Sommersemester 2013

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 2013

physics633 **High Energy Collider Physics**
Tu 8-10, Th 12, HS, IAP
Diplom: VEXP, WPVEXP

Instructor(s): K. Desch, P. Bechtle

Prerequisites:
Nuclear and Particle Physics (physik511)
Particle Physics (physics611): recommended but not mandatory

Contents:
Physics at proton-proton (LHC), electron-proton (HERA) and e+e- colliders (LEP, ILC).
This course is on experimental particle physics, here especially collider physics, and builds on and deepens
topics of the Particle Physics lecture (physics611). The emphasis is put on physics and experimental methods applied at the LHC, but also results and techniques from other high-energy colliders are included.
Topics include: physics and kinematics of pp-collision and e+e-collisions, LHC machine and detectors, electroweak precision measurements, proton structure, QCD at hadron colliders, Higgs physics, top quark
physics, searches for physics beyond the standard model like SUSY and Extra Dimensions. Very recent

results from the LHC (Higgs discovery, ...) will be discussed.

Literature:
The lectures do not follow a particular text book as the topics covered
are much on current results an measurements.
Recommendations on background literature will be provided during the course.
Some good books are:
Ellis, Stirling, Webber: QCD and Collider Physics
Bettini: Elementary Particle Physics
basic: Halzen+Martin: Quarks and Leptons

Comments:
Lecture material will appear on eCampus

physics639 **Advanced Topics in High Energy Particle Physics**
Tu 12-14, We 8-10, HS, IAP
Diplom: VEXP, WPVEXP

Instructor(s): I. Brock, J. Kroseberg

Prerequisites:
Course lecture "Nuclear and Particle Physics".
Knowledge of particle physics, as obtained for instance from the lecture "Particle Physics" given in the winter semester, is recommended.

Contents:
This lecture complements the introductory courses in particle physics.
It will focus on topics flavor physics in the hadron and lepton sector:

1. Hadron sector: from the physics of B,D,K mesons
(CP violation, measurements of the CKM matrix and SM parameters, search for new physics with rare decays)
2. Lepton Sector: physics of neutrinos (neutrino oscillations, neutrino masses, recent and future neutrino experiments).

Literature:
Will be given in the lecture

Comments:
The first lecture will be on Tuesday 9th April, 12h c.t.
Registration for exercise classes will be via Ilias:
https://ecampus.uni-bonn.de/goto_ecampus_crs_264491.html

physics631 **Quantum Optics**
Tu 10-12, Th 14-16, HS, IAP
Diplom: VEXP, WPVEXP

Dozent(en): M. Weitz

Erforderliche Vorkenntnisse:
Optik und Atomphysik-Grundvorlesung, Quantenmechanik

Inhalt:
Atom-Licht Wechselwirkung, Bloch-Vektor
Kohaerenz von Licht
Quantisierung des Lichtfeldes
Zwei- und Dreiniveauatome
Laserkuehlung von Atomen, Quantengase

Literatur:
R. Loudon; The quantum theory of light (Oxford University Press 2000)
G. J. Milburn, D. F. Walls; Quantum Optics (Springer 1994)
D. Meschede; Optik, Licht und Laser (Teubner, Wiesbaden 2nd edition. 2005)
M. O. Scully, M. S. Zubairy; Quantum Optics (Cambridge 1997)
P. Meystre, M. Sargent; Elements of Quantum Optics (Springer 1999)

Bemerkungen:
Vorlesung: 3 Semesterwochenstunden
Übung: 2 Stunden alle 14 Tage im Wechsel mit der Vorlesung: 1 Semesterwochenstunde
Di 10 c.t.-12: Vorlesung
Do 14 c.t.-16: Vorlesung bzw. Übung

physics636 **Advanced Theoretical Particle Physics**
Tu 14-16, Th 13, HS I, PI
Diplom: VTHE, WPVTHE

Instructor(s): M. Drees

Prerequisites:
Courses in Theoretical Particle Physics and Quantum Field Theory

Contents:
This class covers extensions of the Standard Model of particle physics. It begins with a quantum field theoretical description of neutrino oscillations, followed by a discussion of models that generate small but non-vanishing neutrino masses. Next Grand Unified theories will be discussed. The second half of the class will be devoted to an introduction to Supersymmetry.

Literature:
G. Ross, Grand Unified Theories
M. Drees, R.M. Godbole and P. Roy, Theory and Phenomenology of Sparticles

Comments:
Language will be English.

