Sommersemester 2018

Summer Term

Kommentiertes Vorlesungsverzeichnis Physik-Astronomie

Veranstaltungen des Hauptstudiums, von den Dozenten/innen kommentiert

Annotated Course Catalogue Physics-Astronomy

a list of advanced courses, with comments by the instructors

Herausgeber: Fachgruppe Physik-Astronomie April 2018

physics639 **Advanced Topics in High Energy Particle Physics**
Tu 10-12, Th 12-14, HS, HISKP

Instructor(s): Ph. Bechtle, N. Wermes

Prerequisites:
BSc Degree
physics611: Particle Physics (Master Course)
not alone sufficient: Nuclear and Particle Physics (Bachelor Course)

Contents:
see comments:
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in particular:
- CKM and PMNS flavor matrices
- mixing angles and their determination
- neutrino physics
- quark flavor physics
- matter-antimatter oscillations
- CP violation
- rare decays

Literature:
M. Thomson, Modern Particle Physics – Cambridge University Press (2013) (here: Chapter 12, 13)

V. Barger, D. Marfatia, K. Whisnant, The physics of neutrinos, Princeton University Press, 2012.

further literature will be given at the start of the lecture

Comments:
The topics in this lecture generally address particle physics beyond "physics611"
except "Collider Physics (LHC, ILC)" (although quite some of the topics are or have been done at colliders).
The focus will be on "flavor physics", i.e. lepton and quark flavors.

physics636 **Advanced Theoretical Particle Physics**
Tu 16-18, Th 10, HS I, PI

Instructor(s): M. Drees

Prerequisites:
Theoretical Particle Physics 1; some knowledge of quantum field theory is expected in some parts of the lecture.

Contents:
Neutrino oscillations and neutrino masses;
Grand Unified Theories;
Supersymmetry

Literature:
G. Ross, Grand Unified Theories, discusses both supersymmetric and non-supersymmetric GUTs.
Drees, Godbole and Roy, Theory and Phenomenology of Sparticles, gives an in-depth treatment of supersymmetry, with emphasis on phenomenological aspects.
Peskin and Schroeder, An Introduction to Quantum Field Theory, treats the underlying formalism, but also contains many particle physics applications

Comments:

physics637 **Advanced Theoretical Hadron Physics**
We 14-17, SR I, HISKP

Instructor(s): A. Nogga, A. Rusetsky

Prerequisites:
Advanced Quantum Mechanics, Quantum Field Theory 1, Theoretical Hadron Physics 1 (preferable)

Contents:

1. Notion of an effective field theory
2. Appelquist-Carrazzone theorem
3. Renormalization group, relevant/marginal/irrelevant operators
4. Matching
5. Symmetries and Ward identities; Euler-Heisenberg Lagrangian
6. Ward identities in QCD
7. Anomalies
8. Effective Chiral Lagrangian; CCWZ method
9. Wess-Zumino-Witten Lagrangian
10. Chiral Perturbation Theory at tree level: overview
11. Meson sector: loops, renormalization, LECs, power counting
12. Relativistic baryon ChPT; the breakdown of the power counting
13. HB ChPT, infrared regularization, EOMS scheme
14. Heavy quark effective theories

Literature:

1. J.F. Donoghue, E. Golowicz and B.R. Holstein, Dynamics of the Standard Model, Cambridge. University
   Press (Cambridge, 1992).
2. S. Scherer,M.R. Schindler, A Primer for Chiral Perturbation Theory, Springer (Heidelberg, 2012).
3. M.E. Peskin, D.V. Schroeder, An Introduction to Quantum Field Theory, Perseus (Reading, 1995).

Comments:

physics712 **Advanced Electronics and Signal Processing**
Tu 9, Th 10-12, HS, HISKP

Instructor(s): P.-D. Eversheim, H. Krüger

Prerequisites:
Mandatory: Electronics lab course
Recommended: Electronics for Physicists

Contents:
This lecture addresses basic concepts, techniques, and electronics necessary to identify and handle relevant events in complex data streams or detector arrays, respectively. Advantages and limits of analogue and digital electronics will be explained and can be experienced by means of three major topics.

