Bayesian test of the mass of the graviton with planetary ephemerides

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Abstract

In this work, we investigated Bayesian methodologies for constraining in the Solar System a Yukawa suppression of the Newtonian potential—which we interpret as the effect of a non-null graviton mass—by considering its impact on planetary orbits. Complementary to the previous results obtained with INPOP planetary ephemerides, we consider here a Markov Chain Monte Carlo approach associated with a Gaussian Process Regression for improving the resolution of the constraints driven by planetary ephemerides on the graviton mass in the Solar System.

At the end of the procedure, a posterior for the mass of the graviton is presented, providing an upper bound at 1.01e-24 eV cˆ(-2) with a 99.7 % confidence level. The threshold value represents an improvement of 1 order of magnitude relative to the previous estimations. This updated determination of the upper bound is mainly due to the Bayesian methodology, although the use of new planetary ephemerides (INPOP21a used here versus INPOP19a used previously) already induces a gain of a factor 3 with respect to the previous limit. The INPOP21a ephemerides is characterized by the addition of new Juno and Mars orbiter data, but also by a better Solar System modeling, with notably a more realistic model of the Kuiper belt.

Finally, by testing the sensitivity of our results to the choice of the *a priori* distribution of the graviton mass, it turns out that the selection of a prior more favorable to zero-mass graviton (that is, here, General Relativity) seems to be more supported by the observations than non-zero mass graviton, leading to a possible conclusion that planetary ephemerides are more likely to favor General Relativity. Arxiv link to the paper: https://arxiv.org/abs/2306.07069

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