Abstract Submitted
for the APR10 Meeting of
The American Physical Society

An Adaptive QSE-reduced Nuclear Reaction Network for Silicon Burning SUZANNE PARETE-KOON, University of Tennessee, WILLIAM RAPHAEL HIX, Oak Ridge National Laboratory/ University of Tennessee, FRIEDRICH-KARL THIELEMANN, University of Basel — The nuclei of the "iron peak" are formed late in the evolution of massive stars and during supernovae. The nucleosynthesis resulting from silicon burning during these events is responsible for the production of nuclei with atomic mass numbers ranging from 28 to 64. The large number of nuclei involved makes accurate modeling of silicon burning computationally expensive. Examination of the physics of silicon burning reveals that the nuclear evolution is dominated by large groups of nuclei in mutual equilibrium. We present a nuclear reaction network scheme that takes advantage of this quasi-equilibrium (QSE) to reduce the number of independent variables needed to calculate the nucleosynthesis. Because the membership and number of these groups vary as the temperature, density and electron faction change, achieving maximal efficiency requires dynamic adjustment of group number and membership. The resultant adaptive QSE-reduced network calculates the nucleosynthesis up to 20 times faster than the full network it replaces without significant loss of accuracy. These reductions in computational cost make QSE-reduced networks well suited for inclusion within multi-dimensional hydrodynamic simulations, such as those of Type 1A Supernovae.

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Date submitted: 03 Feb 2010 Electronic form version 1.4