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Branchings, neutron sources and poisons: evidence for stellar nucleosynthesis

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The first evidence of the occurrence of nucleosynthesis in stars was provided in the 1950s by the detection of the unstable heavy element technetium in the atmospheres of stars on the Asymptotic Giant Branch (AGB), a late evolutionary phase of stars of low mass. Technetium can be produced by slow neutron captures (the s process) and thus its detection requires that neutron source reactions are activated in these stars, triggering the production of heavy element. The best candidates as sources of neutrons have been identified in the C13(alpha,n)O16 and Ne22(alpha,n)Mg25 reactions. The C13(alpha,n)O16 reaction appears to be responsible for the production of most of the neutrons, while the Ne22(alpha,n)Mg25 reaction is important for the activation of branching points on the s-process path. Detailed evidence of the operation of branching points is shown by recent measurements of the isotopic composition of heavy elements in meteoritic silicon carbide (SiC) grains that originated from AGB stars. Interesting examples that will be discussed are the Ba134/Ba136, Kr86/Kr82 and Zr96/Zr94 ratios. During the s process, elements lighter than iron represent "neutron poisons", stealing neutrons from the production of heavy elements. Nevertheless, neutron captures on light elements are of much interest in triggering secondary nucleosynthesis path. For example, the activation of the N14(n,p)C14 reaction on one hand can strongly inhibit the production of heavy elements by the C13(alpha,n) source, on the other hand it leads to the production of fluorine, which is observed to be enhanced in AGB stars.
Neutron-capture reactions on the isotopes of Mg, Si and Ti are also of great interest as they change the composition of these elements, which are also recorded in meteoritic grains.

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