

## M2 Internship offer – Year 2023-2024

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**Mentoring team:** Groupe Théorie in particular L. Darmé, A.Deandrea and A. Chrysostomou

**Research field:** Theoretical physics and Cosmology

**Internship title:** Gravitational waves signatures of first order phase transitions with  $SU(2)_f$

The aim of this internship is to explore the presence, strength, and finally possible GW signatures of first order transitions in new physics models with supplementary gauge groups motivated by the Standard Model flavour problems – so-called horizontal gauge groups [1]. Possible directions include (but are not limited to) computing higher-order corrections (e.g. due to fermionic contributions) to the finite temperature effective potential of the flavour model [2,3], building and implementing new model files for fully parallelized simulations of the real-time evolution of scale-gauge theories in an expanding universe [4], as well as modelling GW behaviour in the wake of a first-order phase transition. For interested candidates with experience in C++, programming-intensive directions could also include developing a Monte-Carlo generator for thermal configurations or a generic numerical model for the dynamics of a phase transition and subsequent emission of GWs.

Interactions with the experimental GWs group at IP2I is expected. This internship may be continued by a PhD project pending to obtaining a PhD funding from the Doctoral School.

### REFERENCES

[1] **Gauge  $SU(2)_f$  flavour transfers,**

Luc Darmé, Aldo Deandrea, Farvah Mahmoudi  
e-Print: 2307.09595 [hep-ph]

[2] **Thermal Resummation and Phase Transitions**

D. Curtin, P. Meade, and H. Ramani, Eur. Phys. J. C 78, 787 (2018),  
e-Print:1612.00466 [hep-ph]

[3] **Theoretical uncertainties for cosmological first-order phase transitions**

D. Croon, O. Gould, P. Schicho, T. V. I. Tenkanen, and G. White, JHEP 04, 055 (2021), e-Print:2009.10080 [hep-ph].

[4] **The art of simulating the early Universe — Part I**

D. G. Figueroa, A. Florio, F. Torrenti, and W. Valkenburg, JCAP 04, 035,  
ePrint:2006.15122 [astro-ph.CO].