The $a_0(980)$ revisited

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A way to understand the light scalar sector of hadron physics is by applying a type of dynamical generation in which additional resonances arise as companion poles from quark-antiquark seed states by incorporating mesonic loops at the level of S-wave propagators.[1–3] Along this line, we first repeat and complete the calculations of previous works of Törnqvist and Roos (TR) and Boglione and Pennington (BP), where the resonance $a_0(980)$ appears as an additional pole of the propagator of the predominately quark-antiquark state $a_0(1450)$. Both works were important as they demonstrated the feasibility of the idea of companion poles – however, we show that in TR, the same as in BP, the pole width of both states is too large by a factor of 2 when compared to data, and that in BP the pole mass of $a_0(1450)$ is too large of about 400 MeV.
We then construct an effective model Lagrangian for $a_0(1450)$ coupling to pseudoscalar mesons with both non-derivative and derivative interactions, and calculate its propagator. We demonstrate that it is indeed possible to obtain two poles, one for $a_0(980)$ and one for $a_0(1450)$, in good agreement with data, thus showing that the mechanism of companion poles can deliver not only qualitative but also quantitative correct results.

References

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