Sommersemester 2021

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 2021

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

Instructor(s): I. Brock

Prerequisites:
BSc Degree
physics611: Particle Physics (Master Course)

Contents:
The emphasis will be on quark flavour physics and neutrinos.
- Properties of the CKM and neutrino mixing matrices
- CKM and P-MNS mixing angles and their determination
- Oscillations in flavour and neutrino physics
- CP violation
- Neutrino oscillations and neutrino properties

Literature:
M. Thomson, Modern Particle Physics – Cambridge University Press (2013)
V. Barger, D. Marfatia, K. Whisnant, The physics of neutrinos, Princeton University Press, 2012.
Further literature will be given and made available 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 "flavour physics", i.e. lepton and quark flavours and oscillations between them.

physics636 **Advanced Theoretical Particle Physics**
Mo 12-14, We 13, 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:

physics641 **Photonics**
Tu 14-16, Th 12-14, HS, IAP

Instructor(s): D. Meschede

Prerequisites:
Optics, Atomic Physics, Quantum Mechanics

Contents:
- Propagation of Laser Beams, Resonators
- Optical Components
- Light Matter Interaction
- Principles of Lasers, Laser Systems
- Applications of Lasers
- Frequency Doubling, Sum and Difference Frequency Generation
- Parametric Processes, Four Wave Mixing

Literature:
- P. Miloni, J. Eberly; Lasers (Wiley, New York, 1988)
- D. Meschede; Optics, Light and Lasers (Wiley, Wiesbaden, 2017)
- F. K. Kneubühl; Laser (Teubner, Wiesbaden, 2005)
- J. Eichler, H.J. Eichler; Laser (Springer, Heidelberg, 2003)
- R. Boyd; Nonlinear Optics (Academic Press, Boston, 2003)
- Y.-R. Shen; The principles of nonlinear optics (Wiley, New York, 1984)

Comments:
The Lecture is suitable for BSc Students beginning with the 5. Semester and for Master-Students.

physics718 **Programming in Physics and Astronomy with C++ or Python**
We 8-10, HS, IAP

Instructor(s): E. von Törne

Prerequisites:
Knowledge of basic programming language constructs like "for loops" or "if clauses" is highly beneficial.

Contents:
This course introduces to python with an emphasis on machine learning in high energy physics
- basics of python
- object oriented programming
- data analysis with numpy and pandas
- the scipy library
- machine learning and multivariate analysis
- keras and tensorflow
- applications in high energy physics
- modern software development

Literature:
All course materials on ecampus
Any python text book for background information.
"Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurelien Geron

Comments:
Registration on ECampus and Basis is required.
Lectures Wednesday 8-10 via zoom.
Exercises 2hrs biweekly. Several exercise classes offered via zoom.
Exercise times will be determined first week of class.
Students are required to have a computer/laptop with either lunix, windows10 or macOS. Limited number of rental laptops also available.

physics719 **BCGS intensive week HEP**
block course in September 2021

Instructor(s): I. Gregor

Prerequisites:
Basic knowledge of particle physics at the bachelor or master level is assumed. Some programming knowledge (C or C++) would also be very useful but is not mandatory.

Contents:
This course will be of interest for students beyond their bachelor, students who start their master project soon, and Ph.D. students from other fields of physics who wish to broaden their horizon. We will discuss particle detectors as mostly used in particle physics with focus on silicon tracking detectors. A pixel telescope is a broadly used tool to investigate newly developed particle detectors at test beams such as ELSA, DESY or CERN. The course is a combination of lectures on the main topic and practical hand-on studies around a pixel telescope will be performed. These include lab tests with a CMOS sensor, data analysis of data taken at the CERN test beam with a pixel telescope, and simulations of tracks in a pixel telescope. An overview of important parameters for detector testing will be given and some of them studied in laboratory tests. The week is scheduled for 13.-16.9.2021

While following these lines, particular emphasis is given to

- Overview on detectors for particle physics
- Passage of particles through matter
- Basics on tracking detectors with focus on  semi-conductor detectors
- Reconstruction of hits
- Important parameters for detector testing and  how to measure those
- Radiation damage effects
- Simulation of tracks
- Taking data with a pixel telescope (electrons at DESY test beam)
- Test beam data analysis

Of course, not all topics can be addressed to depth within one week. Thus, an effort is made that students will receive an overview and understand the most important concepts. The course is an all-week seminar starting on Monday morning of the selected week. In case the Corona situation does not allow an in-person lab course, an all-online version of the course will be offered. We developed tasks which can be done in small teams (using breakout rooms in Zoom) working on virtual boxes. Real test beam data will be analyses as well as systems simulated using MonteCarlo simulation tools.

Registration: To take part please register on eCampus: before August 31, 2021.
Receiving credit points
Students who wish to receive course credits (3 credit points) also need to register on BASIS! Registrations opens on April 15th until end of August 31st 2021.

