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SECTION 3 — NUCLEAR STRUCTURE

3.1. Solving the many-body problem with linear programing

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3.2. Quadrupole moments of the even-even vibrational nuclei

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Recent measurements of the quadrupole moments in the even-even vibrational nuclei have provided a good test for different nuclear models. The purpose of the present report is to extract the main effects responsible for the existence of the quadrupole moment and to compare the mechanisms provided by different types of approach.

In analogy with the polarization effect observed in the odd-proton nuclei, such as Sb, In, etc., where the large ground-state quadrupole moment was explained by coupling one particle to the harmonic vibrator

$$Q(j) = Q_{s.p.}(j)\left[e^{p}_{\text{eff}} + \frac{5}{4\pi} Ze \frac{\langle k\rangle}{C}\right],$$

one expects a similar process for two or more particles coupled to the vibrator[1,2,3]. However, in going from the one- to the two-particle case, a qualitatively new feature, i. e., the short-range residual force between the two particles, is encountered.

The quadrupole moment of a two-particle 2^+ state is given as

$$eQ(2_1^+) = Q[(j)^2 2]\cdot\left[e^{p}_{\text{eff}} + \frac{5}{4\pi} Ze \frac{\langle k\rangle}{C}\right], \tag{1}$$

exhibiting the same polarization effect as in the one-particle case. However, in a vibration nucleus the 2_1^+ state is of the one-phonon rather than of the two-particle type due to the large energy gap Δ separating the paired from the broken pair states. In this case both the zeroth and first order contributions vanish. The lowest nonzero particle and vibrational contributions are of second and third order, giving the result

$$eQ(2_1^+) = Q_{s.p.}[(j)^2 2]\left[e^{p}_{\text{eff}} + \frac{5}{4\pi} Ze \frac{\langle k\rangle}{C}\right]\cdot x^2(j),$$