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Helicity states for two- and three-gluon glueballs

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One of the earliest predictions of Quantum Chromodynamics (QCD) is the existence of color singlet pure-gauge states known as glueballs. However, despite this anticipation, consensus on their theoretical properties and experimental evidence remains elusive. Two-gluon glueball states have been quite abundantly explored both theoretically and experimentally. One may cite, for example, on the theory side, results from various phenomenological approaches, from functional methods, and lattice QCD. Notable experimental endeavors, such as PANDA, Crystal Barrel or WA102, continue to seek evidence for the states. In contrast, three-gluon glueballs garnered less attention, due to the technical complexity of the task. On the theory side, the lattice QCD spectrum being insensitive to the number of gluons, it should encompass three-gluon levels, while, on the experimental side, the possible observation of an odderon exchange at TOTEM is still debated.

This presentation aims to apply the helicity formalism to the description of two- and three-gluon systems within constituent models. After revisiting one-body helicity states, the two-body formalism is presented and applied to describe two-gluon glueballs. The incorporation of symmetries and parity reveals selection rules consistent with lattice QCD results. Introducing dynamical considerations yields a quantitative spectrum of two-gluon glueballs that can also be compared to lattice results. These results are also compared to some obtained by considering that gluons have spin degrees-of-freedom, concluding that helicity is a significant ingredient in reproducing the spectrum.

In a subsequent phase, the three-body helicity formalism is employed to model three-gluon glueball states. Expected symmetries and parity are implemented using Berman's definition for three-body helicity states and the obtained selection rules are compared with existing literature results. Before concluding, perspectives on acquiring a quantitative spectrum for three-gluon glueballs are presented.

session

B. Hadron Spectroscopy

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