sition density of the monopole
ained model implies a different
licable anymore. Moreover, a
sed and the volume coefficient
, in practice it is not wise to
adly converges for real nuclei

model under consideration is
tree-Fock or Dirac-Brueckner
tion of these models to finite
rtunity to examine monopole
he thus obtained compressibi-
corresponding nuclear matter
the high precision demanded
ming calculations.

---

# Chapter 5

# Summary

The main concern of this work has been the relativistic description of finite nuclei taking advantage of the microscopic Dirac–Brueckner model which has proven to be very successful in nuclear matter. In finite nuclei translational invariance doesn't hold and as a consequence, the nuclear wavefunctions can no longer considered to be plane waves. Full Dirac–Brueckner calculations for nuclei thus become impracticable. We have therefore taken an alternative approach. The nuclear matter G-matrix elements resulting from a Dirac–Brueckner approach of nuclear matter are fitted to a simple effective one boson exchange potential which is used in the Hartree–Fock approximation. Introduction of an explicit density dependence in the coupling constants, viz. linear in $k_F$, yields a good reproduction of the G-matrix elements and, even more important, produces a good saturation curve for densities less than 1.5 times normal nuclear density. Illustrative for the quality of the parametrization is the fact that both the saturation point and the compressibility of nuclear matter are reproduced quite accurately.

Relativistic Hartree–Fock theory for finite nuclei subsequently serves as a basis for application of the parametrized Dirac–Brueckner interaction in order to obtain nuclear ground state properties (effective Dirac–Brueckner–Hartree–Fock (DBHF) approach). Conventional relativistic mean field and relativistic Hartree–Fock calculations provide a check on our numerical procedure and are furthermore used to study various presumably doubly magic nuclei, viz. $^{114}$Sn, $^{146}$Gd and the superheavy nucleus $^{298}114$.

The effective DBHF model is found to be an improvement over non-relativistic Brueckner–Hartree–Fock calculations. This becomes particularly clear by the observation of the 'Coester' lines for $^{16}$O and $^{40}$Ca in both approaches. The DBHF approach turns out to be a clear favourite. This encouraging result is strengthened by the good of both approaches can be provided by a study of the transition density of the monopole resonance in $^{208}$Pb [115]. A decision in favour of the constrained model implies a different view on the leptodermous expansion. Eq.(4.18) is not applicable anymore. Moreover, a different expression for the Coulomb coefficient is to be used and the volume coefficient does not equal the bulk compressibility [111]. However, in practice it is not wise to implement these changes as the leptodermous expansion badly converges for real nuclei in the constrained approach.

It is well known that the equation of state in the $\sigma$-$\omega$ model under consideration is too stiff. More realistic potentials like the relativistic Hartree-Fock or Dirac-Brueckner potential [26, 20] definitely yield a softer EOS. Application of these models to finite nuclei as discussed in the previous chapter offers the opportunity to examine monopole resonances in these approaches as well. Extrapolation of the thus obtained compressibilities is expected to result in the bulk compressibility of the corresponding nuclear matter calculations. This project has not yet been carried out due to the high precision demanded of these models, making them to uncommonly time-consuming calculations.