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Hans A. Bethe Prize: Astrophysical, observational and nuclear-physics aspects of r-process nucleosynthesis

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Guided by the Solar System (S.S.) abundance peaks at A$\simeq$130 and A$\simeq$195, the basic mechanisms for the rapid neutron-capture process (the *r-process*) have been known for over 50 years. However, even today, all proposed scenarios and sites face problems with astrophysical conditions as well as with the necessary nuclear-physics input. In my talk, I will describe efforts in experimental and theoretical nuclear-structure data for modeling today's three groups of r-process *"observables"*, i.e. the bulk S.S. isotopic abundances, the elemental abundances in metal-poor halo stars, and peculiar isotopic patterns measured in certain cosmic stardust grains. To set a historical basis, I will briefly recall our site-independent *"waiting-point"* model, with superpositions of neutron-density components and the use of the first global, unified nuclear input based on the mass model FRDM(1992). This approach provided a considerable leap forward in the basic understanding of the required astrophysical conditions, as well as of specific shell-structure properties far from stability. Starting in the early millenium, the above simple model has been replaced by more realistic, dynamical parameter studies within the high-entropy wind scenario of core-collapse supernovae, now with superpositions of entropy (S) and electron-fraction (Y_e) components. Furthermore, an improved, global set of nuclear-physics data is used today, based on the new mass model FRDM(2012). With this nuclear and astrophysics parameter combination, a new fit to the S.S. r-abundances will be shown, and its improvements and remaining deficiencies in terms of underlying shell structure will be discussed. Concerning the abundance patterns in metal-poor halo stars, an interpretation of the production of *"r-rich"* (e.g. CS 22892-052) and *"r-poor"* (e.g. HD 122563) stars in terms of different (Y_e), S combinations will be presented. Finally, for the third group of *"r-observables"*, a possible origin of the anomalous Xe-H pattern in presolar nanodiamonds by the *"main"* component of a *"cold"* r-process is suggested.