CHAPTER VI

CONCLUSIONS

In this thesis it has been our aim to study spectroscopic properties of nuclei with Skyrme-type interactions in the projected Hartree-Fock (HF) formalism. Because of the inherent difficulties associated with the three-body contact force, we have proposed a modification of the Skyrme interaction by replacing the three-body force by a two-body "scalar band averaged" density dependent interaction in order to be able to calculate the spectroscopic properties of nuclei.

We have performed deformed HF calculations for some light nuclei in 1p and 2s-1d shells employing a large configuration space of first four major shells. The core-polarization effects are thus automatically taken care of and uncertainties due to the renormalization of the effective interaction avoided. We showed that when centre-of-mass motion (c.m.m.) is incorporated in HF calculations, the Koopman's theorem no longer holds. We derived the expression for single particle separation energy incorporating the c.m.m. and showed that the HF intrinsic solution is independent of the form of Hamiltonian used. We showed that the Koopman's theorem does

not hold also when the density dependent forces are used. This follows for any Hamiltonian which depends explicitly on the number of nucleons in the nucleus.

Projection calculations for the ground state band for the nuclei ^{8}Be, ^{12}C and ^{20}Ne with the modified Skyrme interaction BASIV (defined in chapter IV) give spread out spectra and yield very good agreement with the experimental spectra as compared with the interaction SV, a Skyrme variant with no density dependence. We showed that the overall nature of the spectrum is decided by the s-state attractive and s-state repulsive parts of the Skyrme interaction. The effect of density term is only indirect since this term and the p-state repulsive term govern the strength of the s-state repulsive term.

We performed projected HF calculations for the nuclei ^{8}Li, ^{8}Be and ^{8}B with Sussex and SV interactions. For ^{8}Li and ^{8}B, band mixing calculations were performed. Sussex interaction, although gives underbinding and small radii, reproduces spectroscopic properties of these nuclei quite well. The results obtained with SV for these nuclei may be improved by using a density dependent Skyrme interaction. We also showed that the two-body spin-orbit interaction is crucial in explaining the structure of ^{12}C and is quite important in this region.

In the following we shall enumerate a few suggestions for the extension and further investigation of the present work.

In view of the encouraging results obtained with the band averaged density dependent Skyrme interaction BASIV, it would be interesting to extend the present calculations to other nuclei in 1p and 2s-1d shells and also to heavier nuclei with the same interaction. To get the excited bands, it would be necessary to perform band-mixing calculations. If the scalar densities of various bands to be mixed are not very different, these calculations could be carried out.

The introduction of density dependence spreads out the energy spectra for the nuclei ^{8}Be, ^{12}C and ^{20}Ne providing excellent agreement with the experimental spectra. This effect may be extremely important for high angular momentum states. However, instead of using band-averaging, it might be necessary to use the scalar density of the particular level to be calculated in order to investigate "back-bending" effects in the rotational spectra. It might also be necessary to incorporate pairing correlations.