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PT2GWFinder: a Handy Tool for Cosmological Phase Transitions and Gravitational Waves

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The baryon asymmetry problem remains a crucial challenge in particle physics and cosmology. Electroweak baryogenesis, a leading mechanism to produce the matter-antimatter asymmetry we observe today, requires an extension of the Standard Model to achieve a sufficiently strong first-order phase transition (FOPT). Besides representing a target for several future-generation colliders, such Beyond the Standard Model (BSM) theories carry the potential to generate, through a thermal phase transition, gravitational waves (GWs) detectable by future space-based detectors.
Despite growing interest in the problem, publicly available code for studying different BSM scenarios is limited, with the leading tools being *CosmoTransitions*, *PhaseTracer* and *BSMPT*. While they offer powerful methods for model building, there remains a need for an accessible tool that enables the study of FOPTs in a simple and straightforward manner.
We are releasing a fully Mathematica-based paclet to fill the gap, offering a user-friendly and fully automated tool to derive phase transition and gravitational wave parameters. To compute the Euclidean tunneling action, the paclet exploits the recently developed FindBounce, which implements the polygonal bounce method.
The user provides any scalar potential in the form $V(\phi, T)$, where ϕ is the field direction in which a FOPT is expected, and the paclet automates the following steps:
- multiple phase tracing methods
- identification of first order phase transitions
- construction of a semi-analytical fit function for the bounce action $S_3/T(T)$
- computation of phase transition parameters: nucleation and percolation temperatures, strength, duration, …
- derivation of GW spectra from templates found in the literature.

Although designed to work with any given thermal potential, we offer additional tools to construct thermal potentials both in the daisy-resummation and dimensional reduction approaches. Specifically, the paclet is intended to interface smoothly with DRalgo, a Mathematica tool implementing dimensional reduction and thermal effective field theory computations.
The tool has been tested on a variety of single-field models, including the dark Abelian Higgs and a coupled fluid-field model. This presentation will cover current results and future development plans, showcasing the potential for this new paclet to become an invaluable resource in the field of cosmological phase transitions.

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