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Cancellation of the sigma mode in the thermal pion gas by quark Pauli blocking

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We calculate the pressure of the interacting pion gas using the Beth-Uhlenbeck approach to the relativistic virial expansion with Breit-Wigner phase shifts for the sigma - and pi- meson resonances. The repulsive phase shift delta_20 is taken from quark interchange model of Barnes and Swanson [Phys. Rev. D 46 (1992) 131] in very good agreement with experimental data. In this work we show that the cancellation of the attractive (I = 0) and repulsive (I = 2) isospin channel contributions to the scalar pi-pi interaction in the low-energy region that is known for the vacuum phase shifts, takes place also at finite temperature. This happens despite the strong medium dependence of these phase shifts that enters our model by the temperature dependence of the sigma- meson and constituent quark masses because for these masses the relation m_sigma (T) = 2m_q(T) holds and the scattering length approximation is valid as long as the strong decay channel sigma -> pi pi is open. Exploiting the Nambu –Jona - Lasinio model for describing the dynamical breaking of chiral symmetry in the vacuum and its restoration at finite temperature, we justify with our approach that the -meson should be absent from the hadron resonance gas description at low temperatures because the above cancellation holds. However, since this cancellation breaks down in the vicinity of the hadronization transition, where due to chiral symmetry restoration the decay channel sigma -> pi pi closes and the sigma - meson becomes a good resonance, the latter should be included into the statistical model description of chemical freeze-out in heavy-ion collisions.

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