1. Hands on experiment at the Bonn Isochronous Cyclotron: Set up electronics to identify whether an ejectile was a Proton, Deuteron, 3He or α particle. Set up electronics to discriminate Neutrons from Gammas by pulse shape.
2. Understand the potential of Digital Signal Processors (DSP). The hard- and software aspects are discussed and demonstrated by means of an experimental DSP-board. The demonstrations will focus on digital signal conditioning and filtering.
3. Hands on course in Field Programmable Gate Array (FPGA) programming.

Literature:

Comments:
The experiments at the Bonn Isochronous Cyclotron will take place on 4 afternoons

physics713 **Particle Detectors and Instrumentation**
Tu 14-16, We 14, Konferenzraum II, PI 1.049, PI

Instructor(s): H. Schmieden, T.C. Jude

Prerequisites:
Completed B.Sc. in Physics, with experience in quantum mechanics, atomic- and nuclear physics

Contents:
Quark structure of mesons and baryons, nucleon excitation; electromagnetic probes, electron accelerators, photon beams, relativistic kinematics, interaction of radiation with matter, detectors for photons, leptons and hadrons;
Main issue is the hands-on laboratory course: setup of detectors and experiment at ELSA, and a real experiment will be performed to observe excited states of the proton through meson production with high-energetic photon beams.

Literature:
B. Povh, K. Rith, C. Scholz, F. Zetsche; Teilchen und Kerne (Springer, Heidelberg 6. Aufl. 2004)
Perkins; Introduction to High Energy Physics (Cambridge University Press 4. Aufl. 2000)
W. R. Leo; Techniques for Nuclear and Particle Detection (Springer, Heidelberg 2. Ed. 1994)
K. Kleinknecht; Detektoren für Teilchenstrahlung (Teubner, Wiesbaden 4. überarb. Aufl. 2005)

Comments:

physics716 **Statistical Methods of Data Analysis**
Fr 10-12, HS, IAP

Instructor(s): J. Dingfelder

Prerequisites:
Some prior basic knowledge of particle physics would be helpful, but is not absolutely necessary.

Contents:
From the first lab course that you take to the design and construction of an experiment; from the first simulations to the final analysis of the data from our experiment, the proper application of statistical methods is essential.

The aim of this course is to provide a foundation in statistical methods and to give some concrete examples of how the methods are applied to data analysis. Standard statistical distributions will be discussed and examples given of when they are expected to occur and how they are related.

Techniques for fitting data will be discussed. The treatment of systematic errors, as well as methods to combine results from different experiments which may have common error sources will also be covered.

The search for new physics, even when no signal is observed, allows limits to be placed on the size of possible effects. These can provide severe constraints on theoretical models. Methods for calculating upper
limits taking into account several error sources will also be considered.

Literature:
R. J. Barlow: Statistics
V. Blobel and E. Lohrmann: Statistische und numerische Methoden der Datenanalyse
F. James: Statistical methods in experimental physics
Glen Cowan: Statistical Data Analysis

Comments:

physics718 **Programming in Physics and Astronomy with C++ or Python**

Instructor(s): T. Erben, O. Cordes

Prerequisites:
The course does not require prior programming knowledge. Basic knowledge on Unix/Linux is beneficial.

Contents:
The Python-version of the course is offered in SS2018
- A thorough introduction to scientific computing with the easy-to-learn, high-level programming language Python
- Introduction to numpy-arrays (primary Python-data structure for scientific computing)
- Introduction to the scientific-python modules (scipy)
- Interactive work / development with Python
- Plotting and visualization of scientific data with python (the matplotlib module)
- Version control / collaborative software development

Literature:
All required course materials will be made available online

Comments:

1. The lectures are hands-on with every student working on an own computer in the CIP-Pools of the Physics and Astronomy departments
2. The course is offered two times:
   [listu]
   [li] Wed., 13:00 - 16:00 (astronomy department by Thomas Erben)
3. Fr., 08:00 - 11:00 (physics department by Oliver Cordes)

[/li]
[li] Prior registration for the course is necessary (limited number of computers in the CIP-Pools)[/li]
[/listo]

physics721 **BCGS Intensive Week (Advanced Topics in Hadron Physics) Hadron Physics Summer School (HPSS 2018), September 24th-28th 2018, JUFA Jülich**

Instructor(s): C. Hanhart, B. Kubis, A. Nogga, A. Thiel, A. Wirzba et al.

