where $H$ is the two-well Hamiltonian, with energies broadened by the decay widths $\Gamma_S$ and $\Gamma_N$. The ND branching ratio is then given by Parseval's theorem as [4]

$$F_N = \Gamma_N \frac{\int dE |G_{NS}(E)|^2}{2\pi} \left(\frac{\Gamma_N \Gamma_S}{\Gamma_S + \Gamma_N \Gamma'}\right)$$

where the spreading width for tunneling through the barrier is

$$\Gamma' = \frac{(\Gamma_N + \Gamma_S)^2}{(\Gamma_N + \Gamma_S)^2 + (\Gamma_N + \Gamma_S)^2/4}$$

This exact two-level result for $\Gamma'$ is consistent with Fermi's Golden Rule [3]. We note that Eq. 2 is exactly what one would expect for a two-stage quantum tunneling problem. Furthermore, inversion of this result yields $\Gamma'$ purely as a function of experimentally known values:

$$\Gamma' = \frac{F_N \Gamma_N}{F_N - F_N \Gamma_N \Gamma'}$$

Without knowing the theoretical quantity $\Gamma_N - \Gamma_S$, it is impossible to exactly determine the tunneling matrix element $V$ from experimental data. We can nonetheless treat the detuning probabilistically by the assumption that the states of the ND band are distributed according to the Gaussian Orthogonal Ensemble. This approach yields a probability distribution $V$, with an ensemble average

$$\langle V \rangle = \sqrt{\frac{\Gamma'}{\Gamma_n + \Gamma_N}} \frac{D_N}{4} + \beta \left(\frac{(\Gamma_N + \Gamma_N)^2}{D_N}\right)$$

where $D_N$ is the average level spacing in the ND well.

The two-level approximation thus provides an exactly solvable model for SD decay. It has been shown [4, 5] that the effect of the other ND levels is negligible in the $A \approx 190$ mass region, and only moderate in the $A \approx 150$ region. The merit of this simple, exactly solvable model is that it allows relatively easy extraction of parameters related to nuclear structure.

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Role of the intruder level in upper-pf shell nuclei

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Abstract. Shell-model calculations for $^{68}$Cu and $^{64}$Ge in the $p/f_5/2g_9/2$ model space using a realistic interaction are reported and compared to those generated using an appropriately renormalized counterpart of the interaction in the truncated $p/f_5/2$ subspace. The results suggest that reliable computations can be performed in a space that does not explicitly include the intruder level so long as the interaction as well as the transition operators are renormalized appropriately.

The role of intruder levels that penetrate down into lower-lying shells in atomic nuclei has been the focus of many studies and debates. These levels are found in heavy deformed nuclei where the strong spin-orbit interaction destroys an underlying harmonic oscillator symmetry of the nuclear mean-field potential. In this contribution we report on calculations that consider the occupancy of these levels, their contribution to the nuclear deformation, and the role they play in the overall dynamics.

FIGURE 1. Energy spectrum and B(E2) transition strengths for $^{64}$Ge. The widths of the arrows in the figure represent the relative B(E2) strengths, normalized to unity for the ground band $2^+ \rightarrow 0^+$ transition. Numbers in each box are for the $p/f_5/2g_9/2$ and the more restricted $p/f_5/2$ model spaces, respectively.

We carried out $m$-scheme shell-model calculations for the $^{68}$Cu and $^{64}$Ge nuclei in the $p/f_5/2g_9/2$ model space assuming the occupancy of the $f_{7/2}$ orbital to be 'frozen'. This choice was motivated by the $f_{7/2}$ orbit's high occupation as reported elsewhere [1]. The Hamiltonian we used is a $G$-matrix with a phenomenologically adjusted monopole part [2]. A renormalized version of this interaction in the $p/f_5/2$ space has been introduced for describing beta decays [3].

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Global and Local Behaviour of Nuclear Ground-State Properties as fingerprints to Shape Coexistence in the Lead Isotopes

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Abstract. A three-configuration mixing calculation is presented in the context of the Interacting Boson Model (IBM), with the aim to describe recently observed collective bands built on low-lying $0^+$ states in the neutron-deficient lead isotopes. Possible effects on the nuclear binding energy are addressed, caused by mixing of these low-lying $0^+$ intruder states into the ground state, and a new method is described in order to provide a consistent description of both ground-state and excited-state properties.

Ample evidence has been accumulated for the presence of nuclear shape coexistence phenomena throughout the whole table of isotopes, especially at and near closed shells [1, 2]. The neutron-deficient lead isotopes in particular, with a closed proton shell at $Z = 82$, show very rich excitation spectra. Three "families" of excited states are observed, with different spectroscopic properties, and with a behaviour that strongly depends on the neutron number [3]. The low-lying excited $0^+$ states have been interpreted within two different frameworks: the mean-field and the shell model. In a mean-field approach [4], the spectrum is understood as reflecting several competing minima in the potential energy surface (PES), corresponding to spherical, oblate and prolate deformations. In a shell-model picture, the excited $0^+$ states are generated by multi-particle multi-hole (mp-mh) proton excitations across the $Z = 82$ shell gap. The excitation energies of these intruder states are lowered by the residual proton-neutron interaction. mp-mh excitations cannot be easily handled in full-scale shell model calculations, in particular for the large model space required for the description of heavy open-shell nuclei. They are, therefore, treated with the help of algebraic models, such as the Interacting Boson Models (IBM). In the first part of this poster, an IBM-mixing calculation is proposed, that describes the three different intrinsic "shape" configurations. In order to reduce the number of parameters that appear in such a configuration-mixing calculation, use is made of the concept of intruder-spin symmetry, relating configurations with different numbers of particle ($N_p$) and hole ($N_h$) bosons (i.e., fermion pairs), but with a constant total number of bosons ($N = N_p + N_h$). In this way, experimental excitation energies in adjacent Pt and W nuclei are used to fix the essential IBM parameters [5]. Apart from mean-field and shell model, a third, purely phenomenological approach has also been used in order to interpret the experimental findings: the shape-mixing picture [6]. In this model, the physical observed states are the result of interactions between the several configurations. They result as a superposition of spherical, oblate and prolate configurations, the relative

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