Extremely metal poor stars and Chemical Evolution in the Early Universe

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Extremely metal-poor (EMP, [Fe/H] < −2.5 in this paper) stars are stars formed in the early universe in terms of chemical evolution. They are formed at high redshift but are still shining with the glow of nuclear burning in the Local Group. Hundreds of the EMP stars has been identified in the Milky Way halo and element abundances of these stars are revealed by follow-up spectroscopic observations. They provide a means of probing the earliest phases of the evolution of the Milky Way and supernovae in the early universe. Among them, two hyper metal-poor (HMP) stars with [Fe/H] < −5 are the most metal deficient objects observed yet.

In our previous study[1], we give constraint on the initial mass function (IMF) of the EMP stars and argue that typical mass of EMP stars is ~$10M_{\odot}$. Changeover of the IMF affects the chemical evolution of the Milky Way.

We investigate early phases of the chemical evolution of the Galaxy and formation history of EMP stars using hierarchical chemical evolution models. We build a merger tree of the Galaxy according to the extended Press-Schechter theory. We follow the chemical evolution along the tree, and compare the model results to the metallicity distribution function (MDF) and the abundance ratio distribution of EMP stars. We also study the feedback effect from the very massive population III stars.

The MDF predicted by the hierarchical model with the high mass IMF consistent with observations[2]. Second and later generations of stars in each dwarf primordial galaxies distribute at [Fe/H] > −4 and stars with [Fe/H] < −4 are the first stars in mini-halos. Observational scarcity of HMP stars indicate that the IMF of first stars are shifted to higher mass than EMP stars. Abundance ratio distributions predicted by the high mass IMF is also consistent with observations[3].

We further study the effects of the surface pollution through the accretion of interstellar matter (ISM) onto stars along the chemical and dynamical evolution of the Galaxy. Because of shallower potential of smaller minihalos, the accretion of ISM in the mini-halos in which these stars were born is dominant. It can account for the surface iron abundances as observed for the HMP stars if the cooling and concentration of gas in their birth minihalos is taken into account.

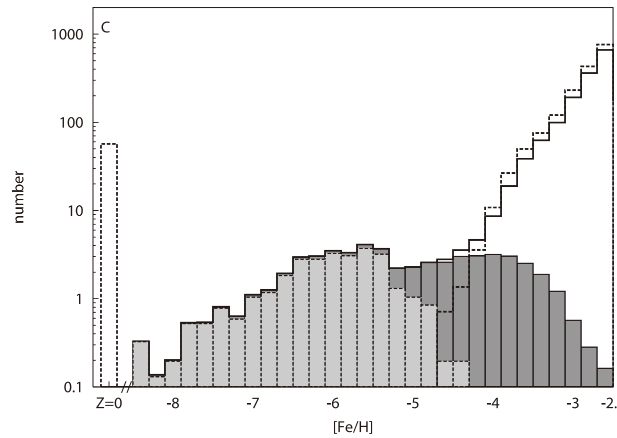

Figure 1: Dashed and solid lines shows predicted MDF before and after surface pollution, respectively. Dark and light shaded histograms denote distributions of Pop. III dwarf and giant, respectively. (This figure is reprinted from[2])

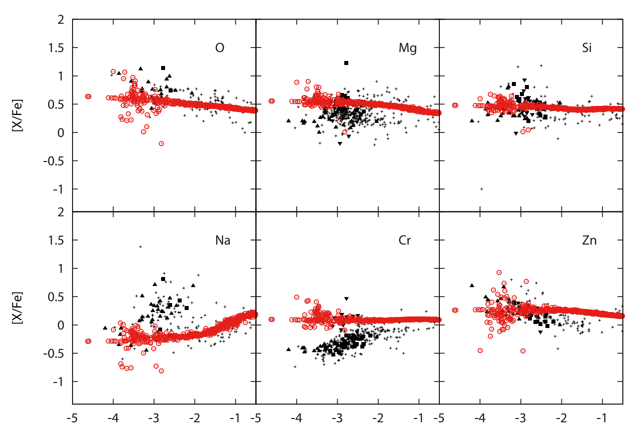

Figure 2: Abundance distributions of metal poor stars. *Red*: Model results. *black*: Observations. (This figure is reprinted from [3])

References

[1] Komiya, Y., et al.: 2007, *ApJ*, **658**, 367.
[2] Komiya, Y., et al.: 2010, *ApJ*, **717**, 542.
[3] Komiya, Y.: 2011, *ApJ*, **736**, 73.