Prerequisites:
The school aims at advanced undergraduate and graduate students in the field of hadron physics or accelerator physics.

Contents:
The school comprises lectures and working groups (from which each participant joins one) on theoretical, experimental, and accelerator aspects. The focus is on current issues in hadron physics with emphasis on current and future programs at the accelerators COSY (Jülich), ELSA (Bonn), LHC (CERN), CEBAF (Jefferson Lab), BEPC (Beijing) and FAIR (Darmstadt) featuring experiments like PANDA, Crystal Barrel, LHCb, CLAS, BESIII, Belle II as well as the search for electric dipole moments of charged particles in storage rings (JEDI) and neutrino physics.

Literature:

Comments:
Registration deadline is May 15, 2018. The registration form is available on the webpage.

physics722 **Advanced Gaseous Detectors - Theory and Practice**
Mo 10-12, HS, IAP, Fr 12, SR I, HISKP

Instructor(s): K. Desch, J. Kaminski

Prerequisites:

Contents:
You will acquire detailed knowledge about the physics of gaseous detectors.
The theory of the important processes will be discusses in lectures and the knowledge will be deepened by simulations in the exercises. There will also be lab work, e.g. assembling a detector, which will be used for basic measurements.

Literature:

1. Blum, Rolandi, Riegeler, Particle Detection with Drift chambers, Springer
2. Kolanoski, Wermes, Teilchendetektoren, Springer
3. F. Sauli, Gaseous Radiation Detectors, Cambridge University Press

Comments:

physics740 **Hands-on Seminar: Experimental Optics and Atomic Physics**
Mo 9-11, IAP

Dozent(en): M. Weitz u.M.

Erforderliche Vorkenntnisse:
Optik- und Atomphysik Grundvorlesungen, Quantenmechanik

Inhalt:
Diodenlaser
Optische Resonatoren
Akustooptische Modulatoren
Spektroskopie
Radiofrequenztechnik
Spannungsdoppelbrechung
und vieles mehr

Literatur:
wird gestellt

Bemerkungen:
Vorbesprechung am Montag, den 9.4.18, 9 c.t.,
Hörsaal IAP, 3. Stock Wegelerstr. 8

Seminartermine ab 16.4.18

physics754 **General Relativity and Cosmology**
Mo 10-12, We 11, HS, HISKP

Instructor(s): B. Metsch

Prerequisites:
physik221 and physik321 (Theoretical Physics I and II)
optional: some differential geometry

Contents:
Relativity principle;
Gravitation in relativistic mechanics;
Curvilineal coordinates;
Curvature and energy-momentum tensor;
Einstein-Hilbert action and the equations of the gravitational field;
Black holes;
Gravitational waves;
Time evolution of the universe;
Friedmann-Robertson-Walker solutions.

Literature:
[1] L.D. Landau, J.M. Lifschitz: Lehrbuch der theoretischen Physik (Band 2) Klassische Feldtheorie, Harri Deutsch, ISBN 3817113277 (also available in English: Classical Field Theory);
[2] C.W. Misner, K.S. Thorne, J.A. Wheeler: Gravitation, W.H. Freeman, ISBN 0-7167-0344-0;
[3] B.F. Schutz: A first course in general relativity, Cambridge University Press, ISBN 0-521-27703-5;
[4] S. Weinberg: Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity, John Wiley, ISBN 0-471-92567-5;

Comments:

physics773 **Physics in Medicine: Fundamentals of Medical Imaging**
Mo 10-12, We 12, SR I, HISKP

Instructor(s): K. Lehnertz

Prerequisites:
BSc

Contents:
Introduction to physical imaging methods and medical imaging
(1) Physical fundamentals of transmission computer tomography (Röntgen-CT), positron emission computer´tomography (PET), magnetic resonance imaging (MRI) and functional MRI
(1a) detectors, instrumentation, data acquisition, tracer, image reconstruction, BOLD effect
(1b) applications: analysis of structure and function
(2) Neuromagnetic (MEG) and Neuroelectrical (EEG) Imaging
(2a) Basics of neuroelectromagnetic activity, source models
(2b) instrumentation, detectors, SQUIDs
(2c) signal analysis, source imaging, inverse problems, applications