First lecture will be on Tuesday April 9th, 2013.

physics637 **Advanced Theoretical Hadron Physics**
Tu 10-12, Th 9, SR II, HISKP
Diplom: VTHE, WPVTHE

Instructor(s): U. Meißner, A. Rusetsky

Prerequisites:
Quantum Mechanics, Quantum Field Theory I, Theoretical Hadron Physics I (preferred)

Contents:

- Introduction to the path integral formalism
- Quantization of the non-abelian gauge fields
- Perturbative QCD
- Symmetries and Ward identities; Anomalies
- Renormalization of the non-abelian gauge field theories
- Renormalization group; QCD scale
- Deep inelastic scattering; Operator product expansion; Structure functions
- Introduction to lattice QCD
- Instantons; theta-vacua; Strong CP problem

Literature:

1. M.E. Peskin and D.V. Schroeder, An introduction to quantum field theory, Addison-Wesley (1995)
2. L.D. Faddeev and A.A. Slavnov,Gauge Fields: An Introduction to Quantum Theory, Perseus Books (1991)
3. T. Muta, Foundations of Quantum Chromodynamics, World Scientific (2009)
4. F.J. Yndurain, The Theory of Quark and Gluon Interactions, Springer-Verlag (1993)
5. R. Rajaraman, An Introduction to Solitons and Instantons in Quantum Field Theory, North Holland Publ. (1982)
6. C. Gattringer and C. Lang, Quantum Chromodynamics on the lattice, Springer-Verlag (2009)

Comments:
Language: English/German at the discretion of the audience

physics712 **Advanced Electronics and Signal Processing**
Mo 10-12, Th 12, SR I, HISKP
Diplom: VANG, WPVANG

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

Prerequisites:
Electronics lab course, physics of detectors lecture

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 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 Alpha 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:
The lectures does not follow a particular text book. Recommendations on background literature will be provided during the course.

Comments:
The experimental exercises to this lecture will be organized at the Bonn Isochronous Cyclotron and as a Chip Design Tutorial at the end of the term.

physics714 **Advanced Accelerator Physics**
We, Th 10-12, SR I, HISKP
Diplom: VANG, WPVANG

Instructor(s): W. Hillert, A. Lehrach, R. Maier

Prerequisites:
Mechanics, Electrodynamics, basic knowledge in Physics of Particle Accelerators (e.g. Accelerators Physics)

Contents:
Diese Veranstaltung ist eine Fortführung und Vertiefung der Vorlesung „Physik der Teilchenbeschleuniger“. Hier sollen, neben der Behandlung der Synchrotronstrahlung und ihrem Einfluss auf die Strahleigenschaften in Elektronenbeschleunigern, vornehmlich kollektive Phänomene wie optische Resonanzen und Instabilitäten diskutiert werden. Darüber hinaus ist eine Vertiefung des Lehrstoffes in praktischen Übungen am Beschleuniger ELSA geplant.

This course is a continuation of the lecture „Accelerator Physics“. In addition to the treatment of synchrotron radiation and its influence on the beam characteristics in electron accelerators, mainly collective phenomena like optical resonances and instabilities will be discussed. Furthermore, deepening the subject matter by practical exercises at the ELSA accelerator facility is planned.

Literature:
H. Wiedemann, Particle Accelerator Physics, Springer 1993, Berlin, ISBN 3-540-56550-7

D.A. Edwards, M.J. Syphers, An Introduction to the Physics of High Energy Accelerators, Wiley & Sons 1993, New York, ISBN 0-471-55163-5

F. Hinterberger, Physik der Teilchenbeschleuniger und Ionenoptik, Springer 1996, Berlin, ISBN 3-540-61238-6

K. Wille, Physik der Teilchenbeschleuniger und Synchrotronstrahlungsquellen, 2. überarb. und erw. Aufl., Teubner 1996, Stuttgart, ISBN 3-519-13087-4

S. Y. Lee, Accelerator Physics (Second Edition), World Scientific, Singapore 2004, ISBN 981-256-200-1 (pbk)

Script of the lecture “Accelerator Physics”:
http:/www-elsa.physik.uni-bonn.de/~hillert/Beschleunigerphysik

Comments:
Es besteht die Möglichkeit, den Lernstoff durch detaillierte Besichtigungen und praktische Studien an der Beschleunigeranlage ELSA des Physikalischen Instituts zu veranschaulichen und zu vertiefen. Exkursionen zu anderen Beschleunigern sind vorgesehen. Zu dieser Vorlesung wird ein Script im Internet (pdf-Format) zur Verfügung gestellt.

The opportunity will be offered to exemplify and deepen the subject matter by detailed visits and practical studies at the institute of physics’ accelerator facility ELSA of the institute of physics. Excursions to other accelerators are intended. Accompanying the lecture, a script (pdf-format, english) is provided in on the internet.

physics716 **Statistical Methods of Data Analysis**
Fr 8-10, SR I, HISKP

Instructor(s): M. Kowalski, P. Urquijo

Prerequisites:
Some prior knowledge of particle physics would be helpful.

