Dark Ghosts - 3rd GNN Workshop on Indirect Dark Matter Searches with Neutrino Telescopes

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Faculty of Science - University of Granada

Dark Ghosts

Granada, 31st March - 1st April 2022

3rd GNN Workshop on Indirect Dark Matter Searches with Neutrino Telescopes

Book of Abstracts

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Dark Matter Decay and Annihilation to Neutrinos

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Dark matter particles are predicted to decay or annihilate into Standard Model particles which would produce signals of neutrinos, gamma-rays, and other secondary particles. As no such signal has yet been detected, we turn to the least constrained channel where neutrinos provide an avenue to probe astrophysical sources of dark matter particles. We review the decay and annihilation of dark matter into neutrinos over a range of dark matter masses from MeV/c2 to ZeV/c2. We examine the expected contributions to the neutrino flux at current and upcoming neutrino and gamma-ray experiments, such as Hyper-Kamiokande, DUNE, CTA, TAMBO, and IceCube Gen-2. We consider galactic and extragalactic signals of s, p, and d-wave annihilation and decay processes into neutrino pairs, yielding constraints on the dark matter self-annihilation cross-section to neutrinos $\langle\sigma v\rangle$ and dark matter decay lifetime τ.

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Charon: A Tool for Neutrino Flux Generation from WIMPs

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Indirect searches for signatures of corpuscular dark matter have been performed using all cosmic messengers: gamma rays, cosmic rays, and neutrinos. The search for dark matter from neutrinos is of particular importance since they are the only courier that can reach detectors from dark matter processes in dense environments, such as the core of the Sun or Earth, or from the edge of the observable Universe. In this contribution, I will introduce χarov, a package for generating and propagating neutrino yields from dark matter annihilation and decay.

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Constraining EeV-Scale Dark Matter with Neutrino Observatories Using Tau Regeneration

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In 2016 and 2018, the ANITA collaboration reported the observation of two anomalous events, with polarizations consistent with up-going neutrinos, but coming from too far below the horizon to have traversed Earth given their energies. While all Standard Model (SM) explanations of these events have been ruled out, explanations from beyond Standard Model scenarios have been put forth in the literature, including scenarios in which these events arise from heavy dark matter decay to SM particles. In this contribution, we use tau neutrino regeneration to constrain one such explanation.

Using ANTARES and IceCube public data, we look for an excess of neutrinos coming from this dark matter decaying in the Galactic Center and the Sun. Furthermore, we show the first accurate simulation of tau neutrino regeneration in the Sun.

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Decaying Dark Matter at IceCube and its Signature in High-Energy Gamma-Ray Experiments

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The measurement of ultra-high energy starting event neutrinos in the TeV-PeV range in IceCube has afforded us with the possibility of answering questions through multimessenger efforts in astroparticle physics. However, the origin and nature of these astrophysical neutrinos is still largely unresolved. Among existing tensions, for example, is the excess of neutrinos observed in the energy range of 40-200 TeV, a contribution that could come from heavy dark matter decay. The dark matter decay hypothesis has been studied extensively through comparisons with gamma-ray data, due to the fact that a coincident gamma-ray flux is expected to accompany the neutrino flux that IceCube observes. Diffuse gamma-ray data has placed strong constraints that rule out the dark matter hypothesis for IceCube's observations. However, gamma-rays become heavily suppressed for sources dominating in particular energy ranges. This is due to properties of the traversed medium, which generally consists of extragalactic background light (EBL), the cosmic microwave background (CMB), and the intergalactic magnetic field, the first of which, in particular, is very difficult to measure and thus involves many uncertainties. In this work, we elaborate on previous dark matter decay results by considering the impact that the EBL could have on predicted gamma-ray spectra for dark matter. We present limits on galactic and extragalactic dark matter decay by comparing our calculations to Tibet 2021 data and Fermi-LAT diffuse data, featuring uncertainties among different EBL models that could have implications for existing limits.

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Limits for Dark Matter annihilation in the Sun with ANTARES neutrino telescope

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One of the most popular candidate of Dark Matter (DM) particle are the Weakly Interacting Massive Particles (WIMPs). These, once gravitationally captured in massive celestial objects and annihilating between them into Standard Model particles, can be indirectly detected. The centre of those massive objects is, therefore, a place where to look for a possible neutrino excess from DM annihilations using neutrino telescopes. The closest of such potential astrophysical DM sources is the Sun.
The ANTARES deep-sea neutrino telescope, located in the Mediterranean Sea, best
performs in indirect searches for neutrino signals from DM annihilation in the 100 GeV to 1 TeV energy range. In this work the results from the search for WIMPs towards the Sun direction, using 13 years of data collected by ANTARES telescope are presented.
Upper limits on the WIMP –nucleon cross section are obtained for DM mass in the range from 50

GeV/c^2 to 3 TeV/c^2 , improving the results of the last ANTARES publication by more than a factor of two.

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