SCIENCES & BIOENGINEERING SCIENCES

The Research Group
High-Energy Physics

has the honor to invite you to the public defence of the PhD thesis of

Aäron Rase

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

The Stochastic Gravitational Wave Background from Domain Walls: From Numerical Modeling to Observational Signatures

Supervisor:
Prof. dr. Alberto Mariotti (VUB)
Co-supervisor:
Prof. dr. Alexander Sevrin (VUB)

The defence will take place on
Wednesday, June 17, 2026 at 3:30 p.m.

VUB Etterbeek campus, Pleinlaan 2, Elsene,
In auditorium I.0.01

The defence can be followed via Zoom (Meeting ID: 885 0591 5548 - Passcode: 3vU3ya)

Members of the jury

Prof. dr. Steven Lowette (VUB, chair)
Prof. dr. Ann Dooms (VUB)
Prof. dr. Laura Lopez Honorez (VUB/ULB)
Dr. Fabrizio Rompineve (UAB/IFAE, ES)
Dr. Pierre Auclair (Sorbonne Université, FR)

Curriculum vitae

Aäron obtained his MSc in Physics and Astronomy from VUB in 2021. He then started a PhD at VUB with support from an FWO fellowship. His research focuses on gravitational waves from domain walls, combining numerical simulations and theoretical modeling to study their observational signatures.

As part of his PhD, Aäron is a member of the LIGO-Virgo-KAGRA and Einstein Telescope collaborations. His work has contributed to several publications on gravitational waves and early-universe cosmology. In addition to his research, he has taught experimental physics courses and supervised bachelor and master theses.

Abstract of the PhD research

With the first observation of gravitational waves (GWs) in 2015, a new era of GW astronomy began. These ripples in spacetime, predicted by Einstein's theory of General Relativity, allow us to observe the Universe in a fundamentally different way, beyond electromagnetic observations. Strong GW signals can arise from nearby astrophysical systems, such as binary black hole mergers. However, for sources that are too distant or too faint to be individually resolved, the associated weak GWs mix to form a random, noise-like background known as the stochastic gravitational wave background (SGWB). In addition to astrophysical sources, the SGWB includes contributions from processes in the very early Universe, potentially originating shortly after the Big Bang. Observing a cosmological SGWB would therefore provide profound insights into these largely unexplored epochs.

This thesis focuses on a particular cosmological source of the SGWB: domain walls (DWs). These are hypothetical, surface-like structures that could have formed during phase transitions when the early Universe evolved to a less symmetric state. Although extremely thin, DWs can contain enormous amounts of energy, and their formation, evolution and eventual annihilation can generate GWs, contributing to the cosmological SGWB. The existence of DWs would indicate new physics beyond the Standard Model, and detecting a GW signal from them would provide direct evidence.

A detailed understanding of how DWs contribute to the cosmological SGWB is therefore of central importance. To investigate this, lattice field simulations are employed, evolving DWs in a cubic box to compute the resulting SGWB and evaluate its detectability in current and future GW experiments, with particular focus on the LIGO-Virgo-KAGRA network and the Einstein Telescope. Motivated by the recent evidence for a SGWB reported by the Pulsar Timing Array collaborations, the possibility that such a signal could originate from a DW network is also explored, with special attention given to axion DWs. In this context, a comprehensive analysis of modifications to the SGWB arising from DW interactions with the surrounding cosmic plasma plays a crucial role in determining the feasibility of an axion DW interpretation, and these friction effects are therefore investigated thoroughly.