Cosmic-ray energy spectra

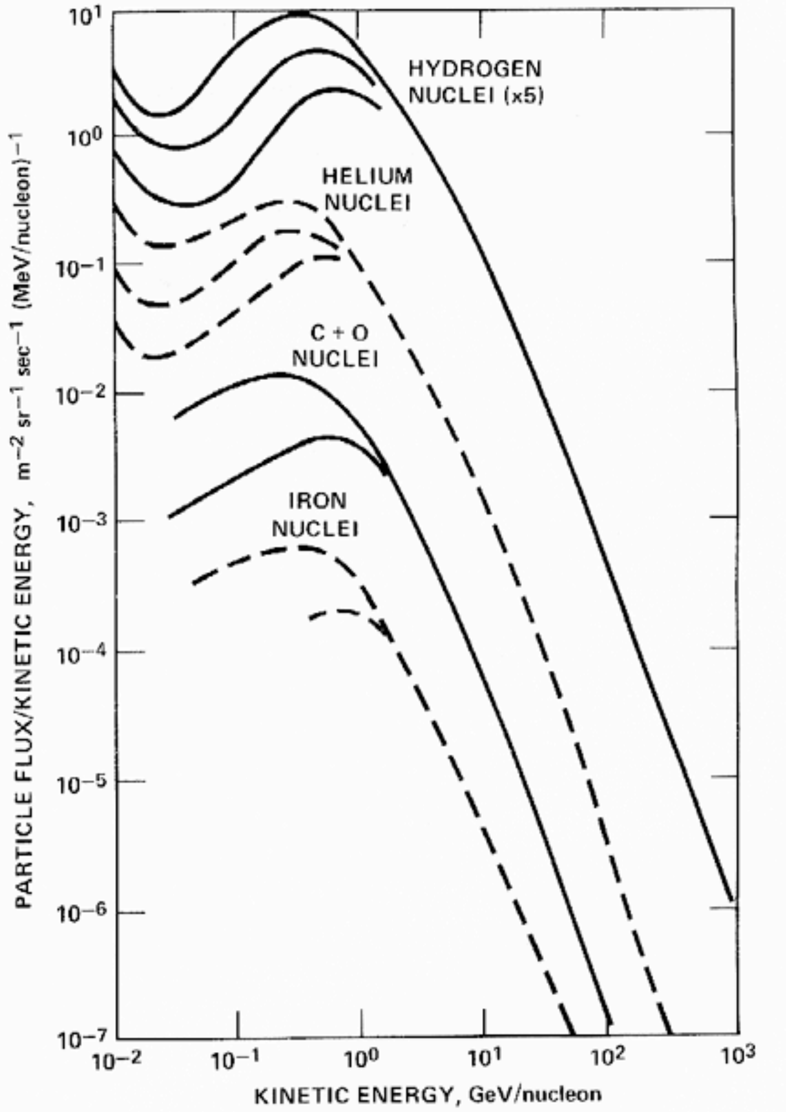
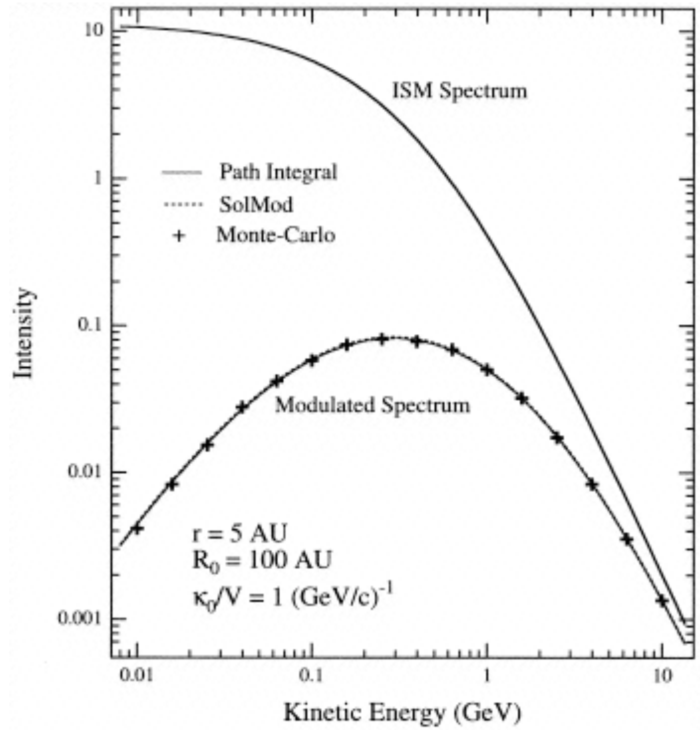


Figure 2-7.– *Distribution of energies of galactic cosmic rays. This is a graph of the more abundant nuclear species in cosmic rays as measured near the Earth. Below a few GeV/nucleon these spectra are strongly influenced by the Sun. The different curves for the same species represent measurement extremes resulting from varying solar activity. (Taken from* Physics Today, *Oct. 1974, p. 25.)*



