Intensity Gradients in the Heliosheath and the Location of the Source of Anomalous Cosmic Rays

E. C. Stone*, A. C. Cummings*, F. B. McDonald†, B. C. Heikkila‡, N. Lal§, and W. R. Webber§

*Caltech, Pasadena, CA 91125
†Univ. Maryland, College Park, MD 20742
‡NASA/GSFC, Greenbelt, MD 20771
§New Mexico State Univ., Las Cruces, NM 88003

Abstract. Beginning in 2007, it has been possible to measure the intensity gradients of anomalous cosmic rays (ACRs) in the heliosheath. At the highest energies (e.g. >50 MeV/nuc He) there has been essentially no gradient between Voyager 1 and 2 and no significant change in intensity since Voyager 2 entered the heliosheath. However, at lower energies the intensity at Voyager 1, now at 110 AU, has been persistently greater than that at Voyager 2, now at 90 AU, corresponding to typical gradients of 1 to 5%/AU in the heliosheath, depending on energy and species and assuming the gradient is entirely radial. This indicates that the location of the ACR source is beyond the location of V1. With the approach of solar minimum conditions, the ACR intensity at lower energies has increased by 25 to 50% per year.

Decreases in the gradient between Voyager 1 and 2 indicate changes in the heliosheath inside 110 AU, while the increases in the Voyager 1 intensities at low energies indicate changes in the propagation conditions in the heliosheath between Voyager 1 and the ACR source. Because of the reduced radial velocity of the heliosheath plasma, it takes more than two years for the solar wind plasma to flow from the Sun to beyond 110 AU and produce the changes in modulation in the heliosheath during solar minimum conditions. Correlation of the changes in modulation level with changing properties of the solar wind and interplanetary magnetic field may provide insight into the location of the modulation region and the source of anomalous cosmic rays.

This work was supported by NASA under contract NAS7-03001.

Keywords: Anomalous cosmic rays, gradients, heliosheath