# Program of the IRAP PhD School, Nice, September 2012

## First week

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<tr>
<th>Day</th>
<th>Monday 3</th>
<th>Tuesday 4</th>
<th>Wednesday 5</th>
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## Second week

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AHARONIAN, Felix: 1. “Gamma Ray Production in AGN: sites, acceleration and radiation processes, challenges” 2. “Gamma-rays from AGN -cosmological implications”

AMATI, Lorenzo: “Introduction on Cosmology with GRBs”

ARGUELLES, Carlos: 1- “Semi-degenerate Self-gravitating system of fermions as Dark Matter in Galaxies II: Core & Halo description” 2- “Einstein clusters and Dark Matter”

BEGUE, Damien: “Photospheric emission in GRBs from Monte-Carlo simulations of Compton scattering”

BENEDETTI, Alberto: “Boltzmann equations with anisotropic momentum distributions and transparency of GRB plasma”

BERNARDINI, Maria Grazia: "The prompt-afterglow connection: a universal scaling for short and long GRBs”

BIANCO, Carlo Luciano: "Gamma-Ray Bursts"

BOSHKAYEV, kUANTAY: 1- “Non-rotating and slowly rotating stars in the Newtonian gravitational theory (Hartle’s approach)” 2- “Non-rotating and slowly rotating relativistic stellar models and their applications”


DAMOUR, Thibault: “Gravitational Waves” (4 talks)

DE BERNARDIS, Paolo – MASi, S.: “Cosmic Microwave Background Observations”

This short course on "Cosmic Microwave Background Observations" focuses on CMB observables, on the fundamental limits of these measurements, and on the methods to extract CMB information from overwhelming disturbance of astrophysical, environmental and instrumental origin. After the necessary description of the related physics, and of the status of the art, we conclude on the newest trends. The course is organized as follows:

**Lecture 1:** de Bernardis 12/09 9:00
CMB Observables (spectrum, anisotropy, polarization, quantum fluctuations, environment)

**Lecture 2:** Masi 12/09 12:00
How to detect CMB photons (fundamental limits, detectors, telescopes, polarimeters)

**Lecture 3:** de Bernardis 13/09 9:00
Extraction methods (environment problems, modulation/demodulation techniques, cryogenics, space, current experiments)

**Lecture 4:** Masi 13/09 12:00
The future of CMB research (current status of the field, new targets and methods, including B-modes and CMB spectroscopy)

I will give a historical account of the developments leading up to the unification of weak and electromagnetic interactions, as I saw them from a viewpoint in Imperial College. This will cover theoretical particle physics in the years after the second world war, early gauge theories, obstacles to unification, especially the Goldstone theorem, the development of the idea of spontaneous symmetry breaking in gauge theories, and the construction of the unified electroweak model, together with a brief discussion of later developments.
• IYYANI, Shabnam: “Photospheres in prompt emission of GRBs - spectral analysis of GRB110721A”
• JULLO, Eric: 1. Modeling of gravitational lensing systems 2. Cosmological parameters with gravitational lensing
• KIBBLE, Tom (Imperial College): “Genesis of electroweak symmetry breaking”
• KUNZ, Jutta: “Gravitating solitons and black holes”
• LAEMMERZAHN, Claus: "The Equivalence principle"
• MAVROMATOS, Nikolaos: “Neutrinos and the Universe”

lecture 1: Neutrino properties : types of masses, see-saw mechanism for neutrino mass generation, structure of the neutrino mixing matrix and CP symmetry constraints , Neutrino Oscillations in vacuum and in dense matter

lecture 2: Neutrinos and the Baryon Asymmetry in the Universe: Leptogenesis / Baryogenesis

lecture 3: Neutrinos and the Dark sector of the Universe

lecture 4: Neutrinos in curved geometries of the early universe and CPT violation as alternative scenarios for baryogenesis/leptogenesis without the need of sterile neutrinos

• PELSTER, Axel: “Ultracold Quantum Gases – A Fascinating Playground for Basic Research in Physics”
• PENACCHIONI, Ana: Tuesday 3: "GRB 111228 and Supernova association: a binary system?"; Wednesday 4: "GRB 110709B as a new member of the proto-back hole family"
• ROSQUIST, Kjell: “Inhomogeneous cosmology”
• RUEDA, Jorge: "Fundamental interactions in White Dwarfs and Neutron Stars"
• SAHAKYAN, Narek: 1. “High energy gamma rays from Centaurus A radio galaxy” 2. “High energy photons and neutrinos from thin and thick sources”
• SIUTSOU, Ivan: “Radiative transfer in relativistic outflows with application to GRBs”
• SUVENDU, Rakshit: "Differential Interferometry of BLR of 3C273"
• VAKILI, Farrokh: “Introduction to optical interferometry and high angular resolution astrophysics: state of art, results and future prospects”
• VERESHCHAGIN, Gregory: “Photospheric emission in Gamma Ray Bursts”

Lecture 1. Hydrodynamics and thermodynamics of relativistic plasma and GRBs
The problem: first light from initially optically thick relativistic plasma
Energy-momentum and baryonic number conservation
Expanding GRB plasma: winds versus shells
Equations of motion in fireball and fireshell models
Proper Gamma Ray Burst and photospheric models
Transparency and the baryonic loading
The role of the rate equation for electron-positron pairs
Analogies with cosmology and “black body photosphere”

Lecture 2. Photospheric emission in GRBs
Mean free path and optical depth in media with relativistic motion
Laboratory vs. comoving reference frames
Invariant definition of the optical depth
Optical depth and transparency (photospheric) radius
Photon thick and photon thin asymptotics

Lecture 3. Diffusion in space and diffusion in energy
Photon escape from relativistically expanding plasma
Diffusion in stellar astrophysics and in GRBs
Diffusion radius and photon thin asymptotics
Kompaneets equation
Diffusion approximation for Compton scattering in expanding medium
Comparison with previous works
• WU, Yuanbin: “Surface tension of neutron star matter”
• XUE, Shesheng: “Electron and positron pair production in strong electric fields”