Threshold Cluster States in Nuclear Astrophysics

Michael Wiescher

University of Notre Dame

It is well known that pronounced alpha cluster states emerge in the near vicinity of the alpha threshold in self conjugate nuclei. This was phenomenologically expressed by the Ikeda rule. This effect has been of great importance for nuclear astrophysics, namely for the understanding of stellar helium burning, which is facilitated through reactions that sensitively depend on weakly bound alpha cluster states, which greatly enhance the reaction rates. The best known case is the triple-alpha process followed by the 12C(α,γ)16O reaction corresponding to a pure alpha cluster sequence. Other cases are the nuclei which are built on d⊗α configurations such as 6Li, 10B, 14N, 18F and linked by weak interaction symmetry to 2n⊗α configurations such as 6He, 10Be, 14C, 18O, 22Ne, 26Mg, which are predicted to play an important role in the neutron production for the s- and r-process. The latter chain is mirrored by 2p⊗α configurations such as 6Be, 10C, 14O, 18Ne, 22Mg, which, as part of the αp-process, drive the supply of protons for explosive hydrogen burning in X-ray bursts environment. In all of these cases the resonance strength is characterized by the extent of the α-clusterization. I will discuss some of these cases and describe the importance for the respective astrophysics burning environments.