

The Research Group

Elementary Particle Physics

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

Pablo Correa Camiroaga

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Merging High-Energy Neutrino Astronomy with the Extreme Infrared Sky: A Search for Cosmic Neutrinos from Ultra-Luminous Infrared Galaxies with the IceCube Observatory

Promotor:

Prof. dr. Nick van Eijndhoven (VUB)

Co-promotor:

Prof. dr. Krijn de Vries (VUB)

The defense will take place on

Friday, September 9, 2022 at 16h in auditorium Q.B

The defense can also be followed through a livestream. Please contact pablo.correa.camiroaga@vub.be for more details.

Members of the jury

Prof. dr. Jorgen D'Hondt (VUB, chair)

Prof. dr. Stijn Buitink (VUB, secretary)

Prof. dr. Dominique Maes (VUB)

Prof. dr. Mauricio Bustamante (Niels Bohr Institute - University of Copenhagen)

Prof. dr. Anna Franckowiak (Ruhr University Bochum)

Prof. dr. Annarita Margiotta (University of Bologna)

Curriculum vitae

In 2017, Pablo obtained his master's degree in Physics & Astronomy at the VUB, for which he was awarded the best master thesis prize by the Belgian Physical Society. That same year, he was awarded a PhD Fellowship by the Flemish Research Foundation to start his graduate studies. His research on sources of high-energy astrophysical neutrinos, which focused on ultra-luminous infrared galaxies, has been published in a number of international conference proceedings and peer-reviewed journals. During his PhD, Pablo was also the teaching assistant for two physics courses, as well as the thesis supervisor of several bachelor and master students. In addition, he was the main organizer of various outreach activities, and the PhD representative several academic councils within the faculty.

Abstract of the PhD research

High-energy astrophysical neutrinos were discovered in 2013 with the IceCube Neutrino Observatory at the South Pole, marking the birth of neutrino astronomy. Because they have no electric charge and only interact weakly, these "ghost particles" are the ideal cosmic messenger to probe some of the most explosive phenomena in the Universe. However, the diffuse flux of astrophysical neutrinos measured with IceCube is mostly unresolved, such that their exact origin remains largely unknown.

Ultra-luminous infrared galaxies (ULIRGs) are a promising class of high-energy neutrino sources. These merging systems of spiral galaxies are characterized by an infrared luminosity that is at least 100 times greater than the total electromagnetic luminosity of our own galaxy, the Milky Way. The infrared radiation is emitted by dense dust clouds, which reprocess high-energy radiation from the central engines powering these objects. ULIRGs are mostly powered by starbursts, compact stellar factories that produce an equivalent of more than 100 Suns per year. An additional contribution can come from active galactic nuclei (AGN), supermassive black holes that are actively accreting matter. Both the dust-enshrouded starburst and AGN environments are ideal for the production of high-energy neutrinos.

This work presents a novel IceCube study searching for high-energy neutrinos originating from ULIRGs using 7.2 years of high-quality IceCube data, recorded between 2011--2018. First, a selection of 75 ULIRGs is performed, primarily based on observations of the Infrared Astronomical Satellite (IRAS). Next, a dedicated statistical IceCube analysis is conducted to identify high-energy neutrinos originating from the 75 selected ULIRGs. In particular, a stacking technique is applied, where instead of investigating each source individually, their cumulative neutrino emission is studied. The stacking analysis yields a null result, as no astrophysical neutrinos originating from ULIRGs are identified. This null result is used to set the first ever constraints on the neutrino emission from the complete ULIRG source population over cosmic history. One of the major results of this work is that the ULIRG source class cannot account for more than about 10% of the diffuse neutrino flux observed with IceCube. Furthermore, these results constrain several model predictions of high-energy neutrino emission from ULIRGs. As such, new insights are obtained in the high-energy astrophysics of these sources.