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An Adjoint Monte Carlo Calculation of Radiation Transport through the Heliosphere

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A Monte Carlo code has been written to solve the heliospheric transport equation in the finite difference approximation. The heliosphere was represented by a 140-AU sphere with the sun at 100 AU from the bow-shock direction. Results agree with the spectral measurements of Neher (1967) at 1 AU, and with the Voyager 1 and 2 spacecraft measurements of proton and alpha fluxes from 2 to 72 AU (Caballero-Lopez, et al., 2004). Some pre-modulation of the primary spectrum was found necessary to yield agreement at the larger distances from the sun. Calculations yield the expected isotropy of the cosmic-ray flux at 1 AU. An interesting result is that solar modulation is greater for planets "behind the sun, " (in the direction opposite the bow-shock) than for planets in the bow-shock direction for the same level of solar activity. The effect should be undetectable, since there is no measure of solar activity independent of the earth's position in the heliosphere.

Caballero-Lopes, R. A. ; Moraal, H. ; McDonald, F. B. Galactic cosmic ray modulation: Effects of the solar wind termination shock and the heliospheath. Joural of Geophysical Research, 2004, 109, A05105, doi:10.1029/2003JA010358.

Neher, H. V. Cosmic-ray particles that changed from 1954 to 1958 to 1965. Journal of Geophysical Research 1967, 72, 1527-1539.