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:

physics717 **High Energy Physics Lab**
4 to 6 weeks on agreement

Instructor(s): E. von Törne

Prerequisites:

Contents:
This course offers students in their first year of their Master studies the opportunity to participate in research activities.

Literature:

Comments:
The students join one of the high energy physics groups groups and conduct their own small research project for typically 4 weeks. We recommend to participate in a project during term break (either in spring or summer/ early fall) but projects during the semester are also possible. More information here: http://heplab.physik.uni-bonn.de/

physics718 **C++ Programming in High Energy Physics**
We 16-18, HS, IAP

Instructor(s): E. von Törne

Prerequisites:
Basic understanding of a programming language (C, Java, ..) is required. Basic constructs such as if-clauses, for-loops and such are regarded as prerequisites.

Contents:

- Introduction, Basic ingredients of C and C++
- Object orientation: classes, encapsulation, inheritance, polymorphism
- How to solve physics problems with C++
- How to navigate in complex programs
- How to write and maintain complex programs
- C++ in Data analysis, example: the ROOT library
- C++ and large scale calculations
- Standard Template Library
- Debugging and profiling
- Test-driven design

Literature:

- Eckel: Thinking in C++, Prentice Hall 2000.
- Lippman, Lajoie, Moo: C++ Primer, Addison-Wesley 2000.
- Deitel and Deitel, C++ how to program, Prentice Hall 2007.
- Stroustrup, The C++ Programming Language, Addison-Wesley 2000.

Comments:
Exercises will be held in the CIP-pool (AVZ). In the exercises students will be introduced to modern programming tools, such as Debugger, profiler, integrated development environments (eclipse).

physics732 **Optics Lab**
4 to 6 weeks on agreement

Instructor(s): F. Vewinger, S. Linden, D. Meschede, M. Weitz

Prerequisites:
BSc

Contents:
The Optics Lab is a 4-6 week long practical training/internship in one of the research groups in Photonics and Quantum Optics, which can have several aspects:
- setting up a small experiment
- testing and understanding the limits of experimental components
- simulating experimental situations

Credit points can be obtained after completion of a written report.

Literature:
Will be given by the supervisor

Comments:
For arranging the topic and time of the internship, please contact the group leader of the group you are interested in directly. Please note that a lead time of a few weeks may occur, so contact the group early. In case you are unsure if/where you want to do the optics lab, please contact Frank Vewinger for information.

physics737 **BCGS Intensive Week (Advanced Topics in Photonics and Quantum Optics)**
Build your own laser

Instructor(s): F. Vewinger

Prerequisites:
Bachelor in Physics or "Vordiplom".

Contents:
Topic: Build your own Laser

The intensive week contains focused lectures, seminar talks given by the participants, as well as advanced practical training. Lectures and seminar talks will provide the fundamentals of laser physics needed in order to understand how to build a laser from scratch. In the practical training the participants will set up a flashlamp pumped Nd:YAG laser in groups and will characterize their setup. Depending on progress more advanced practical trainings will be offered.

Prior knowledge is helpful, but not required. This course especially aims at students that only want to have a "glimpse" into laser physics.

Literature:
Literature information will be provided during the course

Comments:
The intensive week will take place from Spetember 23–27, 2013 (full day).

The language will be English if one or more participants require this. Credit points can be obtained after successful participation if a seminar talk is given.

Participation is limited to 10 students, thus an early application is recommended. Application is possible using the web interface
http://tiny.iap.uni-bonn.de/bcgs/physics737.php

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 15.4.13, 9 c.t.,
Konferenzraum IAP, 3. Stock Wegelerstr. 8

Seminartermine ab 22.4.13

physics741 **Modern Spectroscopy**
We 14-16, HS, IAP

Instructor(s): F. Vewinger

Prerequisites:
BSc

Contents:
The lecture gives an introduction in the field of optical spectroscopy, covering fundamental concepts as well as applications of spectroscopy.
On the fundamental side, the lecture focusses on the physical principles of atomic and molecular spectra, as well as the principles of different spectroscopy techniques. Here both the fields of low and high resolution spectroscopy are discussed. The lecture also covers important research applications of spectroscopy, for example the determination of fundamental constants and their possible time variation. The "real-world" applications discussed in the lecture include topics such as trace gas analysis, optical clocks and lasers in medicine.

Literature:
Original literature will be given in the lecture. Some useful textbooks include the follwing:

W. Demtröder; Laser spectroscopy (Springer 2002)
S. Svanberg; Atomic and molecular spectroscopy basic aspects and practical applications (Springer 2001)
A. Corney; Atomic and laser spectroscopy (Clarendon Press 1988)
N. B. Colthup, L. H. Daly, S. E. Wiberley; Introduction to infrared and Raman spectroscopy (Academic Press 1990)
P. Hannaford; Femtosecond laser spectroscopy (Springer New York 2005)
C. Rulliere; Femtosecond laser pulses: principles and experiments (Springer Berlin 1998)

Comments:

physics753 **Theoretical Particle Astrophysics**
Mo 12, Fr 13-15, HS I, PI
Diplom: VTHE, WPVTHE

Instructor(s): H.-P. Nilles

Prerequisites:
Knowledge of (relativistic) Quantum Mechanics, and basic knowledge of the Standard Model of particle physics, will be assumed. Knowledge of Quantum Field Theory and General Relativity is helpful, but not essential.

