2. Anomalous Cosmic Ray Data Sets

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2.1. Introduction

The current solar minimum offers a unique opportunity for ACR studies, with an unprecedented array of instruments being carried by spacecraft at widely separated locations in the heliosphere. Of particular importance in this respect were the polar passes of Ulysses in 1994 and 1995, which provided the first mapping of ACR fluxes over the full range of heliolatitudes within 5 AU of the Sun. In order to exploit this opportunity to the full, comprehensive sets of ACR energy spectral data covering the epochs of the two Ulysses polar passes have been assembled with a view to providing theorists with detailed observational constraints to models of ACR acceleration and transport.

2.2. The Data Sets

The two time periods chosen over which to average the energy spectral data correspond to the times at which Ulysses was above 70° heliographic latitude in either heliospheric hemisphere, namely 1994/178.00–309.00 (27 June – 04 November incl.) and 1995/170.00–273.00 (19 June – 29 September incl.). In some cases, the

Table II
ACR Data Sets Included in the ISSI Data Base.

Spacecraft	S/C Position (helioc. range/heliog. lat.) 1994/178–309	1995/170–273	Instrument	ACR Species
SAMPEX	Earth orbit		HILT[a]	O, Ne, Ar
			LICA[b]	O
			MAST	C, N, O, Ne
WIND	Near Earth orbit		LEMT	He, O
Geotail	Earth orbit		HEP[c]	C, N, O
Ulysses	2.8–1.9 AU/ 70–80.2–70S	1.7–2.5 AU/ 70–80.2–70N	COSPIN/LET	C, N, O, Ne
			HISCALE	C, N, O, Ne
Voyager 1	56.9 AU/32.6N	60.3 AU/32.8N	CRS	H, He, C, N, O
Voyager 2	43.8 AU/12.3S	46.5 AU/14.3S	CRS	H, He, C, N, O
Pioneer 10	60.4 AU/3.2N	62.9 AU/3.1N	GSFC	He, O

[a] Averaging period 1: 1994/201–309 (16.9 d total); period 2: 1995/170–212 (7.9 d)
[b] Averaging period 1: 1994/208–309 (47.0 d total); period 2: 1995/170–273 (9.6 d)
[c] No data for 1995. Only quiet times used (38% of 1994 interval)

data for certain days within these periods have been removed in order to exclude non-quiet times. A summary of the various instruments contributing to, and the ACR species included in, the data sets is presented in Table 2.2.

For ease of manipulation, the data from each instrument, ACR species and period have been assembled in the form of ASCII files, each containing the following information: minimum, maximum and mean energy for each spectral point (in MeV/nuc), the corresponding ACR flux (in units of particles/(cm^2 sr s MeV/nuc) and corrected for GCR contributions where applicable and/or possible), and its uncertainty. Information concerning the location of the various spacecraft at the time of measurement, also included in the files, is reproduced in Table 2.2.

2.2.1. *Accessing the Data Sets*

The ASCII files containing the spectral data can be accessed via anonymous ftp on the ISSI server `vega.unibe.ch`. A `README.TXT` file is included in the subdirectory `/workshop/cosmrays/acrdat` that provides additional information concerning the data sets.

N.B. The primary purpose of the data sets is to assist in ACR modeling. Authors wishing to use a given data set for publication purposes are strongly urged to contact the PI of the instrument in question prior to submission.

