HK 5 Theorie

Zeit: Montag 14:00–16:00 Raum: B

HK 5.1 Mo 14:00 B

Pion-photon exchange nucleon-nucleon potentials — •Norbert Kaiser — Physik-Dept. T39, TU Muenchen, 85747 Garching

We calculate in chiral perturbation theory the long-range isospin-violating NN-potential generated by pion-photon exchange. The leading order term and the dominant next-to-leading correction (proportional to the large isovector magnetic moment $\kappa_v = 4.7$ of the nucleon) turn out to be of similar size but opposite in sign. The corresponding spin-spin and tensor potentials $\widetilde{V}_{S,T}(r)$ in coordinate space have a simple analytical form. We consider also effects from virtual Δ-isobar excitation as well as other isospin-breaking contributions to the 2π-exchange NN-potential induced by additional one-photon exchange. The dominant two-loop $2\pi\gamma$-exchange potential proportional to the large isoscalar p-wave πN-coupling c_3 is also evaluated. Our analytical results are in form such that they can be easily implemented into phase-shift analyses and few-body calculations.

HK 5.2 Mo 14:15 B

Chiral extrapolations of lattice QCD results: perspectives and uncertainties — •Bernhard Musch, Massimiliano Procura, Thomas Hemmert, and Wolfram Weise — Institute for Theoretical Physics (T39), TU München, Germany

Lattice QCD calculations are so far performed with up- and down-quark masses typically more than 5 times as large as their physical values; nevertheless they provide valuable input for the determination of parameters of chiral effective field theory. The quark mass dependence of the nucleon mass [1] can be successfully matched to lattice data [2]. Finite volume corrections [2] increase the data base further. We explore the statistical uncertainty and the convergence of the perturbative series. The fit function turns out to be statistically well constrained.

We also fit the one-loop formulae [3] to pion and kaon mass data from MILC [4] and discuss the validity of the Gell-Mann - Oakes - Renner relation.

Supported in part by BMBF and DFG.

[1] M. Procura, T. Hemmert, W. Weise, Phys. Rev. D69 (2004) 034505
[2] A. Ali Khan et al., Nucl. Phys. B689 (2004) 175-194
[3] J. Gasser, H. Leutwyler, Nucl. Phys. B250 (1985) 465
[4] C. Aubin et al., Phys. Rev. D70 (2004) 094505

HK 5.3 Mo 14:30 B

Chiral dynamics of nuclear matter — •Monika Mühlbauer, Norbert Kaiser, and Wolfram Weise — Physik-Department, Technische Universität München, D-85747 Garching, Germany

In the framework of chiral perturbation theory, we investigate binding and saturation of nuclear matter through explicit two-pion exchange dynamics. Excitations of virtual $\Delta(1232)$-isobars and associated three-body forces are systematically taken into account. The high momentum components of the pion-loop integrals are regularized by a πNN-vertex function of monopole type. In adjusting the monopole mass (the single parameter) to $\Lambda = 1.18 GeV$, the empirical saturation point of nuclear matter can be well reproduced: $\rho_0 = 0.158 fm^{-3}$, $\bar{E}_0 = -16.8 MeV$. Variations of Λ can be compensated by two contact interactions contributing as k_f^3 and k_f^5 to the energy per particle. In the same framework, we study the equation of state of pure neutron matter, the density-dependent asymmetry energy and the single-particle potential (nuclear mean field).

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HK 5.4 Mo 14:45 B

Volume dependence of the chiral phase transition — •Bertram Klein[1], Jens Braun[2], Hans-Jürgen Pirner[2], and Amir H. Rezaeian[2] — [1]GSI, Planckstrasse 1, 64159 Darmstadt — [2]Institut für Theoretische Physik, Universität Heidelberg, Philosophenweg 19, 69120 Heidelberg

We investigate chiral symmetry restoration at finite temperature in a finite volume for the quark-meson model, using renormalization group methods. We determine the dependence of the transition temperature on the size of the spatial volume and on the value of the current-quark mass.

