SYSTEMATICS OF THE K X-RAY MULTIPLICITY FOR TRANSITIONAL NUCLEI WITH A ≃ 200

H.J. Karwowski, S.E. Vigdor, W.W. Jacobs, T.G. Throwe, D.L. Wark,
S. Kailas, P.P. Singh, F.Soga, T.E. Ward, and J. Wiggins
Indiana University Cyclotron Facility, Bloomington, Indiana 47405

During the past year we have extended our measurements of the multiplicity $\langle M_K \rangle$ of prompt K X-rays accompanying (^{6,7}Li,xn) reactions to several additional target-bombarding energy combinations. The additional measurements were intended to complement those compiled in last year's Annual Report,[1] which suggested an unexpectedly simple systematic behavior of $\langle M_K \rangle$ as a function of neutron number for the populated residual nuclides. In fact, as shown in Fig. 1, the complete data set very nicely defines this systematic dependence, indicating plateaus of high and constant multiplicity for the transitional-shape nuclides with $110 < N < 120$, and rapid, nearly linear, falloffs in $\langle M_K \rangle$ for both smaller N (entering the strongly-deformed, rare earth region) and larger N (approaching the shell closure at N=126).

The new data thus support the nuclear structure scenario we had proposed previously to provide a qualitative explanation for our $\langle M_K \rangle$ measurements. In this scenario we assume that the observed X-rays arise predominantly from internal conversion in M1 transitions among members of strongly-coupled rotational bands at moderately high spin (I~10-20h), associated with mildly deformed, high-K, few-quasiparticle intrinsic states. The high X-ray multiplicities suggest that such collective bands are a

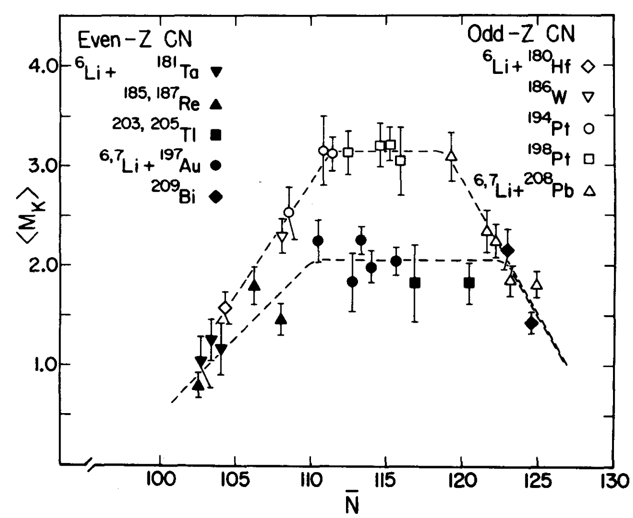

Figure 1. Compilation of measured K X-ray multiplicities for (Li,xn) reactions induced on the targets shown at bombarding energies from 75 to 124 MeV, plotted vs the neutron number N averaged over the residual-nuclide production distribution appropriate to each target and energy. [Typically, two or three (Li,xn) residues are significantly populated for a given target and energy.] The values of N are deduced to within ±0.5 from systematics established by γ-singles spectra measured in the present experiment and the work of Ref. 4. The dashed curves guide the eye and are qualitatively consistent with the nuclear structure arguments presented in Refs. 2,3.

much more general feature of the A≈200 transitional region than existing γ-spectroscopy data indicate. The $\langle M_K \rangle$ measurements and our nuclear structure inferences are described in detail in two recent publications.[2,3]

1) S.E. Vigdor et al., IUCF Scientific and Technical Report 1980, p. 108.

2) H.J. Karwowski et al., Phys. Rev. Lett. 47, 1251 (1981).

3) H.J. Karwowski et al., Phys. Rev. C, in press (IUCF preprint no. 171).

4) J. Kropp et al., Z. Phys. A280, 61 (1977).

THE INFLUENCE OF DEFORMED-NUCLEUS LEVEL DENSITIES ON STATISTICAL MODEL CALCULATIONS FOR HIGH-SPIN FISSION

S.E. Vigdor and H.J. Karwowski
Indiana University Cyclotron Facility, Bloomington, Indiana 47405

During the past year we have continued our investigation[1-4] of fission and particle emission from hot, high-spin nuclei by making substantial further improvements in the statistical model analysis of such data. We have specifically incorporated methods for estimating the effects of (1) the expected dilution of collective rotational bands with increasing temperature on the level densities for deformed nuclei, and (2) the deformation of daughter nuclei on the barrier transmission coefficients for particle emission. In the process of introducing the latter change, we also found and corrected a significant long-standing error in the widely used optical model subroutine TLJ. With these and the numerous other improvements we have introduced over the past few years (see refs. 1-4), our statistical model code now differs extensively from its progenitor MB-II (ref. 5), and we have renamed the Indiana version MBEGAT.

We have previously stressed[2] the importance, for the sake of consistency in calculations of fission-evaporation competition, of generating level densities as a function of total angular momentum not by the conventional technique,[5] which implicitly assumes spherical symmetry, but rather by the K-summation technique introduced for deformed nuclei by Bjornholm, Bohr, and Mottelson (BBM).[6] In the latter approach, collective rotational bands built upon every intrinsic nucleon configuration are included in the level density. For an axially symmetric nuclear shape characterized by moment of inertia $\mathcal{J}_\perp$ with respect to an axis orthogonal to the symmetry axis, inclusion of the rotational bands enhances the intrinsic level densities at nuclear temperature τ by a factor $\mathcal{J}_\perp \tau/\hbar^2$. In our previous analysis of measurements of fission-evaporation competition following ^{6}Li-induced fusion reactions,[2,3] we incorporated this collective enhancement of level densities at both the strongly prolate saddle-point deformations relevant to fission and the mildly oblate equilibrium deformations used in evaluating particle emission widths. We were able to reproduce very well the relative values of fission cross sections (σ_{fiss}) and anisotropies (γ_{fiss}) and α-evaporation cross sections (σ_α) measured for various targets and bombarding energies, without any adjustable parameters. [All nuclear structure properties needed for the calculations were fixed according to predictions of the rotating-liquid-drop (RLDM) and non-interacting Fermi gas (NIFG) models, see Refs. 2,3]. However, after allowance in the calculations for pre-equilibrium nucleon emission manifested in the observed proton energy spectra and (^{6}Li,xn) residue mass distributions, the calculated absolute values