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Color restoration in the early Universe: A minimal leptoquark model

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The electroweak phase transition is a promising explanation for the origin of baryon asymmetry in the universe, a core problem in cosmology and particle physics.

An extension of the Standard Model is necessary to generate a strong first-order phase transition. Besides representing a target for several future-generation colliders, such Beyond the Standard Model (BSM) theories can generate - through a thermal phase transition - gravitational waves (GWs) potentially detectable by future space-based detectors, such as LISA [1], DECIGO, and BBO.

As a result, the interplay between BSM phenomenology and GWs is among the most active areas in the field of high-energy physics. Of particular interest are leptoquark (LQ) models, offering an alternative to conventional seesaw scenarios for the generation of Majorana neutrino masses at TeV scale. The presence of LQs can induce first order phase transitions with a temporary colour-breaking phase in the early universe.

With this talk, I intend to present results from the analysis of a minimal leptoquark model. In a dimensionally reduced effective theory approach [3], the model presents strong first order transitions, producing - in some scenarios - gravitational waves detectable by LISA. To our knowledge, these results provide the first evidence for the potential detection of color-breaking and color-restoration features in the above mentioned detectors.

I will conclude with a discussion on the intersection between collider and cosmological observables, pointing to the Higgs cubic self-coupling as a relevant quantity for this purpose, both in the current and in future studies.

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[1] Amaro-Seoane, P., Audley, H., Babak, S., Baker, J., Barausse, E., Bender, P., ... & Zweifel, P. (2017). Laser interferometer space antenna. arXiv preprint arXiv:1702.00786.

[2] Felipe F. Freitas, João Gonçalves, António P. Morais, Roman Pasechnik, Werner Porod,

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[3] Andreas Ekstedt, Philipp Schicho, Tuomas V.I. Tenkanen, Comput.Phys.Commun. 288 (2023) 108725. DRalgo: A package for effective field theory approach for thermal phase transitions.

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