NUCLEAR BURNING IN THE FIRST STARS

Alexander Heger[1,2,3,4], Stan Woosley[5], Conrad Chan[1,3], Xiaodong Tang[6], Falk Herwig[7], Hendrik Schatz[3], Eric Deleeuw[3]
[1] Monash Centre for Astrophysics, School of Physics and Astronomy, Monash University, Melbourne, Australia
[2] School of Physics & Astronomy, University of Minnesota, Minneapolis, MN 55455, U.S.A.
[3] Joint Institute for Nuclear Astrophysics, 1 Cyclotron Laboratory, Michigan State University, East Lansing, MI 48824-1321, U.S.A.
[4] Center for Nuclear Astrophysics, Department of Physics and Astronomy, Shanghai Jiao-Tong University, Shanghai 200240, P. R. China
[5] Department of Astronomy and Astrophysics, University of California, Santa Cruz, CA 95064, U.S.A.
[6] Institute of Modern Physics, Lanzhou, P. R. China
[7] Department of Physics and Astronomy, University of Victoria, Victoria, BC V8P5C2, Canada

The first generation of stars forming in the universe have a very unique and pristine primordial initial composition. This dramatically alter both their evolution, the way they die as supernovae, and their resulting nucleosynthesis. For example, the recently discovered most iron-poor star known, SM0313-6708, hints at some primordial production process of calcium that can only be found and seen in such pristine stars. Another example is that reduced mass loss and higher characteristic initial masses may lead to a population of pair instability supernovae that could produce a very unique abundance pattern.

No direct observations of these stars are possible at this time, however, so our ability to study these early stars is limited to indirect measurements and numerical simulations, though possibly we might be able to observe some of their stellar deaths in the near future. Stellar forensics based on nucleosynthesis patterns preserved in subsequent generations of stars may be used to attempt reconstruction of the properties of these first stars. These stars also set the starting point for understanding the chemical evolution of our galaxy and the universe.

In order to be able to use this tool, we need know what abundances were synthesised in this first generations of stars. In this paper we explore the peculiarities of nucleosynthesis and nuclear physics in the these first stars and its unique sensitivity to nuclear reactions.