



Contribution ID: 1011

Type: Talk in the parallel session

Gravitational Interaction in the Chimney Lattice Universe

Thursday, July 8, 2021 6:30 PM (20 minutes)

We investigate the influence of the chimney topology $TxTxR$ of the Universe on the gravitational potential and force that are generated by point-like massive bodies. We obtain three distinct expressions for the solutions. One follows from Fourier expansion of delta functions into series using periodicity in two toroidal dimensions. The second one is the summation of solutions of the Helmholtz equation, for a source mass and its infinitely many images, which are in the form of Yukawa potentials. The third alternative solution for the potential is formulated via the Ewald sums method applied to Yukawa-type potentials. We show that, for the present Universe, the formulas involving plain summation of Yukawa potentials are preferable for computational purposes, as they require a smaller number of terms in the series to reach adequate precision.

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Session Classification: Dark Energy and the Accelerating Universe

Track Classification: Dark Energy and Large Scale Structure: Dark Energy and the accelerating universe