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Solar abundances for nuclei beyond Sr: s, i or r element nucleosynthesis

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We provide an update on nucleosynthesis beyond strontium, utilizing the latest nuclear data for both the slow (s-process) and rapid (r-process) neutron capture processes. A significant portion of the r-process abundance distribution is associated with neutron star mergers (NSMs).
At the state of the art, precise observational constraints on their nucleosynthesis are not yet available, and the uncertainties on the models of r-processe abundances do not depend only on the knowledge of the astrophysical site where they occur, but also on the nuclear physics input.

We estimate the contributions from the r-process to Solar System abundances by adopting the largely site-independent waiting-point concept through a superposition of neutron density components normalized to the r-abundance peaks and the s-process contributions using recent models of asymptotic giant branch stars, acknowledging that uncertainties in these estimates are dominated by nuclear physics. The results from both approaches are critically compared to verify wether the (few) discrepancies revealed hint to an i-process contribution or can be solved by providing more precise nuclear physics input.

Beside the remaining challenges in the nucleosynthesis models, new measurements in ionized plasmas, particularly β-decays from unstable cesium isotopes, could help refine these estimates. For heavier nuclei, the situation is more complicated, as r-process progenitors are beyond current experimental reach and uncertain branching ratios influence the s-process. This particularly concerns nuclei with long half-lives in the lab, such as Lu-176 and Re-187, whose decay rates in stars are not well understood. New measurements for these isotopes are urgently needed.

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