Literature:
1. H. Morneburg (Hrsg.): Bildgebende Systeme für die medizinische Diagnostik, Siemens, 3. Aufl.
2. P. Bösiger: Kernspin-Tomographie für die medizinische Diagnostik, Teubner
3. Ed. S. Webb: The Physics of Medical Imaging, Adam Hilger, Bristol
4. O. Dössel: Bildgebende Verfahren in der Medizin, Springer, 2000
5. W. Buckel: Supraleitung, VCH Weinheim, 1993
6. E. Niedermeyer/F.H. Lopes da Silva; Electroencephalography, Urban & Schwarzenberg, 1998
More literature will be offered

Comments:

physics7502 **Random Walks and Diffusion**
Do 14-18, SR II, HISKP
Beginn: Anfang Juni

Instructor(s): G. Schütz

Prerequisites:
Quantum Mechanics, Thermodynamics

Contents:
Probability spaces, Master equation and Langevin equation, Law of large numbers and Central Limit Theorem, Dynamical scaling, First passage problems, Dynamical scaling.

Literature:
N.G. van Kampen, Stochastic Processes in Physics and Chemistry (Elsevier, Amsterdam, 1992).

G.M. Sch\"utz, in: Phase Transitions and Critical Phenomena,
Vol. 19, eds. C. Domb and J.L. Lebowitz, (Academic Press, London, 2001).

Comments:
Start: 07/06/2018; Two hours of lecture (14:15 - 15:45), followed by two hours of exercise classes.

physics651 **Seminar on Detectors in Nuclear and Particle Physics**
Mo 16 s.t. -18, SR I, HISKP
Please Note: First seminar will take place on April 16 (discussion of topics and assignment of speakers)

Instructor(s): I. Brock, K. Desch, J. Dingfelder, B. Ketzer, F. Klein, N. Wermes

Prerequisites:
BSc in physics, introduction to nuclear and particle physics (Physik 5)
Useful: Lecture on Physics of Particle Detectors

Contents:
The seminar will discuss the fundamentals and techniques of particle detection (tracking, particle identification, calorimetry, ...) in nuclear and particle physics using modern detectors/experiments and developments of new detector techniques as examples.

Literature:
W.R. Leo Techniques for Nuclear and Particle Physics Experiments
K. Kleinknecht Detektoren für Teilchenstrahlung
D. Green The Physics of Particle Detectors
G. Knoll Radiation Detection and Measurement
Special literature will be provided by the tutors of the individual contributions.

Comments:
The seminar is a joint seminar between the universities of Bonn and Cologne within the Bonn-Cologne Graduate School and is open to all students.
The seminar will take place in Bonn (HISKP SR I).

The first seminar will take place on April 16 (discussion of topics and assignment of speakers)

physics652 **Seminar on Quantum Technology**
Mo 14-16, HS, IAP

Instructor(s): D. Meschede

Prerequisites:
Lectures on Quantum Physics (basic, advanced)
Lectures on Modern Atomic and Optical Physics

Contents:
We will select topics on the following general subjects:

Quantum Sensing
Quantum Communication
Quantum Simulation
Quantum Computing

Literature:
Overview:
Michael Raymer: Quantum Physics What Everyone Needs to Know
Oxford University Press

European Commission

Comments:
We expect a preparation (and maturation) period of at least 6 weeks. It is thus advisable to select and start your topic as early as possible.

physics656 **Seminar Medical Physics: Physical Fundamentals of Medical Imaging**
Mo 14-16, SR I, HISKP

Instructor(s): K. Lehnertz

Prerequisites:
Bsc

Contents:
Physical Imaging Methods and Medical Imaging of Brain Functions
Emission Computer Tomography (PET)
- basics
- tracer imaging
- functional imaging with PET
Magnetic Resonance Imaging (MRI)
- basics
- functional MRI
- diffusion tensor imaging
- tracer imaging
Biological Signals: Bioelectricity, Biomagnetism
- basics
- recordings (EEG/MEG)
- SQUIDs
- source models
- inverse problems

