Note:

The following curriculum is a consolidated version. It is legally non-binding and for informational purposes only.

The legally binding versions are found in the University of Innsbruck Bulletins (in German).

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Curriculum for the
Erasmus Mundus Joint Master Program in Astrophysics
at the Faculty of Mathematics, Computer Science and Physics of the University of Innsbruck

§ 1 Description of the Erasmus Mundus Joint Master Program in Astrophysics and its organization

(1) This study programme is European-oriented and based on a cooperation between the University of Innsbruck (in the following abbreviated as IBK) as coordinating institution (letter of notification 159523-1-2009-1-AT-ERA MUNDUS-EMMC of 15 July 2009), and the Partner Institutions Padua (PD), Rome (Roma), Göttingen (GÖ) und Belgrade (BG). It is a study programme within the frame of the Programme of Excellence Erasmus Mundus of the European Commission in which high quality education in the field of Astrophysics will be imparted and where especially the complementary expertise of the Partner universities will be utilized.

(2) The international focus of the course of studies involves that all participating students will complete the first semester (S1) at the coordination University in Innsbruck. The second semester (S2) is offered at the University of Padua and the University of Rome and can be completed at one of those two institutions according to the choice of each student. The third semester is provided by the Universities of Rome, Göttingen and Belgrade and can be spent at one of those institutions. The fourth semester (S4) includes the master thesis and the thesis defence (Defensio) and may be completed at each one of the participating institutions depending on the specialization of the student.

(3) For a successful competition of the Erasmus Mundus Joint Master Program in Astrophysics the acquisition of at least 120 ECTS-Credits is required. The guidelines of the Erasmus Mundus Call 2009-2013 (EAC/04/2009) and the Programme Guide for EMMCs (Action 1A) and the thereof resulting Framework Agreement 2010-0135/001 of 23 November 2009, the Agreement on an Erasmus Mundus Joint Master Program in Astrophysics of 20 January 2010 as well as the Consortium Agreement with the annexes 1 to 10 and the addendum of 22 January 2010 apply.

(4) The degree will be awarded together with a joint official certificate.

§ 2 Qualification Profile

(1) The Erasmus Mundus Joint Master Program is assigned to the field of the Studies of Natural Sciences.

(2) With the support of a special programme of excellence the international study programme of Astrophysics broadens the bachelor studies of Physics with further knowledge and qualifications in order to enable students to carry out highly qualified, independent and innovative research and development projects.

(3) Moreover, students will learn problem solving strategies which will qualify them to gain new knowledge in the research and/or innovative field and to develop new procedures as well as to integrate knowledge of different areas. This will be achieved by deepened studies of chosen prevailing sections together with an international involvement in modern research and increased mobility.

(4) Graduates of this programme possess a crucial awareness for questions regarding education and are qualified to act competently and successfully at interfaces between individual research areas but also between different scientific cultures which is last but not least due to the internationality of the study programme.

§ 3 Scope and Duration

The Erasmus Mundus Joint Master Program in Astrophysics comprises 120 ECTS-Credits; which equals a duration of study of 4 semesters. One ECTS-Credit equals a workload of about 25 hours.

§ 4 Admission, number of students and selection procedure

(1) A prerequisite for the admission to the Erasmus Mundus Joint Master Program in Astrophysics is a bachelor degree or an equivalent study programme from an accredited domestic or foreign educational institution at university level. In case equivalence is in general given and only individual supplements are necessary for complete equivalence the rector’s office is entitled to ask for additional exams during the Master Course in order to ascertain the equivalence.

(2) Equivalent studies according to par. 1 are all studies in the field of Physics, Astronomy or Astrophysics whereas equivalence is given in case of study duration of three years respectively 180 ECTS-Credits.

(3) According to the Agreement on Cooperation (Framework Agreement 2010-0135/001 of 23 November 2009, Annex I, Part E) the number of students is limited to 40.

