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Gravitational anomalies , axions and a string-inspired Running Vacuum Model in Cosmology

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In the talk, I review a string-inspired running vacuum model (RVM) of Cosmology, and its potential connection with the dark sector of the (observable) Universe. Specifically, I consider a gravitational model of the early Universe that is inspired by the low-energy effective actions of string theory. I assume that only gravitational degrees of freedom appear as external fields at early eras. I associate the spin-one Kalb-Ramond (KR) antisymmetric tensor field that exists in the fundamental massless (bosonic) gravitational multiplet of strings with a totally antisymmetric torsion. The latter is known to give rise to the string-model independent KR gravitational axion field, which couples to the gravitational-anomaly Chern-Simons terms, that characterise the model in a self-consistent manner, as I discuss. These terms are non-zero in the presence of primordial gravitational waves (GW), and their condensation leads to an inflationary era in this model, of a RVM type, without fundamental inflatons. A brief discussion on the potential origin of these GW, during a pre-inflationary era of this string-inspired Cosmology, is also presented. At the exit from the inflationary phase, chiral fermionic matter fields are generated in the model, which cancel the primordial gravitational anomalies. Chiral anomalies, though, remain in general, and may lead to a non-perturbative (instanton-induced) generation of the KR-axion mass during the QCD epoch of this Universe. This implies that the KR axion may play the role of a dark-matter component. The KR axion background can also lead to spontaneous Lorentz-violation during inflation, as a result of the presence of the anomaly condensate. It remains undiluted at the exit from inflation, leading to leptogenesis in theories with right-handed neutrinos. Finally, I discuss briefly the current-era phenomenology of this stringy RVM, as far as tensions in data and deviation from the standard concordance model of Cosmology are concerned.

Primary author: MAVROMATOS, Nikolaos (King's College London, Physics Department)

Presenter: MAVROMATOS, Nikolaos (King's College London, Physics Department)

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