9-21-1996

Comment on ``Confirmation of the Sigma Meson''

Joseph Schechter
Department of Physics, Syracuse University, Syracuse, NY

Masayasu Harada
Syracuse University

Francesco Sannino
Syracuse University and Dipartimento di Scienze Fisiche & Istituto Nazionale di Fisica Nucleare Mostra d'Oltremare Pad.19

SU-4240-650

Comment on "Confirmation of the Sigma Meson"

Masayasu Harada [a 1] *Francesco Sannino* [a,b 2]

Joseph Schechter [a 3]

[a] Department of Physics, Syracuse University, Syracuse, New York, 13244-1130.

[b] Dipartimento di Scienze Fisiche & Istituto Nazionale di Fisica Nucleare, Mostra d'Oltremare Pad.19, 80125 Napoli, Italia.

PACS numbers: 13.75.Lb, 11.15Pg, 11.80.Et, 12.39.Fe

In Ref. [1], Törnqvist and Roos presented a model of $\pi\pi$ scattering which supports the existence of the old σ meson at a mass of 397 MeV and width 590 MeV. While this model is constructed to satisfy unitarity, it does not explicitly take crossing symmetry into account. In particular, one may question [2] the validity of neglecting the crossed-channel ρ meson exchange contributions, which are generally considered to be important. It is actually very complicated, as noted by the authors themselves, to examine this question in their model. Here we investigate this issue in the framework of a recently proposed [3] simple model for $\pi\pi$ scattering. We find that the consistent neglect of the ρ exchange does not destroy the existence of the σ meson but modifies its parameters so that they get close to the results of Ref. [1].

The simple model in question may be most conservatively regarded as an approximate parameterization of the relativistic $\pi\pi$ amplitude which satisfies both crossing symmetry and unitarity up to 1.2 GeV. It is based on a chiral

[1] *Electronic address:* mharada@npac.syr.edu
[2] *Electronic address:* sannino@npac.syr.edu,
[3] *Electronic address:* schechter@suhep.phy.syr.edu

symmetric Lagrangian. The amplitude is constructed by adding together four components: (1) the *current algebra* contact term, (2) the ρ exchange diagrams, (3) a σ piece, (4) the $f_0(980)$ with an associated *Ramsauer-Townsend* mechanism. The only three parameters which must be fit to experiment appear in a *regularized* description of the real part of the pole term which is proportional to

$$\mathrm{Re}\left[\frac{M_\sigma G}{M_\sigma^2 - s - iM_\sigma G'}\right] .$$

Note that, since $G \neq G'$, this is not identical to a Breit-Wigner form for this very broad object. Figures 1 and 2 of Ref. [3] show that the σ is absolutely essential to preserve unitarity.

In [3] a best fit to the real part of the $I = J = 0$ partial amplitude, R_0^0 was found for a mass $M_\sigma = 559$ MeV, a width $G' = 370$ MeV and $G/G' = 0.29$. It is an easy matter to neglect the ρ meson contributions (including the associated contact term needed for chiral symmetry) and make a new fit. The resulting R_0^0 in comparison with the experimental data is shown in Fig. 1 and is about as good as the previous fit including the ρ meson. (Of course, the ρ meson is definitely present in nature.) The new fitted parameters are the mass $M_\sigma = 378$ MeV, the width $G' = 836$ MeV and $G/G' = 0.08$. The new mass and width are close to the values found in Ref. [1]. We therefore would expect that including the ρ exchange in their framework would raise their mass by roughly 150 MeV and lower their width prediction. This behavior can be easily understood in a qualitative sense, since the addition of the ρ raises the energy at which the unitarity bound is violated (see Fig. 1 of Ref. [3]). Of course, in Ref. [3], the question of whether the σ and $f_0(980)$ are $q\bar{q}$, $q^2\bar{q}^2$ states or some superposition is not directly addressed.

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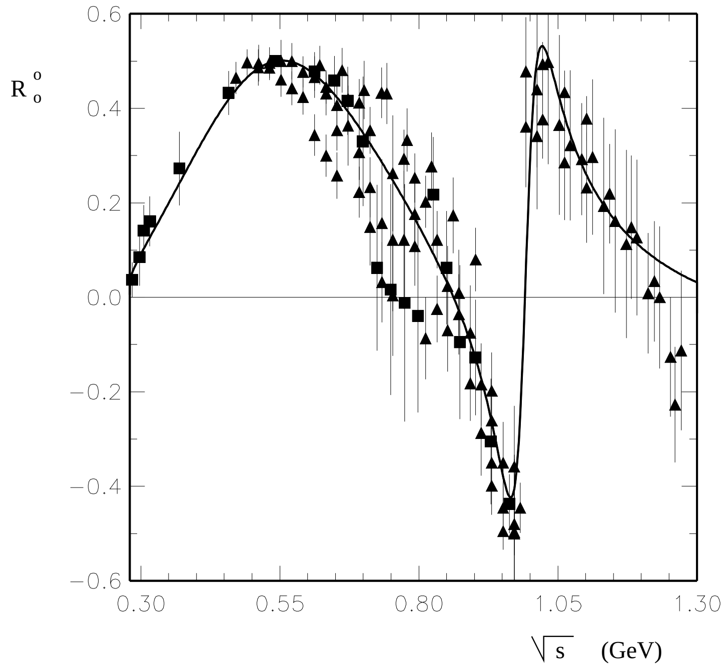

Figure 1: The solid line is the *current algebra* + σ + $f_0(980)$ result for R_0^0. The experimental points are extracted from the measured phase shifts by neglecting the small inelasticity effects. ($\Box$) are extracted from the data of Ref. 4 while ($\triangle$) are extracted from the data of Ref. 5