(4) The admission of students will be performed by the rector’s office. The admission procedure based on the contract to establish the programme will be disclosed by the rector’s office separately.

§ 5 Language

Studies will be held in English with the exception of the optional modules for language training (§ 8 (2) No 10 and No 11).

§ 6 Courses and maximum number of participants

(1) Courses without continuous assessment:

Lectures (VO) are courses held in lecture format. They introduce the research areas, methods and schools of thought for a given subject.

(2) Courses with continuous assessment:

1. Introductory seminars (PS 'Proseminare') introduce students interactively to scientific literature through the treatment of selected issues. They convey knowledge and methods of academic work. Maximum number of participants for compulsory modules: 5, Maximum

number of participants for elective modules: 25

2. Seminars (SE 'Seminare') provide in-depth treatment of scientific topics through students' presentations and discussion thereof. Maximum number of participants: 15
3. Practical training courses (PR 'Praktika') provide practical experience with concrete scientific tasks, complementing occupational and academic training. Maximum number of participants: 10

§ 7 Procedure for the allocation of places in courses with a limited number of participants

In courses with a limited number of participants places will be allocated as follows:

1. Students for whom a postponement would mean a prolongation of their study period have to be preferred.
2. If criterion No 1 is not sufficient for the regulation of the admission to a course then students have to be preferred if the course is part of the compulsory module and then those students should be admitted for whom the course is part of an elective module.
3. In case criteria No 1 and No 2 are not sufficient for the regulation of the admission to a course the available places will be drawn.

§ 8 Compulsory- and elective modules

(1) In the first semester (S1) all students of the Erasmus Mundus Joint Master Program in Astrophysics have to successfully complete the following compulsory modules to the extent of 25 ECTS-Credits:

1.	**Compulsory Module: Concepts of Galactic Astrophysics**	**h**	**ECTS-Credits**
a.	**VO Concepts of Galactic Astrophysics** Hydrodynamics of the stellar interior, stellar evolution and details of the nuclear processes, structure and dynamics of the Galaxy, the Galaxy in the global context, interstellar matter, (extrasolar-)planets	2	3
b.	**PS Concepts of Galactic Astrophysics** Calculus and applications regarding the contents of the lectures.	2	3.5
	Total	**4**	**6.5**
	Learning objectives of the module: Attendees of this module should fully understand the contents of the lecture as well as reproduce and apply them. They should have acquired the skill to work out further concepts of galactic astrophysics independently.		
	Prerequisite(s): none		

2.	**Compulsory Module: Concepts of Extragalactic Astrophysics**	**h**	**ECTS-Credits**
a.	**VO Concepts of Extragalactic Astrophysics** Galaxies: properties, formation and evolution, active galactic nuclei, groups and clusters of galaxies, cosmology, telescopes	2	3
b.	**PS Concepts of Extragalactic Astrophysics** Calculus and applications regarding the contents of the lectures.	2	3.5
	Total	**4**	**6.5**

	Learning objectives of the module: Attendees of this module should fully understand the contents of the lecture as well as reproduce and apply them self-dependently. They should have acquired the skill to work out further concepts of extra- galactic astrophysics and cosmology independently.
	Prerequisite(s): none

3.	**Compulsory Module: Concepts of Physics for Astrophysicists**	**h**	**ECTS-Credits**
a.	**VO Concepts of Physics for Astrophysicists** radiation processes in astrophysics: fundamentals of radiative transfer, basic theory of radiation fields, radiation from moving charges, relativistic covariance and kinematics, bremsstrahlung, synchrotron radiation, Compton scattering, plasma effects, atomic structure, radiative transitions, molecular structure	2	3
b.	**PS Concepts of Physics for Astrophysicists** Calculus and applications regarding the contents of the lectures.	2	3
	Total	**4**	**6**
	Learning objectives of the module: Attendees of this module should fully understand the contents of the lecture as well as reproduce and apply them self-dependently. They master basic techniques in physics within the frame of the common astrophysical overview.		
	Prerequisite(s): none		