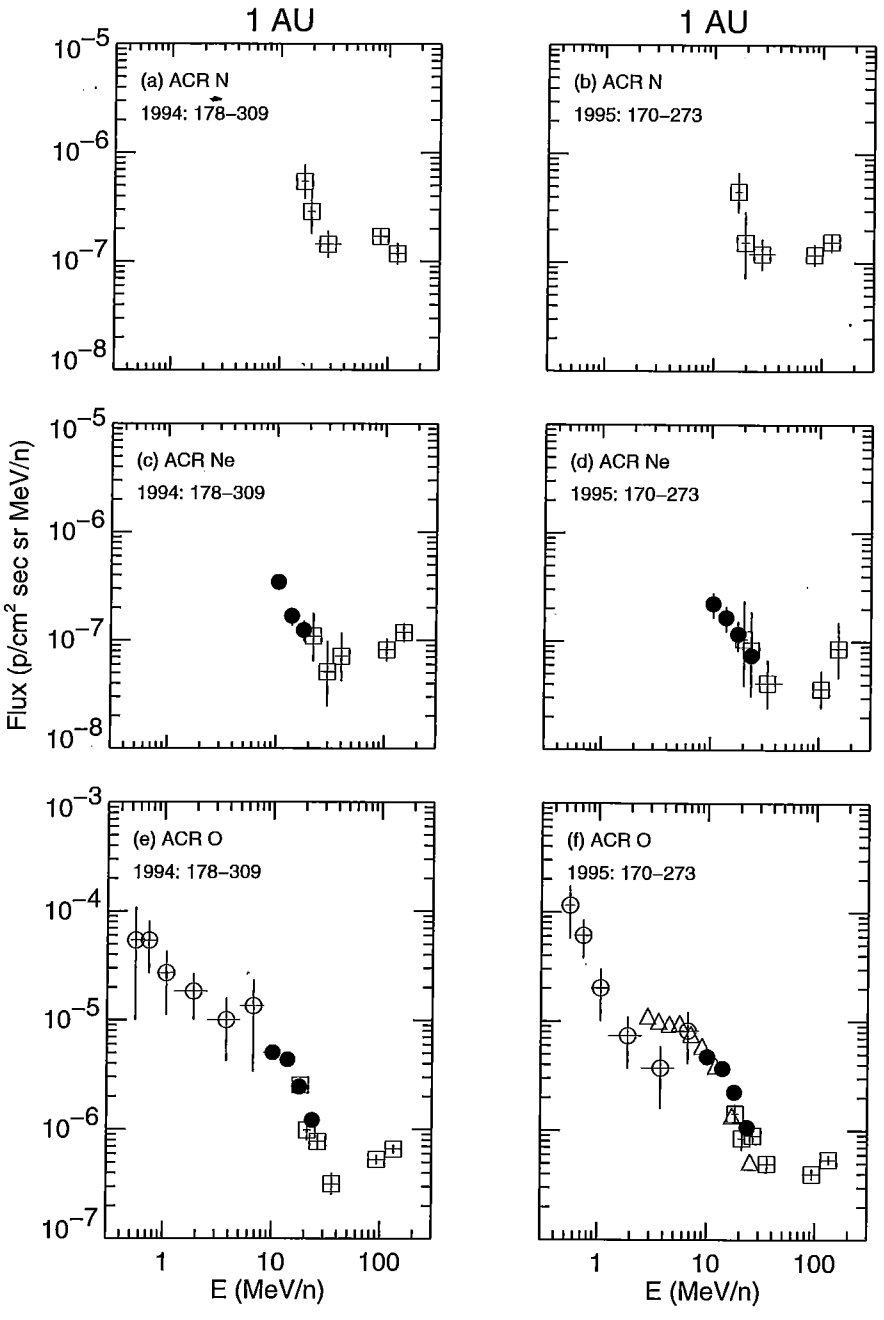

Figure 2. ACR Nitrogen (N), Neon (Ne) and Oxygen (O) spectra for the two ISSI periods measured at 1 AU by SAMPEX/LICA (open circles), SAMPEX/HILT (filled circles), SAMPEX/MAST (open squares), and Wind/LEMT (open triangles). The low energy (< 3 MeV/nuc) spectra include a solar or interplanetary component. Note that for MAST data GCR contributions are not subtracted and dominate above ~ 40 MeV/nuc.

