Evidence Against a Nonstatic Spin-Isospin Order in ^{28}Si

In a recent Letter Lo Iudice and Palumbo[1] have made the fascinating suggestion that the one-pion-exchange (OPE) potential might give rise to a spin-isospin ordered phase in nuclei. One-dimensional oscillations of a proton (spin up) and neutron (spin down) pair against a proton (spin down) and neutron (spin up) pair are considered in an axially symmetric oblate deformed nucleus. The spin quantization axis is parallel to the direction of the oscillation and of the symmetry axis of the nucleus. Thus distinguished spin-isospin order caused by zero-point one-dimensional oscillation should be favored in energy as a result of the OPE potential. Since the OPE potential is also responsible for precursor phenomena[2] to pion condensation and since the two effects might reflect each other we decided to test the idea of Lo Iudice and Palumbo[1] and comment on it here.

There is a qualitative but specific prediction[1] for the excitation energy of $J^{\pi}=2^-$ states and their $M2$ excitation strength from the ground state in a nucleus with $A=28$, i.e., there should be one 2^-, $K=0$ level lowered to $E_x \approx 11$ MeV in the oblate deformed nucleus ^{28}Si with an enhanced transition strength[3] of $B(M2)\uparrow \approx 31$ Weisskopf units (W.u.) $= 2359\ \mu_K{}^2\cdot\text{fm}^2$, and 2^-, $K\neq 0$ levels with retarded strength.

In a high-resolution ($\Delta E \approx 30$ keV full width at half maximum) (e,e') experiment[4] we have discovered a rather fragmented $M2$ strength distribution centered at $E_x \approx 14.6$ MeV (with only little $M2$ strength below $E_x = 12$ MeV). The integrated strength amounts to $\sum B(M2)\uparrow = 408 \pm 84$ $\mu_K{}^2\cdot\text{fm}^2$ or 5.4 ± 1.1 W.u. The retardation of this strength is obvious when it is compared to a one-particle-one-hole (1p-1h) random-phase-approximation (RPA) prediction which yields[4] about 700 $\mu_K{}^2\cdot\text{fm}^2$ or 9.2 W.u. between $E_x \approx 12$ and 17 MeV (see Fig. 1). This observed quenching puts some constraints on the short-range behavior of the effective nuclear force.[5,6]

The results in ^{28}Si—excitation energy of $J^{\pi}=2^-$ states (although there is no distinction possible between $K=0$ and $K\neq 0$ levels) and $M2$ strengths—do not correspond to the predicted pattern based on the proposed nonstatic spin-isospin ordered phase in the nucleus.

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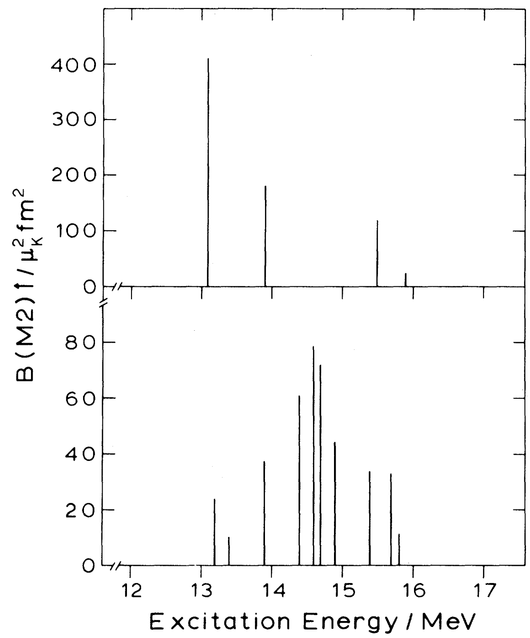

FIG. 1. Experimental $M2$ strength distribution in ^{28}Si (lower part)—the $M2$ giant resonance—and a 1p-1h RPA prediction (upper part).

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[3] Dr. Palumbo has informed us after completion of this manuscript that the transition strength given in Ref. 1 in W.u. should be divided by a factor of 5.

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