Literature:
1. O. Dössel: Bildgebende Verfahren in der Medizin, Springer, 2000
2. H. Morneburg (Hrsg.): Bildgebende Systeme für die medizinische Diagnostik, Siemens, 3. Aufl.
3. H. J. Maurer / E. Zieler (Hrsg.): Physik der bildgebenden Verfahren in der Medizin, Springer
4. P. Bösiger: Kernspin-Tomographie für die medizinische Diagnostik, Teubner
5. Ed. S. Webb: The Physics of Medical Imaging, Adam

Comments:
Time: Mo 14 - 16 and one lecture to be arranged

6820 **Research Internship / Praktikum in der Arbeitsgruppe**
Setup and test of detector components and MC simulations for the COMPASS@CERN and BGO-OD@ELSA experiments. Data analysis using ROOT
pr., ganztägig, Dauer ca. 2-4 Wochen, Zeit n.V., PI

Instructor(s): H. Schmieden

Prerequisites:
Physik V (Nuclear and Particle Physics) or equivalent

Contents:
Setup and test of detector components and Monte Carlo simulations for the COMPASS@CERN and BGO-OD@ELSA experiments. Data analysis using ROOT.

Literature:

Comments:
Duration 2 – 4 weeks (part time), by individual agreement

6826 **Praktikum in der Arbeitsgruppe: Neurophysik, Computational Physics, Zeitreihenanalyse**
pr, ganztägig, ca. 4 Wochen, n. Vereinb., HISKP u. Klinik für Epileptologie

Instructor(s): K. Lehnertz u.M.

Prerequisites:
basics of programming language

Contents:
This laboratory course provides insight into the current research activities of the Neurophysics group.
Introduction to time series analysis techniques, neuronal modelling, complex networks.
Opportunity for original research on a topic of own choice, with concluding presentation to the group.

Literature:
Working materials will be provided.

Comments:
Contact:
Prof. Dr. K. Lehnertz
email: klaus.lehnertz@ukb.uni-bonn.de

6834 **Praktikum in der Arbeitsgruppe: Vorbereitung und Durchführung optischer und atomphysikalischer Experimente, Mitwirkung an Forschungsprojekten der Arbeitsgruppe / Laboratory in the Research Group: Preparation and conduction of optical and atomic physics experiments, Participation at research projects of the group (D/E)**
pr, ganztägig, 2-6 Wochen n. Vereinb., IAP

Dozent(en): M. Weitz u.M.

Erforderliche Vorkenntnisse:
Optik und Atomphysik Grundvorlesungen, Quantenmechanik

Inhalt:
Studenten soll frühzeitig die Möglichkeit geboten werden, an aktuellen Forschungsthemen aus dem Bereich der experimentellen Quantenoptik mitzuarbeiten: Ultrakalte atomare Gase, Bose-Einstein-Kondensation, kollektive photonische Quanteneffekte. Die genaue Themenstellung des Praktikums erfolgt nach Absprache.

Literatur:
wird gestellt

Bemerkungen:
Homepage der Arbeitsgruppe:

https://www.qo.uni-bonn.de/

6838 **Praktische Übungen zur Bildgebung und Bildverarbeitung in der Medizin**
pr, Kliniken Venusberg
(Teilnahme am Seminar "Medizinische Physik" erforderlich)

Instructor(s): K. Lehnertz, C. Berg, P. David, F. Träber, P. Trautner

Prerequisites:

Contents:
Continuation of topics addressed in the seminar; examples of medical imaging in prenatal diagnosis, radiology, and neurosciences.

Literature:

Comments:
Dates to be arranged during the semester.

astro821 **Astrophysics of galaxies**
Th 15:00-18, Raum 0.012, AIfA
Exercises: 1 hr. by appointment

Instructor(s): P. Kroupa

Prerequisites:
see web page

Contents:
see web page

Literature:
see web page

Comments:
see web page

astro822 **Physics of the interstellar medium**
Mo 11:15-12:30, Tu 15-16:15, Raum 0.012, AIfA
Exercises: 1 hr. by appointment

Instructor(s): F. Bertoldi

Prerequisites:
None

Contents:
Constitutens of the interstellar medium, physical processes, radiative transfer, recombination, HI 21cm line,
absorption lines, Stroemgren spheres, HII regions, interstellar dust, molecular gas and clouds, shocks, photodissociation regions, energy balance, the multi-phase ISM, gravitational stability and star formation.