Proceedings of ICRC 2001: 3769 © Copernicus Gesellschaft 2001

ICRC 2001

Solar modulation of the galactic cosmic ray spectra since the Maunder minimum

G. Bonino[1], G. Cini Castagnoli[1], D. Cane[1], C. Taricco[1], and N. Bhandari[2]

[1]Dipartimento di Fisica Generale, Universit di Torino and Istituto di Cosmogeofisica, CNR, To rino, Italy
[2]Physical Research Laboratory, Ahmedabad, India

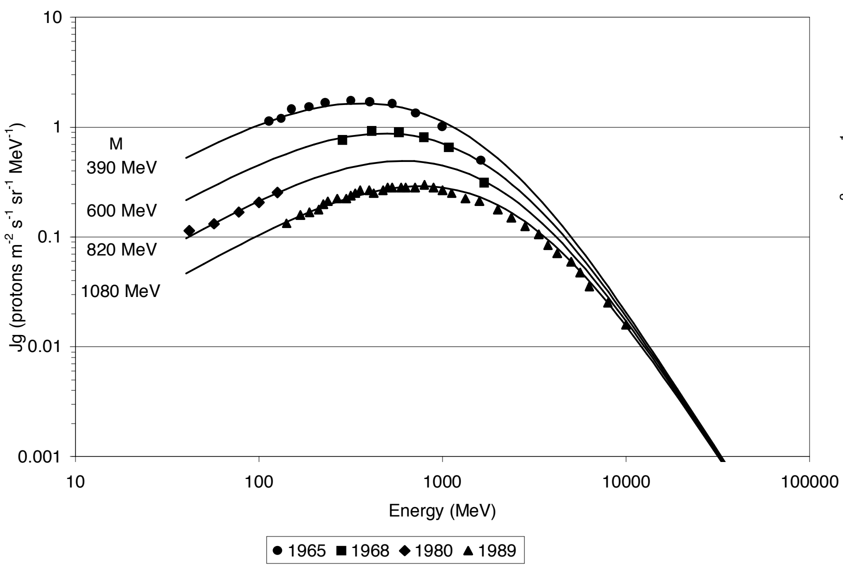


Fig. 1. Differential cosmic-ray spectra obtained from Eq. (1) for different values of the solar modulation parameter M = 390, 600, 820, 1080 MeV corresponding to the measurements performed with balloons or spacecrafts during 1965, 1968, 1980 and 1989 respectively.

