CHAPTER IV

CONCLUDING REMARKS

In this dissertation our main preoccupation has been the study of effective nucleon-nucleon forces in nuclei. The conceptual framework of the shell model supplemented by the work of Brueckner and colleagues has been delineated. We have pointed out that there is unsatisfactory and insufficient knowledge of the effective forces within this framework. It is very necessary, not only for pure shell model calculations of nuclear spectra, but also for a detailed understanding of the origin of "collective motions" within the framework of the shell model, that a reasonably reliable model effective interaction be available.

In chapter II, we have described a simple method by which the nuclear spectra can be calculated in terms of effective interactions in various states of relative orbital angular momentum. This technique we believe is more flexible and gives results of more general interest than the usual method of expanding the effective interaction in multipoles. We have then applied this method to learn something about the nature of the effective interaction which will give rise to some simple observed nuclear spectra, viz. energy levels of (closed shell + two nucleons) $T = 1$ states. Unfortunately even in these simple nuclei, not enough experimental information is available to provide any clear cut answers. In particular, the knowledge of odd-state forces obtained is not satisfactory. However, the calculations reveal the limitations of experimental data and serve to point up the data required for complete satisfactory analysis. For example, the observation of $J = 3^+$ state in O^{18} and the spins and parities of the three states between 2.0 and 3.5 MeV excitation in O^{19} would help to determine the effective forces in these nuclei. The results presented here will be refined when such additional data becomes available. We believe that with availability of additional data, this method of analysis will enable us to study questions such as presence of non-central forces, or non-locality of forces etc. For example, the eight matrix elements involved in analysis of O^{18} and O^{19} (see equation (4.1) chapter III) can be further analysed in terms of the Talmi integrals $I_{n\ell} = \langle n\ell | V_{12} | n\ell \rangle$, once they are empirically determined as in section 4 of chapter III. It is easy to see that only seven Talmi integrals are involved, viz. I_{0s}, I_{1s}, I_{2s}, I_{0d}, I_{1d}, I_{0p} and I_{1p}.† Thus a determination of these will immediately tell us if the forces in the $\ell = 0$ and $\ell = 2$ states are the same or otherwise! We do not carry out this detailed analysis at present since the empirical information is not yet quite clear cut, as mentioned in the previous chapters.

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† With our restriction that contribution of f- and g-states ($\ell = 3, 4$) to interaction energies can be neglected.

It will also be desirable and instructive to extend the analysis to T = 0 states in odd-odd nuclei such as F^{18} when enough states are known in these. For example in F^{18}, the T = 0 states would be $(d_{5/2})^2$ J = 1, 3, 5, $(s_{1/2})^2$ J = 1, $(s_{1/2}d_{5/2})$ J = 2, 3. Experimentally, the two J = 1 states, one J = 3, and the J = 5 state are now located; if one or two additional states are determined, we can apply the above method of analysis to this nucleus also.

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