Geometric Foundations of Gravity 2025



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Weak equivalence principle and nonrelativistic limit of general dispersion relations

We study the weak equivalence principle in the context of modified dispersion relations, a prevalent approach to quantum gravity phenomenology. We find that generic modified dispersion relations violate the weak equivalence principle. The acceleration in general depends on the mass of the test body, unless the Hamiltonian is either 2-homogeneous in the test particles'4-momenta or the corresponding Lagrangian differs from the homogeneous case by a total derivative only. The key ingredient of this calculation is a 3 p 1 decomposition of the parametrization-invariant relativistic test particle action derived from the dispersion relation. Additionally, we apply a perturbative expansion in the test particle's spatial velocity and the inverse speed of light. To quantify our result, we provide a general formula for the Eötvós factor of modified dispersion relations.

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