



Description of the degree programme

Solar System Physics (MPO 2023) Master

Date: 04-02-2026

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If there is a discrepancy or inconsistency of meaning or interpretation between the English version and the original German version, the German version shall prevail.

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Specialised deepening phase

Module name: Planetary Bodies				Module number: PHY-IGeP-30	
Institution: Institut für Geophysik und Extraterrestrische Physik				Module abbreviation: FV-PB	
Workload:	450 h	Attendance time:	140 h	Semester:	1 or 2
credit points:	15	Independent study:	310 h	Number of semesters:	1
Compulsory form:	mandatory			Sem. hours / week:	10
Courses/Main topics: Interiors and Surfaces of Planetary Bodies (L) Interiors and Surfaces of Planetary Bodies (E) Atmospheres and Environments of Planetary Bodies (L) Atmospheres and Environments of Planetary Bodies (E)					
Attendance logic (if alternative selection, etc.): ---					
Lecturers: Prof. Dr. Jessica Agarwal Prof. Dr. Jürgen Blum Prof. Dr. Andreas Hördt Prof. Dr. Ferdinand Plaschke					
Qualifications aims: The students - understand and are able to formulate the empirical and theoretical foundations of modern planetary science. - apply these fundamentals to planetary problems. - are able to independently select a suitable combination of methods for a given problem. - analyse the problems for this purpose and trace them back to empirical and theoretical foundations.					
Contents: Planetary formation (synopsis), internal structure of planetary and small bodies, differentiation and heating, hydrostatic equilibrium, adiabatic temperature gradient, equations of state, gravitational potential, rotational dynamics, seismology, PREM, cooling processes, planetary crusts, (cryo-)volcanism, planetary magnetic fields, nuclear convection and dynamo, geophysical exploration of planets. Primordial atmosphere and its loss, atmospheric stratification, surfaces and winds, climate and greenhouse effect, space plasmas, magnetohydrodynamics, ionosphere, solar wind and interplanetary magnetic field (synopsis), magnetospheres and current systems, reconnection and magnetic convection, cometary activity.					
Forms of Learning: Lectures, exercises					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: homework (b) Examination: oral examination (45 min) or written examination (120 min)					
Turnus (beginning): annual in winter semester					
Responsible for the module: Blum					
Language: English					
Media forms: Blackboard-, smartboard-, tablet lecture, projector					
Literature: J.J. Lissauer, I. De Pater, Fundamental Planetary Science. Physics, Chemistry and Habitability. Cambridge University Press, 2019. B.W. Carroll, D.A. Ostlie. An Introduction to Modern Astrophysics (2nd edition). Cambridge University Press, 2017. J.S. Lewis. Physics and Chemistry of the Solar System (2nd edition), Academic Press, 2004. T. Encrenaz et al. The Solar System. 3rd Edition, Springer, 2004. Baumjohann, W., R. Treumann, Basic Space Plasma Physics, World Scientific, 1997. Birdsall, C.K., A.B Langdon, Plasma Physics via Computer Simulation, Taylor and Francis, 2004 Larson, W.J., J.R. Wertz, Space Mission Analysis and Design, Space Technology Library, 1999.					

<p>Lowrie, W., 2007. Fundamentals of Geophysics. Cambridge. Rubin, Y., Hubbard, S., 2006. Hydrogeophysics, Springer. Kearey, Ph., and Brooks, M., 2002, An introduction to geophysical exploration, Blackwell.</p>
<p>Explanatory comment: ---</p>
<p>Categories (module groups): Specialised deepening phase</p>
<p>Requirements for this module: ---</p>
<p>Degree programmes: Solar System Physics (BPO 2023) (Master)</p>
<p>Comment on allocation: ---</p>

Module name: Solar System				Module number: PHY-IGeP-31	
Institution: Institut für Geophysik und Extraterrestrische Physik				Module abbreviation: FV-SS	
Workload:	450 h	Attendance time:	140 h	Semester:	2 or 1
Credit points:	15	Independent study:	310 h	Number of semesters:	1
Compulsory form:	mandatory			Sem. hours / week:	10
Courses/Main topics: The Sun and Heliosphere (L) The Sun and Heliosphere (E) Formation and Evolution of the Solar System (L) Formation and Evolution of the Solar System (E)					
Attendance logic (if alternative selection, etc.): ---					
Lecturers: Prof. Dr. Jürgen Blum Prof. Dr. h.c. Sami Solanki					
Qualifications aims: The students - understand and are able to formulate the empirical and theoretical foundations of modern solar and heliospheric physics as well as the formation and development of the solar system and can formulate them. - apply these fundamentals to astro-, heliophysical and planetological problems. - are able to independently select a suitable combination of methods for a given problem. - analyse the problems for this purpose and trace them back to empirical and theoretical foundations.					
Contents: Stellar structure equations, stellar nuclear fusion and energy transport, neutrinos, photosphere, limb darkening, optical thickness, sunspots, solar dynamo, coronal heating, sources of the solar wind and the interplanetary magnetic field, coronal mass ejections and eruptions, stellar evolution, Hale cycle, heliopause, interaction of the solar wind and solar radiation with dust particles. Formation of the Sun and of planetary and small bodies, significance of relative velocities for planetary formation, frost line, pebble and gas accretion, migration, formation of moons, collisions of planetary bodies, Poynting-Robertson drag, radiation pressure, YORP effect, Yarkowsky effect, resonance, tides.					
Forms of Learning: Lectures, exercises					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: homework (b) Examination: oral examination (45 min) or written examination (120 min)					
Turnus (beginning): annual in summer semester					
Responsible for the module: Plaschke					
Language: English					
Media formes: Blackboard-, smartboard-, tablet lecture, projector					
Literature: J.J. Lissauer, I. De Pater, Fundamental Planetary Science. Physics, Chemistry and Habitability. Cambridge University Press, 2019. B.W. Carroll, D.A. Ostlie. An Introduction to Modern Astrophysics (2nd edition). Cambridge University Press, 2017. Baumjohann, W., R. Treumann, Basic Space Plasma Physics, World Scientific, 1997. Birdsall, C.K., A.B Langdon, Plasma Physics via Computer Simulation, Taylor and Francis, 2004 In addition, current review articles on the formation of the solar system are recommended in the course.					
Explanatory comment: ---					
Categories (module groups): Specialised deepening phase					

