TITLE:

Experimental Methods in Astroparticle Physics

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Reception hours: Thursday, 15:30-19:30

Program of the course:

0) Introduction

Introduction to the Astroparticle Physics: historical developments, fields of interest, fundamental questions.The Astroparticle Physics in Italy. Particles as messangers from the Universe: the "multi-messanger" approach.

1) Cosmic Rays (primary charged particles)

Cosmic Rays: brief historical overview and general properties. The Energy Spectrum. Acceleration processes: the Fermi mechanism. Sources of cosmic rays. The GZK cut-off. Extensive Air Showers. Direct detection techniques for low, medium and high energy cosmic rays: main experiments and scientific results. Indirect detection techniques for very high, ultra high and extreme energy cosmic rays. Surface detectors and Fluorescence detectors. Main experiments and scientific results. The Pierre Auger Observatory for ultra high energy cosmic rays: the hybrid technique; performances and scientific results.

2) High Energy Photons

Astroparticle Physics of high, very high and ultra high energy photons: sources of gamma rays. Detection techniques: from the space with detectors on satellites to ground level with Cherenkov telescopes. Main experiments and scientific results.

3) Neutrinos

Brief historical overview on neutrino theory and experimental research. The beta decay. Main historical experiments on neutrino detection. Natural and artificial sources of neutrinos. The neutrino oscillating behaviour in vacuum and in matter . Experimental methods to measure the neutrino mass: Kurie plot. The double beta decay. Dirac and Majorana neutrinos. Solar neutrinos: detection techniques, main experiments and scientific results. Atmospheric neutrinos: detection techniques, main experiments and scientific results. Neutrinos from stellar collapses, cosmogenic neutrinos: detection techniques, main experiments and scientific results. Neutrinos from Earth (geoneutrinos): detection techniques, main experiments and scientific results. Artificial neutrinos from reactors or accelerators: detection techniques for neutrino oscillations; short-baseline and long-baseline experiments; main experiments and scientific results.

4) Gravitational Waves

Gravitation waves: theoretical explanation. Search for gravitational waves: detection techniques; use of interferometers. Main experiments and scientific results.

5) Dark Matter

Dark matter: experimental evidences and gravitational lensing. Short outline of dark matter theories. Direct detection techniques: main experiments and scientific results. Indirect detection techniques: main esperiments and results.

Bibliography:

- M.S. Longair ***"High Energy Astrophysics"*** Cambridge University Press (Cambridge, 1990)
- T.K. Gaisser ***"Cosmic Rays and Particle Physics",*** Cambridge University Press (Cambridge, 1990)
- D. Perkins ***"Particle Astrophysics",*** Oxford University Press (Oxford, 2003)
- T. Stanev ***"High Energy Cosmic Rays",*** Springer (Berlin, 2004)