ID: MSCA-2020-NVEijndhoven01

Title: Multi-messenger Studies of Cosmic Phenomena with the IceCube Neutrino Observatory

Since the discovery of cosmic rays in 1912, we still don't know what the sources of these energetic charged particles are. Identification of their sources is hindered by the fact that these charged particles are deflected by (inter)galactic magnetic fields and undergo interactions on their way to Earth. However, the **discovery of cosmic high-energy neutrinos by IceCube** has opened a new era, dubbed **neutrino astronomy** and announced as the **"breakthrough of 2013"**. Neutrinos are excellent astrophysical messengers; they only interact weakly and point back to their source. The sources of the observed cosmic neutrinos still remain a mystery, but one expects that they originate from the same cataclysmic phenomena (e.g. cosmic explosions, binary mergers, accreting black holes) as the cosmic rays. As such, cosmic high-energy neutrinos will enable us to **identify the sources of cosmic rays** and obtain **insight in the inner engines of cosmic phenomena**.

IceCube is a neutrino telescope consisting of an array of more than 5000 optical sensors, located in the icecap of the South Pole at depths between 1450 and 2450 m. In december 2010 the full detector has been completed and has been taking data ever since, representing an operational observatory with an instrumented volume of 1 km^3. This makes IceCube the world's largest neutrino observatory and as such provides a unique instrument to study the phenomena mentioned above.

The VUB members in IceCube are key players in various areas within the international IceCube collaboration (http://icecube.wisc.edu/). Our group focuses on the study of cosmic transient events like Gamma Ray Bursts and sources of Gravitational Waves, and recently has initiated new research directions within IceCube related to dust obscured sources (e.g. Active Galactic Nuclei and Ultra Luminous Infrared Galaxies). These studies are performed by combining the events recorded in IceCube with other observations like for instance electromagnetic radiation detected by satellites or gravitational waves detected by interferometers. These so called **multi-mesenger observations** are very versatile, since they allow to probe various aspects of cosmic phenomena. Next to the experimental investigations our group is also involved in phenomenological activities related to the phenomena mentioned above.

In addition, the members of the Brussels IceCube team participate in the operation of the detector, the verification of the data quality, the event reconstruction, the maintenance of the equipment at the South Pole and the management. Furthermore, Flanders has been a significant contributor to the realization of the IceCube neutrino observatory at the South Pole and the computer cluster in Brussels is among the principal data analysis and simulation centers where currently a significant fraction of the IceCube simulation processing takes place.

Supervisor : Nick.van.Eijndhoven@vub.be

Research Group: https://w3.iihe.ac.be/

To apply: https://www.vub.ac.be/en/european-liaison-office#apply-msca-if