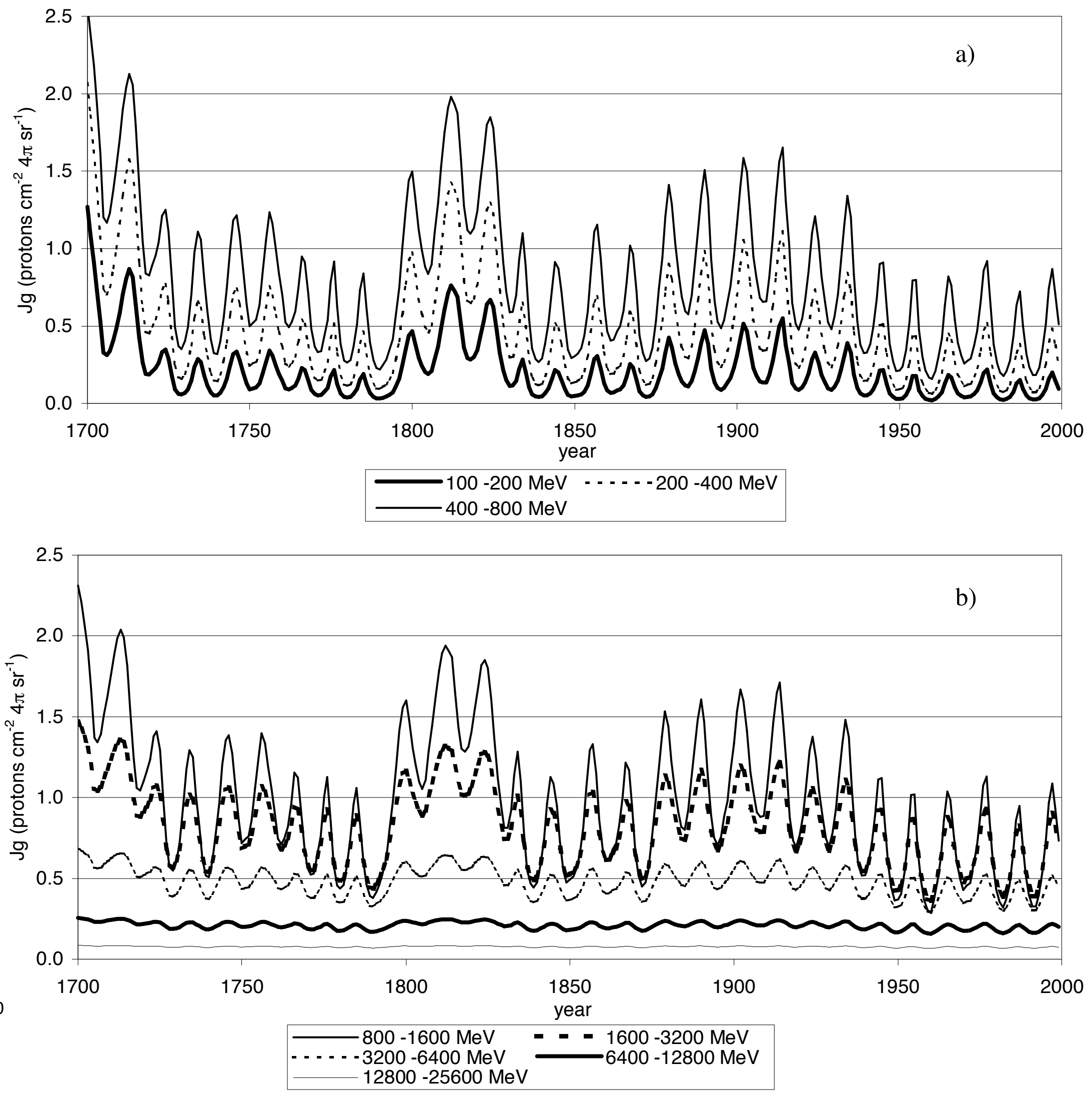
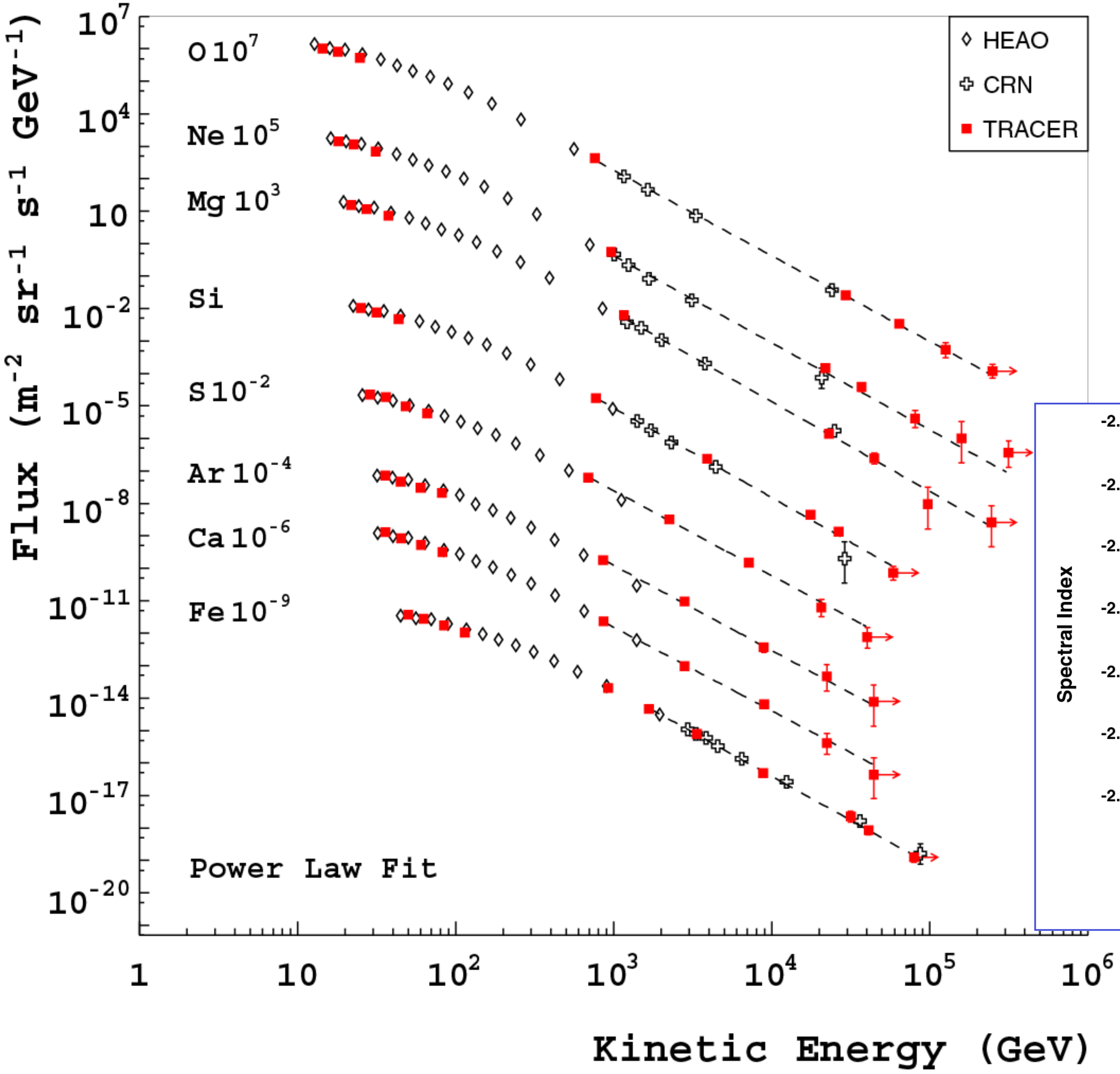