Requirements for this module: ---
Degree programmes: Solar System Physics (BPO 2023) (Master)
Comment on allocation: ---

Module name: Hands-On Solar System Physics				Module number: PHY-IGeP-32	
Institution: Institut für Geophysik und Extraterrestrische Physik				Module abbreviation: FV-HO	
Workload:	450 h	Attendance time:	336 h	Semester:	1
Credit points:	15	Independent study:	114 h	Number of semesters:	2
Compulsory form:	mandatory			Sem. hours / week:	24
Courses/Main topics: Laboratory Solar System Physics (Internship) Astronomy (Internship) Data Analysis and Simulations (Internship)					
Attendance logic (if alternative selection, etc.): ---					
Lecturers: Prof. Dr. Ferdinand Plaschke Prof. Dr. Jürgen Blum Prof. Dr. Jessica Agarwal					
Qualifications aims: The students - can plan and apply the methods of numerical simulation, advanced data analysis procedures and space measurement techniques. - develop their own empirical solution methods for problems without a sound basis and justify them. - are able to analyse data using appropriate methods. - can plan, set up, carry out and evaluate simple laboratory experiments. - can derive conclusions for the relevant physical processes from the experiment results. - can analyse and interpret astronomical observations. - can analyse and evaluate their results in a comprehensible way in a protocol and a presentation.					
Contents: - Set-up and execution of own laboratory experiments - Experiments to solve space physics problems - Analysis of empirical scientific data to solve planetological or astrophysical problems - Interpretation of space-physical measurement series with methods of modern data analysis - Conception/realisation of own numerical experiments - Analysis of astronomical observations					
Forms of Learning: Internships					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: Protocol and presentation on the Laboratory Solar System Physics internship (b) Study achievement: Protocol and presentation on the Astronomy internship (c) Study achievement: Protocol and presentation on the Data Analysis and Simulations internship					
Turnus (beginning): Winter semester or summer semester					
Responsible for the module: Blum					
Language: English					
Media forms: Practical work, suitable software for programming and data analysis, lectures with presentation software, word processing programmes					
Literature: Bendat, J.S., A.G. Piersol, Random Data. Analysis and Measurement Procedures, Wiley, 2010. Menke, W., 2012, Geophysical Data Analysis: Discrete Inverse Theory, Elsevier. McMahon, D., 2007, Signals and Systems Demystified, McGraw Hill.					
Explanatory comment: ---					
Categories (module groups): Specialised deepening phase					

Requirements for this module: ---
Degree programmes: Solar System Physics (BPO 2023) (Master)
Comment on allocation: ---

Compulsory elective area Special Courses

Module name: Computational Fluid Dynamics				Module number: PHY-IGeP-33	
Institution: Institut für Geophysik und Extraterrestrische Physik				Module abbreviation: WSC-CFD	
Workload:	150 h	Attendance time:	42 h	Semester:	2
Credit points:	5	Independent study:	108 h	Number of semesters:	1
Compulsory form:	elective			Sem. hours / week:	3
Courses/Main topics: Computational Fluid Dynamics (L) Computational Fluid Dynamics (E)					
Attendance logic (if alternative selection, etc.): --					
Lecturers: Prof. Dr. Yasuhito Narita					
Qualifications aims: The students - understand the empirical and theoretical fundaments of fluid mechanics simulations and are able to formulate them. - apply these fundaments to basic problems and issues in magnetohydrodynamics. - are able to independently select a suitable combination of methods for a given problem. - analyse the problems for this purpose and relate them back to empirical and theoretical foundations.					
Contents: - Different types of approximations - Discretisation methods (finite differences, finite volumes, finite elements) - Stability criteria - Boundary conditions and boundary layers - (MHD) turbulence - Basics of magnetohydrodynamics and dynamo theory as an application of fluid dynamics					
Forms of Learning: Lectures, exercises					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: homework (b) Examination: oral examination (20 min) or written examination (60 min)					
Turnus (beginning): Summer semester or winter semester					
Responsible for the module: Heyner					
Language: English					
Media forms: Blackboard-, smartboard-, tablet lecture, projector					
Literature: - Ferziger, Computational Methods for Fluid Dynamics, 2019 - Versteeg, An Introduction to Computational Fluid Dynamics, 2007 - Davidson, An Introduction to Magnetohydrodynamics, 2001 Further literature will be announced in good time before the start of the lecture.					
Explanatory comment: ---					
Categories (module groups): Compulsory elective area Special Courses					
Requirements for this module: Module 1 or module 2					
Degree programmes: Solar System Physics (BPO 2023) (Master)					
Comment on allocation: ---					

