Probing the pairing-phase transition with pair-transfer reactions in unstable nuclei

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The application of concepts mediated from superconductivity to nuclear physics has provided a key to understanding the excitation spectra of even-A nuclei, odd-even mass differences, rotational moments of inertia, and a variety of other phenomena. Two types of pairing regimes have been usually discussed: pair vibrations and pair rotations. We discuss an approximate solution at the critical point of the pairing transition from harmonic vibration to deformed rotation in gauge space [1], that is found by analytic solution of the collective pairing hamiltonian, an early approach developped by Bès and co-workers [2] in analogy with the Bohr-Mottelson collective description of the quadrupole degree of freedom. The Bès hamiltonian is solved with a square well potential (this is similar to the $E(5)$ approach of Iachello [3]): the eigenvalues are expressed in terms of the zeros of Bessel functions of integer order. The eigenfunctions are related to Bessel functions and the underlying group structure is identified with the Euclidean group in two dimensions, $E(2)$. The results are compared to the pairing bands based on the Pb isotopes and they show that the transition from vibrational to rotational regimes appears almost suddendly when moving from closed-shell reference nuclei (see figure). The relevance of the present model to nuclear structure far from stability is exemplified by discussing pair transfer amplitudes, $\langle A{+}2 \mid P^\dagger \mid A\rangle$, and cross-sections along a chain of isotopes extending to the drip-lines. A thorough comparison of these quantities with data, obtained from highly challenging measurements of pair-transfer reactions for unstable nuclei (e.g. light lead isotopes), would provide a valuable test for the description of the pairing critical-point.

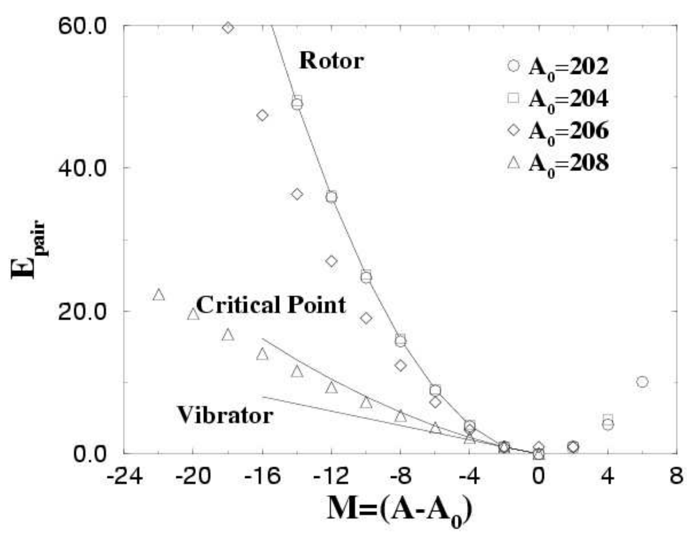

Figure 1: *Sequence of empirical* 0^+ *neutron pair energies,* $E_{pair} = [\varepsilon(A) - \varepsilon(A_0)] - C(A - A_0)$, *for Pb isotopes, using* A_0 *as a reference. Critical-point, pure-vibrational and pure-rotational descriptions are indicated. See [1] for details.*

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