Contents:
Application of particle physics to astrophysical and cosmological problems. Emphasis will be on the physics of the early universe, basically the first few seconds (after inflation).

Literature:
Kolb and Turner, "The Early Universe", Addison Wesley
V. Mukhanov, Physical foundations of cosmology, Cambridge University Press

Comments:
Particle Astro physics works on the interface of traditional particle physics on the one hand, and astrophysics and cosmology on the other. This field has undergone rapid growth in the last one or two decades, and many fascinating questions remain to be answered.

The first lecture will take place on Friday, April 12th, at 1 pm c.t.

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

Instructor(s): S. Förste

Prerequisites:
Theoretical Physics I and II,
Basic Lectures in Mathematics

Contents:
Special Relativity (recap),
Riemannian Geometry,
Einstein's Equation,
Linearised Gravity,
Gravitational Collapse and Black Holes,
Cosmology.

Literature:
Sean M. Carrol: An Introduction to General Relativity Spacetime and Geometry (Addison Wesley)

H. Stephani: General Relativity (Cambridge University Press), also available in German from publisher DVW

L.D. Landau and E.M. Lifshits: Course of Theoretical Physics, Volume 2: Classical Theory of Fields (Butterworth-Heinemann), also available in German from publisher Harry Deutsch

P.K. Townsend: Black Holes, arXiv:gr-qc/9707012

Comments:

physics773 **Physics in Medicine II: Fundamentals of Medical Imaging**
Mo 10-12, HS, IAP, We 12, SR I, HISKP
Diplom: VANG, WPVANG

Instructor(s): K. Lehnertz

Prerequisites:
Vordiplom/Bachelor

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: Mo, Apr 8

physics651 **Joint BCGS Seminar on Detectors for Particle and Nuclear Physics Experiments**
Mo 16:30-18, Konferenzraum I, W 0.027, PI
Diplom: SEXP, WPSEXP

Instructor(s): R. Beck, I. Brock, K. Desch, J. Jolie (Köln), M. Kowalski, P. Reiter (Köln), E. von Törne, N. Wermes

Prerequisites:
Vordiplom or Bachelor, advanced class
useful: particle physics and/or nuclear physics lectures
useful: physics of detectors lecture

Contents:
The seminar will discuss special detectors and detector classes in nuclear and particle physics.

Example topics are:
- Particle identification in neutrino telescopes
- Gaseous Tracking Detectors
- Pixel detectors, from hybrid to monolithic
- Charged particle tracking from COSY to FAIR
- Particle detectors for intermediate energies in the Fragment Separator (FRS) and the Experimental Storage Ring (ESR) at GSI
- Detecting charged particles in nuclear decay studies
- Particle identification in hadron physics
- Transition radiation detectors in particle physics Calorimetry in hadron physics
- Calorimeters at the ILC and Particle-Flow Algorithms
- Energy measurement of the highest energy cosmic rays
- Particle detection in the sub-eV range using retarding potential spectrometers
- Identification of Dark Matter

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

Comments:
The seminar is a joint seminar between the universities of Bonn and Cologne within the Bonn-Cologne Graduate School, but is open to all students.
The seminar will take place alternating in Bonn (Room 300, Phys. Inst.) and in Cologne (Inst. f. Kernphysik).

*** The first meeting is on Monday 8th April 2013, 16:30h in Bonn, Conference room I of the Physics Institute ***

physics652 **Seminar on Advanced Topics in Photonics and Quantum Optics**
Th 16-18, HS, IAP
Diplom: SEXP, WPSEXP

Instructor(s): D. Meschede

Prerequisites:

Contents:
detailed information to be found on ILIAS

Literature:

Comments:

physics653 **Place: to be agreed**
Time: to be agreed
First meeting: April 9th, 16 h.c.t., Heinrich-Hertz-Raum (PI 1. OG re.)
Diplom: SEXP, WPSEXP

Instructor(s): F. Klein, V. Vegna

Prerequisites:
Basic knowledge of Nuclear and/or Particle Physics, Quantum Mechanics preferable
The seminar will be open for students with Bachelors, Masters, diploma candidates and Graduates (PhD-
students). Students shortly before Bachelor degree upon request. The talks will be assigned accordingly.