Module name: Space Plasma Physics				Module number: PHY-IThPh-22	
Institution: Institut für Theoretische Physik				Module abbreviation: WSC-SPP	
Workload:	150 h	Attendance time:	42 h	Semester:	2
Credit points:	5	Independent study:	108 h	Number of semesters:	1
Compulsory form:	elective			Sem. hours / week:	3
Courses/Main topics: Space Plasma Physics (L) Space Plasma Physics (E)					
Attendance logic (if alternative selection, etc.): --					
Lecturers: Prof. Dr. Yasuhito Narita					
Qualifications aims: - Acquisition of basic knowledge of plasma physics, the application of this knowledge to questions of extra-terrestrial plasmas and application of the acquired knowledge to phenomena in space - Computational, content-related and practical handling in the treatment of physical problems of space plasma physics.					
Contents: Basic scales of a plasma, plasma models, Vlasov equation, Landau damping, MHD model, multi-fluid models, waves in plasmas, plasma instabilities, non-linear aspects and turbulence.					
Forms of Learning: Lectures, exercises					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: homework (b) Examination: oral examination (20 min) or written examination (60 min)					
Turnus (beginning): Irregular					
Responsible for the module: Narita					
Language: English					
Media forms: Blackboard-, smartboard-, tablet lecture, projector					
Literature: Baumjohann, W., R. Trumann, Basic Space Plasma Physics, Imperial College University Press, 1996					
Explanatory comment: ---					
Categories (module groups): Compulsory elective area Special Courses					
Requirements for this module: Module 1 or module 2					
Degree programmes: Solar System Physics (BPO 2023) (Master)					
Comment on allocation: ---					

Module name: General Relativity				Module number: PHY-IThPh-010	
Institution: Institut für Theoretische Physik				Module abbreviation: WSC-GR	
Workload:	150 h	Attendance time:	42 h	Semester:	2
Credit points:	5	Independent study:	108 h	Number of semesters:	1
Compulsory form:	elective			Sem. hours / week:	3
Course/Main topics: General Relativity (L) General Relativity (E)					
Attendance logic (if alternative selection, etc.): --					
Lecturers: Prof. Dr. Yasuhito Narita					
Qualifications aims: The students - get an overview of the gravitational physics (in curved space) - get to know the applications to the solar system and astrophysics					
Contents: Physics in curved space-time, gravitational field equation, solutions, applications					
Forms of Learning: Lectures, exercises					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: homework (b) Examination: oral examination (20 min) or written examination (60 min).					
Turnus (beginning): Irregular					
Responsible for the module: Narita					
Language: English, German					
Media forms: Blackboard-, smartboard-, tablet lecture, projector					
Literature: Schutz, B., First course in general relativity, 2nd ed., Cambridge University Press, 2009					
Explanatory comment: ---					
Categories (module groups): Compulsory elective area Special Courses					
Requirements for this module: ---					
Degree programmes: Solar System Physics (BPO 2023) (Master)					
Comment on allocation: ---					

Module name: Planetary Magnetospheres				Module number: PHY-IGeP-34	
Institution: Institut für Geophysik und Extraterrestrische Physik				Module abbreviation: WSC-PM	
Workload:	150 h	Attendance time:	42 h	Semester:	2
Credit points:	5	Independent study:	108 h	Number of semesters:	1
Compulsory form:	elective			Sem. hours / week:	3
Courses/Main topics: Planetary Magnetospheres (L) Planetary Magnetospheres (E)					
Attendance logic (if alternative selection, etc.): --					
Lecturers: Prof. Dr. Ferdinand Plaschke					
Qualifications aims: The students - understand the empirical and theoretical fundaments of plasma physics of planetary magnetospheres and are able to formulate them. - apply these fundaments to problems in planetary magnetospheres. - are able to independently select a suitable combination of methods for a given problem. - analyse the problems for this purpose and relate them back to empirical and theoretical foundations.					
Contents: Basic plasma physics, single particle motion, gyration, drifts, magnetic bottle, adiabatic invariants, distribution functions, Vlasov equation, magnetohydrodynamics, frozen-in theorem, MHD waves, flow around an obstacle, discontinuities, shocks, Rankine-Hugoniot relations, magnetospheric regions, bow shock and magnetopause, influence of the interplanetary magnetic field, magnetic reconnection, magnetospheric and ionospheric convection, Dungey-cycle, ionospheric conductivities, current systems.					
Forms of Learning: Lectures, exercises					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: homework (b) Examination: oral examination (20 min) or written examination (60 min)					
Turnus (beginning): Summer semester					
Responsible for the module: Plaschke					
Language: English, German					
Media forms: Blackboard-, smartboard-, tablet lecture, projector					
Literature: Baumjohann and Treumann: "Basic Space Plasma Physics", 3rd edition, 2022 Russel, Luhmann, and Strangeway: "Space Physics: An Introduction", 2016 Kallenrode: "Space Physics: An Introduction to Plasmas and Particles in the Heliosphere and Magnetospheres", 2001					
Explanatory comment: ---					
Categories (module groups): Compulsory elective area Special Courses					
Requirements for this module: Module 1 or module 2					
Degree programmes: Solar System Physics (BPO 2023) (Master)					
Comment on allocation: ---					

