Quark Matter 2015 - XXV International Conference on Ultrarelativistic Nucleus-Nucleus Collisions

QUARK MATTER 2015
Sep. 27 – Oct. 3, 2015 Kobe, Japan

Contribution ID: **624** Type: **Poster**

Fate of meson states and broken symmetries at high temperature

Tuesday, 29 September 2015 16:30 (2 hours)

Thermal fluctuations cause modifications of meson bound states as well as restoration of broken chiral and $U_A(1)$ symmetries. The former (latter) plays an important role in the analysis of sequential melting patterns of open-flavor mesons (the nature of phase transition in QCD) in hot and dense matter created in relativistic heavy-ion collisions.

We present recent results on lattice QCD calculations of meson correlations which express in-medium modifications of mesonic excitations containing up/down, strange and charmed quarks. Thermal effects are clearly visible in the spatial correlations which, unlike the temporal correlations, can be calculated at separations larger than the inverse of temperature. This makes them more sensitive to thermal modifications of hadrons. Moreover the spatial correlations provide a direct signal for the thermal modification of spectral functions which carry all the information about in-medium properties of mesons and their dissolution.

As a consequence of lattice QCD simulations using Highly Improved Staggered Quarks with physical strange quark mass and (nearly) physical up/down quark masses, we find that light-unflavored, open-strange and open-charm mesons in the pseudo-scalar (π, K and D) and vector (ρ, K^* and D^*) channels show significant modifications even below the critical temperature (T_c). The modification pattern of these mesons is very similar below T_c, whereas a clear flavor dependence appears above T_c where lighter mesons suffer larger modifications. The strange meson (ϕ) and strange-charmed mesons (D_s and D_s^*) show slight modification already at T_c, while the charmonium states (η_c and J/ψ) feel thermal effects only at $T > 1.2T_c$. This confirms that 1S charmonium states can survive beyond T_c. From degeneracies of parity partner it is also found that at T_c the chiral symmetry is restored, whereas the breaking of the $U_A(1)$ symmetry is significant.

On behalf of collaboration:

NONE

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Session Classification: Poster Session

Track Classification: Open Heavy Flavors and Strangeness