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Title : Exploring the High-Energy Neutrino Universe

With the discovery of cosmic high-energy neutrinos IceCube has opened a new research field, dubbed **neutrino astronomy**, which was announced as the "**breakthrough of 2013**". Neutrinos are excellent astrophysical messengers; they travel through the Universe basically unhindered and point back to their source. As such, they can convey information about the underlying processes of cosmic phenomena at cosmological distances. The sources of the observed cosmic neutrinos currently still remain a mystery, but the general consensus is that they originate from cataclysmic events like for instance cosmic explosions, binary mergers and accreting black holes. Consequently, this new window on the Universe will enable us to obtain **insight in the inner engines of cosmic phenomena**.

The current IceCube detector covers a volume of 1 km^3 and an energy range from about 10^{11} eV to a few 10^{15} eV, which is now understood as the low energy tail of interesting signals and new physics is expected at higher energies, as outlined below. The IceCube limitation at the high-energy end is due to the fact that at these high energies the particle flux gets very low. To go beyond this limitation and record a sufficient amount of events for detailed studies, an extension of the current observatory by about two orders of magnitude would be needed. Since this is not feasible with the current IceCube technology, **new detection technologies** have to be employed. Concerning these new technologies, our VUB team has taken a lead towards detection of energetic neutrinos by means of **radio signals from induced cascades in the deep ice**. For this we have planned the installation of a novel **Radio Neutrino Observatory** (supported by a large Flemish International Research Infrastructure (IRI) grant), of which the deployment of the first stations will take place in 2020, enabling commissioning and data analysis in the following years. The use of radio signals allows to cover areas as big as several 100 km^2, enabling the detection of the very low neutrino fluxes at extremely high (i.e. beyond 10^{18} eV) energies and as such opens up the investigation of so-called Greisen-Zatsepin-Kuzmin (GZK) neutrinos, produced by interactions of the most energetic cosmic rays with the cosmic microwave background photons. This would provide a unique and unambiguous proof that the observed flux drop in cosmic rays around 10^{20} eV energies is either due to a maximum energy of cosmic accelerators or indeed due to this GZK effect and the corresponding neutrino flux would provide insight in the composition of these extremely energetic cosmic rays. Radio detection becomes efficient above a neutrino energy of about 10^{17} eV, but the use of a phased radio array (an innovative new technique in this field) would provide sensitivity down to an energy of about 10^{16} eV. This energy range is especially interesting to determine the characteristics of the currently observed cosmic high-energy neutrino spectrum.

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