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Non-zero chiral and isospin imbalance in QCD phase diagram: dualities in effective models and lattice QCD

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in this talk there will be discussed the phase structure of the dense quark matter with isospin and chiral imbalances has been investigated in the framework of effective models and lattice QCD. It has been shown that in the large-N_c limit (N_c is the number of colours of quarks) there exist duality correspondences, which are the symmetries of the thermodynamic potential and the phase structure itself. The first one is a duality between the chiral symmetry breaking (CSB) and the charged pion condensation (PC) phenomena. The dualities were shown to exist in the matter with chiral imbalance that can be produced in compact stars or heavy ion collisions. One of the key conclusions of these studies is the fact that chiral imbalance generates charged PC in dense baryonic/quark matter even in the case of charge neutral matter, which is interesting in the context of neutron stars. It was also shown that the duality can be observed in lattice QCD. Moreover, they were used for prediction of catalysis of chiral symmetry breaking by chiral imbalance. It is known that chiral imbalance can occur due to temperature and sphaleron transitions. Our studies show that chiral imbalance can occur in the cores of neutron stars or in heavy ion collisions at NICA, FAIR, where large baryon densities can be reached, due to other phenomena the so-called chiral separation and chiral vortical effects. Even if the phase diagram contains phases with inhomogeneous condensates, it still possesses the duality. Just by the duality we obtained, in the inhomogeneous case, without any calculations, a full phase diagram of chirally asymmetric dense quark matter. This shows that the duality is an instrument of high predictivity power. The obtained phase diagram is quite rich and contains various spatially inhomogeneous phases.

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