



Observatoire
de la CÔTE d'AZUR



UNIVERSITÉ
CHAMBERY
ANNECY SAVOIE



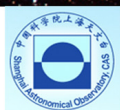
ERASMUS MUNDUS JOINT DOCTORATE



INTERNATIONAL RELATIVISTIC ASTROPHYSICS DOCTORATE PROGRAM



SAPIENZA
UNIVERSITÀ DI ROMA



Max-Planck-Institut
für Gravitationsphysik
ALBERT-EINSTEIN-INSTITUT



university of ferrara
600 YEARS OF LOOKING FORWARD



Guide for Students

ERASMUS MUNDUS

IRAP PHD

We offer for the first time in the World a high level PhD training program with a diploma delivered by thirteen Institutions residing in Europe and Asia. This diploma carries the prestigious label of “Erasmus Mundus” from the European commission.

The IRAP PHD program intends to create conditions for high level education in Astrophysics mainly in Europe to create a new generation of leading scientists in the region. No single university in Europe today has the expertise required to attain this ambitious goal by itself. For this reason we have identified universities which offers a very large complementarity expertise.

Each student admitted to the Ph.D. program will be part of a team inside one of the laboratories of the consortium. Each year they will have the opportunity to visit the other laboratories of the consortium and enlighten themselves with new topics in the forefront research from world leading experts. In this way the students will come in direct contact with some of the leading scientists in the world working in General Relativity, Relativistic Astrophysics and in Quantum Field Theory. In addition to the theoretical centers, we associate experimental and observational center as well. This will provide an opportunity to the Ph.D students to obtain a complete education in theoretical relativistic astrophysics and also an experience on how to carry out a specific astrophysical mission.

All the institutions participating in IRAP PhD have an extensive experience in international collaborations including visiting professors, post-doctoral researchers and training of Ph.D. students. All of our partners have enrolled Ph.D. students inside their laboratories in various aspects of astrophysics.

The European universities of Berlin, Ferrara, Roma, Nice, Savoie and Stockholm have also the needed structures to organize courses at Ph.D. level through numerous qualified professors.

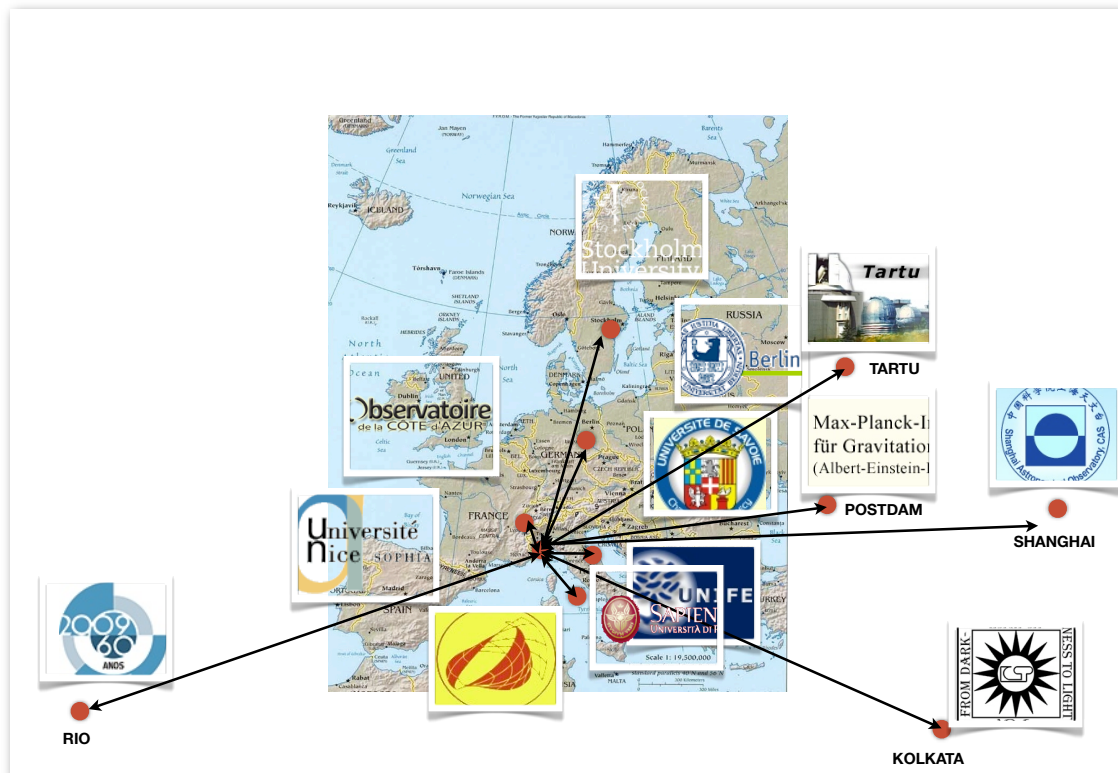
In addition the non European partners will provide expertise in their fields and could also host Ph.D. students.

