Azores 17 – Student Talk Abstracts

Florian Kaefer (fkaefer@mpe.mpg.de)
eROSITA - Covariances of galaxy cluster parameters and their impact on cosmology

To be able to constrain precise cosmological parameters by use of galaxy clusters properties in the future X-ray eROSITA all-sky survey, selection effects related to the detection method of clusters need to be well understood. Therefore, we investigate scaling relations between shape and other cluster properties like temperature and luminosity to simulate a realistic set of galaxy clusters as observed by eROSITA. These simulations take covariances between cluster parameters into account, a component usually neglected in such simulations. We test different selection algorithms and the impact of covariances on obtained cosmological parameters. Finally, we obtain the survey selection function by quantifying the completeness and purity as a function of temperature and redshift.

Ana Catarina Leite (Ana.Leite@astro.up.pt)
Preparing ESPRESSO's fundamental physics tests

ESPRESSO is a high-resolution-ultra-stable spectrograph for the VLT, whose commissioning will start this year. One of its key science goals is to test the stability of nature's fundamental couplings with unprecedented accuracy and control of possible systematics. As the first light approaches quickly a set of ESPRESSO-like spectra is being simulated to evaluate the optimal strategy to detect a possible variation of fine-structure constant looking into metal absorption lines produced by the intervening clouds along the line of sight of the QSO. In this talk, I will present the ongoing spectra simulations and show examples of the complexity of the observational features that are key to improved measurements of the variation of the fine structure constant using ESPRESSO. I will also discuss the impact that these improved measurements can have on cosmology, more specifically on Bekenstein-type models.

Katarzyna Leszczynska (katarzyna.leszczynska@usz.edu.pl)
Varying constants baryogenesis models

The origin of the baryon number asymmetry is a long-standing problem in cosmology. Conventionally, the asymmetry between matter and antimatter may be generated under the following conditions: baryon number violating interactions, C and CP violation and loss of thermal equilibrium. However, due to violation of CPT symmetry in the early Universe, baryogenesis can be developed in the regime of thermal equilibrium. In this talk I am going to present models of baryogenesis, which spontaneously break CPT symmetry by coupling the derivative of a specific scalar field and the baryon current (spontaneous baryogenesis). The above mentioned field may be linked to the variability of fundamental constants: the gravitational constant G (the Brans- Dicke theory), the speed of light (Moffat model) and the fine structure constant (Bekenstein-Sandvik-Barrow-Magueijo).

Konrad Marosek (konrad.marosek@usz.edu.pl)
Cyclic Multiverses

Using the idea of regularisation of singularities due to the variability of the fundamental constants in cosmology we study the cyclic universe models. We find two models of oscillating and non-singular mass density and pressure ('non-singular' bounce) regularised by varying gravitational constant G despite the scale factor evolution is oscillating and having sharp turning points ('singular' bounce). Both violating (big-bang) and non-violating (phantom) the null energy condition models appear. Then, we extend this idea onto the multiverse containing cyclic individual universes with either growing or decreasing entropy though leaving the net entropy constant. In order to get an insight into the key idea, we consider the doubleverse with the same geometrical evolution of the two `parallel' universes with their physical evolution (physical coupling constants c(t) and G(t)) being different. An interesting point is that there is a possibility to exchange the universes at the point of maximum expansion – the fact which was already noticed in quantum cosmology. Similar scenario is also possible within the framework of Brans-Dicke theory where varying G(t) is replaced by the dynamical Brans-Dicke field phi(t) though these theories are slightly different.

Jurgen Mifsud (jmifsud1@sheffield.ac.uk)
On the interactions between dark energy and dark matter

Dark energy and dark matter might be coupled and hence mediate a fifth force, which is constrained by cosmological observations. I will consider interacting dark energy models, in which dark energy and dark matter are interacting via a conformal and a disformal coupling. After an overview of these interacting models, I will discuss the constraints on these models by employing the latest cosmological observations that probe the expansion history and the growth of structures of our universe.

