CHEMICAL COMPOSITION OF HIGH-ENERGY COSMIC-RAY NUCLEI AND ITS POSSIBLE ORIGIN IN TYPE-II SUPERNOVA

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High energy cosmic ray spectrum has been known to have an interesting bump in the energy range 10^{14} - 10^{16} eV. Various models to explain the spectral break in this energy range have been so far proposed; which incorporate either a large-scale termination of galactic wind [1], shocks with greater age and spatial extent associated with hypothetical super-bubbles powered by multiple supernovae [2], intersection of two quantum-gravitational components [3], extra-galactic component [4], red-shift of big-bang remnant [5], or a proton component from pulsars [6]. More recently, their possible origin in type-II supernovae with magnetic acceleration mechanism is proposed [7] by considering direct observational results of chemical composition near the bump regime of cosmic ray spectrum.

To discriminate these models detailed observation of the chemical composition at the bump regime is imperative. The latest data include those obtained by the Spacelab-2 (CRNE-experiment of the University of Chicago) [8], and the 1986 balloon-flight experiment by the Japanese-American-Cooperative-Emulsion-Experiment (JACEE) Collaboration [9]. The latter still indicates high A/Fe ratios for A being medium heavy to calcium nuclei, while the former indicates a less steep power spectrum for iron than the known spectrum for protons (as measured by the JACEE experiments). Plans to advance the observation are recently encouraged by a promotion of an exposure facility JEM S-003 in the Japanese Space Station Program [10], which is promising in revealing elemental and isotopic details of high energy nuclei at around the bump.

Among many remaining theoretical problems in defining supernova-pulsar origin of high energy cosmic rays, we illustrate here an importance of x-ray photo-disintegration in the vicinity of a supernova remnant, which substantially modifies elemental and isotopic composition in the SN-II pulsar component. X-rays originating from both comptonization of line gamma-rays of Co^{56} decays and pulsar's electro-magnetic radiation are sufficiently abundant to induce copious photo-disintegration of ultra-relativistic nuclei in flight. Due to steep power-law nature in the energy spectrum of a pulsar component over the life of a pulsar,

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different Q-values in $\gamma - \alpha$ nuclear reaction will significantly alter the abundance ratio in the highest energy regime of pulsar-oriented nuclei. Fig. 1 illustrates relative loss of low-threshold component such as Zn^{66}, which, otherwise, should be prominent in SN-II component [7,11]. It is interesting to note that several nuclei with high Q-values, such as neutron-rich Ca^{48}, can survive at the highest energy range of the bump. The x-ray luminocity of 3×10^{36} erg/s of the crab pulsar is used in this calculation. Much higher luminosity of 10^{37} - 10^{38} erg/s in SN1987a would certainly reduce high energy components further. This "milking" of nuclei in the vicinity of a neutron star must be taken into account for consideration of elemental composition from SN-II with a pulsar remnant, which consequently can serve as a discriminator of SN-II (pulsar) origin of cosmic rays in the bump regime, and may provide some information on elemental abundances near the surface of a neutron star.

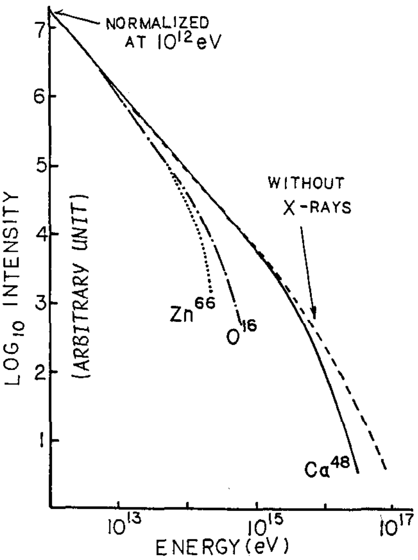

Fig. 1

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