- intro to wavelet analysis and data compression

Recommended Literature: Bracewell: The Fourier Transform and its Applications

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