Form of Testing and Examination: Written reports on the lab results. Students who would like to obtain course credit for the intensive week will be asked to write a report on the results of the lab course and submit a week after. Please contact gregor"at"physik.uni-bonn.de if you have any questions. The course can also be taken without course credit.

In case the Corona situation does not allow an in-person course in the Physikalisches Institut in Bonn, an all-online course will be offered.

Literature:
Will be provided.

Comments:
The course is an all-day workshop in the lecture free time: one week in September, date still to be defined.

The Intensive Week will have lectures in the morning and hands-on exercises in the afternoon.

physics722 **Advanced Gaseous Detectors - Theory and Practice**
Mo 12-14, HS, HISKP, We 14-16, SR II, HISKP

Instructor(s): J. Kaminski, B. Ketzer, M. Lupberger

Prerequisites:
Recommended: physics618 Physics of Particle Detectors

Contents:
The aim of this course is twofold: In online lectures the work principle and the physics of gaseous detectors will be reviewed in detail and the formulae will be derived. Also different gaseous detectors as well as the readout electronics and applications in large (LHC) experiments will be discussed. I addition the exercise will serve to familiarize the students with designing and operating a gaseous detector. For this design software, simulations software and lab work will be introduced as part of the course.

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
4. F. Sauli, Micro-Pattern Gaseous Detectors, World Scientific Publishing

Comments:
Because of the continuation of the pandemic the lectures will be given online. The exercises will also be online initially, but if the situation allows, practical lab work in small groups is envisioned for the end of the semester.
For the exercises basic knowledge of C++ is recommended.

physics739 **Lecture on Advanced Topics in Photonics: Nanophotonics**
Tu 8-10, HS, IAP

Instructor(s): S. Linden

Prerequisites:
Basic knowledge in optics, electrodynamics, and quantum mechanics.

Contents:
Nanophotonics - Small is beautiful

1.) Introduction
2.) A brief recap of electromagnetic fields and waves
3.) Elements of solid state optics
4.) Photonic crystals
5.) Plasmonics
5.) Matematerials and metasurfaces
6.) Optical antennas
7.) Near-field microscopy

Literature:
Lecture notes will be available on the ecampus site of the course.

Comments:
Nanophotonics focuses on the interaction of light with nanostructured materials.
The goal of the course is to introduce the students to the principles of nanophotonics and to give an overview of the current state of the art.

physics740 **Hands-on Seminar: Experimental Optics and Atomic Physics**

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 12.4.2021, um 9 c.t.,

Die Vorbesprechung findet Online per Zoom statt, wobei Zugangsdaten auf ecampus zu finden werden sind.

Seminartermine ab 26.4.2021

Das Seminar ist eine Präsenzveranstaltung und setzt damit die Möglichkeit voraus dass entsprechernder Laborbetrieb stattfinden kann.

physics754 **General Relativity and Cosmology**
Mo 16-18, We 12, HS I, PI

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:

physics7505 **High performance computing: Modern computer architectures and applications in the physical science**
Fr 12-14, HS, IAP

Instructor(s): S. Krieg, E. Suarez

Prerequisites:
Knowledge of a modern programming language like C/C++

Contents:

- Computer architectures and system components (CPU, memory, network)
- Software environment
- Parallel architectures and parallel programming paradigms (MPI, OpenMP/threads)
- High Performance Computing

Literature:

- John L. Hennessy, David A. Patterson: Computer Architecture - A Quantitative Approach. Morgan Kaufmann Publishers, 2012
- David A. Patterson, John L. Hennessy: Computer Organization and Design - The Hardware / Software Interface. Morgan Kaufmann Publishers, 2013
- W.H. Press et al.: Numerical Recipes in C (Cambridge University Press)
- Message Passing Interface Forum: MPI: A Message-Passing Interface Standard, Version 3.1
- OpenMP Application Programming Interface, Version 4.5, November 2015

Comments:
Oral examination

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:
Beginning April 12, 2021

physics651 **BCGS Seminar on Detectors in Nuclear and Particle Physics**
Mo 16-18, SR I, HISKP

Instructor(s): 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.

The seminar will pursue a special topic as a connecting red line through the student talks.

Literature:
H. Kolanoski, N. Wermes, Particle Detectors, Fundamentals and Applications, 2020
G. Knoll Radiation Detection and Measurement
W.R. Leo Techniques for Nuclear and Particle Physics Experiments
H. Kolanoski, N. Wermes, Teilchendetektoren, 2016
K. Kleinknecht Detektoren für Teilchenstrahlung
D. Green The Physics of Particle Detectors
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 virtually.

