

ABSTRACT

This thesis deals mainly with the study of fusion reaction cross-section of some light and intermediate-mass nuclei and the equation of state of nuclear matter as well as of neutron matter. Also the statistical properties of nuclear matter have been considered.

First a theoretical investigation of fusion reaction cross-sections have been performed for many light and intermediate-mass nuclei. To do this investigation we have used three types of potentials i.e. M3Y, DDM3Y and W-S interactions. Different approximation methods have been taken into account in the calculation of fusion reaction cross-section. The analytical expressions for calculating the real part of the potential between two ions have been introduced into a computer programme, which gives the required calculations with high accuracies.

Secondly we have developed Thomas-Fermi model to calculate different thermal properties of nuclear and neutron matter at zero temperature. We extended this calculations to finite temperature using Fermi integrals in its exact form and an expanded form up to T^2 -approximation. To calculate these properties we have used the density dependent modified three Yukawa (DDM3Y) interaction, which is commonly used into collision processes, and we obtained its new parameters suitable for asymmetric nuclear matter. Such parameters are adjusted to reproduce the binding energies, densities and symmetry energies of nuclear matter. Then we used these parameters to obtain

other properties of nuclear and neutron matter. We show also the effect of the neutron excess parameter on nuclear matter.

We applied the effective n-n interaction of DDM3Y to derive an expression for pressure of nuclear matter as a function of the specified density and temperature up to T^4 - approximation. We expanded this expression around the critical density and temperature (ρ_c and T_c) to obtain the critical exponent of nuclear matter near the critical point of the phase transition. The density fluctuations are evaluated by expanding the Gibbs free energy near the critical point. The statistical weight of nuclear system is used to investigate the statistical properties of the system.

We used the derived stiff equation of state of neutron matter to analyse the neutron star structure (mass and radius). We find that the maximum mass and maximum radius derived from our equation of state are in a reasonable agreement with that derived from x-ray pulsar. The effect of temperature on mass and radius is very small and can be neglected.

Generally good results have been obtained especially for nuclear matter and its application.

Concerning fusion we find that the results obtained with M3Y and W-S interactions are better than those with the original DDM3Y interaction, but this interaction, after readjusting its parameters to fit the nuclear matter properties, give better result for fusion C.S. calculations.