Contents:
Subject: Concepts and Experiments on the (Quark) Structure of Hadrons

Preliminary List of talks:

The Zoo of Hadrons
The Size and other static properties of Hadrons
(Photo)production of Pseudoscalar and Vector Mesons
The concept of Flavour, quarks and Colour
Quark Models of Hadrons
Elastic, Inelastic und Deeply Inelastic Scattering of Leptons
(Elastic and Transition Form Factors, Quasi-elastic scattering, other basic observations)
Quarks and Partons, (PDF's, scale invariance and scale breaking)
The Proton Spin and its Flavour Decomposition (Spin dependent Observables)
Weak Interactions in Lepton Scattering, the role of Strangeness

(Titles of seminar talks can be modified and extended upon request)

Literature:
General
Textbooks on Particle Physics, e.g.
D. Perkins: Introduction into Particle Physics
Frauenfelder/Henley: Subatomic Physics
A. Seiden: Particle Physics
B.R. Martin and G. Shaw: Particle Physics
R. Mann: Particle Physics and the Standard Model
and many others

specific literature will be given individually for the preparation of talks

Comments:
Time: to be agreed

place: depending on time
First meeting date: April 9th, 16 h.c.t., Heinrich-Hertz-Raum (PI 1. OG re.)

Default language is English.
Upon request the language can be changed to German in exceptional cases

physics654 **Seminar Medical Physics: Physical Fundamentals of Medical Imaging**
Mo 14-16, SR I, HISKP
Diplom: SANG, WPSEXP

Instructor(s): K. Lehnertz, K. Maier

Prerequisites:
Vordiplom/Bachelor

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
Beginning: Mo Apr. 8

physics656 **Seminar on Symmetries and Symmetry Breaking in Particle and Nuclear Physics**
We 10-12, SR II, HISKP
Diplom: STHE, WPSTHE

Instructor(s): H.-W. Hammer, C. Hanhart, S. Krewald, B. Kubis, U. Meißner, B. Metsch, C. Urbach, A. Wirzba

Prerequisites:
Quantum Mechanics

Contents:
Possible topics (to be adjusted at the level of expertise of the participants):
- The discrete symmetries C, P, and T and weak interactions
- CP violation and electric dipole moments
- Spontaneous symmetry breaking: Goldstone theorem, Higgs mechanism
- Anomalies
- Chiral symmetry
- Heavy-quark symmetry
- Symmetry breaking on space-time lattices

Literature:

- General Textbooks on Particle/Hadron Physics and Quantum Field Theory, e.g.:
- J.F. Donoghue, E. Golowich, B.R. Holstein, Dynamics of the Standard Model, Cambridge Univ. Press (1992)
- M.E. Peskin & D.V. Schroeder, An Introduction to Quantum Field Theory, Westview Press (1995)

[li]Specific literature will be given individually for the preparation of talks[/li][/listu]

Comments:
The two main goals of this seminar:
1. Learning physics
2. Learning how to give a good talk!

The first meeting will take place on April 10th at 10:15, SR II, HISKP

physics657 **Seminar on Advanced Topics in Surface Analysis Methods**
Mo 15-17, HS, IAP
Diplom: SANG, WPSEXP

Instructor(s): E. Soergel

Prerequisites:
None

Contents:
Techniques for investigating various surface properties

Literature:
Will be given in the course

Comments:
Kick-Off meeting April 8'th

There will be only 12 talks available.
Send me a mail on time if you want to make sure that you get a talk!
"The early bird gets the worm."

physics658 **Seminar on Astroparticle Physics**
Fr 10-12, Konferenzraum II, PI 1.049, PI
Diplom: SEXP, WPSEXP, STHE, WPSTHE

Instructor(s): M. Drees, M. Kowalski

Prerequisites:
Introductory particle physics is required. A prior class in (experimental and/or theoretical) astroparticle physics may be helpful, but is not required; the same goes for introductory cosmology.

Contents:
Astro-particle physics deals with particle physics aspects of astrophyiscs and (early universe) cosmology. This seminar combines experimental and theoretical astro-particle physics.

Possible topics for seminar talks include: Neutrino oscillations; solar neutrinos and their detection; atmospheric neutrinos and their detection; neutrinos from core collapse supernovae; observational evidence for Dark Matter; calculation of the thermal WIMP Dark Matter density; direct WIMP detection; indirect WIMP detection; Big Bang Nucleosynthesis and the abundance of light elements; cosmic microwave background -- theory and observations; cosmic rays.

Students are encouraged to suggest additional topics.

Literature:
Literature for each talk will be provided.

Comments:

6821 **Research Internship / Praktikum in der Arbeitsgruppe (SiLab): Semiconductor pixel detector development and materials, FPGAs and ASIC Chips (Design and Testing) (D/E) (http://hep1.physik.uni-bonn.de), whole day, ~4 weeks, preferred during off-teaching terms, by appointment, PI**

Instructor(s): F. Hügging, H. Krüger, E. von Törne, N. Wermes u.M.

