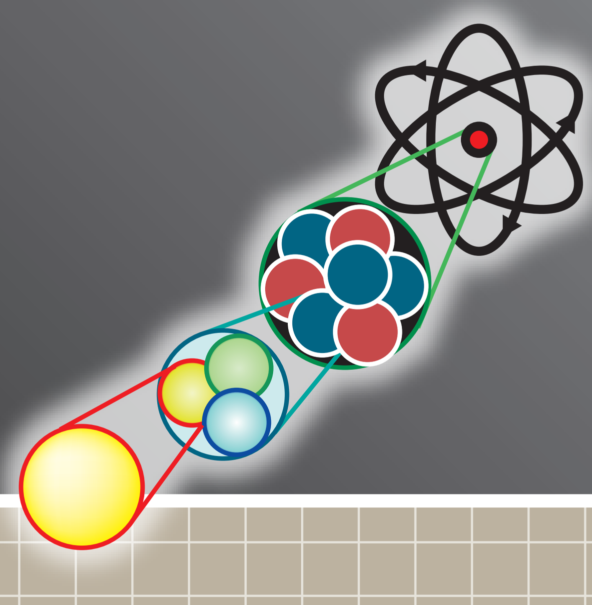
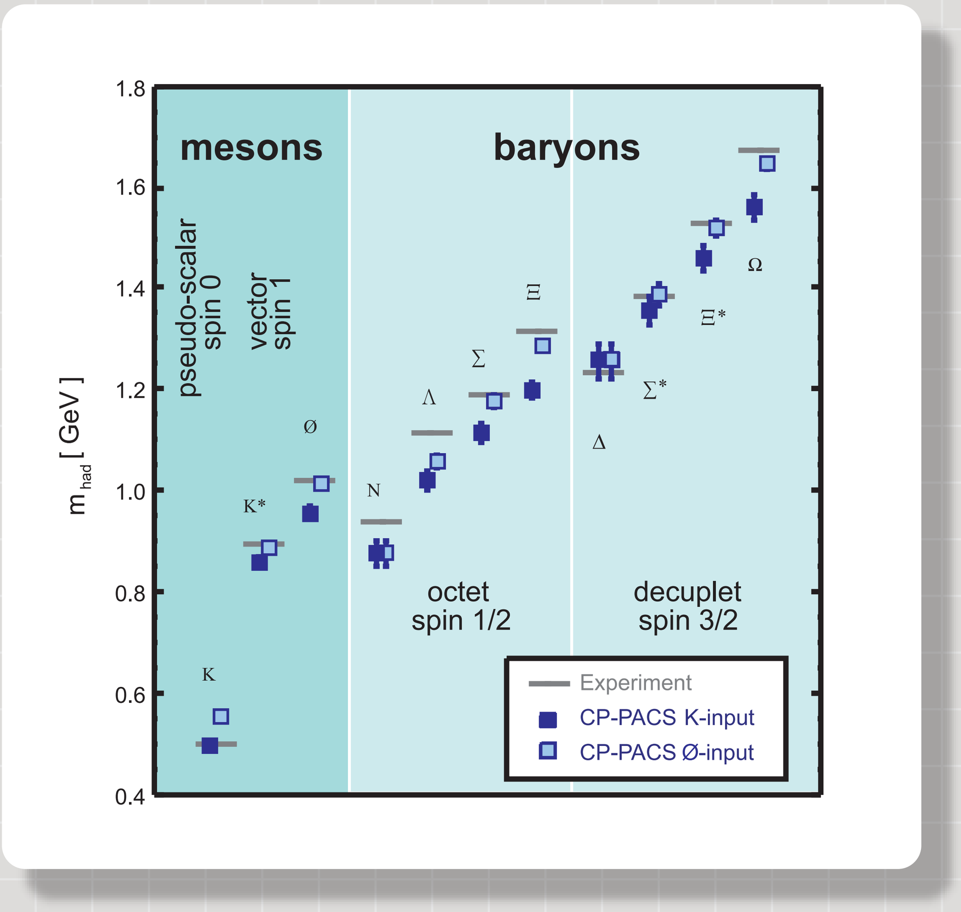
Research in Particle Physics (1)