The High Energy Astrophysical Group of Ferrara University, which developed Beppo-SAX satellite, has obtained the Bruno Rossi Prize in 1998 of the American Astronomical Society and the Descartes Prize of European Committee in 2002 for their contribution in solving a mystery of gamma ray bursts.

The Observatory de la Cote d'Azur is already collaborating with major European and other non-European organizations including ESA, ESO, NASA, Polar Institutes, EGU and has developed a long tradition of educating graduate students from all continents.

Nice is the coordinating organization and we will use the “savoir faire” of the “Ecole Doctorale” in terms of logistic and administrative experience on the management of Ph.D. students.

A complete Network all around the World



- UNIVERSITY OF NICE - SOPHIA ANTIPOLIS, FRANCE
(Co-ORDINATING INSTITUTION)
- SHANGHAI ASTRONOMICAL OBSERVATORY, CHINA
- FREE UNIVERSITY OF BERLIN, GERMANY
- AEI - POTSDAM, GERMANY
- TARTU OBSERVATORY, ESTONIA
- STOCKHOLM UNIVERSITY, SWEDEN
- UNIVERSITY OF FERRARA, ITALY
- UNIVERSITY OF ROME - LA SAPIENZA, ITALY
- BRAZILIAN CENTRE FOR PHYSICS RESEARCH, BRAZIL
- OBSERVATORY OF THE CÔTE D'AZUR, FRANCE
- INDIAN CENTRE FOR SPACE PHYSICS, INDIA
- INTERNATIONAL CENTER FOR RELATIVISTIC ASTROPHYSICS NETWORK, ITALY
- UNIVERSITY OF SAVOIE, FRANCE

THE FACULTY

The IRAP PhD Faculty is the core of the Erasmus Mundus Doctorate. The Faculty is in charged of recruitment, selection criteria and supervision of all the Ph.D. students.

Each student has, in addition of her/his Ph.D. director, a member of the Faculty which correspond to her/his tutor. The Faculty defines the courses of each year to be followed by the students. We have established a code for the Ph.D. student, “the charter thesis” including all the duty and the law of the student. The Faculty organized meeting twice a year in the Coordinating Organization, first in order to select the Ph.D. student and second to follow the development of research of each student.

Prof. Remo RUFFINI (Director); ICRANet

Prof Sandip Kumar CHKABARTI, INDIAN CENTRE FOR SPACE PHYSICS

Prof. Pierre COULLET, UNIVERSITY OF NICE-SOPHIA ANTIPOLIS

Prof. Yipeng JING, SHANGHAI OBSERVATORY

Prof. Hagen KLEINERT, FREE UNIVERSITY OF BERLIN

Prof. Mario NOVELLO, BRAZILIAN CENTRE FOR PHYSICS RESEARCH

Prof. Kjell ROSQUIST, STOCKHOLM UNIVERSITY

Prof. Farrokh VAKILI, OBSERVATORY OF THE COTE D'AZUR

Prof. Filippo FRONTERA, UNIVERSITY OF FERRARA

Prof. Jaan EINASTO, TARTU OBSERVATORY

Prof. Hermann NICOLAI, ALBERT EINSTEIN INSTITUTE

Prof. Vladimir BELINSKI, UNIVERSITY OF ROMA LA SAPIENZA

Prof. Pascal CHARDONNET (coordinator), UNIVERSITY OF SAVOIE



OUR RESEARCH PROGRAM

Following the successful scientific space missions by the European Space Agency (ESA) and the European Southern Observatory (ESO) in Chile, as well as the high-energy particle activities at CERN in Geneva, IRAP is a Ph.D. program dedicated to the formation of scientists in the field of relativistic astrophysics. The students of such a program will lead the theoretical developments of one of the most active fields of research, based on the above observational and experimental facilities. This program offers expertise in the most advanced topics of mathematical and theoretical physics, and in relativistic field theories. It requires the ability to model the observational data received from the above facilities, as well as all the basic knowledge in astronomy, astrophysics and cosmology. This activity is necessarily international, as no single university can cover the broad expertise required.

