Contribution ID: **19** Type: **Oral talk**

Phase transitions in a system of self-interacting particle-antiparticle

Wednesday, 21 December 2022 17:20 (20 minutes)

The thermodynamic properties of a particles and antiparticles boson system with a strong interaction at finite temperatures are studied within the framework of the thermodynamically consistent Skyrme-like mean-field model. The mean field contains both attractive and repulsive terms. Isospin density is conserved for all temperatures. Self-consistency relations between the mean field and thermodynamic functions are derived. It is shown that, when attractive mean field is lesser than the critical value A_c, only one component undergoes the phase transition of second order to the Bose-Einstein condensate at the critical temperature T_c. For sufficiently strong attractive interactions when $A > A_c$ the meson system develops a 1st order phase transition at temperature T_{cd} via forming a Bose condensate and releasing the latent heat. In this case both components develop Bose-Einstein condensate which is characterized by a constant total density of particles. At the point where a curve of particle density touches a critical curve ($A = A_c$), there exists a point-like or virtual phase transition of the 2nd order, i.e., a phase transition without setting the order parameter.

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Session Classification: Afternoon session

Track Classification: Physics of Nuclei and Elementary Particles