Exploring the Energy Ladder of the Universe

Monday 30 May 2016 - Friday 10 June 2016

Mainz Institute for Theoretical Physics, Johannes Gutenberg University

Scientific Programme

Despite the breathtaking progress in observational cosmology in the last 15 years the established ΛCDM cosmological model does not provide any direct indication of the existence of new energy scales, beyond the traditional Big Bang Nucleosynthesis (BBN) and recombination scales. This is also despite the fact that the solutions of the four cosmological puzzles, coming from a ΛCDM-Standard Model clash, strongly point to the existence of new energy scales in the early Universe and that these typically require temperatures much above the BBN scale. For example, models of baryogenesis usually require an energy scale close to or much above the electroweak scale. Models of Dark Matter production imply new energy scales spanning from keV, in the case of a sterile neutrino Dark Matter, to energies close, for example, to the GUT scale in the case of super heavy Dark Matter. This frustrating picture might rapidly change in the next years in view of the restart of the LHC collider (LHC second stage), new expected information on the light neutrino mass matrix (mixing parameters and absolute mass scale), new possible cosmological observations (e.g. a non-vanishing tensor-to-scalar perturbations ratio), and many other experimental sources.

The Scientific Program would discuss to what extent new energy scales in the early Universe can be considered established or on the verge of being excluded, in particular trying to address: (i) Whether a TeV scale for baryogenesis (including leptogenesis) is indicated or cornered from the data. (ii) Whether a Dark Matter traditional WIMP thermal production should be still considered the standard paradigm. (iii) `How Hot was the early Universe', trying to pin down the most plausible value of the reheat temperature in the early Universe.

Indicatively the first week will be devoted to models able to address the cosmological puzzles (Dark Matter, Baryogenesis, Inflation and all possible connections) and the second week to phenomenological tools, implications and connections (e.g. kinetic theory in the early Universe, DM searches, constraints on inflationary models, reheat temperature bounds, tests of cosmological models with (astro-)particle physics).