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Role of a four-quark and a glueball state in pion-pion and pion-nucleon scattering

We consider the two-flavor version of the extended linear sigma model (eLSM), which contains (pseudo)scalar and (axial-)vector quark-antiquark mesons, a scalar glueball [predominantly corresponding to $f_0(1710)$], as well as the nucleon and its chiral partner. We extend this model by the additional light scalar meson $f_0(500)$, predominantly a putative four-quark state. We investigate various interaction terms of the four-quark and glueball states with the other particles, some of which preserve and some of which explicitly break the $U(1)_A$ symmetry. We test our model by performing a global fit to masses and decay widths of the scalar resonances and pion-pion scattering lengths. We also discuss the influence of the scalar four-quark state and the glueball on the baryon sector by evaluating pion-nucleon scattering parameters. We find that the inclusion of $f_0(500)$ improves the description of pion-pion and pion-nucleon scattering lengths.

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