Contribution ID: **7** Type: **not specified**

String Regge trajectory on de Sitter space and implications to inflation

Wednesday 13 November 2019 11:15 (1 hour)

We study the spectrum of semiclassical rotating strings on de Sitter space and its consistency. Even though a naive extrapolation of the linear Regge trajectory on flat space implies a violation of the Higuchi bound (a unitarity bound on the mass of higher-spin particles in de Sitter space), the curved space effects turn out to modify the trajectory to respect the bound. Interestingly, there exists a maximum spin for each Regge trajectory as a consequence of accelerated expansion, which is helpful to make the spectrum consistent with the Higuchi bound, but at the same time it could be an obstruction to stringy UV completion based on an infinite higher-spin tower. By pushing further this observation, we demonstrate that the vacuum energy V inflating the universe has to be bounded by the string scale Ms as $V < M_s^4$, if UV completion is achieved by the leading Regge trajectory with higher spin states up to the 4D Planck scale. Its application to inflation at the early universe implies an upper bound on the tensor-to-scalar ratio, $r < 0.01 \times (M_s/10^{16} GeV)^4$, which is within the scope of the near future CMB experiments. We also discuss another possibility that UV completion is achieved by multiple Regge trajectories.

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