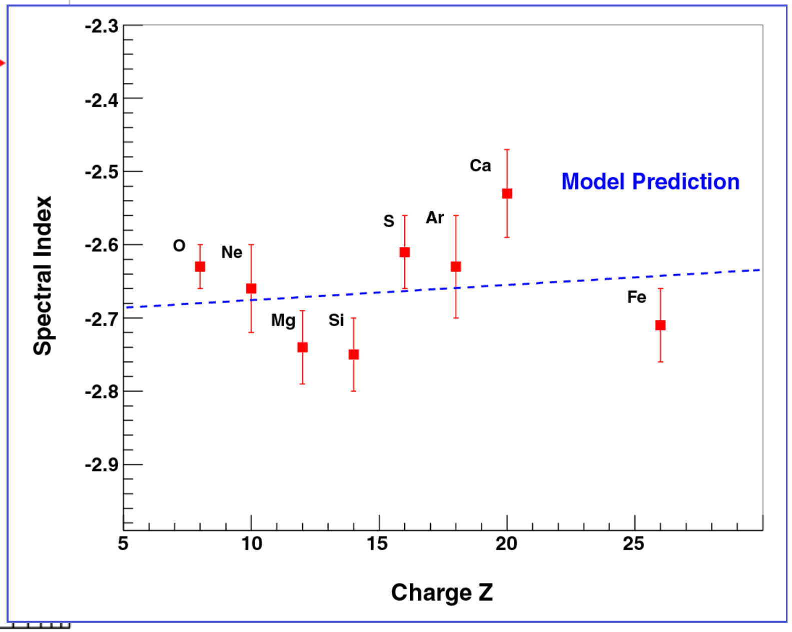


