since it can be removed in a special gauge resulting in a standard local expression for the canonical spin decomposition. The corresponding definitions for the spin operator are gauge equivalent and lead to the same matrix elements. Notice, that the notion of such defined gauge invariant spin operator with using a non-local operator function for the physical field is similar to the notion of the quantum effective action which is gauge invariant but has a different operator form depending on a chosen gauge.

As is known, there are two principal issues in the nucleon spin decomposition problem. The first one is how to separate contributions of nucleon constituents. Another one is related to the problem of observability in experiment. In QED the photon spin and orbital angular momentum are measurable quantities, and they correspond to the canonical decomposition. In QCD, since hadrons represent strongly bound states, other schemes of nucleon spin decomposition with dynamic quark momentum might be more relevant.

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1 - 24 Topology and (in)Stability of Non-Abelian Monopoles

Zhang Pengming, Horvathy Peter A.[1] and Rawnsleyc John[2]

In this work, we make the review that is devoted to the study of various aspects of "Brandt-Neri-Coleman" instability of monopoles. Our clue is to reduce the problem to pure Yang-Mills (YM) theory on the "sphere at infinity" with the residual group H as gauge group. Studying the Hessian we have proved the theorem announced by Goddard an Olive, and by Coleman, which says that each topological sector admits a unique stable monopole whereas all other solutions of the YM equations are unstable with an even Morse index (number of negative modes).

Turning to the global aspects, we show that to each such unstable monopole with Morse index $v=2n$ sits on the top of n energy-reducing two-sphere whose bottom is some lower-energy monopole.

An unstable monopole should decay by radiating away its energy. Describing such a process would require solving the time-dependent YM field equations with initial conditions close to a static solution. But this is beyond the reach of present technical knowledge. An approximate approach would be to argue first that, under suitable conditions, a monopole can be considered a classical object which preserves its identity during the process; then radiation could act as a sort of effective potential.

Intuitively, our monopole could "roll down" to some lower-lying critical point, from which it would continue to "roll" further down as a sort of "cascade" until it ends up at the stable lowest-lying state. It is tempting to figure that our energy-reducing spheres could provide us with possible decay routes for an unstable monopole. Realizing this picture in a physical framework is quite challenging an we have not been able to carry it out yet. All what we did so far has been to construct a sort "monopole landscape": no dynamics has been considered.

Would like to hint at an analogy, namely that with monopole scattering following Manton's ideas[1]. Remember first that the space of static self-dual monopoles of the Bogomolny Prasad Sommerfield type form a finite dimensional submanifold called the moduli space, whose dimension is the number of independent zero modes. Every point in the moduli space labels such a solution which saturates the Bogomolny bound of the energy. All of them have therefore the same (namely the lowest possible) energy, determined by the topological charge. Then the kinetic term in the Yang Mills Higgs action defines a metric on the moduli space, and slowly moving monopoles follow approximately geodesics.

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1 - 25 DN, $\pi\Sigma_c$ Interaction in Finite Volume and $\Lambda_c(2595)$ Resonance

Xie Jujun and Eulogio Oset[1]

One of the topics where efforts are recently devoted within Lattice QCD is the determination of hadron spectra, both in the meson and baryon sector. After earlier claims of a successful determination of the hadron spectra using rough approximations and large pion masses, work continues along this line with more accurate approaches and problems are arising that were not envisaged at first glance. The "avoided level crossing" is usually taken as a signal of a resonance, but this criteria has been shown insufficient for resonances with a large width. The use of Luescher's approach[1] is gradually catching up. It is suited for the case when one has resonances with one decay channel in order to produce phase shifts for this decay channel from the discrete energy levels in the box. Yet, most of the hadronic resonances have two or more decay channels and the need to go beyond Luescher's approach becomes obvious.

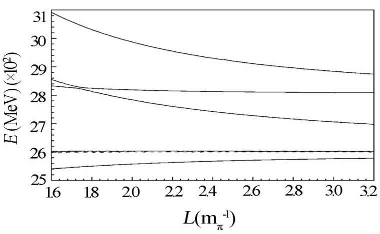

Fig. 1 Energy levels as functions of the cubic box size $L(m_\pi^{-1})$ derived from the chiral unitary approach.

In our work, we study the interaction of the coupled channels DN and $\pi\Sigma_c$ in an $SU(4)$ extrapolation of the chiral unitary theory. The resulting interaction is used to reproduce the position of the $\Lambda_c(2595)$ resonance in the isospin zero DN channel. Then we conclude that the $\Lambda_c(2595)$ is mostly a DN bound state. We then study the interaction of the coupled channels DN and $\pi\Sigma_c$ in the finite volume. Energy levels in the finite box are evaluated as shown in Fig. 1. We assume that the results obtained would correspond to results given by lattice calculations. From there we address the inverse problem. We propose a rather general and realistic potential and, using two coupled channels, a fit to the synthetic data is made assuming some reasonable errors in the data. Then this potential is used in the infinite volume case, generating the $\pi\Sigma_c$ phase shifts within an error band around the original results. This part provides information for lattice QCD calculations about the accuracy in the energies of the spectrum needed to get a desired accuracy in the phase shifts.

A second part of the investigation was about the use of a one channel Luescher's approach, with just the open $\pi\Sigma_c$ channel, to induce $\pi\Sigma_c$ phase shifts from the finite volume spectrum. We found in this case that, due to the large weight of the closed DN channel in this problem, the results obtained using Luescher's approach with just the $\pi\Sigma_c$ channel was of no use. Even more, making a fit analysis to the lattice data with just the $\pi\Sigma_c$ channel produced erroneous $\pi\Sigma_c$ phase shifts. Certainly one does not know a priori from the lattice QCD results whether two channels would be necessary in the analysis.

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