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 2020
Quantum Optics
Tu 14-16, Th 8-10, HS, IAP

Instructor(s): F. Vewinger

Prerequisites:
Optics and Atomic Physics Lectures, Quantum Mechanics

Contents:
The lecture will deal with the quantized version of the light field. We will discuss the (observable) differences between a classical and a quantum light field, and we will try to shed some light on the concept of a “photon”.

Special focus will be put on the description of the state of a field. While the density matrix contains all relevant information, it is in many cases infinite in size, and descriptions in phase space are more convenient. Some of them allow to distinguish between classical states (as the thermal Planck radiation) and non-classical states (as squeezed states or Schrödinger cat states). We will also discuss the problem of the interaction between a single atom and a quantized light field, the so-called Jaynes-Cummings model.

The lecture is an experimental one, which means we will discuss how the theoretical concepts of quantum optics can be measured in the lab, and what signatures of the quantization are important.

The course will cover:
- Quantization of the light field
- Classical and nonclassical states of the light field
- Coherence properties of light fields
- Phase-space representations and their measurement
- Cavity QED
- Schrödinger cat states
- Introduction to quantum information theory

Literature:
R. Loudon; The quantum theory of light (Oxford University Press 2000)
G. J. Milburn, D. F. Walls; Quantum Optics (Springer 1994)
M. O. Scully, M. S. Zubairy; Quantum Optics (Cambridge 1997)
P. Meystre, M. Sargent; Elements of Quantum Optics (Springer 1999)

Comments:
Lecture: 3 Teaching hours (3 Semesterwochenstunden)
Exercises: 1 Teaching hour (1 Semesterwochenstunde)
The exercises, in two hour blocks, alternate every two weeks with a lecture.

Details: See ecampus for more details

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:
**physics713**  
**Particle Detectors and Instrumentation**  
Mo 14-16, HS I, Tu 16, Konferenzraum II, PI 1.049, PI

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

**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:**  
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:**

**physics718**  
**Programming in Physics and Astronomy with C++ or Python**  
Fr 8-10, Hörsaal des Meteorologischen Instituts, Auf dem Hügel 20

Instructor(s): T. Erben

**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 SS2020  
- 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:**  
Lectures Friday 8-10 (lecture room of the Meteorologisches Institut, Auf dem Hügel 20)

**IMPORTANT**  
- An own Laptop is required to attend lectures and exercises!  
- Prior registration for the course is necessary via eCampus (https://ecampus.uni-bonn.de/goto_ecampus_crs_1650305.html). The number of participants is limited to 50 students and the spots are distributed on a first come-first serve basis.
BCGS intensive week (Test beam measurements with a pixel telescope at the DESY electron test beam)
September 7th - 11th

Instructor(s): I. Gregor

Prerequisites:
Bachelor in Physics

Contents:
- overview on detectors for particle physics
- passage of particles through matter
- basics on tracking detectors with focus on semi-conductor detectors
- important parameters for detector testing
- radiation damage effects
- taking data with a pixel telescope (electron tracks at DESY test beam)
- data analysis
- simulations

[for questions please contact gregor[at]physik.uni-bonn.de ]

Literature:
Will be provided.

Comments:
The course is an all-week workshop at DESY in Hamburg starting on September 7th at 9:15.

The Intensive Week will have lectures in the morning and hands-on exercises in the afternoon organised at the test beam facility at DESY. Travel support will be covered by BCGS and centrally organised at the end of June 2020.

IF the corona situation will no allow travel to Hamburg a full online alternative for this course will be offered!

Lecture on Advanced Topics in Photonics: Precision measurements in atomic physics
Th 10-12, HS, IAP

Instructor(s): S. Stellmer

Prerequisites:
Basic knowledge in atomic physics and laser physics, as obtained in the Bachelor Courses "Experimentalphysik III" and "Experimentalphysik IV”.

Contents:
The development of lasers marked the advent of a new era in precision measurements. In this lecture, we will cover a number of different topics, mainly in the fields of atomic physics. The tentative program:

Lecture 0: Introduction
Lecture 1: Ramsey spectroscopy
Lecture 2: Optical clocks 1
Lecture 3: Optical clocks 2
Lecture 4: Hydrogen spectroscopy 1
Lecture 5: Hydrogen spectroscopy 2
Lecture 6: Highly charged ions
Lecture 7: EDM measurements
Lecture 8: Inertial sensing
Lecture 9: Pulsar timing

Literature:

Comments:
Lectures will be on Thursdays 10-12, tutorials on Tuesdays 8-10. We are planning for an all-online semester of teaching. The first lecture will be on April 23. More information will follow.
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 7. September 2020, um 9 c.t.

Anmerkung: Das Seminar setzt einen uneingeschränkten Laborbetrieb voraus. Falls dies zum angekündigten Zeitpunkt aufgrund der Corona-Situation nicht möglich ist, müsste das Seminar verschoben werden.

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

More literature will be offered

Comments:
Beginning: April 15, 2020
Physics 775  Nuclear Reactor Physics  
We 10-12, SR I, HISKP

Instructor(s): F. Klein

Prerequisites:

Contents:

Preamble:
This lecture was a part of the regular scheme over decades at the university of Bonn, given in summer terms. After leave of absence of the last lecturer in charge it was removed from the written lecture announcements, but is now again offered for continuation for at least the running term to comply with the relevance of the subject. By dictate of rules following the Corona crises classical lectures in halls are not adequate for the time being. As for all other lectures ways to present the lectures by online transmission are presently investigated and prepared. Corresponding information will be communicated as soon as possible.