Module name: Planetary Magnetism and Dynamo Theory				Module number: PHY-IGeP-35	
Institution: Institut für Geophysik und Extraterrestrische Physik				Module abbreviation: FV-SC	
Workload:	150 h	Attendance time:	42 h	Semester:	2
Credit points:	5	Independent study:	108 h	Number of semesters:	1
Compulsory form:	elective			Sem. hours / week:	3
Courses/Main topics: Planetary Magnetism and Dynamo Theory (L) Planetary Magnetism and Dynamo Theory (E)					
Attendance logic (if alternative selection, etc.): --					
Lecturers: Dr. Daniel Heyner					
Qualifications aims: The students - understand and are able to formulate the empirical and theoretical foundations of dynamo theory. - apply these fundamentals to dynamo models in the laboratory as well as to models in the context of planetary bodies. - are able to independently select a suitable combination of methods for a given problem. - analyse the problems and trace them back to empirical and theoretical foundations.					
Contents: What is a dynamo? Where do dynamos occur in space? Magnetic field of the Earth and other planets, Induction equation. What drives convection? Experimental dynamos. Dynamo simulations.					
Forms of Learning: Lectures, exercises					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: homework (b) Examination: oral examination (20 min) or written examination (60 min)					
Turnus (beginning): Summer semester or winter semester					
Responsible for the module: Heyner					
Language: English					
Media forms: Blackboard-, smartboard-, tablet lecture, projector					
Literature: - Lowrie, Fundamentals of Geophysics, Cambridge, 2007 - Hulot, Magnetic Field of the Earth - Olson, Planetary Magnetism - Chandrasekhar, Hydrodynamic and Hydromagnetic Stability - Jacobs, Geomagnetism - Davidson, An Introduction to Magnetohydrodynamics, 2001 - Cardin, Dynamos - Olson, Core Dynamics Further literature will be announced in good time before the start of the lecture.					
Explanatory comment: ---					
Categories (module groups): Compulsory elective area Special Courses					
Requirements for this module: Module 1 or module 2					
Degree programmes: Solar System Physics (BPO 2023) (Master)					
Comment on allocation: ---					

Module name: Stellar Astrophysics				Module number: PHY-IGeP-36	
Institution: Institut für Geophysik und Extraterrestrische Physik				Module abbreviation: WSC-SA	
Workload:	150 h	Attendance time:	42 h	Semester:	2
Credit points:	5	Independent study:	108 h	Number of semesters:	1
Compulsory form:	elective			Sem. hours / week:	3
Courses/Main topics: Stellar Astrophysics (L) Stellar Astrophysics (E)					
Attendance logic (if alternative selection, etc.): --					
Lecturers: Prof. Dr. Jürgen Blum					
Qualifications aims: The students - understand and are able to formulate the empirical and theoretical foundations of star formation, stellar structure and stellar evolution. - apply their fundamentals to specific problems. - are able to independently select a suitable combination of methods for a given problem. - analyse the problems and trace them back to empirical and theoretical foundations.					
Contents: Physical understanding of the following stellar evolutionary phases: Star formation (molecular clouds, protostars, TTauri stars, Herbig Ae/Be stars), main sequence stars (stellar structure, energy production, energy transport), post-main sequence stars (RGB stars, AGB stars, supernovae, planetary nebulae), final phases of stellar evolution (white dwarfs, neutron stars, black holes).					
Forms of Learning: Lectures, exercises					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: homework (b) Examination: oral examination (20 min) or written examination (60 min)					
Turnus (beginning): Summer semester or winter semester					
Responsible for the module: Blum					
Language: English, German					
Media forms: Blackboard-, smartboard-, tablet lecture, projector					
Literature: B.W. Carroll, D.A. Ostlie. An Introduction to Modern Astrophysics (2nd edition). Cambridge University Press, 2017.					
Explanatory comment: ---					
Categories (module groups): Compulsory elective area Special Courses					
Requirements for this module: Module 1 or module 2					
Degree programmes: Solar System Physics (BPO 2023) (Master)					
Comment on allocation: ---					

Module name: Extrasolar Planetary Systems				Module number: PHY-IGeP-37	
Institution: Institut für Geophysik und Extraterrestrische Physik				Module abbreviation: WSC-EPS	
Workload:	150 h	Attendance time:	42 h	Semester:	2
Credit points:	5	Independent study:	108 h	Number of semesters:	1
Compulsory form:	elective			Sem. hours / week:	3
Courses/Main topics: Extrasolar Planetary Systems (L) Extrasolar Planetary Systems (E)					
Attendance logic (if alternative selection, etc.): --					
Lecturers: Prof. Dr. Jürgen Blum					
Qualifications aims: The students - understand and are able to formulate the empirical and theoretical foundations of the discovery and structure of extrasolar planets and their systems. - apply these fundamentals to specific problems. - are able to independently select a suitable combination of methods for a given problem. - analyse the problems and trace them back to empirical and theoretical foundations.					
Contents: Synopsis of solar system architecture; methods of exoplanet detection and characterisation; properties of exoplanets, especially mass distribution, orbits, multiple systems, resonances, mass-radius relationship and internal structure, atmospheres; comparisons with the solar system and lessons learnt on the formation and evolution of planetary bodies.					
Forms of Learning: Lectures, exercises					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: homework (b) Examination: oral examination (20 min) or written examination (60 min)					
Turnus (beginning): Summer semester or winter semester					
Responsible for the module: Blum					
Language: English					
Media forms: Blackboard-, smartboard-, tablet lecture, projector					
Literature: H.J. Deeg, J.A. Belmonte (Hrsg.). Handbook of Exoplanets. Springer International Publishing AG, 2018. In addition, current review articles on the formation of the solar system are recommended in the course.					
Explanatory comment: ---					
Categories (module groups): Compulsory elective area Special Courses					
Requirements for this module: Module 1 or module 2					
Degree programmes: Solar System Physics (BPO 2023) (Master)					
Comment on allocation: ---					

