Presolar grains in the Galaxy formation

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I will discuss the origin of chemical abundances of presolar grains (e.g., Si isotope ratios in SiC grains) based on the results of chemo-dynamical simulations of the Galaxy formation and evolution. The new simulations enable us to investigate the interaction between dust ejected from supernovae (SN) and AGB stars and a giant molecular cloud (GMC) that formed our Sun. Therefore the simulations can predict (i) how many AGB stars could interact with the Sun-hosting GMC and chemically pollute the GMC about 4.6-4.7 Gyr ago, (ii) whether or not mergers between neutron stars (NSM) that create r-process elements could interact with the GMC, and (iii) what the chemical abundances are for the SNe and AGBs that polluted the early solar systems. I mainly compare the observed Si three-isotope diagram with the simulated one in order to discuss where the Sun was born in the Galaxy. The main results from these simulations are as follows:

(1) The observed 29Si and 30Si higher than the solar values in presolar SiC can be explained if the Sun originates from a GMC orbiting the Galaxy at R~ 6 kpc (not ~ 8kpc, which is the present location). This is because the Sun-hosting GMC needs to interact with more metal-rich AGB stars that can produce higher 29Si and 30Si. If the Sun was born in the inner region of the Galaxy, then the Sun needs to migrate to the outer region of the Galaxy through some dynamical process.

(2) However, the simulations predict many SiC grains with 29Si and 30Si significantly lower than the solar values, because the inner Galactic regions can include old, metal-poor stars that interact with the Sun-hosting GMC. These metal-poor SiC grains are not observed, which implies either that SiC grains cannot be formed from metal-poor AGB stars or that the present chemo-dynamical model of the Galaxy formation is not so realistic.

(3) There are many possible candidates of the Sun-hosting GMC in the simulations (i.e., there are many stars that were formed in GMCs 4.6 Gyr ago and reside at R ~ 8 kpc at the present). Each GMC interacts with many AGB stars with different metallicities and ages, which means that presolar grains have diverse stellar origins. The interaction histories of these GMCs with existing AGB stars, SNe, and NSM are also quite diverse (e.g., some GMCs are influenced by NSM whereas some are not). I will discuss the implications of these in my talk.