Fig. 2. Proton flux $J_G(t)$: a) for the kinetic energy intervals ΔT = 100-200 MeV, 200-400 MeV, 400-800 MeV; b) for ΔT = 800-1600 MeV, 1600-3200 MeV, 3200-6400 MeV, 6400-12800 MeV, 12800-25600 MeV.

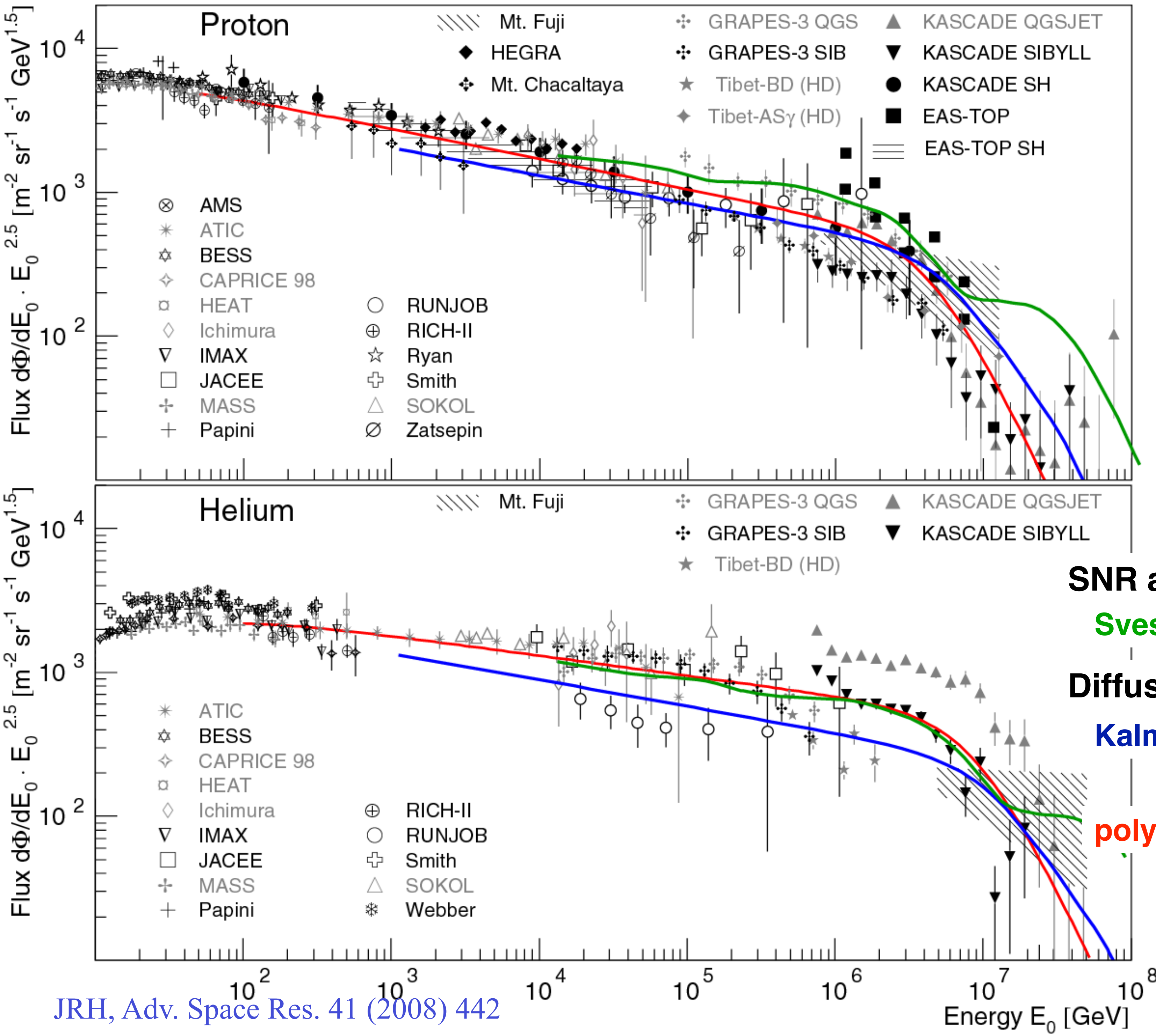
TRACER Energy Spectra for individual elements



$$\frac{dN}{dE} \propto E^{\gamma}$$



M. Ave et al., ApJ 678 (2008) 262



SNR acceleration:

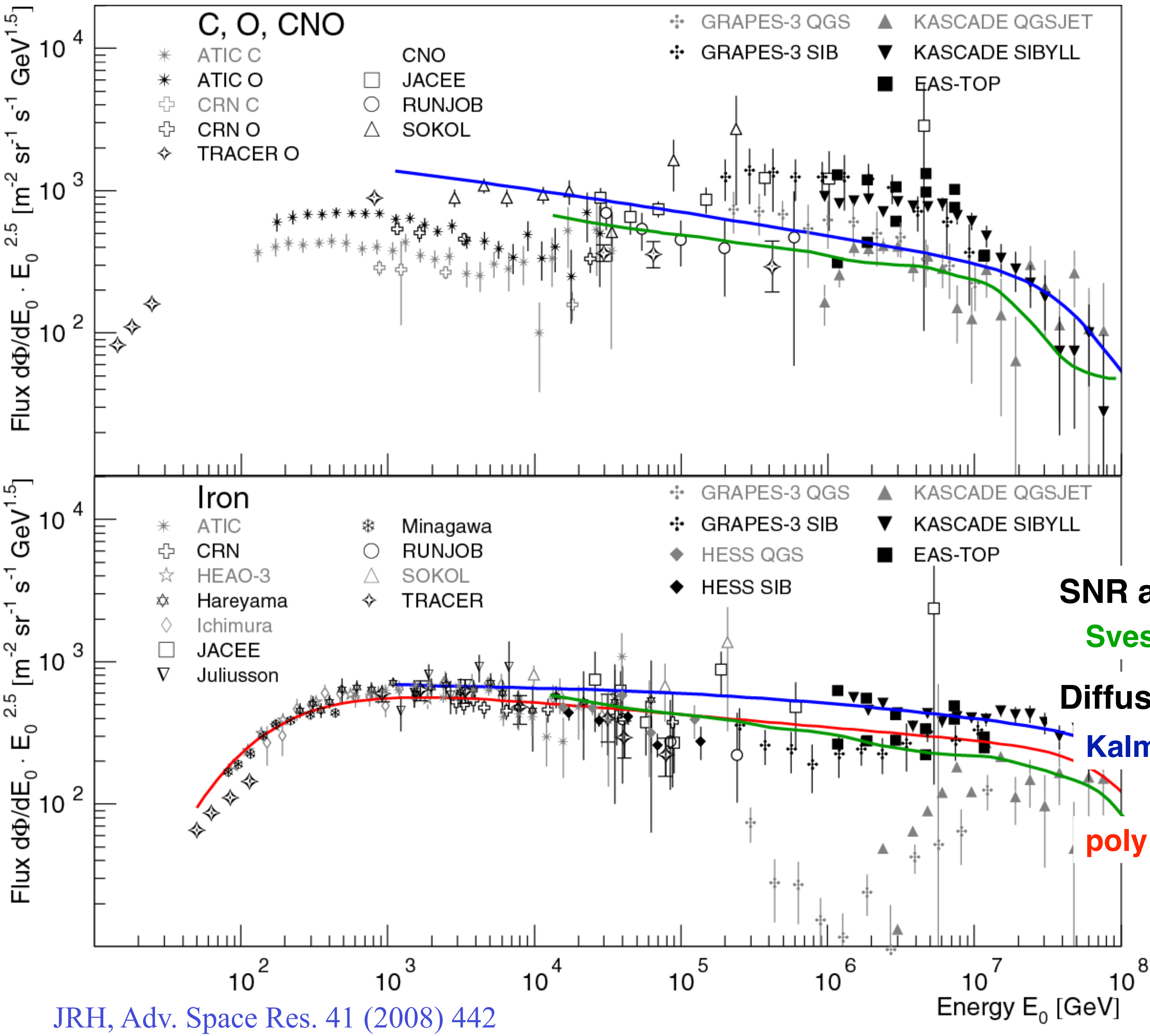
Sveshnikova++ 2003

Diffusion:

Kalmykov+JRH 2007

poly gonato ~Z

JRH, Adv. Space Res. 41 (2008) 442



SNR acceleration:

Sveshnikova++ 2003

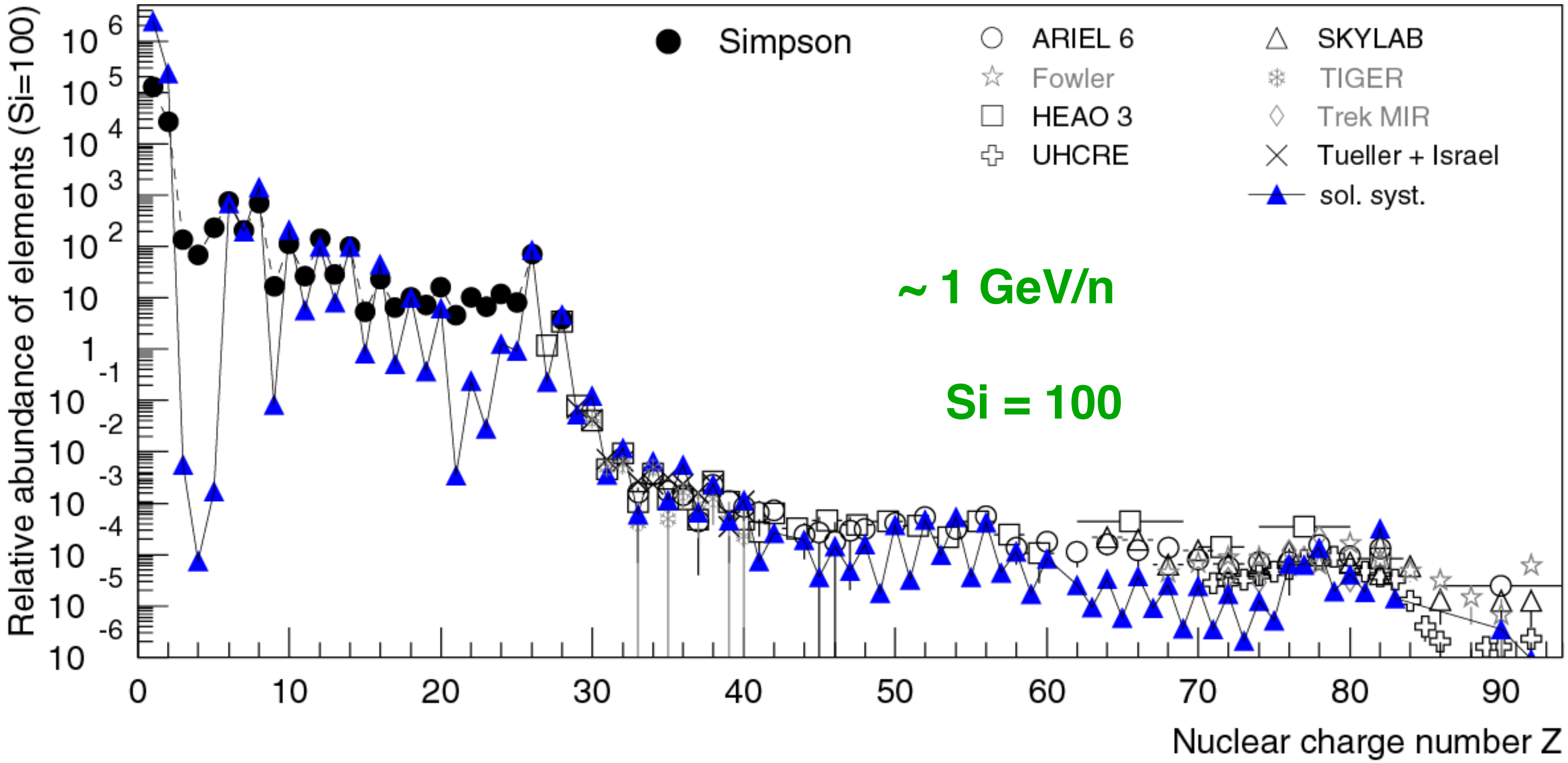
Diffusion:

Kalmykov+JRH 2007

poly gonato ~Z

JRH, Adv. Space Res. 41 (2008) 442

Relative abundance of elements at Earth

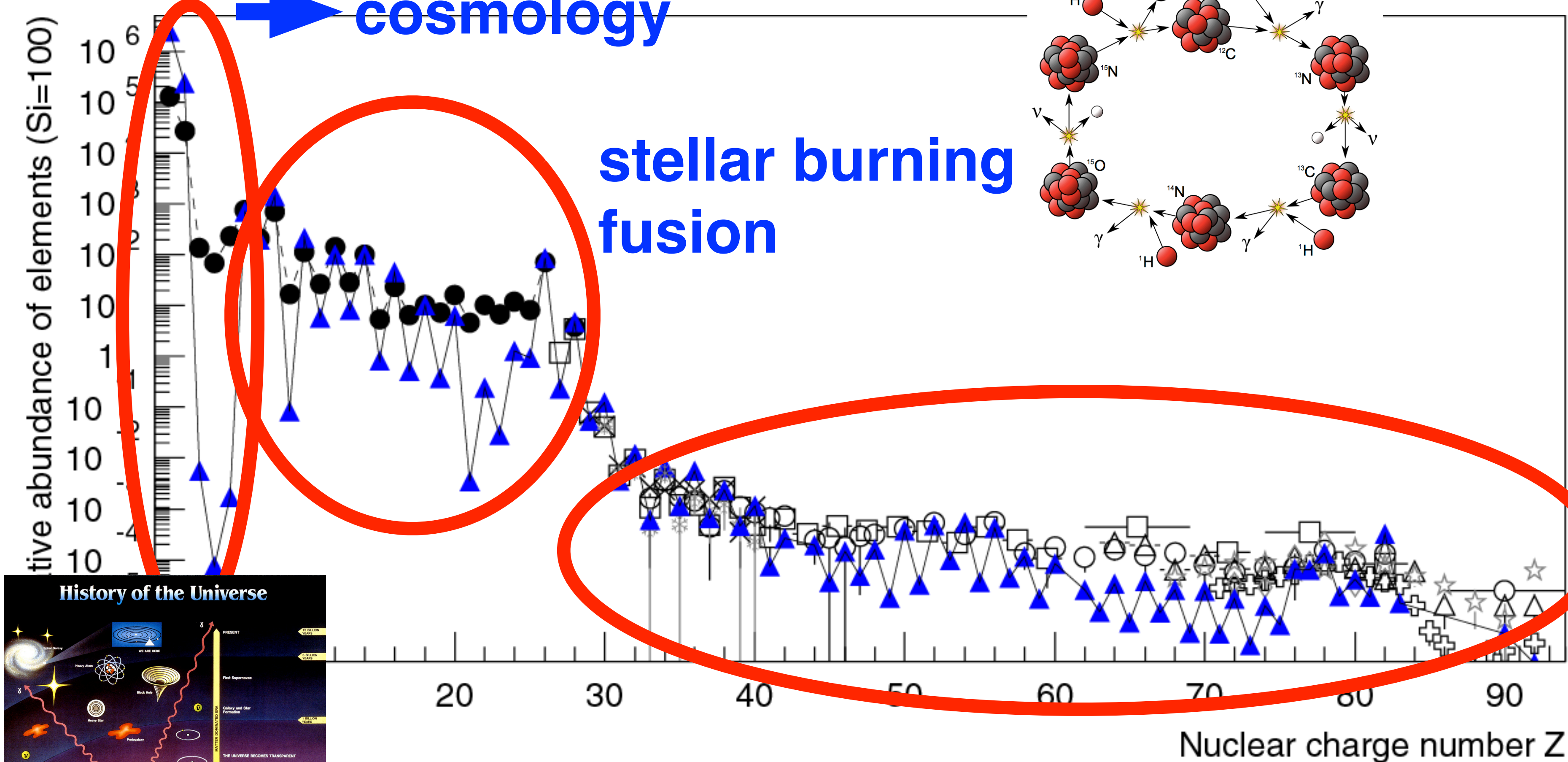


→Cosmic rays are „regular matter“, accelerated to extremely high energies

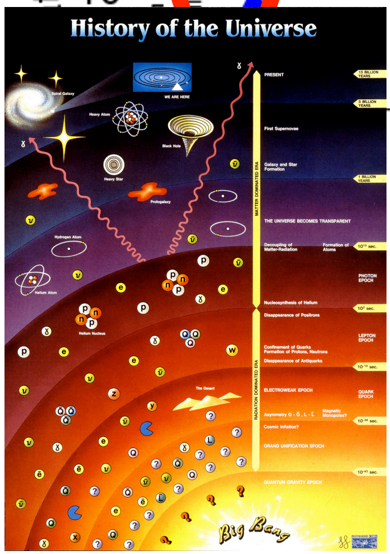
JRH, Adv. Space Res. 41 (2008) 442

Origin of the Elements

big bang
cosmology



stellar burning
fusion



supernova
explosions

Pathlength of cosmic rays

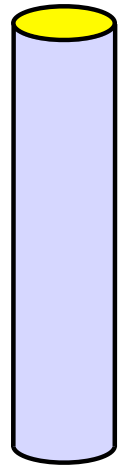
VOLUME 29, NUMBER 7 PHYSICAL REVIEW LETTERS 14 AUGUST 1972

Composition of Cosmic-Ray Nuclei at High Energies*

Einar Juliusson, Peter Meyer, and Dietrich Müller
Enrico Fermi Institute and Department of Physics, University of Chicago, Chicago, Illinois 60637
