Contribution ID: **101** Type: **Poster**

Constraint on properties of dust grains created by Population III supernovae

Tuesday 12 June 2018 14:13 (1 minute)

Dust grains play an important role in star formation also in the early Universe. The stellar initial mass function is considered to transfer from top-heavy to the normal Salpeter one in the course of metal/dust enrichment of interstellar medium because thermal emission cooling by dust grains induce the fragmentation of their parent gas clouds. However, dust properties such as size distribution and metal condensation efficiency are largely unknown. We here focus on the lower limits of elemental abundances of metal-poor stars. Recently, by survey campaigns, we obtain large statistical samples of metal-poor stars. They are classified into C-enhanced metal-poor (CEMP) stars and C-normal metal-poor (CNMP) stars, and their carbon and iron abundances show the lower limits of $A_{\rm cr}({\rm C}) \sim 6$ and $[{\rm Fe/H}]_{\rm cr} \sim -5$, respectively. This suggests the critical elemental abundances above which cooling of carbon and silicate grains is dominant, respectively. Since the dust cooling rate depends on the condensation efficiency of metal and grain size distribution with a given metallicity, we estimate them from the observed lower-limits of carbon and iron abundances. As a result, we find that the ratio of characteristic grain size to condensation efficiency (effective grain radius) is 10 μm and 0.1 μm for carbon and silicate grains, respectively.

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Presenter: CHIAKI, Gen

Session Classification: Poster Presentations

Track Classification: The creation and evolution of dust