Contribution ID: **69** Type: **Talk/seminar**

Superfluid vacuum theory predictions for astrophysics

Monday 6 September 2021 14:50 (20 minutes)

Using the logarithmic superfluid model, one can formulate quantum post-relativistic theory of superfluid vacuum, which contains special and general relativity in the "phononic"(low-momenta) limit, but differs at higher momenta. According to the theory, an effective gravitational potential is induced by the quantum wavefunction of physical vacuum in a stationary state, while the vacuum itself is viewed as the superfluid described by the logarithmic quantum wave equation. On a galactic scale, the model explains the non-Keplerian behaviour of galactic rotation curves, as well as why their profiles can vary depending on the galaxy. It also makes a number of predictions about the behaviour of gravity at larger galactic and extragalactic scales, which are expected to be seen in the outer regions of large spiral galaxies. We compare the non-flat asymptotics'prediction with the furthest data points available for a number of galaxies. Using a two-parameter fit, we do a preliminary estimate; which disregards the combined effect of gas and stellar disc, but is relatively simple and uses minimal assumptions for galactic luminous matter. The data strongly points out at the existence of a crossover transition from flat to non-flat regimes at galactic outskirts and beyond. Another range of applications of the "logarithmic"matter can be found in the astrophysics of cold dense stars. We demonstrate the existence of equilibria in self-gravitating logarithmic fluid, described by spherically symmetric nonsingular finite-mass asymptotically-flat solutions in general relativity. Unlike other boson star models known to date, equilibrium configurations of relativistic logarithmic fluids are shown not to have scale bounds for their gravitational mass or size. Therefore, they can describe large massive dense astronomical objects, such as bosonized superfluid stars or cores of neutron stars.

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Session Classification: Regular Sessions