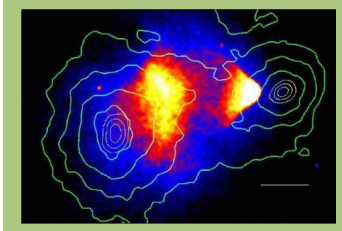
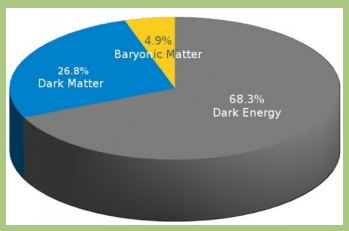
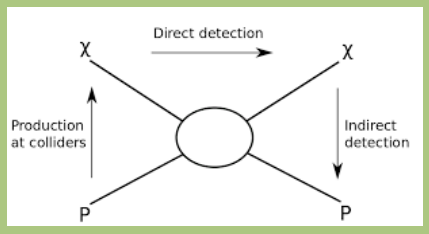
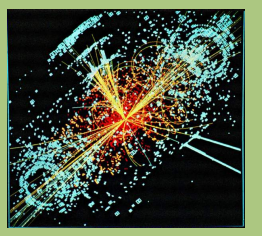
Dark matter: the astroparticle perspective









DATES : 18-23 DECEMBER 2017

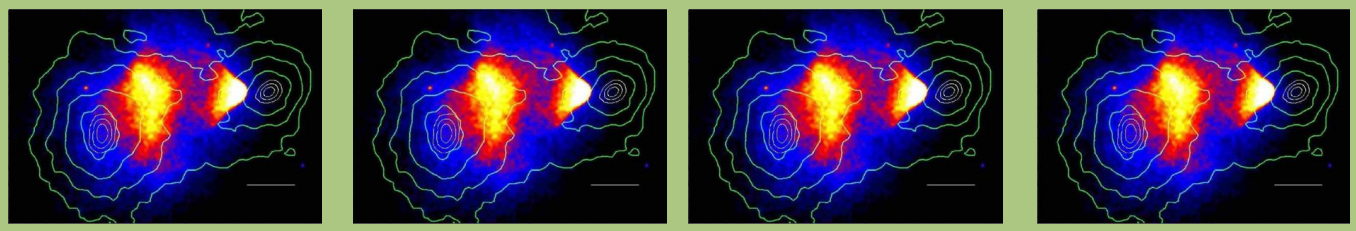
Overview

Neutrinos are the most abundant relic particles which have mass, however they cannot be the major constituent of the 'dark matter' which makes up 27% of the mass-energy of the Universe (i.e. ~5 times more abundant than baryonic matter). While the discovery that neutrinos have mass provides the first evidence for new phenomena beyond the 'Standard Model' of particle physics, attempts to construct such theories must also accommodate a new stable massive particle which constitutes the dark matter. Moreover since physical laws are (almost) exactly the same for antiparticles and particles, the observation that the universe contains only baryons but no anti-baryons, may well be due to the generation of an asymmetry in neutrinos and/or dark matter in the early universe, and a common dynamical origin for all massive particles. The identification of the dark matter is therefore *the* key question in astro-particle physics and an ambitious international experimental search on several fronts has been launched to this end.

Objectives

These lectures will provide the necessary astrophysical and cosmological background to the dark matter problem and discuss candidate particles arising in models of new physics, as well as attempts to detect them by both direct and indirect means. The course is aimed primarily at Graduate students but will be accessible to Masters (and even advanced Undergraduate) students. We will review the observational evidence in the framework of the Big Bang cosmology, the theoretical motivation for new stable particles, and experimental methods to look for non-gravitational interactions of dark matter. This is a multi-disciplinary topic at the interface of astrophysics and cosmology and particle physics, and of interest to both experimentalists and theorists.