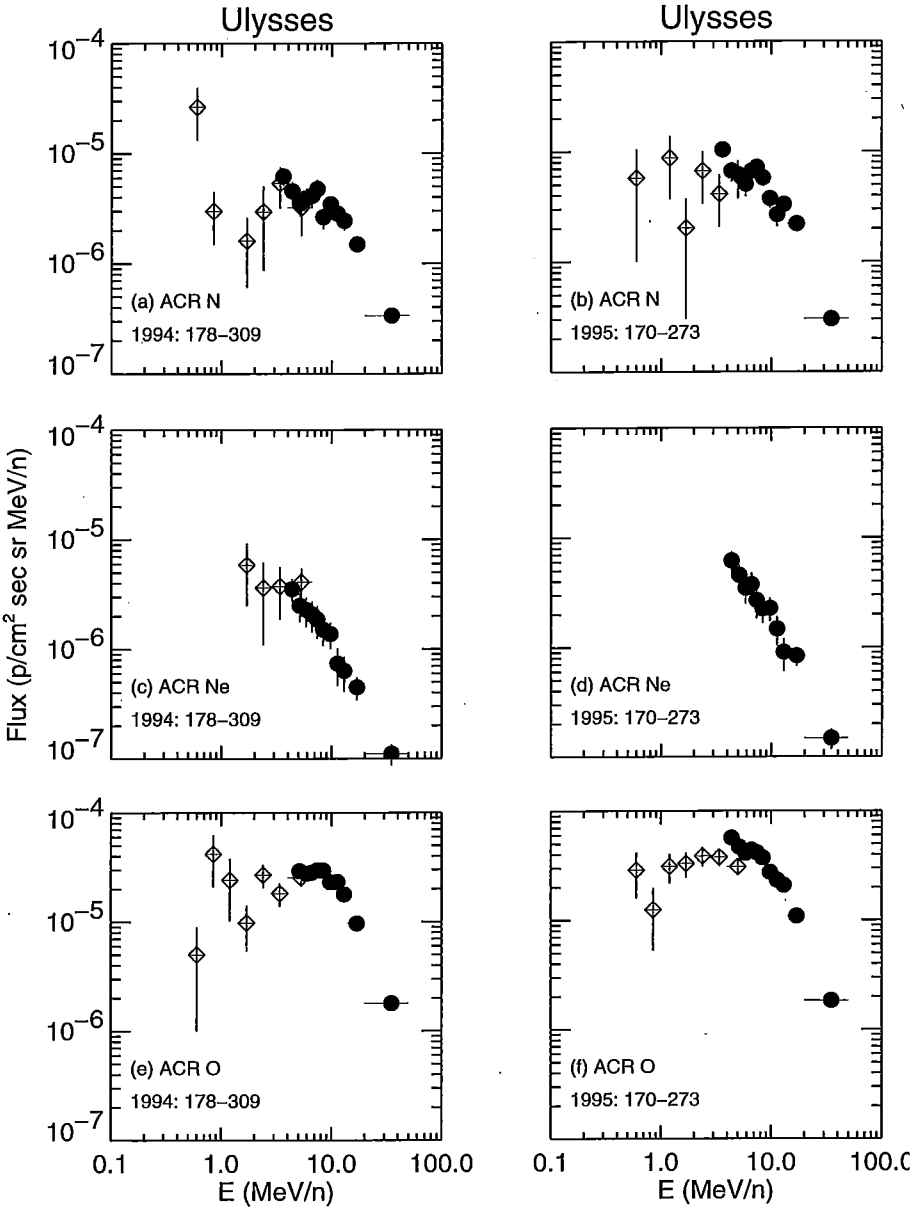

Figure 3. ACR Nitrogen (N), Neon (Ne) and Oxygen (O) spectra for the two ISSI periods measured at Ulysses by COSPIN/LET (filled circles) and HI-SCALE (open diamonds).

2.3. The Energy Spectra

Sample energy spectra from the ISSI data base are plotted in Figures 2.2 to 2.2. Many more spectra are contained in the data base than can be displayed in the restricted space available here. For comparison purposes, the spectra have been

