New Models for the r-process Mechanism and Origin Site

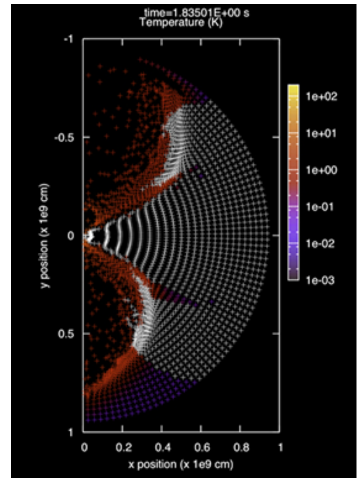
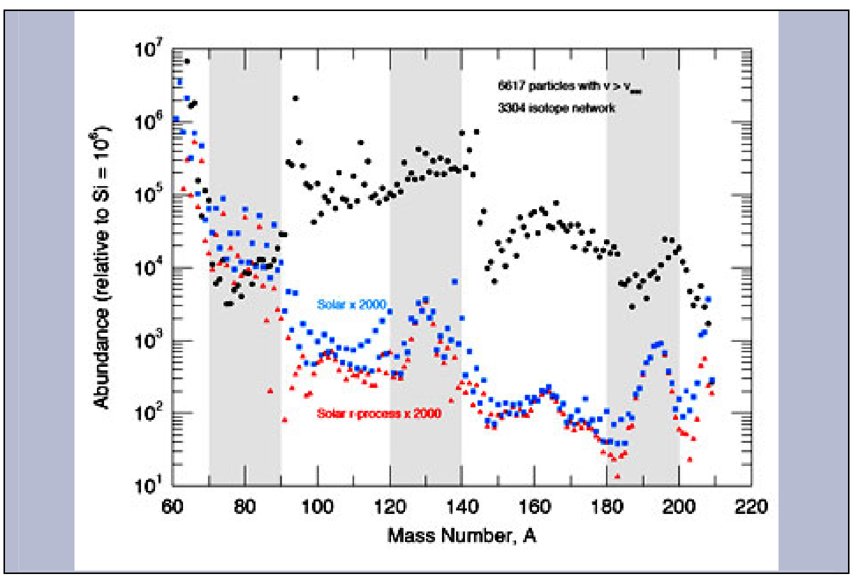


Figure 1

Chris Fryer (LANL), Aimee Hungerford (LANL), Falk Herwig (Keele) and Frank Timmes (LANL) have recently investigated a pathbreaking model for the rapid neutron capture process involving the mass ejected by fallback in a supernova explosion. The nucleosynthetic products of this ejected material produces r-process elements, including those in the vicinity of the elusive 3rd peak at mass number 195. Trans-iron element production beyond the second peak is made possible by a rapid (<1ms) non-equilibrium freezeout of alpha particles which leaves behind a large nucleon (including protons!) to r-process seed ratio. This rapid phase is followed by a relatively long (>15ms) simmering phase at aproximately 2 billion K, which is the thermodynamic consequence of the hydrodynamic trajectory of the turbulent flows in the fallback outburst. During the slow phase high mass elements beyond the second peak are first made through rapid capture of both protons and neutrons. The flow stays close to valley of stability during this phase. After freeze-out of protons the remaining neutrons cause a shift out to short-lived isotopes as is typical for the r-process. A low electron fraction isn't required in this model, however, the detailed final distribution is sensitive to the electron fraction. Their simulations suggest that supernova fallback is a viable alternative scenario for the r-process.



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