GR 2: Cosmology I

Time: Monday 16:30–18:30 Location: ZEU/0255

GR 2.1 Mon 16:30 ZEU/0255

Anisotropies in the Cosmological Gravitational Wave Background — •Florian Schulze — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

The cosmological stochastic gravitational wave background (CGWB) is expected to be detected by future gravitational wave (GW) interferometers. A map of angular fluctuations in the CGWB provides an independent measurement of cosmological parameters, similar to the cosmic microwave background (CMB). Furthermore, it contains information about the cosmological model and a multitude of possible CGWB sources, such as inflation, primordial black holes or phase transitions in the early universe.

In this presentation, I will discuss anisotropies in the CGWB and introduce CLASS_GW, an extension of the Cosmological Linear Anisotropy Solving System (CLASS) to calculate CGWB anisotropies. Using CLASS_GW, I present forecasts for future GW experiments, showing their capabilities of testing the early universe physics and the cosmological model.

GR 2.2 Mon 16:50 ZEU/0255

Redshift Drift in Linear Perturbation Theory — Pedro Bessa, •Dennis Stock, and Ruth Durrer — Département de Physique Théorique, Université de Genève, Switzerland

The technical advance and continuously increasing precision of cosmological observations will make measurements of time variations of the redshift of a given source possible in the near future. This so-called redshift drift effect promises to be an exciting future cosmological probe of the Universe. In this talk, we derive its fully relativistic, gauge-invariant expression within linear perturbation theory and study in detail its angular power spectrum based on large scale structure observations.

GR 2.3 Mon 17:10 ZEU/0255

Lightcone invariant observables in cosmology — Bhuvan Agrawal[1], Markus Fröb[2], and •William Lima[2] — [1]Mathematisch-Naturwissenschaftliche Fakultät, Universität zu Köln, Köln, Germany — [2]Institut für Theoretisches Physik, Universität Leipzig, Leipzig, Germany

I will discuss a recent proposal by Brunetti et al. to construct gauge-invariant relational observables in gravity in the context of cosmological perturbation theory. I will report on new results showing how their method can be use to produce invariant observables adapted to measurements along the observer's past lightcone. These observables aim to model the experimental situation in cosmology, where virtually all experimental data is gathered via light-like signals. The lightcone observables are constructed using a field-dependent coordinate system, which I will take to be geodesic lightcone coordinates. As a concrete application, I will present a new computation of the correlator of an observable measuring the redshift produced by quantum-gravitational fluctuations on the de Sitter spacetime.

GR 2.4 Mon 17:30 ZEU/0255

Cosmological backgrounds and their pertubations in teleparallel gravity — •Manuel Hohmann — University of Tartu, Estonia

Within the framework of teleparallel gravity, a flat affine connection is used as a dynamical field in addition to the metric tensor. This general teleparallel connection may further be restricted by imposing either vanishing torsion, giving rise to symmetric teleparallel gravity, or vanishing nonmetricity, which then leads to metric teleparallel gravity. In the field of cosmology, a homogeneous and isotropic connection must been chosen alongside the homogeneous and isotropic metric. This presentation gives a complete classification of all homogeneous and isotropic teleparallel geometries (general, metric and symmetric), as well as their perturbations. For the latter, gauge transformations and gauge invariant quantities are presented.

GR 2.5 Mon 17:50 ZEU/0255

Torsional dark energy in quadratic gauge gravity — •Armin van de Venn[1], David Vasak[2], Johannes Kirsch[3], and Jürgen Struckmeier[4] — [1]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany — [2]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany — [3]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany — [4]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany

The Covariant Canonical Gauge theory of Gravity (CCGG) is a gauge field formulation of gravity which a priori includes non-metricity and torsion. It extends the Lagrangian of Einstein's theory of general relativity by terms at least quadratic in the Riemann-Cartan tensor. This work investigates the implications of metric compatible CCGG on cosmological scales. For a totally anti-symmetric torsion tensor we derive the resulting equations of motion in a Friedmann-Lemaître-Robertson-Walker (FLRW) Universe. In the limit of a vanishing quadratic Riemann-Cartan term, the arising modifications of the Friedmann equations are shown to be equivalent to spatial curvature. Furthermore, the modified Friedmann equations are investigated in detail in the early and late times of the Universe's history. It is demonstrated that in addition to the standard ΛCDM behaviour of the scale factor, there exist novel time dependencies, emerging due to the presence of torsion and the quadratic Riemann-Cartan term. Finally, at late times, we present how the accelerated expansion of the Universe can be understood as a geometric effect of spacetime through torsion.

GR 2.6 Mon 18:10 ZEU/0255

Consistent solution of Einstein-Cartan equations with torsion outside matter — •Klaus Morawetz — Münster University of Applied Sciences, Stegerwaldstrasse 39, 48565 Steinfurt, Germany — International Institute of Physics- UFRN, Campus Universitário Lagoa nova,59078-970 Natal, Brazil

The Einstein-Cartan equations in first-order action of torsion are considered. Inside matter the torsion is given by the spin which leads to an extended Oppenhaimer-Volkov equation. Outside matter a second solution is found besides the torsion-free Schwarzschild one with the torsion completely determined by the metric and vice-versa. This solution is shown to be of non-spherical origin and its uniqueness with respect to the consistence is demonstrated. Unusual properties are discussed in different coordinate systems where the cosmological constant assumes the role of the Friedman parameter in Friedman-Lamaître-Robertson-Walker cosmoses. Parameters are specified where wormholes are possible. Possible consequences on cosmological scenarios are discussed. [Class. Quantum Grav. 38 (2021) 205003]