This has resulted in the programme offered by IRAP PhD in one of the youngest and most dynamic French universities, pole of research and teaching in the Euro-Mediterranean region (PRES): the University of Nice. It benefits from the presence of the astrophysics research institute of Observatoire de la Côte d'Azur involved in relativistic and non-photonic astrophysics as well as of the Center of ICRANet at Villa Ratti, where the coordination of the Doctorate will take place. The participation of the Freie Universität Berlin and of the Einstein Institute in Potsdam offers the possibility of teaching in relativistic field theories at the highest level. The University of Savoie offers the link to the particle physics at CERN. The activities at the University of Rome, at Stockholm University and at ICRA and ICRANet offer teaching programs in all the fields of relativistic astrophysics, including cosmology, the physics of gravitational collapse, gamma-ray bursts, and black hole physics. The University of Ferrara will be present with lectures and researches in the topics they have pioneered such as the development of space missions in X and gamma ray astrophysics and observational cosmology. Through ICRANet the extra-European connections with Brazil, China and India will be guaranteed: in China, with the Shanghai Observatory of the Chinese Academy of Science, studying the formation and evolution of large-scale structure and galaxies; in India, with the Indian Centre for Space Physics (ICSP), renowned for its research on compact objects as well as on solar physics and astrochemistry; in Brazil, with ICRA-BR at CBPF, where a successful program of research and teaching in relativistic astrophysics has been established in recent years.

FIELD OF EXPERTISE

- Cosmology, Gravitation and Multidimensions
- Cosmology and Large Scale Structure of the Universe
- Early Cosmology and Fundamental Relativity
- Relativistic Astrophysics around compact objects
- Chaos in Astrophysical and Cosmological Problems
- Structure and Morphology of Galaxies: Equilibrium and Stability
- Gamma-ray bursts
- High Energy Astrophysics

PHD TRAINING

Each annual batch of students will begin an academic year in our Ph.D. program which has a duration of three years. Every year, all the students of a batch will be grouped in some of the organization partners to follow the lectures mentioned above in a period of one month each. These sessions are unique occasions to create a spirit of school inside our Ph.D. even if the students will be working in various partner institutions for their respective research. In this way they are part of a group and the organization coordinator will coordinate the availability and movements of professors and students. During these month-long sessions, each student will present his personal research to the faculty and to the other students of the group. This is also the occasion to discuss together to our organization and have the feedback from our students.

The future scientists have to assume leadership role in new investigations in astronomy and astrophysics. To this effect, they will be trained to be skillful in writing and communicating.

We have the chance in our organization to have a leading observatory in Europe: Observatoire de la Cote d'Azur. This institution is in contact also with the European Southern Observatory where the biggest telescope (VLT) and projects in astronomy (ALMA) are built. They have a great experience in managing projects. We want to develop a competence in leadership and project management through one month session of our PhD students in Observatoire de la Cote d'Azur.

In astrophysical research there is a natural link between industry and research. The University of Ferrara has been a strong partner with industries in the aerospace sector, and so has been the Observatoire de la Cote d'Azur with a long tradition of collaboration with industries such as Aerospatiale and Thales. Similar activities have been promoted by the Tartu Observatory. All these experiences will be shared with our students.

COURSES AT IRAP

Professors	Courses
Felix AHARONIAN (ICRANet & Max Planck Inst.)	ULTRA HIGH ENERGY GAMMA RAY SOURCES
Vladimir BELINSKI (ICRANet)	THE APPROACH TO THE SINGULARITY
Carlo BIANCO (ICRANet)	RELATIVISTIC EFFECTS IN GRBS
Sandip CHAKRABARTI (Indian Centre for Space Physics and S.N. Bose National Ctr for Basic Sciences)	ACCRETIONS ON BLACK HOLES AND NEUTRONS STARS
Pascal CHARDONNET (LAPTH & Univ. Savoie)	PARTICLE PHYSICS APPLIED TO ASTROPHYSICS
Sandip CHAKRABARTI (Indian Centre for Space Physics and S.N. Bose National Ctr for Basic Sciences)	EXO BIOLOGY
Thibault DAMOUR (ICRANet & IHES)	GENERAL RELATIVITY
Jaani EINASTO (ICRANet AND Tartu Observatory)	LARGE SCALE STRUCTURE OF THE UNIVERSE
Andrea FERRARI (Universite de Nice)	SIGNAL TREATMENT
Filippo FRONTERA (Universita di Ferrara)	X-RAYS AND GAMMA RAYS ASTRONOMY
Riccardo GIACCONI (ICRANet)	X RAYS CLUSTERS
Tristan GUILLOT (Observatoire de la Cote d'Azur)	PLANETOLOGY
Ypeng JING (Shanghai Observatory)	FORMATION OF GALAXIES
Roy KERR (ICRANet)	ON THE KERR SOLUTION
Hagen KLEINERT (Freie Universitat Berlin)	RELATIVISTIC FIELD THEORY
Alessandro MORBIDELLI (Observatoire de la Cote d'Azur)	PLANETOLOGY
Hermann NICOLAI (Einstein Institute Postdam)	DEVELOPMENT ON BKL WORK
Mario NOVELLO (CBPF Brazil)	NON SINGULAR COSMOLOGY
Jose PACHECO (Observatoire de la Cote d'Azur)	EXTRAGALACTIC ASTROPHYSICS
Tania REGIMBAU (Observatoire de la Cote d'Azur)	GRAVITATIONAL WAVES
Kjell ROSQUIST (Stockholm University)	SINGULARITIES AND GENERAL RELATIVITY
Remo RUFFINI (ICRANet & Univ. Roma La Sapienza)	BLACK HOLES AND FUNDAMENTAL PHYSICS
Gregory VERESHCHAGIN (ICRANet)	THERMALIZATION AND COLLECTIVE EFFECTS IN ASTROPHYSICS
Jean-Yves VINET (Observatoire de la Cote d'Azur)	GRAVITATIONAL WAVES
She-Sheng XUE (ICRANet)	ULTRA RELATIVISTIC ELECTRON POSITRON PLASMA

