New α-decay chains of Z=117

A. Bhagwat[1], Y. K. Gambhir[2,3*] and M. Gupta[3]
[1]*Department of Physics, IIT-Gandhinagar, Ahmedabad – 382424, INDIA*
[2]*Department of Physics, IIT-Powai, Mumbai - 400076, INDIA*
[3]*Manipal University, Manipal - 576104, INDIA*
** email: yogy@phy.iitb.ac.in*

Introduction

The synthesis of two isotopes of Element Z=117 using $^{48}_{20}$Ca + $^{249}_{97}$Bk have been reported recently[1]. At excitation energies of 35 MeV and 39 MeV respectively, a single α - decay chain attributed to the parent ^{294}117 and five α - decay chains assigned to the parent ^{293}117 were measured. All the decay chains ended with a spontaneously fissioning (SF) nuclide. The α - energies and the respective decay half lives were extracted.

Since nuclear physics experiments are primarily focused on measuring the properties of the decay products accurately, assignments rely on identifying the decay daughters by comparison with known properties of descendents whenever possible (*e.g.* cold fusion). Unfortunately, extremely poor statistics present a challenge to conclusive identification particularly when the decay chains end in unknown regions (*e.g.* hot fusion) as is the case here. While estimates of randomness under beam-off conditions support the observation that the sequences result from the decay of a single parent nucleus in each case, adequate nuclear structure information will be helpful in upholding the mass assignments. Finally, since these nuclides have been synthesized for the first time, they represent excellent candidates for theory to point the way.

We report in this short communication, the ground state decay properties for all the nuclei appearing in these α - decay chains of Z=117 in the framework of the Relativistic Mean Field (RMF) theory.

Calculations, Results and Discussions

The relativistic mean field (RMF) calculations[2] with frozen gap approximation using axially symmetric deformed oscillator basis are carried out. The NL3 Lagrangian parameter set is used. The pairing gaps are obtained by reproducing the pairing energies of the relativistic Hartree–Bogoliubov (RHB) calculations. The ground state properties are well reproduced as expected. The calculated Q-values shown in Figs. 1 and 2 reasonably agree with the experiment.

The α - nucleus potential is generated in the double folding ($t\rho\rho$) approximation using RMF densities along with M3Y nucleon-nucleon interaction. This potential is then used in the WKB approximation to calculate the decay half-lives. The calculated Q-values are used. The results are shown in Figs. 3 and 4.

The agreement between theory and experiment is reasonable, though they do differ substantially at some places. Experimental inconsistencies exist given the extremely small number of events. Furthermore, only the average values for the five decay chains attributed to ^{293}117 have been reported thereby placing in question the basis for a direct comparison with theory. We suggest that any such comparison may be taken to be purely indicative. Further experiments have been done and analysis is in progress.

References

[1] Yu. Ts. Oganessian *et al.*, Phys. Rev. Lett. **104**, 142502 (2010)
[2] Y. K. Gambhir *et al.* Ann. Phys. (NY) **320**, 429 (2005)

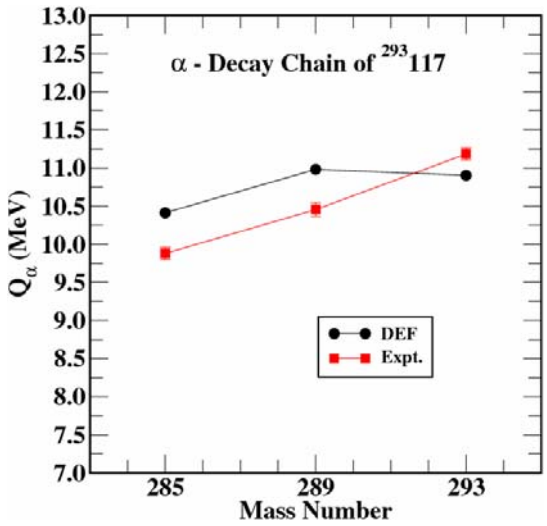

Fig. 1 Calculated (RMF) Q values along with the corresponding experimental values for α-decay of $^{293}117$. The calculated values are denoted by DEF while Expt denotes the corresponding experimental values[1].

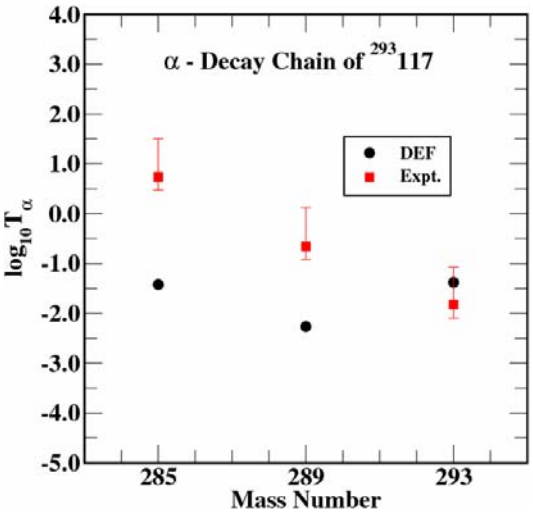

Fig. 3 Calculated and the corresponding experimental half lives for α-decay of $^{293}117$. The calculated values are denoted by DEF while Expt denotes the corresponding experimental values[1].

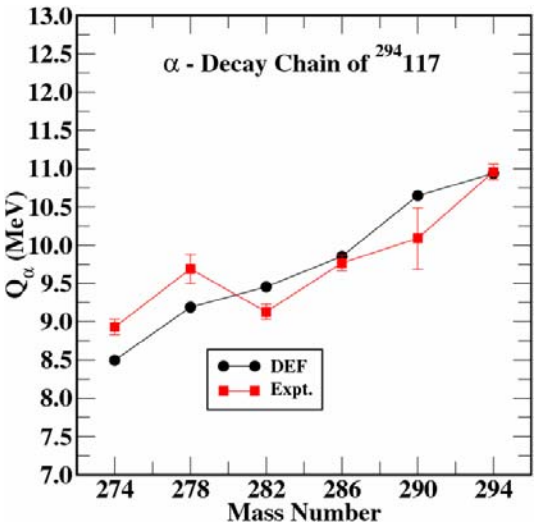

Fig. 2 Calculated (RMF) Q values along with the corresponding experimental values for α-decay of ^{294} 117. The calculated values are denoted by DEF while Expt denotes the corresponding experimental values[1].

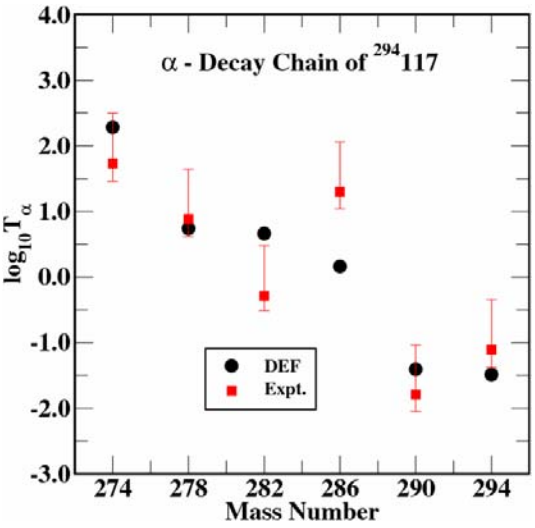

Fig. 4 Calculated and the corresponding experimental half lives for α-decay of $^{294}117$. The calculated values are denoted by DEF while Expt denotes the corresponding experimental values[1].