Studying the low-energy excess in cosmic ray iron: a possible evidence of a massive supernova activity in the solar neighborhood

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Preamble: thanks to AMS-02 high precision data we can constrain CRs production and propagation at the % level**.**
AMS-02 published data can be fitted in the combined framework of **GALPROP and HelMod** (for Galactic and Heliosphere propagation, respectively) **with a single model**, capable of reproducing all primary and secondary spectra at the same time (*see* ApJ **840**:115 No 2, 2017; ApJ **854**:94 No 2, 2018; ApJ **858**:61 No 1, 2018; ApJ 889:167, 2020; ApJS **250** 27, 2020; ApJ **913** 5, 2021), representing a **forecasting tool for astroparticle and solar physics.**

The problem: the analysis of new iron spectrum by AMS-02 within the GALPROP–HELMOD framework, together with Voyager-1 and ACE-CRIS data, provided an updated local interstellar spectrum in the energy range from 1 MeV/n to 10 TeV/n: it revealed an **unexpected bump** both in iron and in the Fe/He, Fe/O and Fe/Si ratios at 1–3 GV. Because of the large fragmentation cross section and large ionization energy losses, most of CR iron at low energies is local.

The explanation: the new-found excess in the Fe spectrum around 2 GV is falling in line with other excesses in iron rare isotope ^{60}Fe, which is likely connected to the **past SN activity in the Local Bubble**: deposits in the deep ocean sediments, in lunar regolith samples and in the Antarctic snow, along with observation in CRs. ACE-CRIS experiment measured a ^{60}Fe/^{56}Fe ratio of (4.6±1.7)·10^-5 near Earth.

Starting from the AMS-based LIS and the ^{60}Fe/^{56}Fe abundance measured by ACE, **^{60}Fe primary component** was estimated (^{60}Fe/^{56}Fe = 8.7·10^-5 at source), along with the important SubFe/Fe. Possible progenitor events occurred 1.5 ÷ 3 Myr ago, 50 ÷ 100 pc away and $\sim 9M_{\odot}$. It will be fundamental to measure the spectra of other heavy CR species to see if a similar spectral feature is present.

To further constrain the ^{60}Fe yield from SNe it will be useful to study the possible associate production of the long-lived radioactive ^{26}Al isotope, along with X-rays emission from ^{60}Co transitions and gamma lines from ^{60}Fe itself.