We find that the transition temperature is only weakly volume-dependent for large current-quark masses, but depends strongly on the volume for small current-quark masses and correspondingly for small pion masses. We also find a clear dependence on the choice of the quark boundary conditions for the spatial directions. We conclude from our model results that finite-volume effects should remain small for volume sizes of the order of 2 fm, if pion masses are about 300 MeV, but that they can become significantly larger if the pion mass is decreased to more realistic values.

HK 5.5 Mo 15:00 B

Utilizing covariant BChPT for chiral extrapolations — •Tobias A. Gail and Thomas R. Hemmert — Institut für theoretische Physik T39, Physik Department der TU-München

We discuss the use of covariant BChPT for chiral extrapolations. We explain the difference between $\overline{\rm MS}$ and IR [1] regularization and use a new variant of IR [2] to connect the ChEFT results both to dispersion theory and to nonrelativistic approaches like HBChPT.

We use all three methods to calculate the quark mass dependence of the nucleon mass and of the nucleon anomalous magnetic moment at order p^4 in covariant BChPT and apply our results to chiral extrapolations of lattice data [3],[4] for these quantities.

Work supported by BMBF and I3HP.

[1] T. Becher and H. Leutwyler, Eur.Phys.J C9:643 (1999).
[2] T. Gail and T. Hemmert, forthcoming.
[3] M. Göckeler et al. (QCDSF Collaboration), Phys.Rev. D71:034508 (2005).
[4] A. Ali Khan et al. (QCDSF-UKQCD Collaboration), Nucl.Phys. B689:175 (2004).

HK 5.6 Mo 15:15 B

Verbesserung des UV-Verhaltens in baryonischer chiraler Störungstheorie — •Dalibor Djukanovic, Matthias R. Schindler, Jambul Gegelia und Stefan Scherer — Institut für Kernphysik, Johannes Gutenberg-Universität, J. J. Becherweg 45, 55099 Mainz

Wir stellen eine neue Formulierung der baryonischen chiralen Störungstheorie (BChPT) vor, in der die Propagatoren durch zusätzliche Terme mit höheren Ableitungen modifiziert werden. Die so erhaltenen Propagatoren weisen ein verbessertes UV-Verhalten auf. Die Modifikation kann als Regularisierungsschema mit einem *smooth cutoff* interpretiert werden, wobei es alle Symmetrien erhält und damit die Ward-Identitäten erfüllt. Unsere Formulierung ist sowohl auf den Vakuum- und 1-Nukleon-Sektor als auch auf den Wenig-Nukleonen-Sektor anwendbar. So sind die Gleichungen (Bethe-Salpeter, Lippmann-Schwinger, usw.) für die Streuamplituden des Wenig-Nukleonen-Sektors frei von UV-Divergenzen. Ein Vorteil unserer Formulierung ist, dass der *cutoff* ein freier Parameter der allgemeinsten Lagrangedichte ist und somit nicht entfernt werden muss.

[1] Phys. Rev. D 72, 045002 (2005)

Gruppenbericht

HK 5.7 Mo 15:30 B

Relativistic nuclear energy density functional constrained by low-energy QCD — •Paolo Finelli[1], Norbert Kaiser[2], Dario Vretenar[3], and Wolfram Weise[2] — [1]Physics Department, University of Bologna and INFN — [2]Physics Department, Technical University of Muenchen — [3]Physics Department, University of Zagreb

A relativistic nuclear energy density functional is developed, guided by two important features that establish connections with chiral dynamics and the symmetry breaking pattern of low-energy QCD: a) strong scalar and vector fields related to in-medium changes of QCD vacuum condensates; b) the long- and intermediate-range interactions generated by one-and two-pion exchange, derived from in-medium chiral perturbation theory, with explicit inclusion of $\Delta(1232)$ excitations. Applications are presented for ground-state properties and collective excitations, in particular Gamow-Teller and IAS resonances.

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