4.	**Compulsory Module: Advanced Mathematical Methods for Astrophysicists**	**h**	**ECTS-Credits**
a.	**VO Advanced Mathematical Methods for Astrophysicists** Numerical methods and statistics applied to astrophysics problems: theory of distributions, principal component analysis, maximum likelihood method, Bayesian likelihood analysis, Monte Carlo modelling, bootstrap and jack-knife, statistical properties of Fourier transforms, filtering, two-point angular correlation function, counts in cells.	2	3
b.	**PS Advanced Mathematical Methods for Astrophysicists** Calculus and applications regarding the contents of the lectures.	2	3
	Total	**4**	**6**
	Learning objectives of the module: Attendees of this module master numeric, mathematical and statistical methods and apply those for the solution of problems within astrophysics according to the contents of lectures and are able to use those methods self-dependently.		
	Prerequisite(s): none		

(2) Within the first semester (S1) all students of the Erasmus Mundus Joint Master Program in Astrophysics have to attend optional modules to the extent of 5 ECTS-Credits:

1.	**Elective Module: Basic Concepts of Quantum Physics**	**h**	**ECTS-Credits**
	VO Basic Concepts of Quantum Physics Basic information for the understanding of research relevant topics from the atomic physics, molecular physics, quantum optics and quantum information: Light - matter interaction, coherence effects, interferometry, folding, matter waves, quantum gases, precision measuring, macroscopic quantum phenomena.	3	5
	Total	**3**	**5**
	Learning objectives of the module: Attendees of this module should fully understand the contents of the lecture as well as reproduce and apply them. They should have acquired the skill to work out further basic concepts of quantum physics self-dependently. Moreover, they should have obtained a basic understanding for the research oriented way of thinking within the field of the quantum physics.		
	Prerequisite(s): none		

2.	**Elective Module: Basic Concepts of Ion, Plasma, and Applied Physics**	**h**	**ECTS-Credits**
	VO Basic Concepts of Ion, Plasma, and Applied Physics Electron / ions - matter interaction, plasmas in nature and technology, behaviours of plasmas, concepts the nuclear fusion and energy physics, molecule physics, mass spectrometry and analysis method, cluster physics and nanotechnology, nonlinear dynamics, bases the electrical engineering.	3	5
	Total	**3**	**5**
	Learning objectives of the module: Attendees of this module should fully understand the contents of the lecture as well as reproduce and apply them. They should have acquired the skill to work out further basic concepts of Ion, Plasma, and Applied Physics independently. Moreover, they should have obtained a basic understanding for the research oriented way of thinking within the field of Ion, Plasma and Applied Physics.		
	Prerequisite(s): none		

3.	Elective Module: Basic Concepts of Astro and Particle Physics	h	ECTS-Credits
	VO Basic Concepts of Astro and Particle Physics Galactic and extragalactic dynamics, cosmology, structure formation and structure development, dark matter/energy, gamma and X-ray astrophysics, relativistic kinematics, electromagnetic, strong and weak elementary processes, Feynman diagrams, hadron systematics, quark hypothesis and chromodynamics, electric weak union.	3	5
	Total	**3**	**5**
	Learning objectives of the module: Attendees of this module should fully understand the contents of the lecture as well as reproduce and apply them. They should have acquired the skill to work out further basic concepts of Astro and particle physics self-dependently. Moreover, they should have obtained a basic understanding for the research oriented way of thinking within the field of Astro and Particle Physics.		
	Prerequisite(s): none		

4.	Elective Module: Relativity	h	ECTS-Credits
	VO Relativity Minkowski geometry, pseudo-Riemann geometry, Einstein equations, Schwarzschild-Kruskal solutions, cosmology (Robertson-Walker solution)	3	5
	Total	**3**	**5**
	Learning objectives of the module: Attendees of this module should fully understand the contents of the lecture as well as reproduce and apply them. They should have acquired the skill to work out further topics of the theory of relativity self-dependently.		
	Prerequisite(s): none		