PRESENTATION
OF THE UNIVERSITIES,
INSTITUTIONS
AND
THE RESEARCH
LABORATORIES



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SHANGHAI ASTRONOMICAL OBSERVATORY



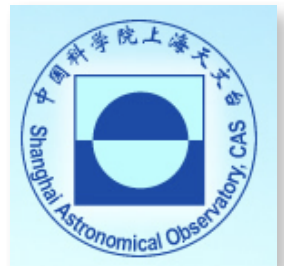
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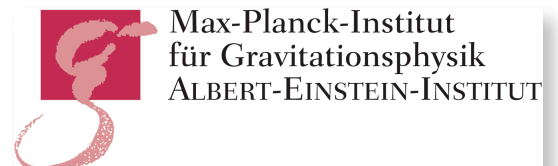




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TARTU OBSERVATORY



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600 YEARS OF LOOKING FORWARD.

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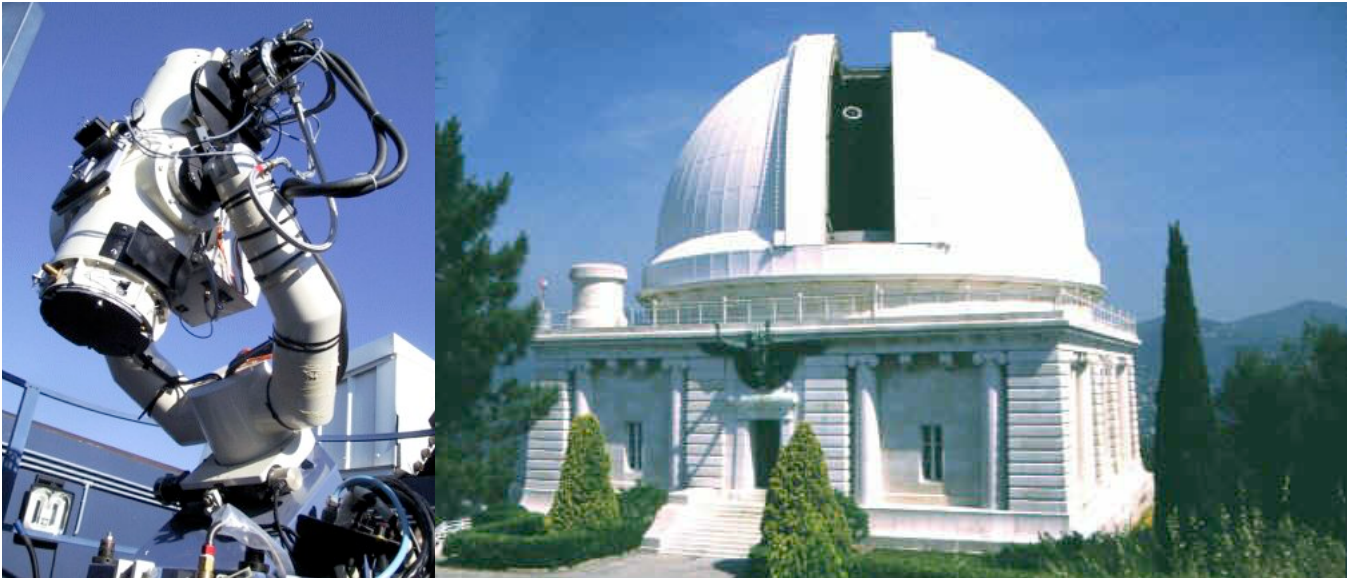
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INDIAN CENTRE FOR SPACE PHYSICS



Indian Centre for Space Physics (ICSP) is a relatively new space research institute situated in the city of Kolkata (Calcutta), well known for giving the phrase "Black Hole" (from Black Hole of Calcutta) to the world. Historically it is the intellectual and cultural capital of India, being home or work place of all the Indian citizen Nobel Laureates. It is also the home of great physicists like M.N. Saha (Saha Equation), S.N. Bose (Bose-Einstein Statistics), J.C. Bose (Microwave communication pioneer etc.). It is a Government Aided Institution.

