In the last few decades cosmic observations have indicated that the vast majority of the matter in the universe is invisible and composed of non-baryonic particles. No further conclusive cosmic clues were found as to the particle nature of this so-called dark matter. In addition, the Standard Model of elementary particle physics does not contain a particle with the right properties to constitute the dark matter. This lead to the current situation in which the nature of the dark matter is one of the central questions in cosmology. Furthermore, its solution may have far-reaching implications for particle physicists as well.

One possibility is that the dark matter is composed of neutralinos, which are massive and weakly interacting particles that appear in the hypothetical, but well-motivated supersymmetric extensions of the Standard Model of particle physics. If this scenario is correct, the Sun should have captured a large amount of neutralinos from the dark matter halo around our galaxy. The annihilations of these particles lead to a steady stream of GeV-TeV neutrinos, whose detection in earthbound detectors would shed a fascinating light on the identity of the dark matter.

In this work we search for these high energy neutrino events from the Sun in a data set collected in 2001-2003 by the Antarctic Muon And Neutrino Detector Array (AMANDA) at the Amundsen-Scott South Pole base. The inspected AMANDA data set consists of 3.5 billion events, mostly downward-going muons created in collisions of cosmic rays with nuclei in the atmosphere. We present an analysis that removes the bulk of these background muons, before developing a novel method to estimate the number of events from the Sun in the remaining, background-dominated data sample.

The main result of our work is that, after reduction of the muon background, no indication was found that the remaining data sample contains neutrinos from the Sun. We therefore report, for neutralinos in the mass range 50 GeV/c^2 - 5000 GeV/c^2 and for both extreme annihilation channels, 90% confidence level upper limits on the neutralino annihilation rate in the Sun, the muon flux at the detector and the neutralino-proton elastic scattering cross section. Our muon flux limits reach down to $9.4 \times 10^2\ km^{-2}\ yr^{-1}$. Particularly, our limits on spin-dependent cross section are much better than those obtained in direct detection experiments, allowing AMANDA and other high energy neutrino detectors to observe a complementary portion of the supersymmetric parameter space.

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