Publication

An approximation for the rp-process

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Hot (explosive) hydrogen burning, or the rapid proton capture process (rp-process), occurs in a number of astrophysical environments. Novae and X-ray bursts are the most prominent ones, but accretion disks around black holes and other sites are candidates as well. The expensive and often multidimensional hydrocalculations for such events require an accurate prediction of the thermonuclear energy generation while avoiding full nucleosynthesis network calculations. In the present investigation we present an approximation scheme that leads to accuracy of more than 15 hydrogen burning from 10(8)-1.5 x 10(9) K, which covers the whole range of all presently known astrophysical sites. It is based on the concept of slowly varying hydrogen and helium abundances and assumes a kind of local steady flow by requiring that all reactions entering and leaving a nucleus add up to a zero flux. This scheme can adapt itself automatically and covers low-temperature regimes, characterized by a steady flow of reactions, as well as high-temperature regimes where a (p, gamma)-(gamma, p)-equilibrium is established, while beta(+)-decays or (alpha, p)-reactions feed the population of the next isotonic line of nuclei. In addition to a gain of a factor of 15 in computational speed over a full-network calculation and energy generation accurate to more than 15 isotopic abundances. Thus, it delivers all features of a full network at a highly reduced cost and can easily be implemented in hydrocalculations.

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