Systematics of Measured Fission Half Lives of Even Even Superheavy Nuclei

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Introduction

The production and study of superheavy nuclei is of current interest. Elements upto Z = 118 have been produced so far, and their α decay properties have been studied in detail. In the shell stabilised superheavy region, spontaneous fission competes with α decay and must be taken into account as an important decay mode. Therefore, the study of fission becomes particularly important in the context of the formation and survival of the superheavy nuclei. A fully microscopic description of the fission phenomenon and hence the fission half lives, though highly desirable, is far from being realised due to the extreme complexity of the fission process. Hence a phenomenological description of the fission process is attempted here.

Results and Discussion

We report a systematic investigation of spontaneous fission half lives of superheavy nuclei. For the present exploratory investigation, we restrict ourselves to the even even nuclei in the superheavy region, with $\log_{10} T_{1/2} < 2$. Xu and Ren [1] have reported a similar investigation earlier, but the formula that they propose turns out to be quite complex.

The fission half lives are expected to depend predominantly on the asymmetry parameter (defined by $I = (N - Z)/A$), shell structure and Coulomb effects. Here, we assume a simple three parameter relation between $\log_{10} T_{1/2}$ (in seconds) and asymmetry as under:

$$\log_{10} T_{1/2} = c_0 \left\{1 + c_1 I + c_2 I^2\right\} \qquad (1)$$

The shell effects have been ignored in the first step. The parameters c_0, c_1 and c_2 have been obtained by χ^2 fit to the available experimental values [2] of the fission half lives. The explicit values of these parameters are: $c_0 = -73.92$, $c_1 = -9.46$ and $c_2 = 22.9$, with *rms* deviation 1.15.

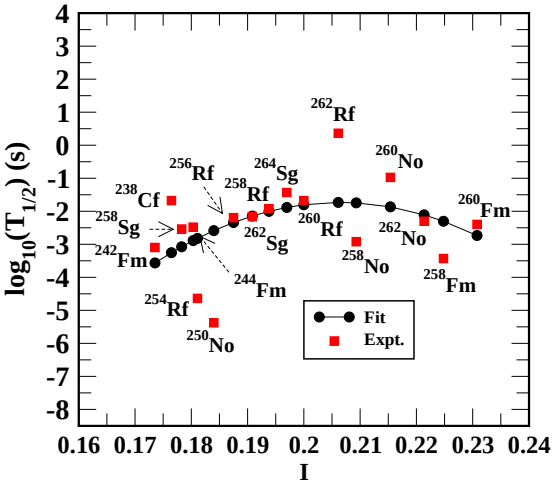

FIG. 1: The fitted and the corresponding experimental values [2] for fission half lives.

The fitted and corresponding experimental values of $\log_{10} T_{1/2}$ have been plotted in Fig. (1) as a function of asymmetry, I. Spontaneous fission half lives spanning the region 82 $\leq$ Z $\leq$ 106 have been taken from [2] as a representative data set. The individual nuclides appearing in the present investigation are also indicated in the same figure. It is seen that the half lives obtained by using the present

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formula are indeed reasonable, given the simplicity of the form assumed. The largest discrepancy is obtained for ^{254}Rf and ^{250}No, for which, the measured half lives are of the order of micro - seconds. The nuclide ^{262}Rf is close to the region where α decay is the predominant decay mode. Therefore, shell effects are expected to play a dominant role in the description of fission half lives.

The agreement between the half lives obtained from the phenomenological model and the corresponding experimental results could be improved by incorporating the shell and Coulomb effects explicitly. Work is in progress along these lines.

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References

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