29th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Interactive Presentations - 29th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (IP)

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DARKNESS: A CUBESAT MISSION TO HUNT FOR DARK MATTER IN THE MILKY WAY

Abstract

Dark matter as a sterile NEutrino Search Satellite (DarkNESS) is a CubeSat mission concept developed by the Fermi National Accelerator Laboratory (Fermilab) in Batavia, Illinois. Additional design guidance was given by the National Aeronautics and Space Administration's (NASA) Jet Propulsion Laboratory (JPL) in Pasadena, California. DarkNESS is a 6U CubeSat equipped with four ultra-high signal-to-noise-ratio (SNR) charge-coupled devices (CCDs) that will be looking at the Galactic Center (GC) of the Milky Way.

After astronomers confirmed the presence of a 3.5 keV signal coming from the GC, physicists began exploring experiments to map the signal directly knowing that a 3.5 keV signal is consistent with a sterile neutrino (Ns) with mass of 7 keV that decays into a standard neutrino (ν) and 3.5 keV photon (γ). Ns have long been thought to be a candidate for dark matter and this mission will survey the 3.5 keV signal to further understand its origins and see if it indeed comes from Ns within the GC.

Four ultra-high SNR CCDs developed by Fermilab will be outfitted to obtain a 40 field of view (FOV) and a collection area of 36 cm2, giving a 0.050 keV resolution with an SNR of 13 for 15 minute exposures. In order to avoid dark current noise, the CCDs are cooled 150 K using an onboard micro-cryocooler and are constantly facing deep space. The spacecraft uses five solar panels that unfold in a similar configuration to JPL's Temporal Experiment for Storms and Tropical Systems - Demonstration (TEMPEST-D) mission. In order to maintain a 150 K cold face of the spacecraft and maximize the amount of time viewing the GC, the optimal orbit is a sun synchronous orbit (SSO) with ascending/descending nodes along the terminator (6am/6pm local nodes).

While this mission concept is still in its infancy, it is looking towards the future for a late-2020's launch date. This paper gives the reader the status of the hardware and testing of the DarkNESS mission in its current phase.