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Nuclear isomers and their implications in stellar environments

Isomers are major tools for the study of nuclear structure especially high-spin spectroscopy. Nuclear isomers occur throughout the nuclear chart, but high-K isomers are abundant in the rare-earth region. This type of isomer has an axially symmetric shape and possesses a quantum number "K", corresponding to the projection of the total angular momentum onto the symmetry axis. Because of K selection rule, decay from a high-K state to low-K state can be hindered. Therefore, they have longer half-lives than usual excited states and form high-K isomers. Rotational bands based on these isomers are also possible and give unique access to the structure in exotic nuclei. From the astrophysical point of view, apart from the prominent peaks at A =130 and A =190, there is a small bump near A ~ 160. This is well-known as the rare-earth element (REE) peak. It has been suggested that deformation plays important role in the formation of the REE peak. Although the structure of neutron-rich nuclei in the rare-earth region has a broad range of interests, spectroscopic information is very limited. We present here the nuclear structure of these nuclei, possible K-isomers and their properties. Isomers potentially have important consequences for nucleosynthesis. In spite of enormous progress, the treatment of isomers in stellar network simulation poses a major challenge. We demonstrate with examples of 26Al, 34Cl and 85Kr, how to treat accurately the isomers and to calculate beta-decay rates at stellar conditions. The explicit treatment of nuclear structure effects is important for calculating nuclear reaction rates in astrophysical conditions.

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