ICSP has experts in the Physics of compact objects, Astrophysical Flows around black holes and neutron stars, Astro-biology/Astrochemistry, Study of Ionospheric disturbances with very low frequency radio waves etc. In addition Instrumentation Section has X-ray laboratory and X-ray detector developing units. It is also involved in sending small payloads with miniature instruments to near space environment using small balloon flights.

In the study of Astrophysical Flows we concentrate on the transonic flows which are relevant for compact objects where General Relativity is important. The Accretive Disk paradigm clearly has the advantage that it explains major spectral and timing properties within the framework of a single theoretical model. Other approaches do not assume any theoretical models, and add components on a case by case basis.

In Astrobiology/Astrochemistry problem we are trying to obtain the origin and evolution of complex molecules, especially those which are useful for formation of life. Very complex molecules have been observed in star forming regions and we synthesize them by coupling the hydrodynamic simulations and chemical evolutions during collapse and fragmentation in the star forming regions. We have been able to show that Glycine/Alanine etc. can be produced in the collapse process.

In the study of the ionospheric disturbances by using Very Low Frequency (VLF) radio waves, we use radio antennas and receivers to detect the effects of terrestrial and extra-terrestrial disturbances on the ionospheric properties. We show that even Gamma Ray Bursts/Soft Gamma-ray repeaters can be detected using the earth's ionosphere as a giant detector.

In Instrumentation, we developed high resolution X-ray imagers which are achromatic. For the first time, Fresnel Zone Plates were studied with parallel and diverging beams and were sent to space in RT-2 payloads on board Russian Satellite CORONAS-PHOTON. These detectors are sending regular data. Already Several GRBs were detected and solar flares have been observed. The instruments are now ready to study solar flares when the Sun becomes active.



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Situated between Grenoble and Lyon, close to the Swiss and Italian borders, the University of Savoie is a state-financed multi-disciplinary establishment of higher education, recognized at regional, national and international levels. In an exceptional environment, the University of Savoie offers its 12,000 students a wide range of courses at three European levels: BA/BSc, MA/MSc and PhD.

The quality of this scientific environment is further enhanced by the proximity of the CERN Geneva, the largest particle accelerator in the world, and the nano-technologies research cluster in Grenoble.

Doing Research at LAPTH : the scientific orientations

The main scientific orientations of the laboratory are threefold:

- mathematical physics in the team Fields, Strings and Symmetries. The key words to characterise the remarkably successful work done in this team are “gauge and string theories” and “quantum integrable systems”. Besides, within this team, a line of research has been developed, since 2000, in the field of biophysics and it gained momentum with the arrival of a biologist in 2008, for a long term stay. This research is carried out in close association with mathematicians from LAMA under the sponsorship of the federation MSIF. To take this recent evolution into account the team is now labelled Fields, Strings and Symmetries, Biophysics.



- particle physics: the future commissioning of the LHC has been a very strong motivation for this team to develop, on the one hand, techniques to allow precise calculations of “multileg” processes which will be dominant at the LHC, and on the other hand, to work on the phenomenological analysis of present and future data from colliders and astrophysical observations. The key words are “precision (loop) calculations” and “phenomenological studies of QCD, new physics, dark matter”. Needless to say that the proximity of LAPP and CERN is an advantage which is exploited by the team.

- particle astrophysics and cosmology: the extraction of cosmological parameters, the analysis of dark matter via its cosmological and astrophysical signatures and its modeling, the precise modeling of cosmic rays and the detailed comparison with cosmic particle spectra, the understanding of energetic astrophysical sources are the main topics studied in this team. The continuous amount of precise data from astrophysical and cosmological observations has been a constant source of motivation for this team, the work of which has a strong international impact.

LAPTH is part of the PHAST “Physics and Astrophysics” doctoral school to which ENS-Lyon and University of Claude Bernard Lyon I also belong. In the period from January 2005 to June 2009, 14 students who prepared their doctorate at LAPTH successfully defended their thesis