Module name: Data and Signal Analysis				Module number: PHY-IGeP-38	
Institution: Institut für Geophysik und Extraterrestrische Physik				Module abbreviation: WSC-DSA	
Workload:	150 h	Attendance time:	56 h	Semester:	2
Credit points:	5	Independent study:	94 h	Number of semesters:	1
Compulsory form:	elective			Sem. hours / week:	4
Courses/Main topics: Data and Signal Analysis (L) Data and Signal Analysis (E)					
Attendance logic (if alternative selection, etc.): --					
Lecturers: Prof. Dr. Ferdinand Plaschke					
Qualifications aims: The students - understand and are able to formulate the empirical and theoretical foundations of time-series analysis. - apply these fundamentals to problems of analysing measurement data. - are able to independently select a suitable combination of methods for a given problem. - analyse the problems and trace them back to empirical and theoretical foundations.					
Contents: Definitions, sampling rate, Nyquist frequency, expectation value, ergodic hypothesis, estimator, bias, probability density functions and their determination, moments, law of large numbers, confidence intervals, Z-transform, covariance and correlation, linear regression, method of the analytic signal, Fourier-transform, spectra, leakage, window functions, polarization analysis, empirical mode decomposition, short term Fourier-transform, wavelets, scalograms, minimum variance analysis, basics of filter theory, transmission systems, impulse response, stability					
Forms of Learning: Lectures, exercises					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: homework (b) Examination: oral examination (20 min) or written examination (60 min)					
Turnus (beginning): Winter semester					
Responsible for the module: Plaschke					
Language: English, German					
Media forms: Blackboard-, smartboard-, tablet lecture, projector					
Literature: Woyczynski: "A First Course for Signal Analysis", 2019 McMahon: "Signals & Systems Demystified", 2006 Glassmeier and Motschmann: "Comments on Time-Series Analysis", 1995 Paschmann and Daly: "Analysis Methods for Multi-Spacecraft Data", 1998					
Explanatory comment: ---					
Categories (module groups): Compulsory elective area Special Courses					
Requirements for this module: Module 1 or module 2					
Degree programmes: Solar System Physics (BPO 2023) (Master)					
Comment on allocation: ---					

Module name: Comets and TNOs				Module number: PHY-IGeP-40	
Institution: Institut für Geophysik und Extraterrestrische Physik				Module abbreviation: WSC-CT	
Workload:	150 h	Attendance time:	42 h	Semester:	2
Credit points:	5	Independent study:	108 h	Number of semesters:	1
Compulsory form:	elective			Sem. hours / week:	3
Courses/Main topics: Comets and TNOs (L) Comets and TNOs (E)					
Attendance logic (if alternative selection, etc.): --					
Lecturers: Prof. Dr. Jessica Agarwal					
Qualifications aims: The students - can give an overview of the populations of TNOs and comets in the solar system and over past space missions to such objects. - understand basic physical processes occurring in comets and TNOs - can explain measurement methods relevant to cometary science and apply them in the approach - can describe physical models currently used in commentary research and apply them in the approach.					
Contents: The topic of the lecture is small bodies beyond the orbit of Neptune (Trans-Neptunian Objects, TNOs) and comets. The lecture will present what we have learned about the composition and interior structure of these objects from space missions and astronomical observations, how they evolve under the influence of solar irradiation, and which information they can give us about the early solar system and the process of planet formation.					
Forms of learning: Lectures, exercises					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: homework (b) Examination: oral examination (20 min) or written examination (60 min)					
Turnus (beginning): Winter semester					
Responsible for the module: Agarwal					
Language: English					
Media forms: Blackboard-, smartboard-, tablet lecture, projector					
Literature: - Comets II, Eds. M. Festou, H.-U. Keller, H. A. Weaver, University of Arizona Press, 2004 (all files available online) - Planetary Sciences, 2nd edition, I. de Pater & J. Lissauer, Cambridge University Press, 2015 - Encyclopedia of the Solar System, 2nd edition, eds. L.-A. McFadden, P. R. Weissman, T. V. Johnson, Elsevier Academic Press, 2007					
Explanatory comment: ---					
Categories (module groups): Compulsory elective area Special Courses					
Requirements for this module: Module 1 or module 2					
Degree programmes: Solar System Physics (BPO 2023) (Master)					
Comment on allocation: ---					

Module name: Asteroids				Module number: PHY-IGeP-41	
Institution: Institut für Geophysik und Extraterrestrische Physik				Module abbreviation: WSC-A	
Workload:	150 h	Attendance time:	42 h	Semester:	2
Credit points:	5	Independent study:	108 h	Number of semesters:	1
Compulsory form:	elective			Sem. hours / week:	3
Courses/Main topics: Asteroids (L) Asteroids (E)					
Attendance logic (if alternative selection, etc.): --					
Lecturers: Prof. Dr. Jessica Agarwal					
Qualifications aims: The students - recognise the different classes of asteroids and meteorites - can describe the role of asteroids and meteorites in the wider context of the solar system - understand and can describe the most relevant measurement methods used in asteroid research - explain basic physical processing actin on asteroids					
Contents: The lecture deals with asteroids in our solar system. Three major methods of asteroid research will be presented: 1. meteorite research, 2. astronomical observations, 3. exploration with space probes. The lecture outlines the classification of asteroids and its connection with the composition of asteroids. Also physical processes driving asteroid evolution and their connection with the formation of the solar system will be discussed.					
Forms of learning: Lectures, exercises					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: homework (b) Examination: oral examination (20 min) or written examination (60 min)					
Turnus (beginning): Summer semester					
Responsible for the module: Agarwal					
Language: English					
Media forms: Blackboard-, smartboard-, tablet lecture, projector					
Literature: - Burbine, T.H., 2017, Asteroids. Cambridge University Press. - Michel, P., DeMeo, F., Bottke, W.F. (Hrsq.) 2015. Asteroids IV. The University of Arizona Press. - Planetary Sciences, 2nd edition, I. de Pater & J. Lissauer, Cambridge University Press, 2015 - Encyclopedia of the Solar System, 2nd edition, eds. L.-A. McFadden, P. R. Weissman, T. V. Johnson, Elsevier Academic Press, 2007					
Explanatory comment: ---					
Categories (module groups): Compulsory elective area Special Courses					
Requirements for this module: Module 1 or module 2					
Degree programmes: Solar System Physics (BPO 2023) (Master)					
Comment on allocation: ---					