Prerequisites:
Lectures on detectors and electronics lab course (E-Praktikum)

Contents:
Research Internship:

Students shall receive an overview into the activities of a research group:

here: Development of Semiconductor Pixel Detectors and Micro-Electronics

Literature:
will be handed out

Comments:
early aplication necessary

6822 **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): E. von Törne, N. Wermes u.M.

Prerequisites:
Lectures 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: E. von Törne, M. Cristinziani, J. Kroseberg, N. Wermes

6823 **Praktikum in der Arbeitsgruppe: Analyse von Proton-Proton (ATLAS) Streuereignissen / Laboratory in the Research Group: Analysis of Proton-Proton (ATLAS) Scattering Events (D/E)**
pr, ganztägig, 3-4 Wochen, vorzugsweise in den Semesterferien, n. Vereinb., Applications to brock@physik.uni-bonn.de, PI

Instructor(s): I. Brock u.M.

Prerequisites:
Introductory particle physics course

Contents:
Introduction to the current research activities of the group (physics analysis with data from ATLAS (LHC) and ZEUS (HERA)), introduction to data analysis techniques for particle reactions, opportunity for original research on a topic of own choice, with concluding presentation to the group.

Literature:
Working materials will be provided.

Comments:
The course aims to give interested students the opportunity for practical experience in our research group and to demonstrate the application of particle physics experimental techniques.

Depending on the students' preferences the course will be given in German or in English.

6824 **Praktikum in der Arbeitsgruppe: Detektorentwicklung und Teilchenphysik an einem Elektron-Positron-Linearcollider / Laboratory in the Research Group: Detector Development and Particle Physics at an Electron-Positron Linear Collider (D/E)**
pr, ganztägig, ca. 4 Wochen n. Vereinb., vorzugsweise in den Semesterferien, PI

Instructor(s): K. Desch, P. Bechtle

Prerequisites:
Vorlesungen über Teilchenphysik

Contents:
In einem 4 wöchigen Praktikum wird den Studierenden die Möglichkeit gegeben

anhand eines eigenen kleinen Projektes einen Einblick in die Arbeitsweise

der experimentellen Hochenergiephysik zu bekommen.

Themen werden bei der Vorbesprechung vereinbart.

Möglichkeiten (Beispiele):

- Simluation von Prozessen am International Linear Collider

- Messungen an einer Zeitprojektionskammer

Literature:
wird ausgegeben

Comments:
Eine frühe Anmeldung ist erwünscht bei Prof. Desch, Dr. P. Bechtle oder Dr. J. Kaminski

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 (e.g. C, C++, Pascal)

Contents:
This laboratory course provides insight into the current research activities of the Neurophysics group.

Introduction to time series analysis techniques for biomedical data, neuronal modelling, cellular neural 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

Instructor(s): M. Weitz u.M.

Prerequisites:
Optik und Atomphysik Grundvorlesungen, Quantenmechanik

Contents:
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.

Literature:
wird gestellt

Comments:
Homepage der Arbeitsgruppe:

http://www.iap.uni-bonn.de/ag_weitz/Bonn_AG_Quantenoptik.html

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:
Vertiefung der Seminarthemen;
Praktische Beispiele der Bildgebung in der pränatalen Diagnostik, Radiologie und Neurowissenschaften.

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

Literature:

Comments:
Termine werden im Laufe des Semester bekannt gegeben.

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:
The following lectures ought to have been attended: Introduction to Astronomy I and II, Stars and Stellar Evolution, The Interstellar Medium

Contents:
The types of galaxies;

fundamentals of stellar dynamics (Jeans equations, relaxation time);

elliptical galaxies;

disk galaxies;

stellar populations in galaxies;

formation of galaxies;

dwarf galaxies (normal dwarfs, tidal dwarfs, ultra-compact dwarfs);

dark matter and alternatives to Newtonian gravity.

Literature:
Galactic dynamics by J.Binney and S.Tremaine (1987, Princeton University Press);

Galactic Astronomy by J.Binney and M.Merrifield (1998, Princeton University Press);

Galaxies in the Universe by L.Sparke and J.Gallagher (2000, Cambridge University Press)

Comments:
This course is worth 6 credit points. To achieve these attendance of the lectures is required and the exam needs to be passed.

astro822 **Physics of the interstellar medium**
Mo 11-12:30, Tu 15:30-17, Raum 0.012, AIfA
Exercises: 1 hr. by appointment

Instructor(s): F. Bertoldi

Prerequisites:
Introductory astronomy

Contents:
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)
shall be studied.
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 balancs, the multi-phase ISM, gravitational stability and
star formation.

