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r-process contributions from massive star explosions triggered by the hadron-quark phase transition

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Canonical core-collapse supernova explosions driven by the neutrino-heating mechanism are presently ruled out as nucleosynthesis site for the production of heavy r-process elements with $A \sim 195$ (third r-process peak). Detailed numerical studies, with accurate neutrino transport and a sophisticated treatment of weak processes included, have shown that the ejected material yields neither sufficiently high entropies nor large neutron excess [1] for the production of elements with atomic numbers greater than $32 < Z < 50$ [2], known as light neutron-capture elements. Here, a review of this caveat will be presented. Based on new insights, a possibility will be revisited that a few rare supernova explosion events can account for a strong r-process, i.e. the production of elements up to mass numbers of $A \sim 195$. Therefore, it has been shown recently that the appearance of exotic phases of hot and dense matter, associated with a 1st-order phase transition from ordinary nuclear matter to the quark-gluon plasma at the supernova interior, can trigger the onset of energetic supernova explosions of massive stars with zero-age main sequence masses of 40–50 solar masses [3]. Surprisingly, these events yield a strong r process, details of which will be presented and discussed in this talk.

References

- [1] G. Martinez-Pinedo, T. Fischer, A. Lohs, and L. Huther, “Charged-Current Weak Interaction Processes in Hot and Dense Matter and its Impact on the Spectra of Neutrinos Emitted from Protoneutron Star Cooling,” *Phys. Rev. Lett.* 109, 251104, 2012.
- [2] G. Martinez-Pinedo, T. Fischer, and L. Huther, “Supernova neutrinos and nucleosynthesis,” *J. Phys. G Nuc. Phys.* 41, 044008, 2014.
- [3] T. Fischer, N.-U. F. Bastian, M.-R. Wu, S. Typel, T. Klahn, and D. B. Blaschke, “Quark deconfinement as a supernova explosion engine for massive blue supergiant star”, *Nat. Astron.* 2, 980

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