Dark matter: the astroparticle perspective



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The Faculty

Subir Sarkar

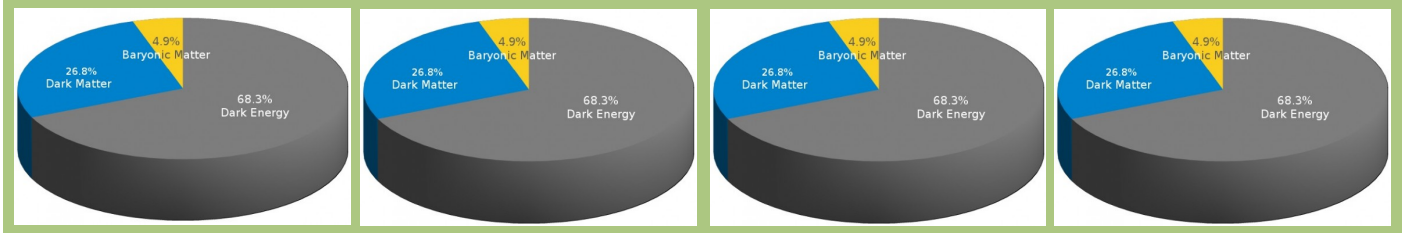
Professor of theoretical particle physics and cosmology

Head, Particle Theory Group, University of Oxford, UK, and
Niels Bohr Professor, Copenhagen University, Denmark

Subir was educated in India, at the Indian Institute of Technology, Kharagpur and obtained his PhD (1982) at the Tata Institute of Fundamental Research, Bombay, where he was a staff member 1979-84. Subsequently, he has held visiting positions at CERN Geneva, Oxford Astrophysics, Rutherford Appleton Laboratory, and also worked in science education and outreach at Eklavya, Bhopal. Since 1990 he has been at Oxford - first as Glasstone Research Fellow, then PPARC Advanced Fellow, appointed University Lecturer (1998) and Professor (2006). He is an Associate of the Discovery Centre and Professor at the Niels Bohr International Academy, both at the Niels Bohr Institute, Copenhagen where he is building up an Astroparticle Physics Group. He is one of the pioneering theoreticians who also works on experiments that drive research in astrophysics, cosmology, and particle physics. Among other recognitions, he has been awarded the Niels Bohr Professorship (2013) and IUPAP-TIFR Homi Bhabha award (2017).

His research interests are at the interface between fundamental physics and astrophysics & cosmology - specifically theoretical aspects of dark matter, inflation and large-scale structure formation, the cosmology of neutrinos and other relic particles, primordial nucleosynthesis, cosmic microwave background *et cetera*. He is also interested in high energy cosmic rays, neutrinos and gamma-rays and participates in the experiments Pierre Auger Observatory in Argentina (ended), IceCube Neutrino Observatory at the South Pole and the Cherenkov Telescope Array to be built in Chile and Spain.

Dark matter: the astroparticle perspective



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Course coordinator

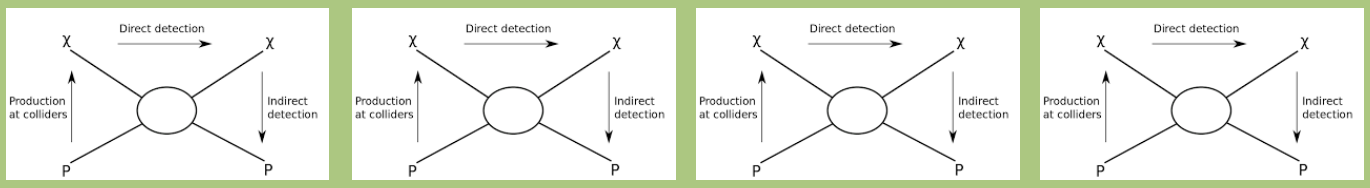
Poonam Mehta
Assistant Professor (UGC)

School of Physical Sciences, JNU

Poonam did her PhD in theoretical high energy physics from the Department of Physics and Astrophysics, University of Delhi in 2004. Thereafter she has held different positions at Harish-Chandra Research Institute (Post-doctoral fellow, 2004-2005), Weizmann Institute of Science (Visiting Scientist, 2005-2007), Raman Research Institute (Research Associate, 2008-2011) and University of Delhi (Dr D S Kothari Post-doctoral fellow, 2011-2013). Since 2013, she has been working as an Assistant Professor (UGC) at the School of Physical Sciences, JNU.