(Planned) contents:
In broad society Nuclear Fission Reactors are mostly known for their role in production of electrical energy. However, their importance goes much beyond: breeding of important radionuclides for medical and technical applications (also of fissionable material for nuclear weapons, unfortunately), sourcing neutrons for fundamental and material research, providing high neutrino fluxes for measurements of neutrino properties and more.

The lecture will elaborate on the underlying nuclear physics, basic principles of nuclear reactor operation and control, waste management (storage, transmutation e.g.), analysis of severe accidents and aforementioned applications. The current research, status and perspectives of fusion reactors will also be addressed, tentatively by invitation of an original researcher involved in the projects at Garching and Greifswald.

Literature:

Comments:
2 h per week, no separate exercises, limited oral practicing included in lectures, dates and ways of performance of lectures to be decided and communicated.

Physics 652  Seminar on Quantum Optics and Technology  
Mo 14-16, HS, IAP

Instructor(s): D. Meschede

Prerequisites:
Courses for the Bachelor of Science in Physics

Contents:
We will discuss central experiments of quantum optics and applications in quantum technology.

Due to Covid-19 contraints the seminar may be hold in terms of an online course.

Literature:
The seminar will be based on original articles. The assignments will be handed out during the first session on April 20 2020, 14 c.t.

Note: Early birds may receive a topic by contacting us any time before April 20.

Comments:
- The reading period should be at least 4 weeks.
- The talks will have a length of 45 min.
- Two weeks before your talk a draft of all slides must be presented with your tutor.
- No later than one week before your talk a test talk must be given.
Seminar on low temperature physics
Mo 16-18, HS, IAP

Instructor(s): E. Soergel

Prerequisites: Bachelor of Science

Contents: Low temperature physics starts with the supplying of low temperatures, and their measurement. Furthermore, a series of fascinating physics such as the superfluidity or the much better known superconductivity occur at low temperatures only. This seminar is intended to give an overview on low temperature physics from the experimental point of view (garnished with a couple of theoretical topics).

Literature:

Comments:

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:
4. P. Bösiger: Kernspin-Tomographie für die medizinische Diagnostik, Teubner
5. Ed. S. Webb: The Physics of Medical Imaging, Adam

Comments:
Beginning: April 20, 2020
Time: Mo 14 - 16 and one lecture to be arranged
Seminar on modern topics in the theory of strong interactions
Th 10-12, HS, HISKP

Instructor(s): U. Meißner, M. Petschlies, C. Urbach

Prerequisites:
AQT, QFT I

Contents:
In this seminar we will cover modern topics in the theory of strong interactions. This will in particular cover topics in:
- nuclear lattice effective field theory
- lattice QCD
- scattering in finite volume
- numerical simulations of QFTs

Literature:
Will be topic dependent and discussed during the first week.

Comments:
We will start April 23rd, probably with a video meeting.

Research Internship
Data analysis, detectors and numerical simulations at BGO-OD (ELSA) and COMPASS (CERN)
pr., all day, 3-4 weeks, applications to
schmieden@physik.uni-bonn.de

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:
Lee, Techniques for Nuclear and Particle Physics Experiments
Povh, Rith, Scholze, Nuclei and Particles
Griffiths, Introduction to Elementary Particles
Cahn and Goldhaber, Particle Physics

Comments:
Duration 2 – 4 weeks (part time), by individual agreement
Research Internship / Praktikum in der Arbeitsgruppe:
Proton-Proton-Collisions at the LHC (D/E)
(http://hep1.physik.uni-bonn.de)
lab, whole day, ~4 weeks, preferred during off-teaching terms, by
appointment, PI

Instructor(s): M. Cristinziani, J. Dingfelder, E. von Törne

Prerequisites:
Lecture(s) on Particle Physics

Contents:
Within 4 weeks students receive an overview/insight of the research carried out in our research group.

Topics: Analyses of data taken with the ATLAS Experiment at the LHC especially: Higgs and Top physics, tau-final states and b-tagging

The exact schedule depends on the number of applicants appearing at the same time.

Literature: will be handed out

Comments: Early application is required
Contacts: J. Dingfelder, E. von Törne, T. Lenz, M. Cristinziani

Praktikum in der Arbeitsgruppe: Vorbereitung und Durchführung von Experimenten zur Laserspektroskopie und anderer Präzisionsmessungen; Mitwirkung an den Forschungsprojekten der Arbeitsgruppe
pr, ganztägig, Dauer: n. Vereinb. 2-6 Wochen, PI

Instructor(s): S. Stellmer

Prerequisites:

Contents:
Small experimental or theoretical projects in relation to our main research work.

Literature:

Comments:
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
e-mail: klaus.lehnertz@ukbonn.de

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:

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, W. Block, P. Trautner

Prerequisites:

Contents:
Continuation of topics addressed in lecture and 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, Alfa
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
astro8402  X-ray astronomy  
Fr 13-15, Raum 0.012, AlFA  
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:

astro847  Optical Observations  
Fr 11-13, Raum 0.012, AlFA  
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 analyzing multi-filter CCD imaging observations of galaxy clusters using the 50cm telescope on the AlFA rooftop.

Literature:
Frederick R. Chromey: To Measure the Sky

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 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:**

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**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:**
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Seminar on galaxy clusters
Th 15-17, Raum 0.006, AlfA

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: