From Lithium to Uranium: Elemental Tracers of Early Cosmic Evolution
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Light element abundances with AMS-02

Mercedes Mollá on behalf of AMS collaboration[1]

[1]CIEMAT, Avda. Complutense 22, 28040- Madrid, Spain
email: mercedes.molla@ciemat.es

Abstract. The AMS-02 experiment is a large acceptance magnetic spectrometer which will operate on the International Space Station for more than 3 years. This will allow to perform high statistics studies of cosmic rays in space and the accurate determination of secondary-to-primary ratios such as B/C, and the ratio ^{10}Be/^{9}B, thus allowing to discriminate among the possible propagation models and to infer other clues about the light elements production.

Keywords. Galaxy: abundances, acceleration of particles, instrumentation: detectors.

1. Galactic Cosmic Rays

The high energy cosmic ray nuclei (CR) are accelerated particles that move through the interstellar medium (ISM) where they experience scattering, re-acceleration and energy loss due to its irregularities and to magnetic fields before reaching the Solar Neighborhood. One of the most important process they suffer is the fragmentation of some (primary) heavy nuclei, such as carbon, nitrogen and oxygen, directly produced by the source of CR. As a consequence of their impact with the ISM hydrogen and helium nuclei, this spallation process produces (secondary) light elements, such as Li, Be and B.

The propagation models simulate these processes, solving the transport equation and giving the nuclei energy spectra in the Solar Region. Comparing model results with data, some important clues about the origin and propagation of the CR might be obtained:

(*a*) The precise measurement of the energy spectra for primary elements up to Fe will allow to obtain the abundance pattern. Its comparison with elemental abundances ejected by different mass stars will give clues about the type of source.

(*b*) The precise measurement of the energy spectra for primary elements, mostly H and He, allows the determination of the spectral index related on their possible origin.

(*c*) The precise measurement of the ratio secondary/primary spectra such as D/p, ^{3}He/^{4}He, B/C and sub-Fe/Fe, will allow to determine the amount of the traversed matter, related to the size of the confinement volume, where cosmic rays move before they escape from the Galaxy, and to the diffusion coefficient.

(*d*) Some of the new species are radioactive. The ^{10}Be is specially interesting since its half time ($t_{1/2} = 1.51\,10^{6}$ yr) is of the same order as the CR confinement time in the Galaxy. Thus, the unstable isotope spectra determination will give information about the time spent by the particles within the diffusive region.

The formation of the light elements, Li, Be and B is, from the chemical evolution point of view, the most important consequence of the CR propagation. Actually, the evolution of these elements is not totally understood. Thus, the new primordial abundance of ^{7}Li (Spergel *et al.* 2003), and the unexpected and recently found ^{6}Li plateau for low metallicity stars, challenge the existing understanding of the production and evolution of this element. The light element production is computed in chemical evolution models through simplified hypothesis about the CR spectrum and sources. In turn, the CR propagation models do not take into account the ISM abundances increase from star

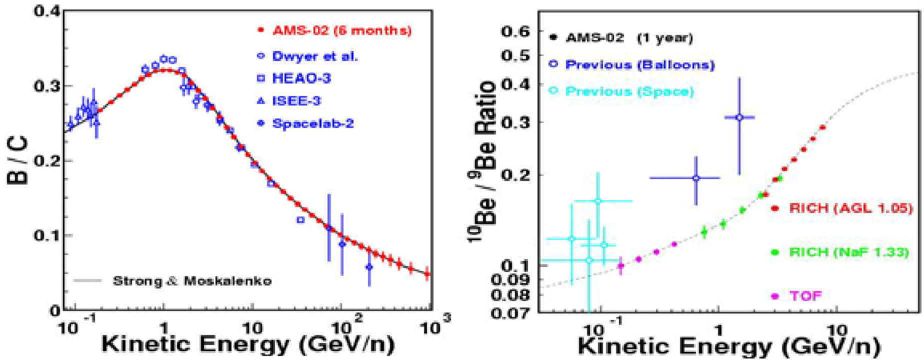

Figure 1. The AMS-02 predicted measurement -solid line- compared with the present day data: Left. B/C after six months; Right. ^{10}Be/^{9}Be after a year of operation.

ejections, nor the abundances radial gradients. By including both facts in a consistent model, the abundance of fragmentation products might be calculated in a realistic way. To do that the measurement of light element isotopic ratios is particularly important.

2. The AMS detector

Precise knowledge of the composition of CR is then needed to understand the origin, acceleration and propagation mechanisms of these particles in our Galaxy. AMS is a magnetic spectrometer with a large geometrical acceptance which will be installed on the International Space Station and will perform measurements of cosmic rays for 3 years approximately (see details about the operation, measurement and particle identification in García López et al. 2005, this volume).

With this detector some current critical measurements can be achieved: a) High accuracy measurements of the spectrum of H and He for rigidities R $\leqslant$ 1 TV; b) Chemical abundances of the cosmic rays for nuclei from H to Fe; c) The ratio of spallation products, such as Beryllium or Boron, to primary nuclei, such as Carbon, as a function of energy for E $\leqslant$ 1 TeV; d) The energy dependence of the fraction of antiparticles for energy E $\leqslant$ 100 GeV; and e) Isotopic ratios of elements up to R $\leqslant$ 10 GV. We use the GALPROP code (Strong & Moskalenko, 1998) to predict the measurements that AMS-02 (see Fig. 1) will collect during three years.

Summarizing, the AMS-02 detector will be able to measure the cosmic rays spectra discriminating among different nuclei up to $Z = 26$ with a unprecedented high statistic. It will allow the determination of the cosmic-ray confinement time and of the size of the diffusion region. These are key measurements to determine the origin of these CR, the mechanisms of their propagation within the Galaxy and the production of light element proceeding from these CR.

References

Strong, A.W., & Moskalenko, I.V. 1998, ApJ, 509, 212
Spergel, D.N., *et al.* 2003, ApJS., 148, 175