5.	Elective Module: Astroparticle Physics	h	ECTS-Credits
	VO Astroparticle Physics astrophysical nucleosynthesis, extensive structures, interstellar medium; standard model of the non-gravitational forces as a calibrating theory, radiation corrections, experimental tests; cosmic radiation, neutrinos	2	2.5
	Total	**2**	**2.5**
	Learning objectives of the module: Attendees of this module should fully understand the contents of the lecture as well as reproduce and apply them. They should have acquired the skill to work out further topics of the astroparticle physics self-dependently. Moreover, they should have obtained a basic understanding of astroparticle physics.		
	Prerequisite(s): none		

6.	Elective Module: Special Lectures	h	ECTS-Credits
	VO Special lectures Chosen topics from the astro and particle physics as offered within the Curriculum Master Physics (e.g.: theory of gravitational lenses, variable stars, introduction to radioastronomy, recent results of galactic research, solar and stellar physics, signal processing, physics of dust, physics of star clusters, …)	2	2.5
	Total	**2**	**2.5**
	Learning objectives of the module: Attendees of this module should fully understand the contents of the lecture as well as reproduce and apply them. They should have acquired the skill to work out further topics of the astro and particle physics independently. Moreover, they should have acquired a deepened understanding for chosen topics of Astro and particle physics.		
	Prerequisite(s): none		

7.	Elective Module: Statistics and Detectors	h	ECTS-Credits
a.	**VO Statistics and Detectors** Basic statistical tests, mathematical background and requirements, small event number statistics, ideal and real detectors, physics of important detectors and their capabilities, data reduction techniques, analysis and interpretation, faulty and nonlinear qualities of detectors and correction possibilities, analysis of time series data.	2	2.5
b.	**PS Statistics and Detectors** Discussion, consolidation and application of content of lecture; training at a computer.	1	2.5
	Total	**3**	**5**
	Learning objectives of the module: Attendees of this module should fully understand the contents of the lecture as well as reproduce and apply them. They should have acquired the skill to work out further contents of statistics and detectors self-dependently. Furthermore, they should have obtained a basic understanding for statistics and detectors.		
	Prerequisite(s): none		

8.	Elective Module: Computational Methods in Physics and Astrophysics	h	ECTS-Credits
	VO Computational Methods in Physics and Astrophysics Various techniques to simulate fluids, plasmas and N-body systems, applications in several examples of cosmic objects, investigating numerical stability.	2	5
	Total	**2**	**5**
	Learning objectives of the module: Attendees of this module should fully understand the contents of the lecture as well as reproduce and apply them. They should have acquired the skill to work out further contents of numerical mathematics. Moreover, they should have acquired a basic understanding for numerical mathematics.		
	Prerequisite(s): none		

9.	Elective Module: Astrophysics Seminar (Seminar AT)	h	ECTS-Credits
	SE Astrophysics Seminar (Seminar AT) Independent preparation and composition of a talk on a technical or scientific problem. Its content should go beyond the topics covered by the previous studies towards new scientific results.	2	5
	Total	**2**	**5**
	Learning objectives of the module: Attendees of this module should fully understand the contents of the lecture as well as reproduce and apply them. They should have acquired the skill to work out independently further contents of the theory of relativity. Attendees of this module should be in a position to deal with problems of the astroparticle physics in a creative and methodically correct way and to present the result of this examination comprehensibly in written and oral form.		
	Prerequisite(s): none		

10.	Elective Module: German as Foreign Language	h	ECTS-Credits
	SE German as Foreign Language	2	2.5
	Total	**2**	**2.5**
	Learning objectives of the module: Attendees of this module are able to introduce themselves and others and are able to communicate and answer simple questions.		
	Prerequisite(s): none		

