A MIXING-FALLBACK SUPERNOVA AS A POSSIBLE SOURCE OF SHORT-LIVED RADIONUCLIDES IN THE EARLY SOLAR SYSTEM. S. Tachibana[1], A. Takigawa[1], J. Miki[1], and T. Yoshida[2], [1]Department of Earth and Planetary Science, University of Tokyo (7-3-1 Hongo, Tokyo 113-0033, Japan. E-mail: tachi@eps.s.u-tokyo.ac.jp), [2]National Astronomical Observatory of Japan (2-21-1 Osawa, Mitaka, Tokyo, 181-8588, JAPAN).

It has been known that several short-lived radionuclides were present in the early solar system from excesses in the abundances of their daughter nuclides in meteorites. Short-lived radionuclides with half lives of <5 Myr, such as ^{10}Be, ^{26}Al, ^{36}Cl, ^{41}Ca, ^{53}Mn, and ^{60}Fe, can be produced either by energetic-particle irradiation in the early solar system or by stellar nucleosynthesis just prior to or shortly after the solar system formation.

The estimated initial abundance of ^{60}Fe in the solar system [1-3], which is produced efficiently only by stellar nucleosynthesis, implies that stellar nucleosynthesis prior to or shortly after the birth of the solar system contributed to the inventory of the solar-system short-lived radionuclides.

A low-mass AGB (Asymptotic-Giant-Branch) star has been proposed as a suitable stellar source for the short-lived radionuclides in the early solar system, but it cannot produce sufficient amounts of ^{60}Fe [e.g., 4]. Intermediate-mass AGB stars may explain the abundances of ^{26}Al, ^{41}Ca and ^{60}Fe [4], but astronomical observation shows that encounters between molecular clouds and AGB stars are extremely rare [5], which makes it implausible for an AGB star to be a source of short-lived radionuclides in the solar system. Models for type II supernovae (SNe II) [e.g., 6-9] indicate that the abundance of ^{53}Mn inferred for SNe II is 10-100 times larger than that estimated for the early solar system. If a SN II occurred with less kinetic energy, most of ^{53}Mn would have undergone fallback onto a collapsing stellar core [10]. If this is the case, ^{53}Mn in the solar system should have been derived from another source. Moreover, ^{60}Fe may have been overproduced if all the ^{26}Al and ^{41}Ca in the solar system were provided by a SN II.

[11] proposed a SN II with mixing-fallback, where the inner region of the exploding star experienced mixing, some fraction of mixed materials is ejected, and the rest undergoes fallback onto the core. The mixing-fall back model that reproduces the abundance pattern of hyper metal-poor stars well [e.g., 9] explains the abundances of ^{26}Al, ^{41}Ca, ^{53}Mn, and ^{60}Fe in the solar system.

In this study, we evaluate effects of a mixing-fallback supernova on the isotopic abundances of light elements in the solar system such as C, N, O and ^{10}Be. Bellirium-10 would have formed mainly by solar energetic-particle irradiation in the early solar system. However, neutrino processes in the supernova, which produces Li, Be, and B via interactions between neutrinos and C, may have contributed the inventory of ^{10}Be in the early solar system. We calculated the yield of ^{10}Be for neutrino processes based on newly calculated reaction cross sections related to ^{10}Be formation, and evaluated the abundance of ^{10}Be mixed to the solar system materials with a mixing ratio and a time interval that explain the abundances of ^{26}Al, ^{41}Ca, ^{53}Mn, and ^{60}Fe. We found that ^{10}Be is synthesized as much as ^{9}Be by neutrino processes during supernova explosion but ^{10}Be injected to the solar system would be much less than its inferred abundance in the early solar system [e.g., 12].

We also evaluated injection of stable isotopes of C, N, and O from a nearby mixing-fallback supernova to the solar system materials. Most of presolar silicates are considered to have formed around AGB stars and have oxygen isotopic compositions enriched in ^{17}O compared to the solar system material [e.g., 13], implying that there are missing components depleted in ^{17}O to explain the solar system oxygen isotopic compositions. We found that the injection of light elements from a nearby mixing-fallback supernova may have changed the isotopic compositions of pre-solar system materials slightly (at most several percent), but not as large as to explain the gap in oxygen isotopic compositions between presolar silicates and solar system materials.

References: [1] Tachibana, S., and Huss, G. R. (2003) *ApJ 588*, L41. [2] Mostefaoui, S. et al. (2005) *ApJ 625*, 271 [3] Tachibana, S. et al. (2006) *ApJ 639*, L87 [4] Wasserburg G. J. et al. (2006) *Nuclear Physics A*, *777*, 5. [5] Kastner J. H. and Meyers P. C. (1994) *ApJ*, *421*, 605. [6] Woosley S. E. and Weaver T. A. (1995) *ApJ*, *101*, 181. [7] Rauscher T. et al. (2002) *ApJ*, *576* 323. [8] Chieffi A. and Limongi M. (2004) *ApJ*, *608*, 405. [9] Nomoto K. et al. (2006) *Nuclear Physics A (Special Issue on Nuclear Astrophysics) 777*, 424. [10] Meyer B. S. and Clayton D. D. (2000) *Space Science Reviews*, *99*, 133. [11] Takigawa A. et al. (2007) *LPS XXXVIII*, #1720. [12] McKeegan, K. D. et al. (2000) *Science 289*, 1334. [13] Nagashima K. et al. (2004)