Testing Local Lorentz Invariance with SLR

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In the framework of the Parametrized-Post Newtonian (PPN) formalism, valid in the weak-field and slow-motion (WFSM) limit of General Relativity (GR), the Preferred Frame Effects (PFE) are described by the three parameters $\alpha 1$, $\alpha 2$ and $\alpha 3$, all equal to zero in GR and in tensor-scalar theories of gravity. A test of PFE is equivalent to a test of Local Lorentz Invariance (LLI), which represents a pillar of GR and states that the result of any local (in space and time) non-gravitational test experiment is independent of the speed of the free-falling apparatus in which the experiment is conducted.

We present a measurement of the PPN parameter $\alpha 1$, In the WFSM limit of GR, based on the analysis of the orbital residuals of the LAGEOS II satellite over a time interval of approximately 28 years. LAGEOS II is very well tracked through the powerful Satellite Laser Ranging (SLR) technique. We considered the possible existence of PFE due to the motion of the Earth-Sun-satellite system with respect to the Cosmic Microwave Background radiation and analyzed the effects on the satellite's observable consisting of the sum of its argument of pericenter and its mean anomaly.

It is important to stress that LLI is well tested in high-energy physics experiments but is much more difficult to test in the gravitational context, both in the weak-field regime and in the strong- or quasi-strong-field regime. In the weak-field regime, the current best results in constraining the parameters $\alpha 1$ and $\alpha 2$ were obtained through the Lunar Laser Ranging (LLR) technique.

The result we obtained is in line with a null value for the $\alpha 1$ parameter and improves the constraint obtained with LLR. Therefore, this improved limit for the PPN parameter constrains further the possible existence vector-tensor theories of gravity.

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