FINE STRUCTURE OF α-TRANSITIONS WITHIN THE COUPLED CHANNELS FORMALISM

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Abstract. *We systematize the available experimental material concerning α-transitions to low-lying excited states in even-even and odd-mass emitters. We show that α-intensities for transitions to excited states depend linearly upon the excitation energy for all known even-even and odd-mass α-emitters. The well known Viola-Seaborg law for α-transitions between ground states can be generalized for transitions to excited states. This rule can be used to predict any α-decay half life to a low-lying excited state. We then describe α-decay transitions to low-lying states in even-even nuclei with $Z > 50$; $N > 82$ by using the coupled channels method. The energy levels and electromagnetic transition rates between the states of the ground band can satisfactorily be reproduced by using two parameters, namely the deformation parameter and the strength of the harmonic Coherent State Model (CSM) Hamiltonian. The B(E2) values can be described in terms of an effective charge which depends linearly on the deformation parameter. The α-emission process is treated by using an α-daughter interaction containing a monopole component, calculated through a double folding procedure with a M3Y interaction plus a repulsive core simulating the Pauli priciple, and a quadrupole-quadrupole (QQ) interaction. The decaying states are identied with the lowest narrow outgoing resonances obtained through the coupled channels method. The α-branching ratios to 2^+ states are reproduced by using the QQ strength. This interaction strength can be fitted with a linear dependence on the deformation parameter, as predicted by CSM. The theoretical intensities to 4^+ and 6^+ states are in reasonable agreement with available experimental data. Predictions are made for spherical, transitional and well deformed even-even α-emitters. Finally we describe electromagnetic and favored α-transitions to rotational bands in odd-mass nuclei built upon a single particle statewith angular momentum projection $\Omega \neq \frac{1}{2}$ in the region $88 \leq Z \leq 98$. We use the particle coupled to an even-even core approach described within CSM and the coupled channels method to estimate partial α-decay widths. We reproduce the energy levels of the rotational band where favored α-transitions occur for 26 nuclei and predict B(E2) values for electromagnetic transitions to the bandhead using a deformation parameter and a Hamiltonian strength parameter for each nucleus, together with an effective collective charge depending linearly on the deformation parameter. Where experimental data is available, the contribution of the single particle effective charge to the total B (E2) value is calculated. The intensity of the transition to the first excited state is reproduced by the QQ coupling strength. It depends linearly both on the nuclear deformation and the square of the reduced width for the decay to the bandhead, respectively. All predicted intensities for transitions to higher excited states are in a reasonable agreement with experimental data.*

Keywords: α -emission fine structure, coupled channels method, coherent state model

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