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CONCEPT STUDY FOR OBSERVING GALACTIC NEUTRINOS IN NEPTUNE'S ATMOSPHERE

Abstract

I discuss the feasibility of a conceptual space-based neutrino detector that utilizes the Ice Giants as Targets for Galactic Neutrinos. The purpose of this research stems from the concept of wanting to find a new method of observing the Galactic Core (GC) of the Milky way and the Supermassive black hole, Sag A*. Observations of the GC have been made in every accessible wavelength except for the regions of space that are too dense for photons to probe. In these regions, we may instead use neutrinos. Neutrinos from the Active Galactic Nucleus are emitted at extreme energies, 10 GeV to EeV scales, but have an extremely low flux measured here at earth. Neutrino telescopes such as the IceCube Observatory have only been able to measure a handful of neutrinos that might correlate to the GC. But using Gravitational lensing, our sun can be used as a lens which increases the "light" collection power for neutrinos by a factor of 10^{13}, with the tradeoff that the minimum focal point is located at 22 AU. This means that Uranus and Neptune are suitable natural targets for these neutrinos to interact with and observe the effects from a spacecraft in orbit. Initial studies use Geant4, a particle physics simulation toolbox developed by CERN, to facilitate the propagation of energetic particles passing through the atmosphere of Neptune. Various aspects are studied ranging from the wavelength of the photons that are being measured at the detector, timing of the hits, and distribution of the photons leaving the atmosphere. For each of these aspects, we modify several variables such as particle type, energy, interaction depth, and orbital distance from the surface. I also discuss the versatility of this neutrino detector which has the possibility of mapping out the inner structure of the Ice Giants, in-depth studies of the neutrinos coming from the GC, and possibilities to use this method for other cosmic neutrino sources. This detector would be of great interest to planetary science, particle physics, and astrophysics communities.