Restoration of a lost symmetry - weight loss in 10^{-22} sec

A particle called η' meson is found to reduce its mass in less than 10^{-22} second in high energy heavy ion collisions at RHIC. Apparently this is the fastest weight reduction ever observed. This indicates the restoration of a lost symmetry of strong interactions in a hot and dense, hadronic matter.

The η and the η' mesons are similar to a pair of identical twins - their quark content is identical. Under usual circumstances, however, the η'(958) is nearly twice as heavy as its partner, the η(548) meson. High energy heavy ion collisions at Brookhaven National Laboratory's RHIC accelerator generate a hot soup of quark gluon plasma (sQGP) which rehadronizes at temperatures of about 2 Terakelvin, and produces mesons like η and η' in a fleetingly short time of about 10^{-22} sec.

Now, in a publication appearing in the Physical Review Letters, T. Csörgő (visiting research scholar at Harvard University from MTA KFKI RMKI, Budapest, Hungary) in collaboration with R. Vértesi and J. Sziklai (both from MTA KFKI RMKI, Budapest, Hungary) report on an indirect observation of a significant, at least 200 MeV mass reduction of the η' mesons in the hot and dense, hadronic medium. Such a medium is formed after the quarks and gluons of sQGP are reconfined into mesons and baryons in a process called hadronization. As long as the η' dwells in such a hot and dense, hadronic medium, the huge mass difference of 410 MeV between the η and the η' mesons disappears within the errors of the analysis, which is based on a combined dataset of the STAR and PHENIX Collaborations. This is just like what might happen in the blink of an eye if the overweight partner of a set of identical twins suddenly lost its extra weight and became the pre-calculated, ideal weight and shape of the slimmer twin.

Such a mass reduction might indicate a restoration of an important symmetry of strong interactions, the so-called $U_A(1)$ symmetry, and the return of a previously lost, „prodigal" Goldston boson, the in-medium modified η'. The results of Csörgő, Vértesi and Sziklai indicate that this $U_A(1)$ symmetry is apparently restored in a hot and dense, hadronic matter. This symmetry restoration happens at temperatures that are below the temperature range of sQGP formation, in agreement with earlier numerical calculations based on discretized (lattice) quantum chromodynamics.

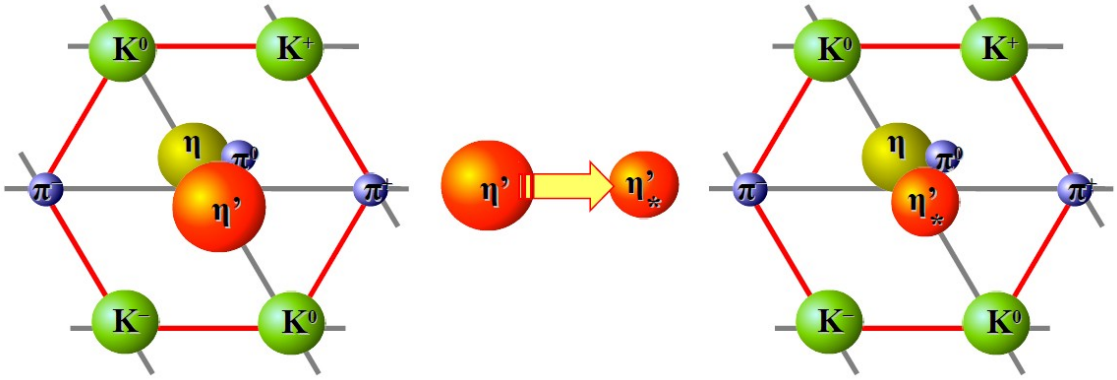

Fig. 1: This illustration indicates the 9 pseudoscalar mesons formed by u, d and s quarks. Sizes of the pellets are proportional to particle masses. Left panel indicates the usual situation, corresponding to masses measured in elementary particle induced reactions (Particle Data Group values). The medium plot indicates a mass reduction of the η' mesons in hot and dense hadronic matter, created in sqrt(s_{NN}) = 200 GeV Au+Au collisions at the Relativistic Heavy Ion Collider, Brookhaven National Laboratory, USA. The right panel indicates the restoration of a symmetry between the η and the η' mesons in hot and dense hadronic matter.