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Neutron interferometry constrains dark energy chameleon fields

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Observational cosmology has determined the dark matter and dark energy density parameters to an accuracy of two significant figures. While dark energy explains the accelerated expansion of the universe, dark matter is needed in order to describe the rotation curves of galaxies and the large-scale structure of the universe. However, the true nature of dark energy and the content of dark matter remain a mystery. The two most obvious candidates for dark energy are either Einstein's cosmological constant or quintessence theories, where the dynamic vacuum energy changes over time.
Worldwide efforts are undertaken to shed light on this unsatisfactory situation. Here, the neutron plays a key role, as many different neutron experiments allow to test hypothetical dark matter and dark energy scenarios in the lab.
Here, we present phase shift measurements for neutron matter waves in vacuum and in low pressure Helium using a method originally developed for neutron scattering length measurements in neutron interferometry. These measurements are used to search for phase shifts associated with a coupling to scalar fields. Stringent experimental limits for a scalar chameleon field are set.

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