Her primary research interests involve neutrino oscillation phenomenology and new physics scenarios. Her group has been working on topics related to CP violation at long baseline neutrino experiments and in close collaboration with experimentalists at Brookhaven National Laboratory. She is a member of international neutrino experimental collaborations such as Deep Underground Neutrino Experiment (DUNE) and India based Neutrino Observatory (INO). She is also listed as Friends of Invisibles Plus and Elusives which are European networks.
She is also interested in the topic of geometric phases and its application in various contexts which include optics and condensed matter systems apart from neutrino physics.

Dark matter: the astroparticle perspective



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Lecture Schedule

Day 1

Lecture 1: 1:30 hr - SS

The universe observed

Lecture 2: 1:30 hr - SS

Relativistic world models

Tutorial 1: 2 hr - PM

Problem solving session/Talks by participants

Day 2

Lecture 3 : 1:30 hr - SS

Reconstructing our thermal history

Lecture 4 : 1:30 hr - SS

Big bang nucleosynthesis

Tutorial 2: 2 hr - PM

Problem solving session/Talks by participants

Day 3

Lecture 5 : 1:30 hr - SS

Dark matter: astrophysical observations

Lecture 6: 1:30 hr - SS

Dark matter: relic particles

Tutorial 3.: 2 hr - PM

Problem solving session/Talks by participants

Day 4

Lecture 7 : 1:30 hr - SS

Dark matter: direct detection

Lecture 8: 1:30 hr - SS

Cosmic rays, gamma-rays and neutrinos

Tutorial 4: 2 hr - PM

Problem solving session/Talks by participants

Day 5

Lecture 9: 1:30 hr - SS

Antimatter in cosmic rays

Lecture 10: 1:30 hr - SS

Dark matter: indirect detection

Tutorial 5: 2 hr - PM

Problem solving session/Talks by participants

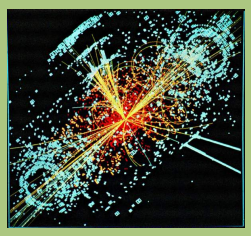
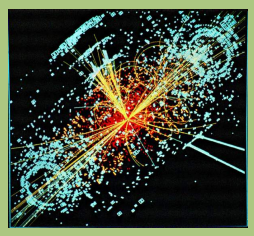
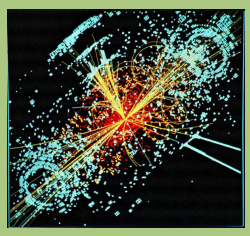
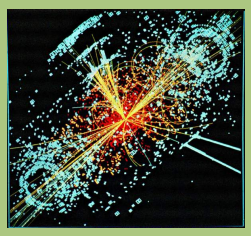
Day 6

Assessment: 2 hr

Examination and feedback from participants

Date of Examination: Dec 23, 2017

Dark matter: the astroparticle perspective

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Who can attend

- Ph.D. students working in the areas of Particle Physics and Astro-particle or Cosmo-particle Physics
- Post-doctoral fellows or young researchers
- M.Sc. students and advanced under-graduate students
- Faculty members from reputed academic institutions and universities who may find the course useful for their current or future research

Registration

- The participation fees for taking the course is as follows:
- Ph. D. Students : Rs. 1500
- M.Sc. Students : NIL
- Participants from abroad : US $100
- Faculty from Academic Institutions: Rs. 2500
- Accommodation based on nominal charges (per day) will be available to all participants.

Important Information

- For course registration, please visit:

  http://www.gian.iitkgp.ac.in/GREGN/index

  and

  http://www.jnu.ac.in/GIAN/

- Registration Deadline: **30 October 2017**

Contact details

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