DAA-DTP COLLOQUIUM

November 22, 2011

Speaker : Prof. Marco Bruni
University of Portsmouth, U. K.

Title : Cosmology from small scales to the horizon: relativistic effects in structure formation

Day, Date & Time : November 29, 2011 (Tuesday) at 1600 hrs

Venue : Lecture Theatre (AG-66)

(A. Gopakumar)

Abstract

The LCDM is the successful standard model of cosmology. Alternatives to the cosmological constants include models of dark energy, modified theories of gravity, as well as general relativistic (GR) models that either weaken the symmetry assumptions of the cosmological principle or try to construct an average universe to explain acceleration as a back-reaction effect. At a time were we are going to have observational data allowing measurements with unprecedented precision, it is however also worth reconsidering the fine details of how we model structure formation in LCDM cosmology, and how this may affect how we interpret observations. By and large, we model very large scales with relativistic perturbation theory, small scales where non-linearity is important with Newtonian N-body simulations, and we interpret observations (e.g. supernovae) as if light was propagating in a homogeneous-isotropic background. In the first part of this talk I will illustrate an example of relativistic effects, on how redshift and distances are affected if we propagate light in a inhomogeneous LCDM universe described by an exact GR solution. In the second part of the talk, I will present a new non-linear post-Friedmannian scheme, which is a sort of generalisation to cosmology of the post-Newtonian approximation. Using a 1/c expansion of Einstein equations, a set of non-linear approximate equations are obtained in the Poisson gauge, which include the full non-linearity of the Newtonian regime at small scales, and when linearised give standard scalar and vector linear relativistic perturbations. The scheme thus provides a unified framework to deal with small as well as large scales, to the horizon and beyond. Just analysing these equations two main results emerge: in the Newtonian regime, a frame-dragging vector potential cannot be neglected in the metric; in the post-Friedmannian non-linear regime, there are two gravitational scalar potentials.