Literature:
B. Draine; The Physics of the Interstellar and Intergalactic Medium (Princeton Univ. Press 2010)
J. Lequeux; The Interstellar Medium (Springer 2005)

Comments:

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

Instructor(s): T. Reiprich

Prerequisites:
Introductory courses on astronomy, atomic physics, and hydrodynamics would be useful.

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, e.g., remnants of exploded stars, the vicinities of lightweight and supermassive black holes, and collisions of galaxy clusters -- the most massive objects in the Universe. The physical properties of X-ray radiation 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 recent X-ray data from a satellite observatory.

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

Comments:

astro8403 **An Introduction to Hydrodynamics**
We 13:30-15, Raum 0.008, AIfA
Exercises: 1 hr. by appointment

Instructor(s): J. Braithwaite

Prerequisites:
Vector calculus, thermodynamics

Contents:
The course covers all fundamental concepts of hydrodynamics, and is accessible for all physics students,
not just astrophysicists. There is a bias towards scientific rather than engineering applications, i.e. a greater emphasis on e.g. stellar winds, and atmospheric waves and supernovae than on airflow over aeroplane wings, and more specifically on astro-, geo- and planetary physics. The topics covered are (in

approximately this order): the hydrodynamics equations; basic concepts such as Bernoulli's equation, (in)compressible, sub- and supersonic flow, nozzles, stellar winds and vorticity; waves of a few different and relevant types, as well as associated instabilities of interest to astrophysicists and associated turbulence; viscosity, similarity flows and boundary layers; shocks; rotating fluid systems; and finally a brief introduction to magnetohydrodynamics, the study of electrically conducting fluids, including some astrophysical contexts such as the solar corona, jets and discs.

Literature:
Landau & Lifschitz "Hydrodynamics";
Choudhuri "The physics of fluids and plasmas";
Pedlosky "Geophysical fluid dynamics";
Shore "Astrophysical hydrodynamics" ;
Spruit "Essential magnetohydrodynamics" http://arxiv.org/abs/1301.5572

Comments:
The last part of the course introduces magnetohydrodynamics, whose applications lie mainly in astrophysics. If you basically know about fluid dynamics already but would like to learn something about

MHD, you are more than welcome to attend the last ~2 lectures in the course as a "tourist" - they are designed to be stand alone, i.e. understandable if you didn't attend the other lectures. The first of the MHD lectures will probably be on 3rd July, but check the webpage beforehand.

astro845 **Observational cosmology**
Th 13-15, Raum 0.012, AIfA
Exercises: 1 hr. by appointment

Instructor(s): C. Porciani, K. Basu

Prerequisites:
Basic concepts of cosmology

Contents:
This class provides an overview of current and future experimental efforts aimed at improving our understanding of the universe, including the nature of dark matter and dark energy. After briefly reviewing the current standard cosmological model, we will focus on the motivations, techniques and aims of the leading experiments in the field.

Literature:
Printouts will be made available and references to relevant review articles will be given during the class.

Related Textbooks (not required for the exam):
Galaxy Formation and Evolution (Mo, van den Bosch & White)
Modern Cosmology (Dodelson)
Cosmological Physics (Peacock)
Galaxy Formation (Longair)
X-ray Emission from Clusters of Galaxies (Sarazin) (available online)

Comments:

astro847 **Optical Observations**
Details to be announced

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

Prerequisites:
Astronomy introduction classes

Contents:
Optical CCD and near infrared imaging, data reduction, catalogue handling, astrometry, coordinate systems, photometry, spectroscopy, photometric redshifts, basic weak lensing data analysis, current surveys, how to write observing proposals.
Practical experience is gained by obtaining and analysing multi-filter CCD imaging observations using the 50cm telescope on the AIfA rooftop, as well as the analysis of professional data from the archive.

Literature:
Provided upon registration.

Comments:

astro848 **Galactic and intergalactic magnetic fields**
Tu 13-15, Raum 0.008, AIfA
Exercises: 1 hr. by appointment

Instructor(s): U. Klein

Prerequisites:
electro-dynamics, introduction to astronomy, interstellar medium

Contents:
1. Introduction
2. Diagnostics
3. Milky Way
4. External galaxies
5. Active Galactic Nuclei
6. Intergalactic magnetic fields
7. Cosmological magnetic fields

Literature:
Lecture Notes, fully spelled out, provided at the beginning of the course

Comments:

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

Instructor(s): T. Reiprich, Y. Zhang

Prerequisites:
Introductory astronomy lectures.

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 intracuster 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, and 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:

astro8501 **Binary stars**
Th 9-11, Raum 0.008, AIfA
Exercises: 1 hr. by appointment

Instructor(s): R. Izzard

Prerequisites:
Stellar Structure and Evolution (N. Langer's course) will be of great help as is a general physics background (e.g. in mechanics, electrodynamics).

