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Inhomogeneous Galactic Chemical Evolution of r-process Elements

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The origin of the heaviest elements is still a matter of debate. For the rapid neutron capture process ("r-process"), multiple sites have been proposed, e.g., neutron star mergers and (sub-classes) of supernovae. R-process elements have been measured in metal-poor halo stars. Galactic archaeology studies show that the r-process abundances among these stars vary by over two orders of magnitude. On the other hand, abundances in stars in the Galactic disk do not differ greatly. This leads to two major open questions:
1. What is the reason for such a huge abundance scatter of r-process elements in the early Galaxy?
2. While the large scatter at low metallicities might point to a rare production site, why is there barely any scatter at Solar metallicities?
We use the high resolution ((20 pc)^3 /cell) inhomogeneous Galactic chemical evolution tool "ICE" to study the role of the contributing sources of r-process elements. Our main findings are that additionally to neutron star mergers, a second, early acting site is necessary. We assume "magnetorotationally driven supernovae" can act as this additional and earlier r-process site and conclude that our simulations with an adequate combination of these two sites successfully reproduce the observed r-process elemental abundances in the Galactic halo. Finally, we discuss the potential role of neutron star-black hole mergers as alternative earlier r-process site.

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