THE $a_0(980)$

The proper $q\overline{q}$ assignment of the $a_0(980)$ scalar meson remains a problem. The observed mass and width seem to be inconsistent with those expected for a member of an $L = 1$ $q\overline{q}$ nonet. However, since the mass and width are distorted by the proximity of the $K\overline{K}$ threshold, the nature of the $a_0(980)$ can be better investigated using different experimental observations.

TORNQVIST 82 has shown that it is possible to understand the unusual experimental features of the $a_0(980)$ in a unitarized quark model. As with the $f_0(980)$, the $a_0(980)$ can be interpreted as a normal $q\overline{q}$ resonance with a large admixture of $K\overline{K}$, $\eta\pi$, and $\eta'\pi$ continuum states.

Assuming dominance of the decay $\eta'(958) \to \eta\pi\pi$ by a virtual $a_0(980)\pi$ intermediate state, BRAMON 80 concludes that the experimental value $\Gamma(\eta'(958) \to \eta\pi\pi) \approx 200$ keV is fully consistent with a $q\overline{q}$ interpretation. The same analysis also finds additional evidence in favor of this interpretation: If the $a_0(980)$ is a $q\overline{q}$ state, one expects that the decay chain $f_1 \to a_0(980)\pi \to \eta\pi\pi$ will be more important for the $f_1(1285)$ than for the $f_1(1420)$; the reverse is true if the $a_0(980)$ is a $q\overline{q}q\overline{q}$ state with a strange quark component. In fact, $f_1(1285) \to a_0(980)\pi \to \eta\pi\pi$ is observed, while $f_1(1420) \to a_0(980)\pi \to \eta\pi\pi$ is (practically) absent.

The main argument in favor of the $q\overline{q}q\overline{q}$ interpretation of the $a_0(980)$ is its degeneracy in mass with the isoscalar $f_0(980)$. A Crystal Ball measurement of $a_0(980) \to \gamma\gamma$ suppression in the reaction $\gamma\gamma \to a_0(980) \to \eta\pi$ (ANTREASYAN 86) has reinforced this four-quark interpretation. ACHASOV 88B points out that none of the calculations performed in the framework of a $q\overline{q}$ scheme can predict such a narrow $a_0(980) \to \gamma\gamma$ width as that found by the Crystal Ball. He then argues that the $a_0(980)$ is unusual and shows that a four-quark model is able to give the correct order of magnitude of suppression of 2γ production for both the scalar $a_0(980)$ and $f_0(980)$ mesons.

Another interesting non-$q\overline{q}$ interpretation is given by WEINSTEIN 83B, 89: The $q\overline{q}q\overline{q}$ system is investigated using the nonrelativistic quark model; assuming a large hyperfine interaction, the $a_0(980)$ and $f_0(980)$ are both interpreted as

$K\overline{K}$ bound states, and then the P-wave $q\overline{q}$ states are all in the 1300-MeV region. With this S-wave $K\overline{K}$ mesonium assignment, many of the peculiar properties of the $a_0(980)$ and $f_0(980)$—masses, widths, branching fractions, and two-photon widths—make sense.

If the $a_0(980)$ is not the $^3P_0$ state, then this state should be observed near 1300 MeV, with partial decay widths close to the flavor symmetry predictions for an ideal nonet (TORNQVIST 90). The candidate $a_0(1320)$ reported by GAMS-4000 has the right mass, but the signal is weak under the dominant $a_2(1320)$, and its width is much smaller than expected.

See also the note on the "$f_0(1300)$".