Contents:
The Binary Stars course (astro 8501 / 6944) course in the summer semester is part of the Master in Astrophysics. The course provides four exciting credit points. The classes will be held on Thursdays at 9am in room 0.008 at the AIfA: please check the website http://www.astro.uni-bonn.de/~izzard/binary_stars.html for the start date.

The classes are a mixture of computer presentations (slides) and blackboard work. You are expected to take your own notes, to complain if I go too fast and to ask pertinent questions. The associated exercise classes are mandatory.

Course abstract:

Most stars in our Galaxy are gravitationally bound in binary star systems. Many of these are close enough to each other to interact at some point in their lives with consequences that include the formation of X-ray binaries, millisecond pulsars, thermonuclear novae, supernovae and gamma-ray bursts.

This course will start by introducing the many types of observed binary-star system. A discourse on orbital dynamics will lead into issues of gravitational interaction such as tides. In the most extreme case this leads to mass-transfer between the components of the binary star. The stability of mass transfer is crucial to understanding, for example, the origin of type Ia supernovae.

A unique aspect of this course will be the study of populations of binary stars. These include chemically peculiar stars which are keys to understanding both stellar physics and the evolution of our Galaxy.

Literature:
Interacting Binary Stars (J.E.Pringle and R.A.Wade; Cambridge University Press) ISBN 0-521-26608-4
An Introduction to Close Binary Stars (R.W.Hilditch; Cambridge University Press) ISBN 0-521-79800-0
Evolutionary Processes in Binary and Multiple Stars (P.P.Eggleton; Cambridge University Press) ISBN-10 0-521-85557-8 / ISBN-13 978-0-521-85557-0

Comments:
Please see:
http://www.astro.uni-bonn.de/~izzard/binary_stars.html
http://www.astro.uni-bonn.de/~izzard/binary_stars-timetable.html

Exercise classes are given by Dominique Meyer on Wednesday afternoons, by appointment, in room 3.010 (third floor seminar room at AIfA). Attendance at these classes is mandatory for entry into the exam (which will be oral or written).

astro8504 **Lecture on Advanced Topics in Modern Astrophysics: The physics of compact objects**
Tu 13-15, Raum 0.01, MPIfR
Exercises: We 15-17, Raum 0.01, MPIfR

Instructor(s): T. Tauris

Prerequisites:
BSc in Physics

Contents:
A general introduction to the basic, fascinating physics of compact objects (neutron stars, white dwarfs and black holes) and their binary interactions. We introduce the theory of degenerate Fermi gases and apply it to simple equations of state for white dwarfs and neutron stars. We investigate the structure, cooling and evolution of white dwarfs and neutron stars and compare with observational properties. We analyse the formation, evolution and detection of X-ray binaries, including the dynamical effects of asymmetric supernovae. In particular, we discuss the formation of millisecond radio pulsars and also the recent discoveries associated with the extremely magnetic neutron stars called magnetars. Finally, we learn about the nature and the detection of gravitational waves which will soon open a new window to the Universe.

Literature:
Key background book: Shapiro & Teukolsky (1983) "Black Holes, White Dwarfs and Neutron Stars" (Wiley), supplemented with recent review papers and the latest observational results. See the lecture homepage for more details.

Comments:
Please see:
http://www.astro.uni-bonn.de/~tauris/course.html

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.

Solar Cycle: Observations
Solar Cycle: Theory
Flare theory
The standard model of the solar flares
Physical Processes
Stellar Coronae

Literature:
The Solar Corona by Golub and Pasachoff. Cambridge University Press, 2009.

Comments:

astro892 **Seminar on radio astronomy**
Th 18-19:30, Raum 0.006, AIfA

Instructor(s): F. Bertoldi, J. Kerp, U. Klein, M. Kramer

Prerequisites:

Contents:
presentation of publications that are (largely) based upon radio-astronomical measurements

Literature:

Comments:
Embedded in the main astrophysics seminar!

astro893 **Seminar on stars, stellar systems, and galaxies**
Tu 16:15-17:45, Raum 3.010, AIfA

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

Prerequisites:
Vordiplom or Bachelor in physics;
The lecture "Stars and Stellar Evolution" (astro811);
The lecture "Astrophysics of Galaxies" (astro821)

Contents:
The newest literature (e.g. papers from the electronic pre-print server) relevant to research on stars, stellar populations, galaxies and dynamics;
current and preliminary research results by group members and guests on the above topics.

Literature:
Latest astro-ph pre-prints, or recently published research papers.

Comments:
This course is worth 4 credit points. The corresponding certificate ("Schein") is awarded if the student (a) attends the seminar and (b) holds a presentation. The certificate can be picked up in the office of the secretary on the third floor (AIfA) at the end of the semester.

The students will be introduced to the newest state of knowledge in the field of stellar astrophysics, star clusters, galaxies and dynamics. They will familiarise themselves with open questions and acquire knowledge on the newest methods in research.