Abstract

High energy phase-shifts and half shell reaction matrices are studied with the Paris nucleon-nucleon potential. Nuclear matter calculations are done with this potential as well as with the Reid soft core (RSC) potential for the continuous choice of single particle spectrum. A comparison with the gap choice at $k_F = 1.36 \text{ fm}^{-1}$ is also made. We obtain a gain of about 7 MeV in the binding energy per particle of nuclear matter for the continuous choice with the Paris potential. Saturation properties are also studied. For the Paris potential, the saturation occurs at $k_F = 1.55 \text{ fm}^{-1}$ corresponding to a binding energy per particle of about $-21$ MeV. Single particle energies for the continuous choice are calculated self-consistently and are parametrised as a function of total energy and density. Nuclear matter properties are also studied including the isobar degrees of freedom explicitly. The calculation is done for the continuous choice through the coupled channel formalism with the Green Niskanen Sainio transition potential. The isobar self-energy is also calculated self-consistently for both the Paris and the RSC potential. The inclusion of $\Delta$ - isobar shifts the saturation point towards the empirical value. The saturation is found at $1.49 \text{ fm}^{-1}$ corresponding to a binding energy of about $-19.3$ MeV per particle for the Paris potential when the isobar is included. The wound integral, correlation function and defect function are also studied with and without the inclusion of isobar degrees of freedom.