1 - 1 Progress of Theoretical Nuclear Research in 2014 at IMP

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In 2014, the researchers of Theoretical Physics Group at IMP have carried out their research work on nuclear physics, heavy ion physics and hadron physics. Some important results have been obtained.

The three-body force (TBF) effect on the off-shell behavior of the neutron and proton mass operators in asymmetric nuclear matter has been investigated within the framework of the extended Brueckner-Hartree-Fock approach[1]. At high densities well above the normal nuclear matter density, the TBF is shown to affect significantly the off-shell behavior of both the proton and neutron mass operators. The density dependence of symmetry energy around the nuclear saturation density has been studied[2]. A new approach has been proposed and applied to determine the symmetry energy coefficient of heavy nuclei based on the available experimental nuclear masses of heavy nuclei. The obtained result is adopted to analyze the density dependence of symmetry energy of nuclear matter around the saturation density. The slope parameter at the saturation density is determined to be $L = (50.5\pm15.5)$ MeV.

The effect of nuclear symmetry energy at high densities on the isospin-fractionation in heavy ion collisions (HIC) has been investigated within two different frameworks of isospin-dependent transport model[3], *i.e.*, the BUU and QMD models. It is shown that the normal or abnormal isospin-fractionation of energetic nucleons can serve as qualitatively a model-independent probe to the high-density behavior of symmetry energy. In order to reduce the isospin effect of the in-medium nucleon-nucleon (NN) elastic scattering cross sections, we have studied the double ratio of π^-/π^+ from neutron-rich and neutron-poor reaction systems with the same mass number[4]. It is found that the isospin effect of the in-medium NN elastic cross sections can be almost completely cancelled out by adopting the double of π^-/π^+ ratio from the two reaction systems of ^{132}Sn+^{124}Sn and ^{128}Pm+^{128}Pm, whereas the effect of symmetry energy is largely kept.

Strangeness production in proton induced reactions at beam energies close to the thresholds has been investigated within the Lanzhou quantum molecular dynamics (LQMD) model[5]. It is shown that the experimental data from KaoS collaboration can be well reproduced by including a weakly repulsive kaon-nucleon potential of the order of 28 MeV and a deeply attractive antikaon-nucleon potential of -100 MeV. The LQMD model has been improved to understand the reaction dynamics induced by antiprotons[6]. Particle production in antiproton induced reactions has been investigated by using the improved model and some valuable results has been obtained.

In hadron physics, the $\mathrm{B\bar{B}^*}$ and $\mathrm{D\bar{D}^*}$ systems are studied[7] in a Bethe-Salpter equation approach with quasipotential approximation by adopting the covariant spectator theory. It is shown that in the isovector sector, no bound state is produced from the interactions of the $\mathrm{B\bar{B}^*}$ and $\mathrm{D\bar{D}^*}$, which suggests the molecular state explanations for $\mathrm{Z_b}(10610)$ and $\mathrm{Z_c}(3900)$ are excluded. The new experimental data of the $\Lambda(1520)$ and $\Sigma(1385)$ photoproductions off a proton target released by the CLAS Collaboration at JLab recently have been analyzed[8]. Based on the analysis, the internal structure of the nucleon resonance around 2 GeV was studied. The meson loop effects on the decay properties of $\Upsilon(5S)$ have been investigated[9]within the framework of an effective Lagrangian approach based on heavy quark limit and chiral symmetry. The decay widths of $\Upsilon(5S) \to \omega\chi_{bJ}$ are calculated and the results are shown to be in good agreement with the recent experimental measurements from Belle Collaboration.

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