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Gravitational footprints of massive neutrinos and lepton number breaking

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We investigate the production of primordial Gravitational Waves (GWs) arising from First Order Phase Transitions (FOPTs) associated to neutrino mass generation in the context of type-I seesaw schemes. We examine both “high-scale”as well as “low-scale”variants, with either explicit or spontaneously broken lepton number symmetry. In the latter case, a pseudo-Goldstone boson, dubbed majoron, may provide a candidate for warm or cold cosmological dark matter. We find that schemes without majoron lead to either no FOPTs or too weak FOPTs, precluding the detectability of GWs in present or near future experiments. Nevertheless, we found that, in the presence of majorons, one can have strong FOPTs and non-trivial primordial GW spectra which can fall well within the frequency and amplitude sensitivity of upcoming experiments, including LISA, BBO and u-DECIGO. We further analyze the associated types of FOPTs and show that in certain cases, the resulting GW spectra entail, as characteristic features, double or multiple peaks, which can be resolved in forthcoming experiments. We also found that the majoron variant of the low-scale seesaw mechanism implies a different GW spectrum than the one expected in the high-scale majoron seesaw. This feature will be testable in future experiments. Our analysis shows that GWs can provide a new and complementary portal to test the neutrino mass sector.

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