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Probing fundamental physics using compact astrophysical objects

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It is well known that alternative theories to the Standard Model allow and sometimes require fundamental constants, such as the fine-structure constant, α, to vary in spacetime. We demonstrate that one way to investigate these variations is through the Mass-Radius relation of compact astrophysical objects, which is inherently affected by α variations. We start by considering the model of a polytropic white dwarf, which we perturb by adding the α variations for a generic class of Grand Unified Theories. We then extend our analysis to neutron stars, building upon the polytropic approach to consider more realistic equations of state, discussing the impact of such variations on
mass-radius measurements in neutron stars. We present some constraints on these models based on current data and also outline how future observations might distinguish between extensions of the Standard Model.

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