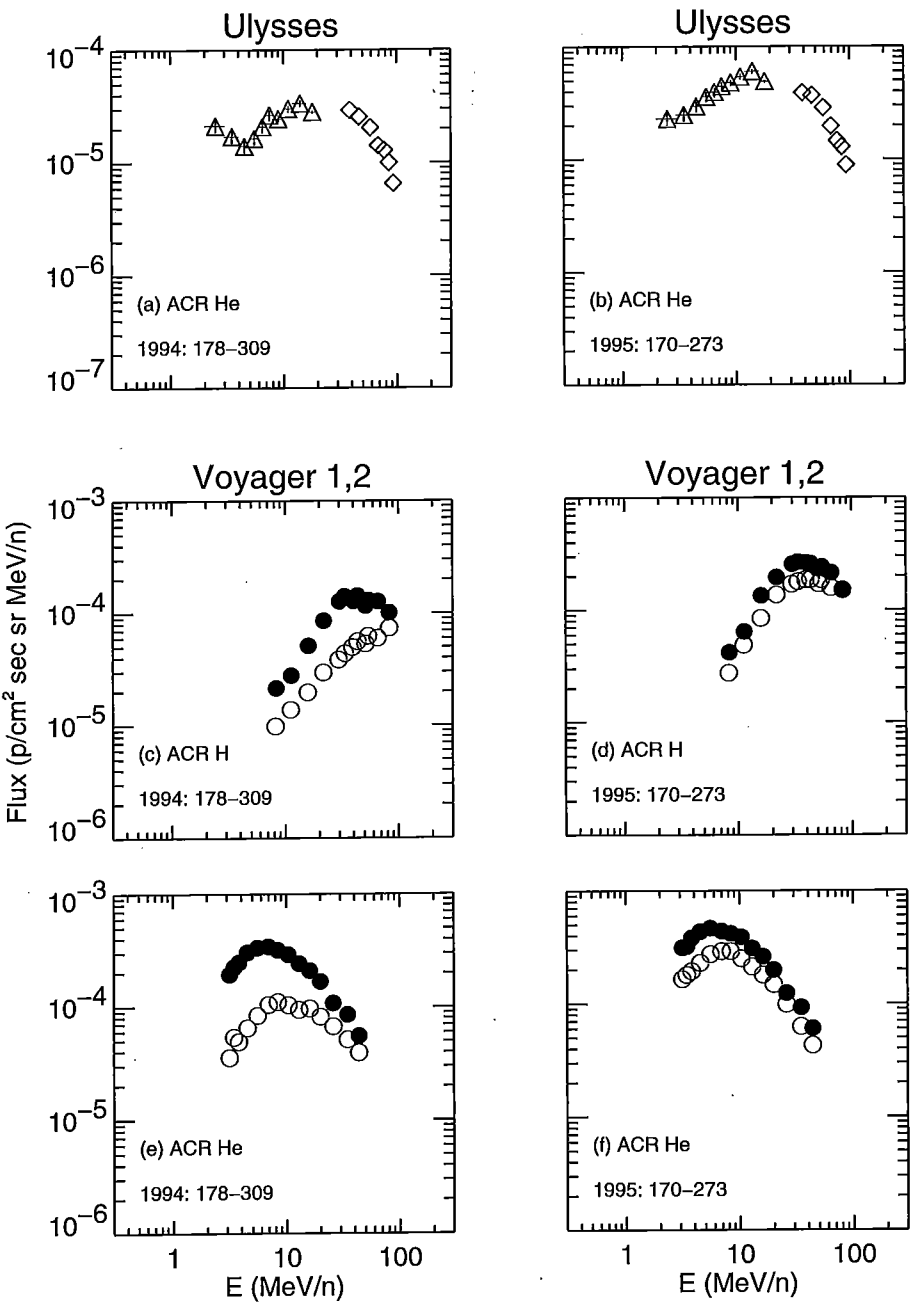

Figure 4. ACR Hydrogen (H) and Helium (He) spectra for the two ISSI periods measured at Ulysses (upper panels) and in the outer heliosphere at Voyager 1 and 2 (center and lower panels; V1: filled circles, V2: open circles). The Ulysses data are from the COSPIN/LET (open triangles) and COSPIN/HET (open diamonds, from McKibben *et al.*, 1996).

