

Test of non-Newtonian forces at micrometer range

In an effort to unify gravity with the other three fundamental forces, many theoretical models have predicted the existence of non-Newtonian gravitational forces at sub-millimeter range or closer. The current constraints at micrometer range were mostly derived from the precision measurements of the Casimir force. However, the reliability of this method depends on the theoretical calculation of the Casimir force and the evaluation of the patch electrostatic force, both of them are still under debate. We performed an isoelectronic test of non-Newtonian forces at micrometer range by sensing the lateral force between a gold sphere and a density modulation source mass using a soft cantilever. Two-dimensional force mapping, in combination with in situ topographic imaging, is applied to verify the isoelectronic property of the surface. The force signal is found to be electrostatic force dominated, which is correlated with the density modulation structure for thinner gold coating and reduced by thicker gold coating and thermal annealing. Maximum likelihood estimation is used to extract the constraint on the hypothetical force based on the 2D data. The experiment sets a constraint on the Yukawa force without subtraction of the model dependent force background.

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