Contribution ID: **15** Type: **not specified**

Importance of fully microscopic approach to delayed neutron emission

Tuesday, 22 May 2012 15:00 (30 minutes)

Incomplete and inadequate decay data for the short-lived fission products restrict applicability of summation codes in estimating the reactor decay heat for the short cooling times or deriving the absolute delayed neutron yields. The beta-decay properties of a much broader set of the very neutron-rich nuclei are of need for the astrophysical r-process modeling. The vast majority of these nuclides are experimentally unknown. Thus, a reference database of evaluated half-lives and beta-delayed neutron emission rates should include reliable theoretical predictions.
The very neutron-rich nuclei present a unique laboratory for exploring nuclear structure under extreme conditions. Recently the half-lives and delayed neutron branchings of Zn to Ge isotopes with N>50 have been measured for the first time at HRIBF ORNL using radioactive beam purification and tagging technique with efficiency calibrated ϒ-detectors [1]. The experiments have shown that the reference global GT model [2], as well as semi-statistical GT+FF models [3,4] fail to reproduce the newly measured half-lives of neutron-rich nuclei near and beyond the shell closures at Z=28, N=50. Thus, the RIB experiments offer a stringent test for the models aiming at the ground state and β-delayed properties.
In particular, beyond the most neutron-rich doubly-magic nucleus 78Ni, the appropriate model should account for the observed sub-shell closure at N=58 [5], related weakening of the 78Ni core and crossing of the p2p3/2 and p1f5/2 levels which causes an inversion of the ground-state spin-parities [6]. Such a drastic change of the single-particle pattern should be properly taken into account in β-delayed emission studies. Moreover, for the N>50 nuclides the first-forbidden (FF) decays start to compete with the Gamow-Teller (GT) decays [5]. The new data [1] give a possibility to verify the different predictions and extend the fully microscopic beta-decay model [7]. The self-consistent DF+CQRPA approach [7] augmented by blocking describes properly the ground state properties of the parent and daughter isobaric companions. A reasonable agreement with both known and new experimental half-lives [4] gives some confidence in extrapolation to more exotic nuclides. A stabilization of the half-lives near new sub-closure of N=58 is predicted which may facilitate the measurements in more exotic Ga isotopes with A>85. Importantly, the new data support the predicted reduction of the delayed total and multi-neutron emission probabilities in the regions of 78Ni and 132Sn due to the high-energy FF transitions [7].
A significant redistribution of the r-process abundances is also found from the new calculations by R. Surman using DF3a+blocking set of the half-lives. Shorter half-lives of less exotic members of the isochains (cf. to the standard half-lives by [2,3]) together with the longer for the more exotic members trap material in the first abundance peak while depleting the second and increasing the abundances of A>140 isobars.
The work is supported by the JIHIR, ORNL and IN2P3-RFBR agreement 110291054.

[1] M. Madurga et al., Phys.Rev.Lett. ,submitted 2012.
[2] B.Pfeiffer et al., Ann.Nucl. Energy 41, 39 (2002).
[3] P. Moeller et al., Phys.Rev. C67, 055802 (2003).
[4] T. Tachibana et al. Prog. Theor. Phys. 84, 641 (1990).
[5] J.A. Winger et al., Phys.Rev. C81, 044303 (2010).
[6] K.T. Flanagan et al., Phys.Rev.Lett. 103, 142501 (2009).
[7] I.N. Borzov, Phys.Rev. C67, 025802 (2003); C71, 065801 (2005).

Primary authors: Dr BORZOV, Ivan (IPPE, Obninsk & JINR, Dubna); Prof. RYKACZEWSKI, Krzysztof (ORNL)

Presenter: Prof. RYKACZEWSKI, Krzysztof (ORNL)

Session Classification: beta dn