Binary White Dwarfs as Laboratories for Extreme Gravity with LISA

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The observation of low-frequency gravitational waves with the Laser Interferometer Space Antenna will allow the study of new sources of gravitational radiation that are not accessible by ground-based instruments. Gravitational wave sources provide invaluable information both about their astrophysics, as well as the nature of the gravitational interaction in their neighborhoods. One low frequency source that has not received much attention regarding the latter are galactic binaries composed of two white dwarves or a white dwarf and a neutron star. We here show that, contrary to the common lore, such gravitational wave sources can indeed be used to constrain an important feature of the gravitational interaction: the absence of pre-Newtonian, dipolar dissipation. We propose a model-independent framework to carry out a null test for the presence of this feature in the data that is very much analogous to tests of General Relativity with radio-observations of binary pulsars. We then go one step further and specialize this test to scalar-tensor theories to derive projected constraints on spontaneous scalarization. We find that these constraints can be comparable to current bounds with binary pulsars, and in some optimistic cases, they can be even stronger.