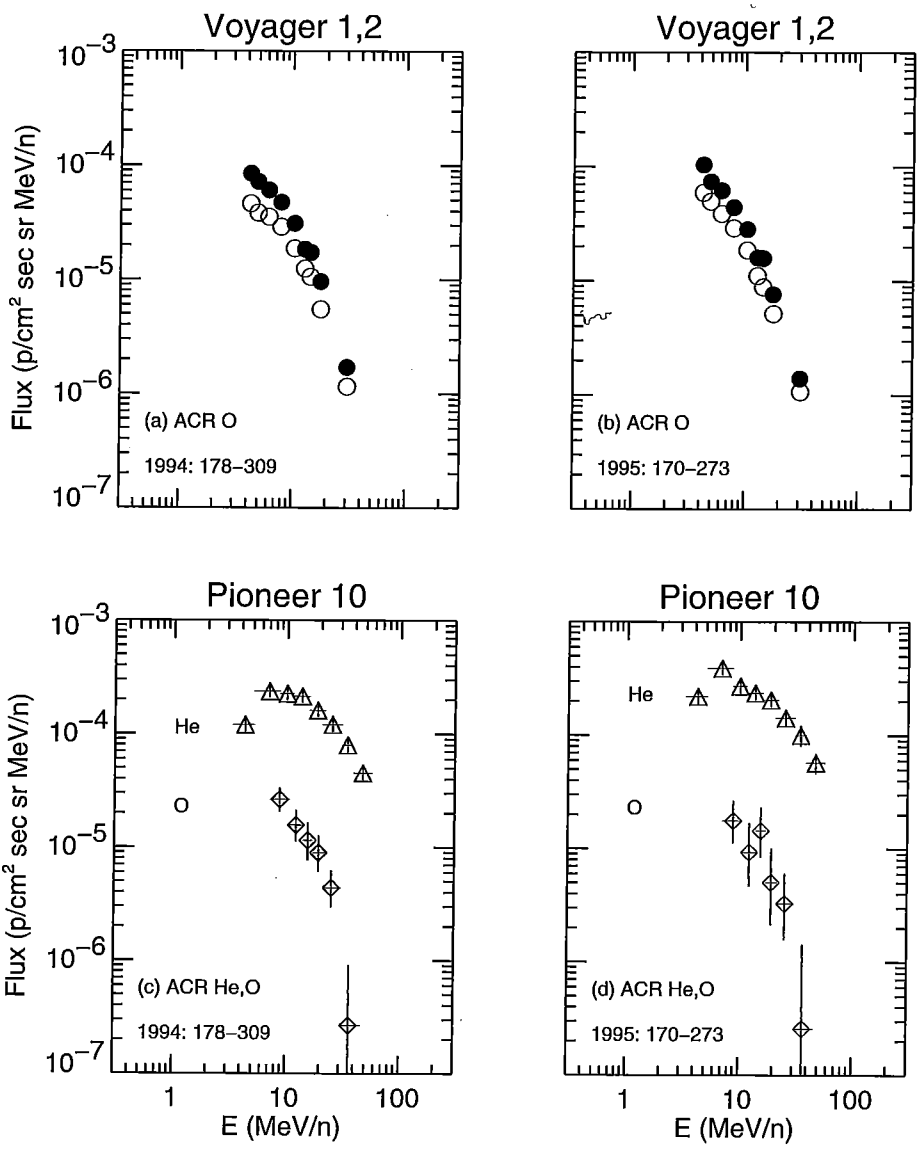

Figure 5. ACR Oxygen (O) and Helium (He) spectra for the two ISSI periods measured in the outer heliosphere at Voyager 1 and 2 (upper panels; V1: filled circles, V2: open circles), and at Pioneer 10 (lower panels).

grouped according to heliospheric location of the spacecraft from which the measurements were taken (i.e., SAMPEX, Wind, Geotail and IMP-8 at 1 AU, Ulysses at high latitudes, and Voyager 1/2 and Pioneer 10 in the outer heliosphere). It should be noted that no inter-normalization has taken place; nevertheless, the spectra from the different instruments and/or spacecraft for a given location show generally good agreement in areas where the energy ranges overlap. In cases where flux

values are plotted without error bars, these are smaller than the symbols used. Note also that the low energy spectra ($E \leq 3$ MeV/nuc) are not corrected for a solar or interplanetary component. As was recently shown by Tappin and Simnett (1996), contributions by e.g. CIRs can be substantial in this energy range and need to be corrected accordingly in order to obtain ACR spectra at low energies (see also Simnett and Roelof, 1998). References to the papers describing the instruments, and to additional published spectra are also contained in the archive.