Module name: Solar System Space Missions				Module number: PHY-IGeP-42	
Institution: Institut für Geophysik und Extraterrestrische Physik				Module abbreviation: WSC-ST	
Workload:	150 h	Attendance time:	42 h	Semester:	2
Credit points:	5	Independent study:	108 h	Number of semesters:	1
Compulsory form:	elective			Sem. hours / week:	3
Courses/Main topics: Space Technologies (L) Space Technologies (E)					
Attendance logic (if alternative selection, etc.): --					
Lecturers: Prof. Dr. Joachim Block					
Qualifications aims: The students - understand the historical development of space technology since the 1960s and can correlate the benchmarks of this technical development with the discrete steps of increasing knowledge about the planets, moons, and small bodies of the solar system (which was gained mission by mission). - are able to specify, estimate, and substantiate the basic requirements of orbit mechanics for the accessibility of different destinations in the solar system (e.g. Hohmann trajectories, gravity-assist manoeuvres, flight durations, etc.). - are able to specify the basic requirements for the design of an interplanetary spacecraft which shall be bound for a given destination (e.g.: When is it inevitable to base on-board power generation on RPGs instead of solar arrays? Which subsystems will need multiple redundancy?). - are able to select a suited effective combination of different types of PI instruments for the scientific payload of an envisaged interplanetary science mission bound for a given destination. - can compare any envisioned future mission scenarios with historical missions that have already been successfully performed.					
Contents: All historically important science missions in the solar system which have been performed since the beginning of the space age (around \approx 1960) are being thoroughly discussed. This includes both the technology of their on-board systems and of their PI instruments. It will be shown that the enormous increase of knowledge about the sun, the planets, moons, and small bodies of the solar system has been achieved in discrete steps which were coupled with the individual space missions and with the development status (or maturity) of their instruments. Based on this, the requirements for any future science missions will be discussed.					
Forms of learning: Lectures, exercises					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: homework (b) Examination: oral examination (20 min) or written examination (60 min)					
Turnus (beginning): Summer semester					
Responsible for the module: Block					
Language: English					
Media forms: Blackboard-, smartboard-, tablet lecture, projector					
Literature: A current selection of literature will be announced in good time before the start of the semester.					
Explanatory comment: ---					
Categories (module groups): Compulsory elective area Special Courses					
Requirements for this module: Module 1 or module 2					

Degree programmes: Solar System Physics (BPO 2023) (Master)
Comment on allocation: ---

Module name: Space Missions and Project Management				Module number: PHY-IGeP-43	
Institution: Institut für Geophysik und Extraterrestrische Physik				Module abbreviation: WSC-MPM	
Workload:	150 h	Attendance time:	42 h	Semester:	2
Credit points:	5	Independent study:	108 h	Number of semesters:	1
Compulsory form:	elective			Sem. hours / week:	3
Courses/Main topics: Space Missions and Project Management (L) Space Missions and Project Management (E)					
Attendance logic (if alternative selection, etc.): --					
Lecturers: Prof. Dr. Joachim Block					
Qualifications aims: The students - understand how scientific space mission (in particular missions bound for destinations in the solar system) are structured in terms of project management, how their basic conception is - at first - being discussed within the scientific community, and how the projects are finally being selected and organized (in Europe mainly by ESA). - understand the role and responsibility of the Principal Investigators (PI's) during and after the "Announcement of Opportunity" (AO). - gain a thorough understanding of the importance of firm project phases with intermediate "Peer Reviews" and the corresponding management tools (RID's, NCR's, systematic project documentation, FMECA, risk analyses, "breadboard" and official qualification models, qualification and acceptance tests, etc.). - are enabled to define the organisation of a fictional project review (e.g. a PDR) for a hypothetically envisaged science mission: Which qualification levels and documentation standards would be required, what kind of experts should be asked for participation as "peers", which kind of RID's would be "major"? - are able to justify their proposals by examples and experiences from the real history of science missions in the solar system, as they will have been discussed in the preceding lectures.					
Contents: The whole course of project planning for scientific missions is being thoroughly discussed, from the first conceptual ideas and feasibility studies (phase A) via design and qualification of the spacecraft (phases B and C) and the construction of the flight model (phase D) until the launch campaign. Subsequently the typical course of a scientific mission (phase E) is taken into consideration. The discussions are geared towards outstanding examples of historical missions into the solar system.					
Forms of learning: Lectures, exercises					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: homework (b) Examination: oral examination (20 min) or written examination (60 min)					
Turnus (beginning): Winter semester					
Responsible for the module: Block					
Language: English					
Media forms: Blackboard-, smartboard-, tablet lecture, projector					
Literature: A current selection of literature will be announced in good time before the start of the semester.					
Explanatory comment: ---					
Categories (module groups): Compulsory elective area Special Courses					
Requirements for this module: Module 1 or module 2					
Degree programmes: Solar System Physics (BPO 2023) (Master)					