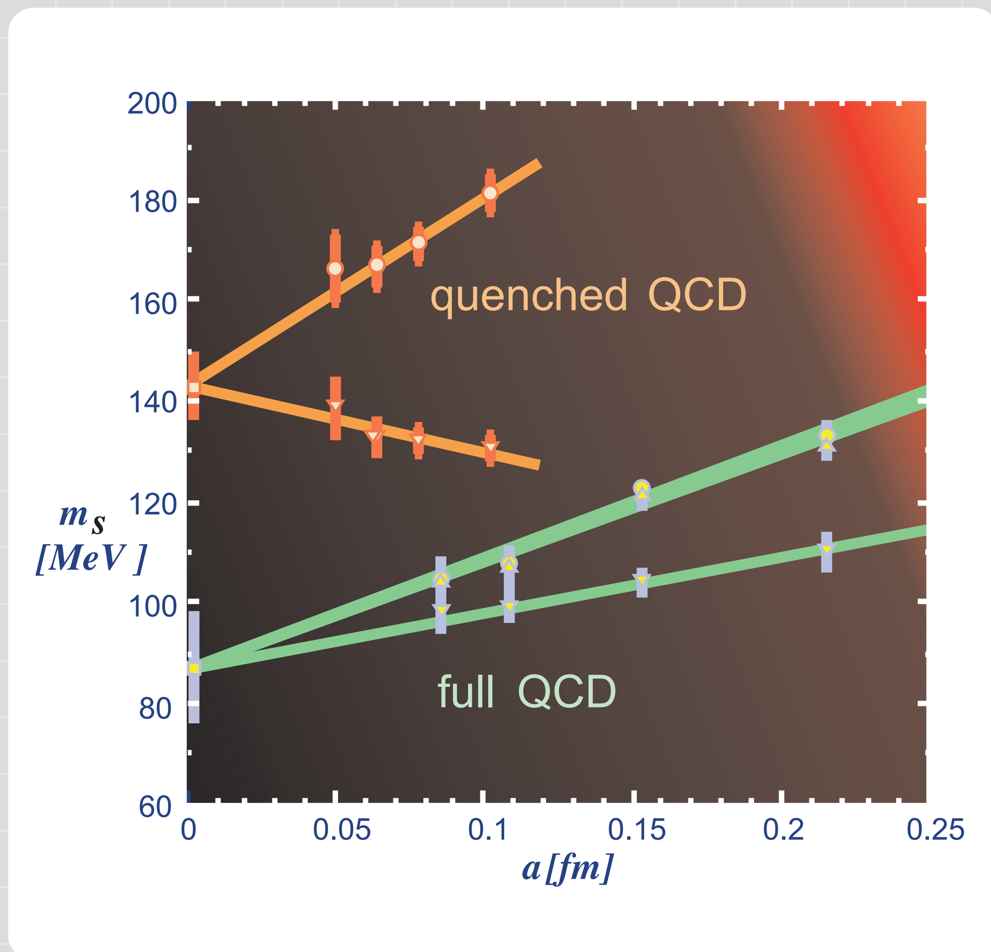
Prediction of hadron spectrum from QCD



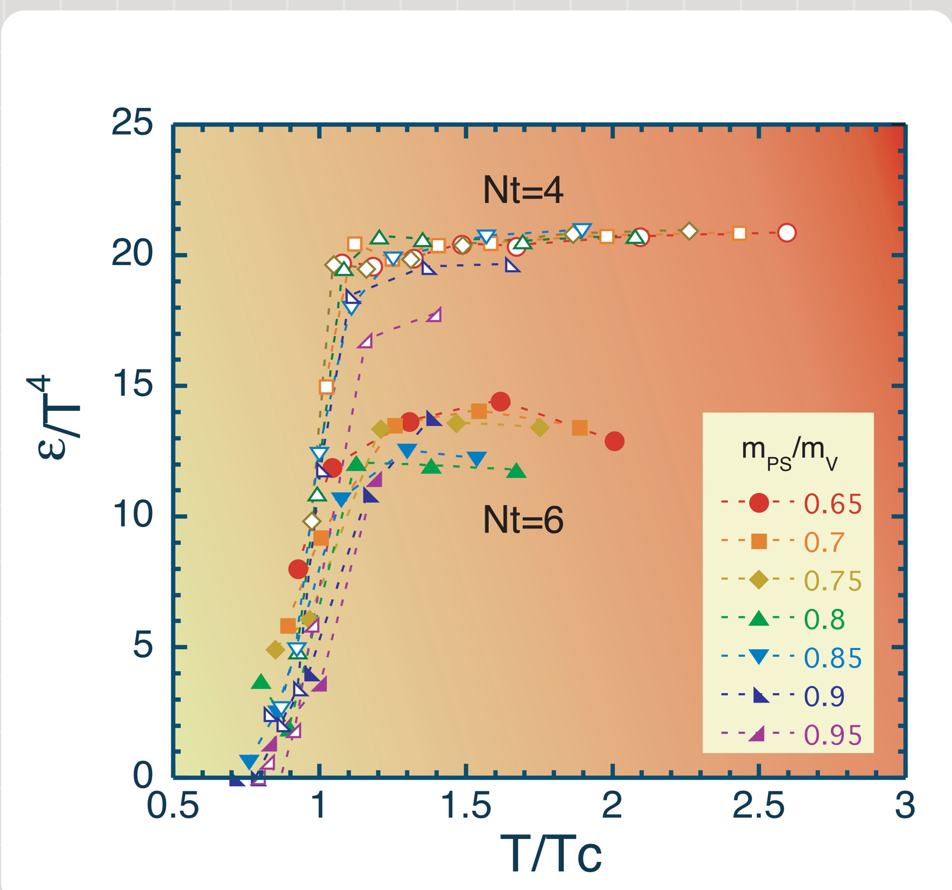
Hadrons are the constituents of atomic nuclei. The computation of their mass spectrum from the quantum chromodynamics(QCD), the fundamental theory of quarks and gluons, has been a principal subject in particle physics. In this figure, our results are compared with experiment. Experimental results are reproduced within about 5-10%, critically proving the validity of QCD. At the same time, with the precision first acheved by the CP-PACS, a limitation of the widely accepted "quenched" approximation, in which dynamical quarks are neglected, was made clear, answering a question since 1981 about the effects of quenching.

Determination of fundamental parameters of the nature

Because quarks are confined within hadrons, their fundamental properties such as masses have to be theoretically calculated from QCD. This figure shows the "s" quark mass determined using different methods in quenched QCD and two-flavor full QCD in which the dynamical effects of the light u, d quarks are incorporated. The final value is obtained after an extrapolation to the limit of vanishing lattice spacing a, and is independent of the methods as expected. On the other hand, the full QCD result is much lower than the quenched value, indicating the importance of dynamical quarks.



Equation of state for Quark-Gluon Plasma



At extremely high temperatures and densities, quarks are expected to be liberated from their confinement, to form a new state of matter, quark-gluon plasma (QGP). Clarification of the nature of QGP is important for understanding nucleosynthesis in the early universe and for detecting QGP through heavy ion collision experiments. This figure shows the temperature dependence of the energy density. Results for N_t (lattice size in the temperature direction) of 6 are believed to be close to the values in the continuum limit.