Contribution ID: **226** Type: **Oral**

Quantum gravity corrections to photon dynamics, white dwarfs and the Big Bang

Planck scale acts as a threshold where a new description of spacetime is expected to appear. We consider the invariant Planck scale modified/deformed Poincare algebra proposed by Magueijo and Smolin and study the consequences as the Planck scale corrections to the known physics. We get Planck scale modified dispersion relation and an effective invariant ultraviolet energy cut-off (Planck energy). We study various equilibrium thermodynamic properties of blackbody radiation (i.e. a photon gas) and degenerate fermions with such modifications. The energy density, specific heat etc. of the photon gas follows the usual acoustic phonon dynamics as have been well studied by Debye. This is in sync with the expectation of the emergence of the granular structure of spacetime at Planck scale. Other modified thermodynamic quantities like pressure, entropy etc. also get the correction. The usual Stefan- Boltzmann law gets modified. The phase-space measure is also expected to get modified for an exotic spacetime appearing at Planck scale, which in turn leads to the modification of Planck energy density distribution and the Wien's displacement law. We found that the non-perturbative nature of the thermodynamic quantities in the SR limit (for both the case with ultravilolet cut-off and the modified measure case), due to nonanalyticity of the leading term, is a general feature of the theory accompanied with an ultraviolet energy cut-off. Due to such modifications, the energy momentum tensor Tμν gets modified and which leads to possible modification in case of the physics of Big Bang and the age of the known Universe. The dynamics of the compact Stellar objects as white dwarfs too gets modified.

Subject

Astro/Cosmo

Abstract Title

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Session Classification: Parallel Session Astro+Cosmo