Literature:
B. Draine "Physics of the Interstellar and Intergalactic Medium" (Princeton Univ. Press 2010 ~49EUR - can be
found in library!)
J. Lequeux "The Interstellar Medium" (Springer 2005 ~90EUR)

Additional or supplementary:
A.G.G.M. Tielens "The Physics and Chemistry of the Interstellar Medium" (Cambridge 2006 ~34/76EUR)
D.E. Osterbrock "Astrophysics of Gaseous Nebulae and Active Galactic Nuclei" (2nd Ed; Palgrave MacMillian
2005 ~71EUR)
Rybicki & Lightman "Radiative Processes in Astrophysics"
"Tools of Radio Astronomy"

Comments:
The student shall acquire a good understanding of the physics and of the phases of the ISM. The importance
for star formation and the effects on the structure and evolution of galaxies is discussed. Observing techniques in the various wavelength domains (radio astronomy, infrared, optical, UV, X-Rays) will be discussed.

astro8402 **X-ray astronomy**
Fr 13-15, Raum 0.012, AIfA
Exercises: 1 hr. by appointment

Instructor(s): T. Reiprich

Prerequisites:
Introductory astronomy course.

Contents:
X-rays are emitted from regions where the Universe is hot and wild. The lecture will provide an overview of modern X-ray observations of all major X-ray sources. This includes, e.g., comets and planets in our solar system; Galactic systems like extrasolar planets, cool and hot stars, remnants of exploded stars, isolated white dwarfs and neutron stars, cataclysmic variables, close binaries with neutron stars and black holes, hot interstellar medium, and the Galactic center region; extragalactic X-ray sources like spiral and elliptical galaxies, galaxy clusters, intergalactic medium, and active galactic nuclei, i.e., supermassive black holes lurking in the centres of galaxies. The X-ray emission and absorption processes as well as current and future space-based instruments used to carry out such observations will be described. In the accompanying lab sessions, the participants will learn how to download, reduce, and analyze professional X-ray data from a satellite observatory.

Literature:
A script of the lecture notes will be provided.

Comments:

astro8404 **Radiointerferometry: Methods and Science**
We 10-13, Raum 0.006, AIfA

Instructor(s): F. Bertoldi, M. Kramer, B. Magnelli, R. Mauersberger, S. Mühle

Prerequisites:
Basic knowledge of radioastronomy

Contents:
The Master-level course "Radio Interferometry: Methods and Science" offers hands-on training in the data reduction and analysis of interferometric data for Master students, PhD students and senior astronomers. The course starts with a brief review of the basic concepts of radio interferometry including calibration and imaging. Then the various steps necessary to create fully calibrated data cubes from interferometric raw data are discussed. Already during the lectures, the participants can practice the individual steps on their copy of an ALMA data set, using two powerful compute servers and the versatile Common Astronomy Software Applications (CASA) package. In the final sessions, the participants learn how to analyze their interferometric data and what additional considerations are required for special research topics like polarization studies.

Literature:

Comments:
If you are a Master student at the university of Bonn or Cologne, you can take this course for credit, obtaining 4 CP. Following the hands-on approach of the course, the coursework relevant for the final grade consists of assignments related to the data reduction and analysis of a small interferometric dataset, followed by a presentation (Referat, 15 min length) and a short paper summarizing the data reduction and the analysis (5-12 A4 pages). It is expected that "for credit" students attend all the lectures/tutorials and register for the exam on Basis before the deadline.

The lectures start on 11 April 2018. We will create the computer accounts needed for the hands-on parts of the course. We will also use it to circulate updates, material and other information related to the course. If you can't attend on 11 April, but are interested in participating in the course, please contact us before Friday, 13 April 2018.

astro847 **Optical Observations**
Fr 11-13, Raum 0.012, AIfA
Exercises: 1 hr. by appointment

Instructor(s): H. Hildebrandt, T. Schrabback

Prerequisites:
Astronomy introduction classes

Contents:
Optical CCD and near infrared imaging, conducting and planning observing runs, detectors, data reduction, catalogue handling, astrometry, coordinate systems, photometry, spectroscopy, photometric redshifts, basic weak lensing data analysis, current surveys, ground-based data versus Hubble Space Telescope observations, how to write observing proposals.

