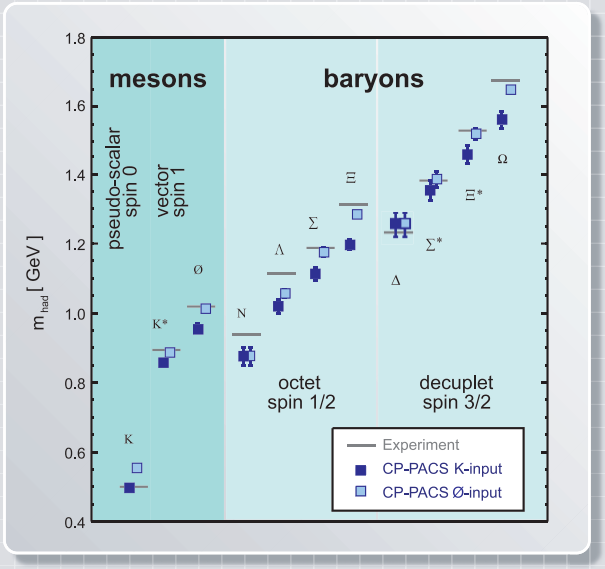
Research in Particle Physics

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 to within about 5–10%, critically proving the validity of QCD.
With the precision first achieved by the CP-PACS, a limitation of the widely adopted "quenched" approximation was made clear, answering a long-standing question since 1981 about the effects of quenching.

Determination of fundamental parameters of the nature

Because quarks are confined in hadrons, their fundamental properties such as masses have to be theoretically calculated from QCD. This figure shows the strange quark mass determined using different methods, with and without the quenched approximation. The final results in the limit of vanishing lattice spacing *a* are independent of the methods as expected, but shows a discrepancy between quenched and full QCD, demonstrating the importance of dynamical quarks. Other fundamental parameters such as the CP violation parameter in weak interactions as well as thermodynamic properties of the quark-gluon-plasma are also determined.