ICTP | International Centre for Theoretical Physics
SAIFR | South American Institute for Fundamental Research

## Campus of IFT-UNESP - São Paulo, Brasil

**February 10 – March 6, 2023**

# MINICOURSE ON COSMOLOGICAL PHASE TRANSITIONS AND GRAVITATIONAL WAVES

**BENEDICT VON HARLING**
**IFAE-Barcelona, Spain**

In this minicourse, it will be given an introduction to phase transitions in the early universe and how they may produce stochastic gravitational waves which could be detected at current and future observatories. After describing the dynamics of cosmological phase transitions and the quantities which control the production of gravitational waves, prof. Von Harling will present several concrete particle-physics models and discuss their discovery prospects at gravitational-wave observatories.

**Lectures 1&2: Introduction:** Phase transitions in the early universe and how they can source gravitational waves. Effective potential and thermal corrections in quantum field theory. Bubble nucleation during first-order phase transitions. Quantities that control the production of gravitational waves and resulting spectra.

**Lectures 3&4:** Overview of current and future gravitational-wave observatories. A simple model with a first-order phase transition: A nearly-conformal scalar. Thermal effective potential, dynamics of the phase transition, supercooling and gravitational-wave signals.

**Lectures 5&6:** The electroweak phase transition. Overview of ways to make it first-order. One model in detail: A scalar coupled to the Higgs. Different possibilities for the phase-transition dynamics in this model.

**Lectures 7&8: Detour:** Randall-Sundrum and composite Higgs models as solutions to the hierarchy problem. Phase transitions in Randall-Sundrum models and their dual conformal field theories are typically strongly first-order. Two-field phase transitions in composite Higgs models.

**There is no registration fee and everybody is welcome to participate.**

**Online application and more information:**
**www.ictp-saifr.org/cptgw2023/**

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