Cold \( r \)-Process in Supernovae

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The \( r \)-process in a low temperature environment is explored, in which the neutron emission by photodisintegration does not play a role (cold \( r \)-process). A semi-analytic neutrino-driven wind model is utilized for this purpose. The temperature in a supersonically expanding outflow can quickly drop to a few \( 10^8 \) K, where the \((n, \gamma)-(\gamma, n)\) equilibrium is never achieved during the heavy \( r \)-nuclei synthesis. In addition, the neutron capture competes with the \( \beta \)-decay owing to the low matter density. Despite such non-standard physical conditions for the cold \( r \)-process, a solar-like \( r \)-process abundance curve can be reproduced. The cold \( r \)-process predicts, however, the low lead production compared to that expected in the traditional \( r \)-process conditions, which can be a possible explanation for the low lead abundances found in a couple of \( r \)-process-rich Galactic halo stars.

References