In the more realistic calculations considered below, we will find that, for strongly deformed configurations in heavy nuclei (superdeformation), the spin will always be much smaller than I_{max}. Therefore, we might expect that $\mathscr{J}^{(2)}$ (as well as $\mathscr{J}^{(1)}$) stays close to $\mathscr{J}_{rig}$ for all spins of physical interest. On the other hand, configurations having a smaller deformation at $I = 0$ might very well reach I_{max} at observable spins (band termination). Then, however, the special shell structure caused by the grouping in the j-shells at $\varepsilon = 0$ might strongly influence the energies and the pure oscillator can only be used to indicate the general trends.

Besides publications quoted previously in this section, one could mention the papers by Zelevinskii (1975) and by Glas, Mosel and Zint (1978), where additional aspects of the rotating harmonic oscillator are considered.

12.3 The rotating liquid-drop model

We will now for a moment ignore the quantal effects and consider the rotation of a nucleus according to the laws of classical mechanics. In such a macroscopic model, the energy is given by

$$E_{\text{macr}}(E, N, \text{def}, I) = E(Z, N, \text{def}) + \frac{\hbar^2 I^2}{2\mathscr{J}(Z, N, \text{def})}$$

The energy $E(Z, N,\text{def})$ is taken as the static liquid-drop energy, which was treated in chapter 4. The variable 'def' denotes a number of deformation parameters, e.g. $\varepsilon, \gamma, \varepsilon_4 \ldots$. For stable nuclei the liquid drop energy has a minimum for spherical shape. This minimum is caused by the surface energy, which overcomes the deforming tendencies of the Coulomb energy.

In our discussion of the harmonic oscillator, we found that the dynamical moment of inertia was essentially equal to the rigid body value. In the case of independent nucleon motion, this is what is generally expected also for potentials other than the harmonic oscillator. The fact that the experimentally observed moment of inertia is smaller than $\mathscr{J}_{rig}$ for low I can be traced back to the pairing correlations. At higher spins, however, these correlations should disappear. As the rotating liquid-drop model is relevant only at relatively high spins, we will use the rigid body moment of inertia in connection with this model.

The rotational energy becomes smaller with increasing $\mathscr{J}$. Thus, with the rigid body value, configurations with the nucleons far away from the rotation axis are favoured. This means that the rotational energy tries to deform the nucleus and this tendency will become dominating for a large enough value of the angular momentum I.