(Received 26 May 1972)

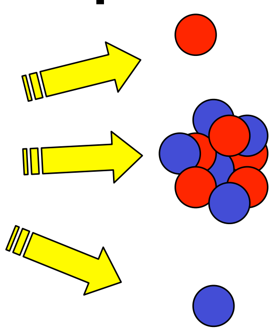
We have measured the charge composition of cosmic-ray nuclei from Li to Fe with energies up to about 100 GeV/nucleon. A balloon-borne counter telescope with gas Cherenkov counters for energy determination was used for this experiment. Our first results show that, in contrast to low-energy observations, the relative abundances change as a function of energy. We find that the ratio of the galactic secondary nuclei to primary-source nuclei decreases at energies above about 30 GeV/nucleon.

g/cm²



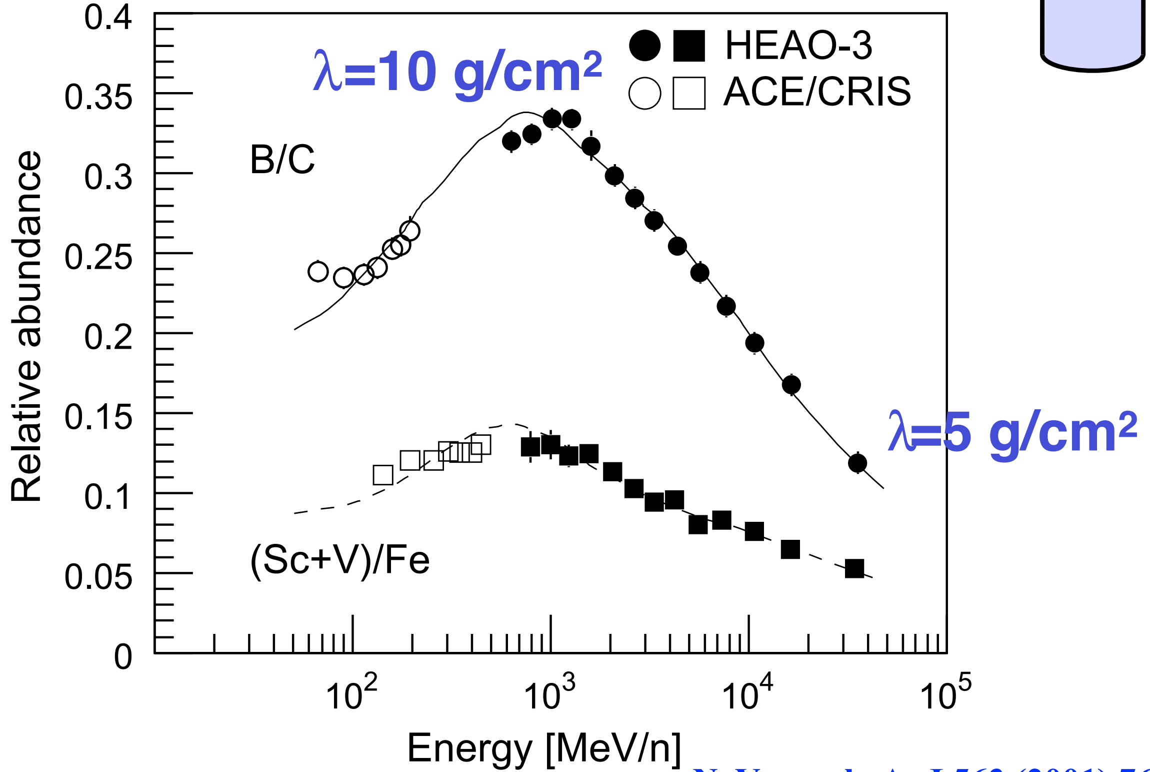
spallation

C → B + n + p



$$\lambda(E) \propto E^{-0.6}$$

primary/secondary-ratio



N. Yanasak, ApJ 563 (2001) 768