Study of the galactic cosmic rays by heavy and ultra heavy nuclei

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The observed results in the galactic cosmic ray (GCR) source composition are shown in Fig.1, in which these nuclei enhanced in the source composition are identified as ultra-heavy (UH) ones. This enhancement relates to the origin and the acceleration mechanism of GCRs. As clearly seen in Fig.1, the condensation temperature of refractory elements is usually higher than about 1000 K. These nuclei synthesized in massive stars and supernovae (SNe) was ejected by stellar wind and SN explosion (SNE) and cooled into the state of such a low temperature as 1000 K or so. Then, these were effectively condensed into the matter identified as dust grains. In fact, the observations identified that refractory elements deplete in galactic cool gas and dust grains have been made after SNE within several months. It seems to suggest the 」 possibility of GCRs acceleration from dust grains. However, UH nuclei must have been synthesized in the s-process initiated with AGB stars and the r-process initiated with the SNE. Therefore, if we discuss this serious problem in more deeply, we must observe the UH isotopes of GCRs precisely. [1]

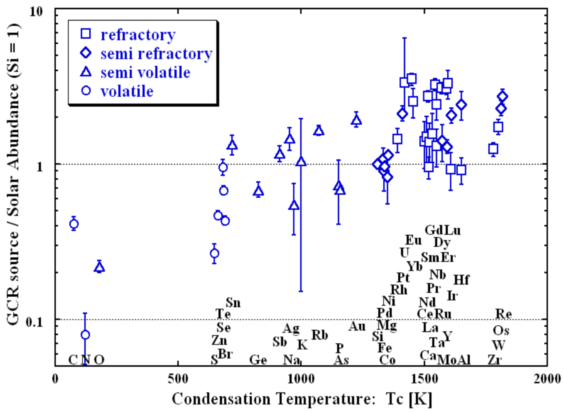

Figure.1 : The source composition of GCRs relative to the solar abundance vs. the condensation temperature of the elements. Both GCR and solar abundances are normalized relative to Si. [1]

Here, we propose the new observation of heavy (H) and ultra-heavy (UH) isotopes of GCRs by means of track detector on board the Antarctica long duration balloon (ALDB) and/or International Space Station (ISS).

The observations of H isotope GCRs have given us the importance information to understand the origin, acceleration and propagation of GCRs. While UH-GCRs have observed only charge composition combined odd and even charge or charge group, but not individual elements or isotope, because of the two difficulties for UH isotopes observation. One is the difficulty of collection caused very small abundance of UH compared to iron, UH/Fe < 10^{-3}. The other is the difficulty of mass resolution for UH region depended on detecting methods.

For the first problem, we can use the facility of ISS or ALDB to observe the GCRs with long observation time, 3 years and 1 month at one flight, respectively. In Fig.2, we show the estimated detection number taking account for cut off energy effect in geomagnetic field obtained by simulation calculation. As clearly seen in Fig.2, we are able to collect enough statistics to analyze UH isotopes in charge range Z from 30 to 60, if the detector area is several m^2 in one flight for ISS and several flights for ALDB. [2]

For the second problem, the mass resolution of plastic track detector CR-39 was improved as 0.28 amu in rms for iron isotopes ^{55}Fe and ^{56}Fe and the mass resolution will be reached 0.2 amu in rms by more improving. This is enough resolution to divide adjacent mass number. [3]

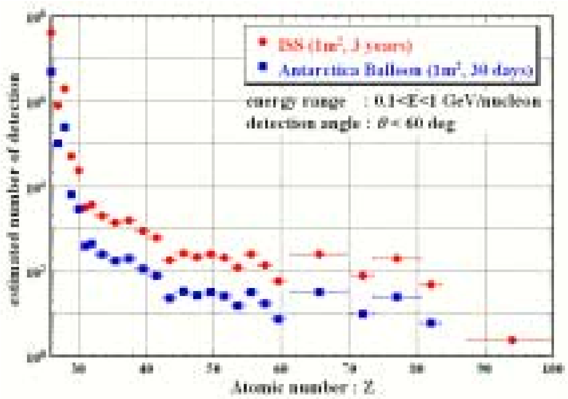

Figure 2 : The estimated detection number of the both facility ISS and ALDB. These estimations were taken account for cut off energy effect at the observation point in geomagnetic field. The energy range was set between 0.1 and 1 GeV/nucleon because of isotope observation.[2]

References

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[2] M. Hareyama et al., Balloon symposium (ISAS/JAXA), in press

[3] S. Kodaira, N. Hasebe et al., Jpn. J. Appl. Phys., 43(2004)6358-6363.