GR 12: Cosmology

Time: Thursday 14:00–16:00 Location: H-HS IV

GR 12.1 Thu 14:00 H-HS IV

Weighing neutrinos on cosmological scales with counts-in-cells — •Cora Uhlemann — DAMTP Cambridge, UK — Newcastle University, UK

Counts-in-cells statistics capture essential non-Gaussian properties of the cosmic large-scale structure, including peculiar regions of high and low density. I will show that those statistics not only provide information complementary to common two-point statistics, but also allow for accurate theoretical predictions. I will explain how matter counts-in-cells statistics and their dependence on cosmological parameters can be predicted from first principles. With a Fisher forecast for constraints on LCDM parameters and the total neutrino mass, I demonstrate the constraining power of the matter PDF and its complementarity to the matter power spectrum at mildly nonlinear scales. Finally, I will discuss how predictions for the matter PDF can be related to biased tracers and weak lensing observables.

GR 12.2 Thu 14:15 H-HS IV

Cosmological structure formation beyond the perfect fluid approximation — •Alaric Erschfeld — Institut für Theoretische Physik, Ruprecht-Karls-Universität Heidelberg, Philosophenweg 16, D-69120 Heidelberg, Germany

Late time cosmological structure formation is often studied in a perfect pressureless fluid approximation in which dark matter is described in terms of its mass density and velocity. Deviations from a homogeneous and isotropic background cosmology are treated perturbatively, leading to good agreement with observations and simulations on large scales. On smaller scales on the other hand the perfect pressureless fluid approximation breaks down due to the phenomenon of shell-crossing. Further, standard cosmological perturbation theory is not applicable anymore since the deviations from the background cosmology become highly non-linear.

In order to overcome the limitations of the perfect pressureless fluid approximation, we extend the description of dark matter in a kinetic theory approach, taking the velocity dispersion tensor into account. To tackle the regime where the deviations are non-linear, we employ the Martin-Siggia-Rose/Janssen-De Dominicis formalism describing dark matter in terms of a statistical field theory. This allows to use resummation techniques such as the one-particle irreducible scheme as well as study the functional renormalisation group for cosmological structure formation.

GR 12.3 Thu 14:30 H-HS IV

Dark matter halo mass densities from a statistical viewpoint — •Jenny Wagner — Universität Heidelberg, Zentrum für Astronomie, Astron. Rechen-Institut, Mönchhofstr. 12–14, 69120 Heidelberg, Germany

During the past decades, large-scale N-body simulations have successfully reconstructed cosmic structure formation with increasing resolution and complexity, as observations corroborate. Complementary efforts have arrived at a hydrodynamical theory that explains cosmic structure evolution up to the non-linear regime. A very recent approach based on a kinetic field theory can derive an analytic, parameter-free equation for the non-linear cosmic power spectrum. While the statistical properties of mass density perturbations for the observable universe as a whole is currently being understood from first principles, it is still unknown why our heuristic approaches for the characterisation of individual, locally collapsed mass agglomerations work so well.

Using a minimum set of prerequisites and approximations, I would like to put forward a new idea to explain the shape of the most common parametric dark matter halo mass density models in the framework of probability theory. It allows for an interpretation of the scaling radii and scaling densities which gives the limiting behaviour in the halo centre and in the outskirts a physical reason. Joining forces with simulation groups, surprising insights into the bulge-halo conspiracy and the cusp-core problem could be gained.

GR 12.4 Thu 14:45 H-HS IV

Causal Diamonds in Cosmology — Mauro Carfora[2], Francesca Familiari[2], and •Dennis Stock[1] — [1]University of Bremen, Center of Applied Space Technology and Microgravity (ZARM) — [2]University of Pavia, Department of Physics

We discuss causal diamonds in a cosmological set-up. In particular, making use of the relations between the area associated with the diamond and the spacetime curvature, we discuss the impact of cosmological inhomogeneities. Using the Einstein field equations and given a reference cosmological model, deviations from the reference model due to inhomogeneities can be understood as additional matter terms within the model. These deviations are linked to (ideal) observations.

GR 12.5 Thu 15:00 H-HS IV

Intensity Mapping observables of cosmology — •Caroline Heneka — Scuola Normale Superiore, Piazza dei Cavalieri 7, 56126 Pisa, Italy

Intensity Mapping (IM) techniques target the Universe from present time up to redshifts beyond ten when the first galaxies formed, from small to largest scales. Similar to CMB measurements, power spectra of emission line fluctuations tell about structure growth and underlying cosmology; but imagine the information encoded in thousands of intensity maps at varying redshifts and for multiple emission lines.

In this talk I will review IM as a test for cosmology and fundamental physics during the dark ages and the epoch of reionization, with power and cross-power spectra (suitable for multi-messenger methods) and global temperature signals probing cosmological structure formation, properties of dark matter and of astrophysical sources. As examples cosmological volumes of line fluctuations and their global temperature signal in general modified gravity scenarios are highlighted to measure deviations from the gravitational constant G and a possible dark matter – dark energy coupling. The ability of upcoming surveys like the SKA to constrain these modifications is demonstrated.

GR 12.6 Thu 15:15 H-HS IV

Systematic Bias in the Zwicky Transient Facility Photometric Calibration and Effects on Hubble Constant Measurement — •Simeon Reusch — DESY Zeuthen, Platanenallee 6, 15738 Zeuthen

I am investigating the photometric accuracy of the Zwicky Transient Facility (ZTF; an all-sky survey) to identify possible sources of systematic errors.

By analyzing data from June to September 2018 I was able to identify a systematic bias in the ZTF photometry which is correlated to the amount of scattered moonlight adding to the background. At full moon, 20.5 mag calibrator stars are estimated up to 400 mmag too bright and at new moon, up to 35 mmag too faint. As simulation shows, such a bias can affect supernova population studies in a systematic way. Studies like this are necessary starting points for the the precise and accurate measurement of the supernovae's distance moduli, which are needed to map the expansion history of the universe. A systematic bias thus directly affects precision measurements of the local Hubble constant. The method developed here could be employed to test the time stability of other optical instruments as well.

GR 12.7 Thu 15:30 H-HS IV

New theory considers cosmological red-shift to be originated in time dilation interacting with universes gravitation — •Bjørn Ebbesen — Hamburg, Germany

Thus far, in cosmology the imagination of an expanding universe is widely accepted. But still some physical laws claimed are not approved by local experiments.

The competing theory here considers cosmological red-shift as effect of universes time velocity changing in time. (Different time velocities at two points in space-time results in time dilation.) It is stated that a cosmological process takes place where universes time velocity evolves from and interacts with universes gravitation.

Examine observations so far in the context of this theory leads to the perspective of a shrinking universe with a decreasing Hubble factor.

GR 12.8 Thu 15:45 H-HS IV

New explanation for the accelerated expansion and flat galactic rotation curves — •Ahmad Sheykhi — Max Planck Institute (AEI)-Potsdam, Golm

Employing the non-additive Tsallis entropy, for the large-scale gravitational systems, we disclose that in the cosmological scales both Friedmann equation and the equation of motion for the Newtonian cosmol-

ogy get modified, accordingly. We then derive the modified Newton's law of gravitation which is valid on the large scales. We show that on the relativistic regime, the modified Friedmann equation admits an accelerated expansion, for a universe filled with ordinary matter, without invoking any kind of dark energy, provided the non-extensive parameter is chosen $\beta < 1/2$. On the non-relativistic regime, however, the modified Newton's law of gravitation can explain the flat galactic rotation curves without invoking particle dark matter.