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Strong Coupling Analysis of SU(2) QCD

Abstract

A strong coupling analysis for SU(2) QCD is carried out when the diagonal gluons with respect to color and vector indices have a vacuum expectation value. The strong coupling analysis assumes that the various fields are rational functions where the usual linear solution appears in the numerator and the function appearing in the denominator is constructed to approximately solve for the dominant quadratic and cubic interactions of SU(2) Yang Mills.

The paper starts by breaking up the Gauss's law equations into their static and time dependent parts. The color electric potentials are solved for and shown to be real exponentials. The dominant interactions for Yang Mills will be the quadratic electric potentials interacting with the gluons. The time dependent part of Gauss's will be used to resolve the projection operators so that there is no arbitrary gauge fixing term.

Plane wave solutions to both the gluon and quarks linear equations of motion are found. The linear gluons equations of motion which will have linear interactions with different color gluons could not be solved for arbitrary wave numbers. However if all the x, y and z components of the wave numbers were the same, then nine generic gluon equations of motion reduced down to three equations which could be solved. The smallest value of the wave number k yielded the result that there are three massless and six massive states for the gluons. The dispersion relation for the up and down quarks could be computed in all generality and the quarks developed masses due to the vacuum expectation values of diagonal gluons.

As mentioned previously the dominant interactions were the quadratic color electric potential fields. The denominator function form is chosen to be the product of the sum of the squares of all possible color electric potentials multiplied by a Fourier series expansion with unknown coefficients in order to construct a well-behaved perturbation theory. The expressions for the quadratic and cubic equations were combined to solve for Fourier coefficients.

The denominator function or the envelope function will be shown to localize or confine both color electric potentials, the static quark solutions and the plane wave solution to both the quarks and gluons.