11.	Elective Module: Gender in Science	h	ECTS-Credits
	SE Gender in science	1	2.5
	Total	**1**	**2.5**
	Learning objectives of the module: Students should possess basic knowledge of gender in science (on the one hand regarding the dimension „women in science“, that is knowledge with respect to scientists for example in the field of physics/astrophysics and on the other hand the dimension „gender in science“, that is knowledge regarding the gender dimension in the culture of science and in the research area). Moreover, they should be aware of relevant equal treatment programmes at university level and EU level in the field of „science and research“.		
	Prerequisite(s): none		

(3) Modules of the second (S2) and third (S3) semester are to be completed at the partner universities according to § 1 (2). An overview for orientation of the second (S2) and the third (S3) semester can be found in the curricula of the partner universities.

(4) If the fourth semester (S4) is spent in Padua, Rome, Göttingen or Belgrade, a master thesis with defense with a total of 30 ECTS-Credits has to be written at one of these partner universities.

(5) If the fourth semester (S4) is spent at the Innsbruck University according to § 1 (2), the master thesis has to be written in Innsbruck and also the following study-concluding compulsory module covering 2.5 ECTS-Credits to be completed:

1.	Compulsory Module: Master’s Thesis Defense	h	ECTS-Credits
	Study-concluding oral defense of master thesis in front of examination senate.		2.5
	Total		**2.5**
	Learning objectives of the module: Reflection of master thesis in the global context of the Erasmus Mundus Joint Master Program in Astrophysics. In the foreground will be theoretical understanding, methodical fundamentals, imparting of results of the master thesis and presentation skills.		
	Prerequisite(s): successful completion of all other compulsory modules and of the required complementary / elective modules as well as of the master thesis		

§ 9 Master’s Thesis

(1) If the master thesis within the Erasmus Mundus Joint Master Program in Astrophysics is written at the Innsbruck University according § 1 (2), it has to amount to 27.5 ECTS-Credits. The master thesis is a scientific thesis which serves the proof of the qualification to work out a scientific subject independently and with regard to contents and methods in a suitable way.

(2) The subject of the master thesis has to be closely connected with the field of research of astrophysics or astroparticle physics.

(3) The student is entitled to propose the subject of the master thesis or to choose from a number of proposals.

§ 10 Study and examination regulations

(1) All students have to take an exam about the contents of each lecture in a compulsory or elective module. The supervisor of the module will inform the students at the beginning of each course if it will be held in written or oral form.

(2) With respect to seminars successful participation, a lecture and a written seminar thesis will be assessed.

(3) For all other courses with the exam mode “continuous assessment of course work” the assessment criteria will be announced by the supervisor respectively lecturer before starting the course.

(4) Each module will be regarded as successfully completed by a positive assessment.

(5) If the fourth semester (S4) will be passed at the University of Innsbruck according to § 1 (2) the studies are finished by the study concluding defense of the master thesis. 2.5 ECTS-Credits will be allotted to this final exam. The exam will last for about 60 minutes and starts with a 20-minutes public lecture on the master thesis. Afterwards the possibility of public discussion is given. The exam will be concluded with questions regarding the master thesis from members of the examination senate.

(6) Modules successfully completed at the partner universities will be acknowledged. For courses at the partner universities the respective national legal regulations are valid.

§ 11 Academic degree

(1) All graduates of the Erasmus Mundus Joint Master Program in Astrophysics will be awarded the academic degree of "Master of Science", in short „MSc“.

(2) The award of the academic degree will take place through a joint official document of all partner universities according to § 87 (5), University Act 2002.

§ 12 Coming into force

(1) This curriculum comes into force on 1 October 2010.

(2) The modification of the curriculum published in the University of Innsbruck Bulletin of 02 June 2014, Issue 24, No 398 comes into force on 1 October 2014 and applies to all students.