Stellar Yields of Rotating First Stars

Koh Takahashi[1], Hideyuki Umeda[1], Takashi Yoshida[2]

[1] Department of Astronomy, The University of Tokyo, Tokyo, Japan
[2] Yukawa Institute for Theoretical Physics, Kyoto University, Kyoto, Japan

First stars, also known as Population III stars, are the first nuclear reactor in the universe. Various heavy nuclei are synthesized in these objects and ejection of the stellar material triggers chemical evolution of the early universe. We report new theoretical results of estimated stellar yields of the first stars obtained from our latest grids of numerical simulations. We calculate stellar evolution of massive first stars. Effects of stellar rotation are included. We found that chemical composition in a helium layer shows wide varieties depending on both the stellar mass and the initial rotation rate. For stars more massive than ~80 Msun, high temperature at the bottom of the helium layer allows efficient alpha capture reaction to occur. As a result, these stars yield orders of magnitude more magnesium in the layer than less massive stars. For rotating stars, internal mixing due to several rotational instabilities affects the composition. First, rotational mixing during core helium burning stage results in nitrogen synthesis via CNO cycle. Then sodium and aluminum are synthesized by a series of alpha- and neutron-capture reactions. Based on the new findings, we discuss possible strategy to determine a property of parent stars of observed carbon-enhanced metal poor stars. Some examples are also presented to show the robustness of the methodology.