Comment on allocation:

Module name: Astroparticle Physics				Module number: PHY-ITHPH-20	
Institution: Institut für Geophysik und Extraterrestrische Physik				Module abbreviation: WSC-APP	
Workload:	150 h	Attendance time:	42 h	Semester:	2
Credit points:	5	Independent study:	108 h	Number of semesters:	1
Compulsory form:	elective			Sem. hours / week:	3
Courses/Main topics: Astroparticle Physics (L) Astroparticle Physics (E)					
Attendance logic (if alternative selection, etc.): --					
Lecturers: Prof. Dr. Yasuhito Narita					
Qualifications aims: The students - acquire the overview of the state-of-the-art elementary particle physics (construction of the Standard Model and historical review), which plays an important role in the solar system and astrophysics. - can actively apply the knowledge and methods of particle physics to the solar system phenomena (solar plasma, solar neutrinos, energetic particle) in context to astrophysics and cosmology.					
Contents: History of elementary particle physics, overview of the Standard Model of elementary particles (fermions and bosons), baryons and leptons, Higgs bosons, collective motion (plasma state), nuclear astrophysics (pp-chain, CNO cycle, nuclear fusion, baryosynthesis) mystery of solar neutrinos, galactic cosmic rays above 1 GeV (measurements, mechanisms, modulation in the solar system. relation to the solar variability. primary and secondary particles, air shower), Solar Energetic Particles in range from 1 MeV to 1 GeV, X-rays and gamma-rays, search for dark matter and dark energy in the solar system.					
Forms of learning: Lectures, exercises					
Examination modalities / Requirements for the award of credit points: (a) Examination: oral examination (20 min) or written examination (60 min)					
Turnus (beginning): Summer semester					
Responsible for the module: Narita					
Language: English					
Media forms: Blackboard-, smartboard-, tablet lecture, projector					
Literature: Astroparticle Physics (Springer, 2005), literature will be announced in the lecture.					
Explanatory comment: ---					
Categories (module groups): Compulsory elective area Special Courses					
Requirements for this module: ---					
Degree programmes: Solar System Physics (BPO 2023) (Master)					
Comment on allocation: ---					

Research phase

Module name: Scientific Key Qualifications				Module number: PHY-IGeP-44	
Institution: Institut für Geophysik und Extraterrestrische Physik				Module abbreviation: FP-SKQ	
Workload:	300 h	Attendance time:	84 h	Semester:	1
Credit points:	10	Independent study:	216 h	Number of semesters:	2
Compulsory form:	mandatory			Sem. hours / week:	6
Courses/Main topics: Scientific Programming Scientific Communication					
Attendance logic (if alternative selection, etc.): --					
Lecturers: Prof. Dr. Andreas Hördt Prof. Dr. Ferdinand Plaschke Prof. Dr. Jürgen Blum Prof. Dr. Jessica Agarwal Prof. Dr. Yasuhito Narita					
Qualifications aims: The students - can solve numerical problems efficiently with the help of self-created programs. - can analyse extensive data sets with the help of self-created programs. - can visualise the results of their analyses and model calculations in an appealing way - can carry out scientific searches - can communicate specialised knowledge in writing. - can communicate specialised knowledge in the form of lectures. - can communicate in a team.					
Contents: Scientific programming and scientific communication are part of the scientific key qualifications. During the course "Scientific Programming" the students should learn modern simulations, modelling and data analysis techniques. The course "Scientific Communication" has two central aspects: 1. The communication of scientific content to the scientific community, e. g. writing of publication, presenting results, and communication within a team. 2. Communication of scientific content to the general public.					
Forms of learning: Lectures, exercises, internship, seminar					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: homework (b) Examination: oral presentation					
Turnus (beginning): Each semester					
Responsible for the module: Plaschke					
Language: English					
Media forms: Blackboard-, smartboard-, tablet lecture, projector, electronic handouts					
Literature: ---					
Explanatory comment: ---					
Categories (module groups): Research phase					
Requirements for this module: ---					
Degree programmes: Solar System Physics (BPO 2023) (Master)					

Comment on allocation:

Module name: Literature Research				Module number: PHY-IGeP-45	
Institution: Institut für Geophysik und Extraterrestrische Physik				Module abbreviation: FP-LR	
Workload:	150 h	Attendance time:	28 h	Semester:	3
Credit points:	5	Independent study:	122 h	Number of semesters:	1
Compulsory form:	mandatory			Sem. hours / week:	2
Courses/Main topics: Oberseminar Geo- und Astrophysik (OS) Seminar Angewandte Geophysik (S) Seminar Sonnensystemastronomie (S) Seminar Planetenentstehung und kleine Körper (S) Seminar Weltraumphysik und –sensorik (S)					
Attendance logic (if alternative selection, etc.): ---					
Lecturers: Prof. Dr. Andreas Hördt Prof. Dr. Ferdinand Plaschke Prof. Dr. Jürgen Blum Prof. Dr. Jessica Agarwal Prof. Dr. Yasuhito Narita					
Qualifications aims: The students - are able to assess the state of the art in a field of solar system research. - can read scientific papers in a goal-oriented manner and reproduce the essential contents in their own words. - are able to structure and organise their own research work. - are able to present the results of their own work to an expert audience in written and oral form in a professional manner.					
Contents: The module encompasses various techniques to conduct literature research. These techniques involve utilising literature databases, managing literature references in conjunction with a word processing program, and the generation of comprehensive literature lists. In addition, current scientific research of the working groups of the participating institutes is presented and discussed in subject-specific seminars. In doing so, the students learn to follow the content of oral presentations and to discuss them critically. The students also learn how to create meaningful scientific illustrations, prepare and give their own presentations, and engage in critical discussions about their own results. Likewise, students learn to prepare their own technical and scientific activities and to place them in an overall scientific context.					
Forms of learning: Seminar					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: oral presentation					
Turnus (beginning): Each semester					
Responsible for the module: Hördt					
Language: English					
Media forms: Blackboard lecture, oral presentation					
Literature: Depending on the topic of the Master's thesis.					
Explanatory comments: ---					
Categories (module groups): Research phase					
Requirements for this module: ---					

