GR 9: Cosmology

Time: Thursday 16:30–17:30 Location: H9

GR 9.1 Thu 16:30 H9

Intensity Mapping Observables of Cosmology — •Caroline Heneka — Hamburg Observatory, UHH

Intensity Mapping (IM) of line emission targets the Universe from present time up to redshifts beyond ten when the Universe reionized and the first galaxies formed, from small to largest scales. Similar to CMB measurements, the power spectra of intensity fluctuations inform about the underlying cosmology; imagine the information encoded in thousands of intensity maps at different redshifts and for multiple emission lines, forming full tomographic lightcones. In this talk I review IM as a test for cosmology and fundamental physics during cosmic dawn and the epoch of reionization. I show how power and cross-power spectra as well as global temperature measurements probe our cosmology, properties of dark matter and of astrophysical sources. The measurement of deviations from the gravitational constant G and a possible dark matter – dark energy coupling are highlighted in general modified gravity scenarios. The ability of upcoming instruments like the SKA to constrain these modifications is demonstrated. Going beyond 'traditional' summary statistics, I furthermore show how 3D neural networks are able to directly infer e.g. dark matter and astrophysical properties from such tomographic line fluctuation lightcones without an underlying Gaussian assumption.

GR 9.2 Thu 16:45 H9

The functional renormalisation group of dark matter gravitational dynamics — •Alaric Erschfeld and Stefan Flörchinger — Institut für Theoretische Physik Heidelberg

While standard cosmological perturbation theory is applicable for the description of cosmic structure formation on large scales, it fails to accurately describe the mildly non-linear regime. The functional renormalisation group of the effective action describing the gravitational dynamics of dark matter, naturally allows for non-perturbative approximation schemes, either by the use of underlying symmetries or via a truncation of the effective action theory space. We show that Galilean invariance of the system gives rise to a Ward identity which allows to solve the renormalisation group flow equations in the limit of small scales and is related to the so-called 'sweeping effect'. Further, we study the flow of an ansatz similar to a derivative expansion of the effective action, which describes dark matter in an effective theory with local dynamics. We find attractive ultraviolet fixed point solutions for the relevant flow parameter, which naturally capture the sweeping effect observed in Eulerian response functions. Further, the full renormalisation group flow is solved for the density and velocity power spectra in the perfect pressureless fluid approximation.

GR 9.3 Thu 17:00 H9

Mori-Zwanzig formalism for general relativity: a new approach to the averaging problem* — •Michael te Vrugt[1], Sabine Hossenfelder[2], and Raphael Wittkowski[1] — [1]Institut für Theoretische Physik, Center for Soft Nanoscience, Westfälische Wilhelms-Universität Münster, D-48149 Münster, Germany — [2]Frankfurt Institute for Advanced Studies, D-60438 Frankfurt am Main, Germany

Cosmology provides a coarse-grained description of the universe that is valid on very large length scales. However, the Einstein field equations are not valid for coarse-grained quantities since, due to their nonlinearity, they do not commute with an averaging procedure. Thus, it is unclear in which way small-scale inhomogeneities affect large-scale cosmology (backreaction). In this work, we address this problem by extending the Mori-Zwanzig projection operator formalism, a highly successful coarse-graining method from statistical mechanics, towards general relativity. This allows to derive a dynamic equation for the Hubble parameter in which backreaction is taken into account through memory and noise terms. Our results are linked to cosmological observations.

**Funded by the Deutsche Forschungsgemeinschaft (DFG) – WI 4170/3-1*

GR 9.4 Thu 17:15 H9

Considering cosmological red-shift originated in an increase of universes time velocity — •Bjørn Ebbesen — Hamburg, Germany

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

This approach considers cosmological red-shift as effect of universes time velocity increasing in time. (Two time velocities spans a time dilation.)

Reevaluating observations so far leads to the perspective of a shrinking universe.

It is stated that a cosmological process takes place, where universes time velocity evolves from and influences universes gravitation. A simplified model of the process is derived.