Dinko Milakovic (dmilakov@eso.org)
Precision Cosmology using the Laser Frequency Comb

Extremely accurate and precise wavelength calibration of spectra is becoming ever more important in the era of new generation instruments and extremely large telescopes. It is crucial for measuring the redshift drift (i.e. the Sandage-Loeb test) and the search for variations in fundamental constants, but also for constraining the Weak Equivalence Principle violations and the search for Earth-like planets. A major improvement in wavelength calibration has been recently offered by the Laser Frequency Comb (LFC). The LFC produces a set of emission lines equidistant in frequency, extremely stable in position and more numerous and uniform than those of currently used ThAr lamps. Precision of LFC wavelength calibration was demonstrated to be at the 2 cm/s level on HARPS. I will present my analysis of HARPS data related to the accuracy of the LFC calibration and instrumental effects affecting it. These results are of great importance for two future LFC calibrated spectrographs operated by ESO: VLT-ESPRESSO and ELT-HIRES.

Albin Nilsson (albin.nilsson@ncbj.gov.pl)
Searching for Lorentz Invariance violation in theories with modified dispersion relations

The breakdown of Lorentz symmetry is a widely expected phenomenological signal of quantum gravity. For example, the arrival time of very-high energy photons from distant galaxies is believed to be modified by quantum effects on the Planck scale. Another way of analysing high-energy effects is by using the framework of Rainbow Gravity, where the spacetime metric gains extra structure in the form of energy dependent functions. These two examples both make use of Modified Dispersion Relations (MDR's), which is a good way to parametrise non-trivial effects in cosmology, and opens up an avenue for phenomenological testing. In this talk I will outline some recent work on this topic, as well as give examples of the major achievements and challenges in detecting quantum gravity signals in cosmological and astrophysical data.

Filippo Oppizzi (oppizzi@pd.infn.it)
Primordial non-Gaussianity and scale dependent bispectra in the CMB

The study of non-Gaussian features in the Cosmic Microwave Background temperature distribution provides crucial tests to probe the physics of the early Universe. To date, the Planck satellite sets strict constraints on the amplitude of the primordial non-Gaussian (NG) signal (fNL) by measuring the CMB bispectrum (three-point function in harmonic space). Even though the fNL parameter is predicted to be scale dependent by many Inflationary models (e.g. scenarios involving multiple fields, or containing non standard kinetic terms in the inflationary action), the running of fNL has not been studied in detail yet. Constraining, or eventually detecting, a running of primordial non-Gaussianity would therefore provide completely new interesting information about Inflation. We develop a new, numerically efficient and analytically exact expression for fNL(k); it allows computing the scale-dependent form for every bispectrum shape existing in the literature. We use this parametrization to build an optimal CMB estimator of the running of fNL for a variety of scale dependent templates. We are currently using this estimator to analyse both WMAP and Planck data. Our final Planck results will be presented in the forthcoming release.

Charalambos Pittordis (c.pittordis@qmul.ac.uk)
Probing modified gravity via wide-binary systems

This project involves probing the extremely weak-field of gravity, using Python-based simulations of large sample orbits for very wide binary stars in various modified-gravity theories. The simulated binaries are then 'observed' at random epochs and viewing angles to produce distributions of observables, notably the 3-D relative velocity vs the 2-D projected separation; This indicates significant observable differences from Newtonian prediction, which should be testable in future observatories from GAIA and 4MOST.

Marianna Torelli (torellimarianna@gmail.com)
On a new empirical calibration of synthetic stellar libraries

Synthetic stellar libraries are quite popular to constrain the stellar populations (age and metallicity distribution) of unresolved systems. However, they are typically based on theoretical Spectral Energy Distributions (SEDs). The main aim of my PhD project is to build up empirical synthetic stellar libraries covering a broad range in ages (globular clusters, old open clusters), chemical compositions (iron, alpha, CNO) and dynamical properties (nearby dwarf galaxies). I am planning to take advantage of ~65 globulars for which we have already secured multi-band optical (UBVRI) photometry collected with both ground-based and space telescope (HST). They will allow us to improve our SED fitting codes to deeply investigate high redshift galaxies. I am planning to present preliminary results concerning the sample selection and the difference with canonical models. Finally, I am also planning to discuss the role that accurate and deep NIR photometry collected with MICADO at ELT will play in this context, and in particular, in constraining the Star Formation History (SFH) of high redshift galaxies.