Degree programmes: Solar System Physics (BPO 2023) (Master)
Comment on allocation: ---

Module name: Research Internship				Module number: PHY-IGeP-46	
Institution: Institut für Geophysik und Extraterrestrische Physik				Module abbreviation: FP-RI	
Workload:	450 h	Attendance time:	400 h	Semester:	3
Credit points:	15	Independent study:	50 h	Number of semesters:	2
Compulsory form:	mandatory			Sem. hours / week:	15
Courses/Main topics: Oberseminar Geo- und Astrophysik (OS) Seminar Angewandte Geophysik (S) Seminar Sonnensystemastronomie (S) Seminar Planetenentstehung und kleine Körper (S) Seminar Weltraumphysik und –sensorik (S) Forschungspraktikum (P)					
Attendance logic (if alternative selection, etc.): The research internship and one of the seminars offered are studied.					
Lecturers: Prof. Dr. Andreas Hördt Prof. Dr. Ferdinand Plaschke Prof. Dr. Jürgen Blum Prof. Dr. Jessica Agarwal Prof. Dr. Yasuhito Narita					
Qualifications aims: The students acquire experimental and theoretical skills to carry out research. In close contact with the chosen research group, the students lay the technical and experimental foundations for their future master projects. They acquire the skills to independently carry out experiments or theoretical investigations that are relevant for the thesis project. They acquire the skills to professionally present their own work and results in a scientific context.					
Contents: 10-week internship on a research topic in solar system physics [in mutual understanding with the master thesis advisor] to familiarise themselves with the theoretical and experimental methods required to carry out the thesis project. For experimental work this includes mainly pre-experiments in the context of the future thesis project, design of components for the experiments, construction of experimental set-ups, ordering of hardware components, and shadowing visits to on-going experiments in the research group. For a theory-based project, students will familiarise themselves with relevant software packages, the development of small pieces of software, test calculations and shadowing visits to the on-going work in the research group. Also attendance of so-called summer- or winter-schools (e.g., the ESA academy) and studies abroad can become part of this module.					
Forms of learning: Project work					
Examination modalities / Requirements for the award of credit points: (a) Study achievement: successful execution of the research internship (b) Examination: oral presentation on the contents and objectives of the Master's thesis					
Turnus (beginning): Each semester					
Responsible for the module: Agarwal					
Language: English					
Media forms: ---					
Literature: The required literature is specified by the supervisor.					
Explanatory comment: ---					
Categories (module groups): Research phase					

Requirements for this module: ---
Degree programmes: Solar System Physics (BPO 2023) (Master)
Comment on allocation: ---

Module name: Master Thesis				Module number: PHY-IGeP-47	
Institution: Studiendekanat Physik				Module abbreviation: FP-MT	
Workload:	900 h	Attendance time:	30 h	Semester:	3
Credit points:	30	Independent study:	870 h	Number of semesters:	2
Compulsory form:	mandatory			Sem. hours / week:	0
Courses/Main topics: Betreuung von Masterarbeiten - Agarwal Betreuung von Masterarbeiten - Blum Betreuung von Masterarbeiten - Hördt Betreuung von Masterarbeiten - Plaschke Betreuung von Masterarbeiten - Narita					
Attendance logic (if alternative selection, etc.): It is recommended to start the Master's thesis only after completion of the other course belonging to the Master's programme.					
Lecturers: Lecturers of the Physics department					
Qualifications aims: The students are able to work on a topic in the field of solar system physics under guidance using scientific methods within a given time limit. In doing so, they show that they understand technical correlations and can expand scientific knowledge boundaries. They can present and assess the procedure and results in the form of a paper. The students can organise their own scientific project.					
Contents: Independent work (under supervision) on a topic from the field of solar system physics using scientific methods and writing of a scientific thesis within a given deadline. The contents depend on the topic of the thesis and lie in the field of experimental and theoretical solar system physics.					
Forms of learning: Independent but supervised academic work; structured supervision meetings					
Examination modalities / Requirements for the award of credit points: Examination: Master Thesis					
Turnus (beginning): Each semester					
Responsible for the module: Office of the Dean of Studies in Physics					
Language: English					
Media forms: ---					
Literature: To be determined individually with the supervisor of the Master's thesis.					
Explanatory comment: The Master's thesis includes working independently on a scientific topic and writing a scientific paper on the results within a period of eight months. The period is calculated from the issue of the topic the submission of the thesis. The Master' thesis must be written in English; other languages may be approved by the examination board upon application.					
Categories (module groups): Research phase					
Requirements for this module: ---					
Degree programmes: Solar System Physics (BPO 2023) (Master)					
Comment on allocation: ---					