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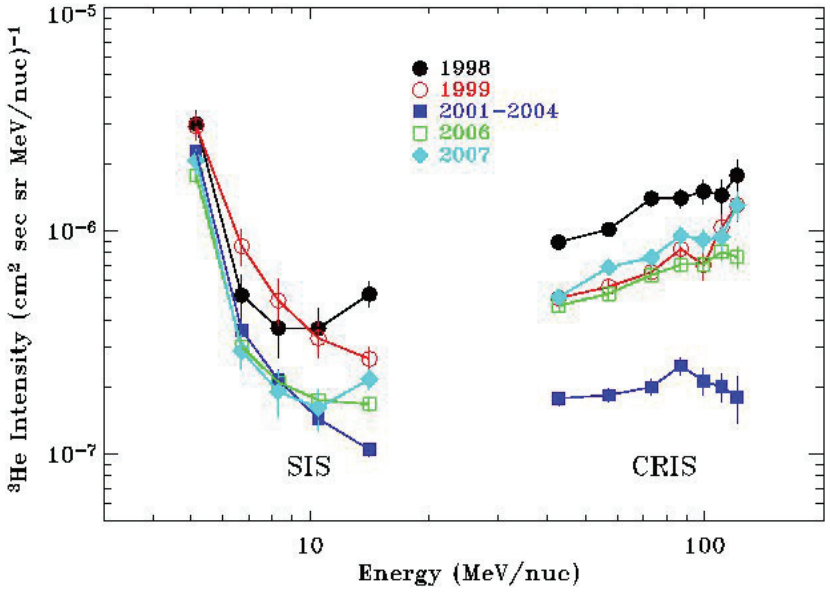
The Origin of Energetic ^{3}He in the Inner Heliosphere



Energetic ^{3}He in interplanetary space is believed to originate from two well-established sources, from ^{3}He-rich solar energetic particle (SEP) events and from the fragmentation of galactic cosmic ray (GCR) ^{4}He in the interstellar medium. The two sources of ^{3}He have very different spectra in the MeV/nuc range, which help to distinguish between the two populations near Earth.

^{3}He quiet-time intensities observed from SIS and CRIS over five different periods during the solar cycle are shown above. Quiet time days are selected by requiring 5 MeV/nuc ^{3}He intensities to be $<5\times10^6$ (cm^2 sec sr MeV/nuc)$^{-1}$ with a ^{3}He/^{4}He ratio that is > 5% (these criteria may bias the lowest energy intensities shown above). Two significant features stand out in these energy spectra. Below ~10 MeV/nuc, the energy spectra exhibit a clear turn up in all time periods studied, suggesting that these nuclei originate from a superposition of small ^{3}He-rich SEP events (as discussed by Richardson et al. in 1990, Mason et al. in 1999 and Slocum et al. in 2002), possibly accelerated to higher energies in interplanetary space. In addition, the ^{3}He spectra from SIS flatten at higher energies and even exhibit a clear turn-up during solar minimum conditions (1998 & 2007). Furthermore, the ^{3}He intensities derived from SIS are consistent with the intensities observed at higher energies from CRIS, suggesting that above ~10 MeV/nuc, the ^{3}He population is dominated by GCRs of secondary origin.

The changing level of solar modulation during the solar cycle also plays a significant role in defining the energy spectra for these two populations. The decrease from 1998 to 2004 in the SIS ^{3}He intensity between 10 and 15 MeV/nuc is consistent with a GCR origin since the level of solar modulation increased significantly in 2000. Comparing the 2007 ^{3}He intensities at 10-15 MeV/nuc with the intensities during 1998-99 also suggests a galactic origin for these particles, since the solar modulation level in 2007 is significantly less than at solar maximum and not quite at its level of 1998. We expect the 10 to 15 MeV/nuc intensities to further increase as we continue into early 2008.

These observations suggest that ~10 MeV/nuc ^{3}He near Earth consists of a mix of solar and galactic components. During solar minimum conditions, the ^{3}He intensity below ~10 MeV/nucleon is dominated by the solar component and near 15 MeV/nuc by a galactic component. During solar maximum conditions, the galactic contribution is suppressed, although it appears to make a non-negligible contribution in the 10-15 MeV/nuc range.

Contributed by Georgia de Nolfo of NASA/GSFC and Mark Wiedenbeck of JPL. Questions or comments can be addressed to georgia@milkyway.gsfc.nasa.gov. For further information see the papers by Wiedenbeck et al. (#1121) and de Nolfo et al. (#663) in the Proceedings of the 30th International Cosmic Ray Conference. See http://www.srl.caltech.edu/ACE/ACENews_Archives.html for earlier ACE News Items.