The first seminar will take place on April 12, 16h c.t. (discussion of topics and assignment of speakers)

physics652 **Seminar on Quantum Physics**
Fr 10-12, HS, IAP

Instructor(s): S. Stellmer, S. Neubert

Prerequisites:
Courses for the Bachelor of Science in Physics

Contents:
From quantum optics to high-energy physics: bridging 30 orders of magnitude in energy scale

Historically, atomic physics and chemistry were associated with the low energy scale of about 1 eV, nuclear physics explored the intermediate regime of keV to MeV, and particle physics represented the high-energy of up to the TeV scale. Since a few years, this hierarchical order has dissolved completely: Laser spectroscopy of molecules allows to exclude hypothetical particles at the 30 GeV scale, plasmas at 10 million Kelvin are used for precision spectroscopy, and the kinetics of neutron stars test General Relativity. Various platforms, reaching all the way from optical clocks to the cosmic microwave background, hunt for signs of physics beyond the standard model.

In this seminar, we will discuss a selection of contemporary experiments that bridge across the previously well-separated areas of physics, spanning almost 30 orders of magnitude between the atto-eV resolution of optical clocks to large particle accelerators of 10 GeV energy.

Literature:
The seminar will be based on original articles.

Comments:

physics653 **Seminar on Current Issues in Theoretical Hadron Physics**
Mo 14-16, SR II, HISKP

Instructor(s): C. Hanhart, T. Luu, A. Nogga, D. Rönchen

Prerequisites:
Advanced Quantum Mechanics necessary,
Theoretical Hadron Physics and Quantum Field Theory helpful for some topics

Contents:
This seminar will cover different topics, which are currently of interest in the field of hadron physics. These
topics will - among others - include:
- Hadrons beyond the Quark Model
- Many body physics
- Resonances in lattice gauge theory
- Baryon spectroscopy - Excited states of protons and neutrons

Literature:
Will be provided during the seminar.

Comments:

physics655 **Seminar Public Presentation of Science: Atmospheric and Climate Physics**
Th 9-11

Instructor(s): H. Dreiner

Prerequisites:

Contents:
Introduction to atmospheric and climate physics

Literature:
D. Andrews: An Introduction to Atmospheric Physics
J. Marshall and R. Plumb: Atmosphere, Ocean and Climate Dynamics
W. Ruddiman: Earth's Climate; Past and Future

Comments:

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

Preliminary discussion on Monday April 19, 2021, 2 pm

6816 **Praktikum in der Arbeitsgruppe: Theorie der kondensierten Materie und Vielteilchen-Physik**
http://www.kroha.uni-bonn.de
für Studierende im Bachelor-Studiengang,
pr, ganztägig, Dauer nach Vereinb., PI

Instructor(s): J. Kroha

Prerequisites:
Grundvorlesungen in theoretischer Physik, insbesondere
Theoretische Physik III: Quantenmechanik (physik421)
Theoretische Physik IV: Statistische Physik (physik521).
Advanced Quantum Theory (physics606) vorteilhaft
Theoretical Condensed Matter Physics (phyics 617) vorteilhaft.

Contents:
Kleinere Projekte im Zusammenhang mit der in der Forschungsgruppe laufenden Forschung. Sowohl analytische als auch numerische Arbeiten. Die Studierenden sollen frühzeitig an die aktuelle Forschung in der theoretischen Quanten- und Vielteilchenphysik herangeführt werden.

Literature:
Wird nach Vereinbarung gestellt.

Comments:
Homepage der Gruppe: https://www.kroha.uni-bonn.de/

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@ukbonn.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/

6835 **Special Topics in Quantum Field Theory: Anomalies and their consequences**
Blockvorlesung: 31.05. bis 02.06.2021

Instructor(s): E. Kraus

Prerequisites:
Quantum field theory (physics 755)
Basics of quantization of gauge theories

Contents:
The anomaly of the axial current
Nonrenormalization of the anomaly
Anomalies in gauge theories: Nonrenormalizabiliy and symmetries

Literature:
N. N. Bogoliubov, D.V. Shirkov; Introduction to the theory of quantized fields (J. Wiley & Sons 1959)
M. Kaku, Quantum Field Theory (Oxford University Press 1993)
M. E. Peskin, D.V. Schroeder; An Introduction to Quantum Field Theory (Harper Collins Publ. 1995)

Comments:

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, W. Block, 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 if pandemic situation permits

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, including the eROSITA space
telescope to be launched in 2019. 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:
It is currently expected that the lecture will be held online. Please check eCampus for up-to-date information.

astro847 **Optical Observations**
Fr 11-13, Raum 0.012, AIfA
Exercises: Mo 9

Instructor(s): T. Schrabback, M. Tewes

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.

Literature:
Provided upon registration.

Comments:
The class has a strong focus on hands-on observations and data analysis in Python. 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 16-17:30, Raum 0.008, AIfA
Exercises: 1 hr. by appointment

Instructor(s): T. Reiprich, F. Pacaud

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:
It is currently expected that the lecture will be held online. Please check eCampus for up-to-date information.

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:

6954 **Seminar on galaxy clusters**
Th 15-16:30, 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:
It is currently expected that the seminar will be held online. Please contact T. Reiprich for details.