Cosmology and High Energy Physics V

Laboratoire Charles Coulomb
28 February 2020

Abstracts

Philippe Brax
Scalar dark matter

Light scalars could play the role of dark matter. I will present results about scalar solitons and their behaviour in the presence of super massive black holes.

Rodrigo Calderon
Properties of the Growth Index of Matter Inhomogeneities in the Universe

I will briefly introduce the Growth Index γ used to characterise the growth of (matter) perturbations in the Universe. I will present some (interesting) properties of its evolution as a function of the fractional energy density of matter Ω_m. We will then apply this formalism to study the case of a varying equation of state $w_{DE}(a) = w_0 + w_a(1 - a)$ for Dark Energy, as well some Modified-Gravity models, in particular $f(R)$-inspired and (brane-world) Dvali-Gabadadze-Porrati models.

Yannick Herfray
Intrinsic conformal geometry of null-infinity and its gravitational wave

Our best current model for describing gravitational waves, as for example measured in LIGO, is a family of solution called asymptotically-flat space-times. Observers are then taken to be situated "at null-infinity" and, since the seminal work of Bondi's group and Sachs, gravitational waves are related to the presence of a certain tensor, the "asymptotic shear", appearing in an asymptotic expansion away from null-infinity. Intuitively the presence of gravitational waves should correspond to the presence of some extra geometrical data at null-infinity but such a geometrisation however proved to be quite elusive. This is essentially because the geometry of null-infinity is of conformal nature which is notoriously tedious to work with. In this work we show how modern methods in conformal geometry (namely tractor calculus) can be adapted to the degenerate conformal geometry of null-infinity to encode the presence of gravitational waves in a completely geometrical way at null-infinity: the "asymptotic shear" is proved to be in 1-1 correspondence with choices of tractor connection, gravitational radiation is invariantly described by the tractor curvature and "soft-modes" of the vacuum correspond to the degeneracy of flat tractor connections

Bruno Le Floch

Cyclic spacetimes through singularity scattering maps

Modifications to 3+1d general relativity (GR) at high curvatures can eliminate the Big Bang singularity in favor of a bounce. Abstracting away microscopic details of the bounce, the spacetime is simply a GR solution on both sides of a singularity hypersurface, with some theory-dependent ”singularity scattering map” relating the asymptotic metrics on both sides. The asymptotic metric near a singularity was studied by Belinsky, Khalatnikov and Lifshitz (BKL) and they found that the time evolution at different points decouples. Motivated by this ultralocality property, we classify all singularity scattering maps that are ultralocal. By matching previous calculations on homogeneous spacetimes in f(R) gravity and in loop quantum cosmology with our classification we obtain a prediction for non-homogeneous bounces in these theories. Lastly, we construct a class of cyclic spacetimes by solving for the collision of plane gravitational waves (which may create infinitely many successive singularities)

Patrick Peter

A simple method for singularity avoidance and some consequences

I will discuss the question of time in a Bianchi I quantum cosmology in the framework of singularity avoidance. The time parameters fall into two distinct classes, that are such that the time development of the wave function either always leads to the appearance of a singularity (fast-gauge time) or that always prevent it to occur (slow-gauge time). Furthermore, in the latter case, there exists an asymptotic regime, independent of the clock choice. This may point to a possible solution of the clock issue in quantum cosmology if there exists a suitable class of clocks all yielding identical relevant physical consequences.

Clément Stahl

Primordial non-gaussianities or relativistic effects in Large Scale Structures?

In this talk, I will discuss some aspects of non-linear structure formation. The calculation of the bispectrum usually involves linear physics on large scales and non-linear (but Newtonian) physics on small scales. However, in the squeezed limit, the bispectrum (unlike the power spectrum) couples large scales with small scales. I will present the calculation of the non-linear relativistic corrections to the dynamics of dark matter perturbations. They are of the same order of magnitude, in the squeezed limit, than a primordial local non-Gaussianity signal. Such signal is expected to be within the accuracy of the next generation of LSS surveys.