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On understanding nuclear reaction network flows wih branchings on directed graphs

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A nuclear reaction flow, appropriately scaled, gives the number of nuclei of a particular species undergoing a particular reaction per unit time. Such information provides important clues as to how nuclei are synthesized in an astrophysical environment and which nuclear reactions govern the resulting yields. For example, reaction flows in the s process of nucleosynthesis show the main reaction pathway as well as the key branchings. Reaction flows become less diagnostic when then are no longer unidirectional. For example, in explosive nucleosynthetic environments, reaction flows in one direction are often nearly balanced in the reverse. One can discuss net flows in such cases, but the overall nuclear flow dynamics are complicated and difficult to follow. Here I describe how consideration of branchings on directed graphs can aid understanding of reaction flows in explosive nucleosynthesis. I illustrate the utility of branchings with examples from alpha-constrained quasi-equilibrium and freeze out of the r-process of nucleosynthesis.

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