Practical experience is gained by obtaining and analysing multi-filter CCD imaging observations of galaxy clusters using the 50cm telescope on the AIfA rooftop, as well as the analysis of professional data from the archive.

Literature:
Provided upon registration.

Comments:
The class has a strong focus on hands-on observations and data analysis. It should be particularly useful for students who consider conducting a master's thesis project which involves the analysis of optical imaging data from professional telescopes (e.g. wide-field imaging data or Hubble Space Telescope observations).

astro849 **Multiwavelength observations of galaxy clusters**
Mo 15.30-17, Raum 0.008, AIfA
Exercises: 1 hr. by appointment

Instructor(s): T. Reiprich

Prerequisites:
Introductory astronomy course.

Contents:
Aims of the course:
To introduce the students into the largest clearly defined structures in the Universe, clusters of galaxies. In modern astronomy, it has been realized that a full understanding of objects cannot be achieved by looking at just one waveband. Different phenomena become apparent only in certain wavebands, e.g., the most massive visible component of galaxy clusters -- the intracluster gas -- cannot be detected with optical telescopes. Moreover, some phenomena, e.g., radio outbursts from supermassive black holes, influence others like the X-ray emission from the intracluster gas. In this course, the students will acquire a synoptic, multiwavelength view of galaxy groups and galaxy clusters.
Contents of the course:
The lecture covers galaxy cluster observations from all wavebands, radio through gamma-ray, and provides a comprehensive overview of the physical mechanisms at work. Specifically, the following topics will be covered: galaxies and their evolution, physics and chemistry of the hot intracluster gas, relativistic gas, active supermassive black holes, cluster weighing methods, Sunyaev-Zeldovich effect, gravitational lensing, radio halos and relics, tailed radio galaxies, and the most energetic events in the Universe since the big bang: cluster mergers.

Literature:
Lecture script and references therein.

Comments:

astro851 **Stellar and solar coronae**
Th 13-15:15, Raum 0.01, MPIfR
Exercises: 1 hr. by appointment

Instructor(s): M. Massi

Prerequisites:

Contents:

T Tauri (young stellar systems not yet in Main Sequence) and RS CVn systems (evolved stellar systems that already left the Main Sequence), although very diverse systems, have similar flare activities observed at radio and X-ray wavelengths.

The flares in both systems are several orders of magnitude stronger than those of the Sun. The origin of this activity, defined "coronal activity", depends on the convective zone, the rotation, the formation and dissipation of magnetic fields. In general terms: This is a mechanism of the same type as on the Sun, but enforced by the binary nature of these systems.

In these lectures we will explore a link between the amplification of initial magnetic fields by dynamo action in several rotating systems (Sun, binary systems and accretion discs around black holes) and the release of magnetic energy into a corona where particles are accelerated.

Together with the basic theory there will be as well illustrated the latest progress in the research on stellar coronal emission derived from recent space missions and high-resolution radio observations.

Literature:
The Solar Corona.
Golub and Pasachoff

Comments:

6952 **Seminar on theoretical dynamics**
Fr 14-16, Raum 3.010, AIfA

Instructor(s): P. Kroupa

Prerequisites:
see web page

Contents:
see web page

Literature:
see web page

Comments:
see web page

6953 **Seminar on stellar systems: star clusters and dwarf galxies**
Tu 16:15-17:45, Raum 3.010, AIfA

Instructor(s): P. Kroupa, J. Pflamm-Altenburg

Prerequisites:
see web page

Contents:
see web page

Literature:
see web page

Comments:
see web page

6954 **Seminar on galaxy clusters**
Th 15-17, Raum 0.006, AIfA

Instructor(s): T. Reiprich

Prerequisites:
Introductory astronomy course.

Contents:
The students will report about up to date research work on galaxy clusters based on scientific papers.

Literature:
Will be provided.

Comments: