SCIENCES & BIOENGINEERING SCIENCES

The Research Group

Elementary Particle Physics

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

Enrique Huesca Santiago

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Understanding radar echoes from high-energy particle cascades: A macroscopic approach to the radar echo scatter

Promotor:
Prof. dr. Krijn de Vries (VUB)

The defence will take place on

Tuesday, June 25, 2024 at 3 p.m. in Auditorium I.2.01

The defence can also be followed through a live stream

Members of the jury

Prof. dr. Nick van Eijndhoven (VUB, chair)
Prof. dr. Stijn Buitink (VUB, secretary)
Prof. dr. Steven Lowette (VUB)
Prof. dr. Frank De Proft (VUB)
Prof. dr. Simona Toscano (ULB)
Dr. Katharine Mulrey (Radboud University Nijmegen, The Netherlands)

Curriculum vitae

Enrique obtained his MSc in Experimental Physics at Utrecht University in 2019. The MSc thesis had a focus on the use of machine learning techniques for the flavor discrimination of astrophysical neutrinos in the KM3NeT detector.

At the VUB-IIHE, Enrique has been working in the astroparticle physics group as part of the Radar Echo Telescope (RET) collaboration. The main topic of his thesis is the accurate modeling of the radar scatter of particle cascades in ice, resulting in a novel model dubbed MARES. As part of his PhD, Enrique was also involved in hardware work for the RET-CR experiment, the supervision of MSc. students, and presenting the obtained results at multiple scientific conferences.

Abstract of the PhD research

Studying the most energetic environments in our universe remains one of the most interesting and challenging topics in modern-day physics. High-energy cosmic messengers like gamma rays, cosmic rays or neutrinos are emitted from these environments and reach Earth.

Neutrinos are usually regarded as one of the feeblest and most elusive particles of the standard model: With no charge and virtually no mass, they can only interact with matter via the weak force. This makes neutrinos usually very hard to detect, as they travel through the universe mostly unimpeded. In the astrophysical context, this makes them excellent cosmic messengers to probe the high-energy universe.

We have yet to see the most energetic, and therefore rarest, among the cosmic neutrinos. To that purpose, the Radar Echo Telescope (RET) is under development. Its goal is to detect cosmic neutrinos by instrumenting a large amount of polar ice with a radar system and constantly scanning for the traces of high-energy neutrinos. When a high-energy neutrino interacts, it will abruptly deposit its energy in the ice, producing a trail of ionized particles. This trail can trigger the radar system and act as a "smoking gun" for the original neutrino.

This work presents a novel modelling effort developed for the RET collaboration, the macroscopic approach to the radar echo scatter, or MARES. MARES describes the radar scatter off the ionization trail left in the wake of a neutrino interaction in ice. MARES describes the interaction between the ionization trail, the ice and the radio waves consistently and completely, and is used to investigate the expected signal in a radar system.