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Post-Newtonian parameter in f(R) gravity

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We derive a formula for the post-Newtonian parameter γ in $f(R)$ gravity in a straightforward manner without using a scalar-tensor representation or the transformation to the Einstein frame.

The post-Newtonian parameters, defined in the parametrized post-Newtonian formalism, have been used in placing observational constraints on modified theories of gravity with local gravity tests.
In $f(R)$ gravity, it has been shown that $\gamma \approx 1/2$ for the case of light mass of the field $\partial_R f$, which is manifestly inconsistent with the constraint $|\gamma - 1| \leq 10^{-4}$ obtained from local gravity tests.
For the case that the effective mass of the field $\partial_R f$ becomes large in the solar-system scale, the effect of the gravity modification would be suppressed due to the chameleon mechanism, and the observational constraint could be satisfied.
An explicit formula for the parameter γ, however, has not been obtained for that case.

In our approach, we employ a cosmological post-Newtonian approximation, and carefully make an order-of-magnitude estimate of each term in the field equations for the derivation.
This approximation enables us to treat local-scale high-density regions, in which the chameleon mechanism would take place.
Our results update the previously known ones and provide more stringent constraints from local gravity tests than before.

Summary

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