Contribution ID: **9** Type: **talk**

Vector induced gravitational waves sourced by primordial magnetic fields

Tuesday 2 September 2025 12:30 (20 minutes)

In the presence of an active source like primordial magnetic fields (PMFs), the vector perturbations of the metric do not necessarily decay away, but may become significant depending upon the background equation-of-state (EoS) parameter, w for instance during reheating. In this work, we develop a generic formalism for the study of tensor perturbations induced at second order by first-order vector metric perturbations, dubbing these induced tensor modes *vector-induced gravitational waves* (VIGWs). Notably, considering an inflation-inspired power-law type magnetic field power spectrum of the form $P_B(k) \propto k^{n_{\rm B}}$ (where $n_{\rm B}$ is the magnetic spectral index), we show that the VIGW signal is enhanced for stiff post-inflationary EoS, with the maximum enhancement happening for $w = 1$. We explicitly demonstrate this contribution is dominant over the first-order magnetically-sourced GWs. The VIGW spectrum exhibits a maximum at around the scale crossing the cosmological horizon at the end of reheating, $k_{\rm reh}$, with its present day peak amplitude scaling as $\Omega_{\rm GW}(k_{\rm reh}, \eta_0) \propto \Delta N_{\rm reh} \times (H_{\rm inf}/M_{\rm Pl})^8$, where $H_{\rm inf}$ is the Hubble parameter at the end of inflation and $\Delta N_{\rm reh}$ the duration of the post-inflationary era in e-folds. For $w = 1$ (kination) and $n_{\rm B} > -3/2$, one further obtains a nearly $n_{\rm B}$-independent frequency scaling of the GW spectrum of the form $\Omega_{\rm GW}(f, \eta_0) \propto \left(\frac{f}{f_{\rm reh}}\right)^{-2.8}$ for $f > f_{\rm reh} \equiv k_{\rm reh}/(2\pi)$. Finally, we need to highlight that the VIGW signal can be well within the detection bands of several next-generation interferometric GW missions at small scales. Indicatively, for $H_{\rm inf} \sim O(10^7)$ GeV and $O(10^{14})$ GeV, and $\Delta N_{\rm reh} \sim 15$ and 10, the VIGW signal is found to be detectable by LISA and ET respectively.

Primary author: Dr PAPANIKOLAOU, Theodoros (Scuola Superiore Meridionale)

Presenter: Dr PAPANIKOLAOU, Theodoros (Scuola Superiore Meridionale)

Session Classification: Morning