THE $f_1(1420)$

This particle is the axial-vector component of the old puzzling E/ι, which has caused much trouble.

In hadron-induced reactions, the $f_1(1420)$ is observed in centrally produced $K\overline{K}\pi$ systems obtained with π and p beams (DIONISI 80, ARMSTRONG 84, 89). A Dalitz-plot analysis gives its quantum numbers and the dominant decay mode. For instance, ARMSTRONG 89 finds that the signal is totally consistent with being an 1^{++} state with a dominant quasi-two-body S-wave decay into $K^*(892)\overline{K}$; furthermore, no 0^{-+} or 1^{+-} waves are required to fit the data. A G parity of $+1$ is suggested by the positive interference between the two overlapping $K^*(892)$ (ARMSTRONG 84). No significant signals in the $\eta\pi\pi$ or 4π decay modes are found in centrally produced 4π systems (ARMSTRONG 89G). All of this is in line with the previous observations made in $\overline{p}p$ annihilations.

In $\gamma\gamma$ fusion from e^+e^- annihilations, a signal at about 1420 MeV is seen only in single-tag events (AIHARA 86C, GIDAL 87B, BEHREND 89, HILL 89), where one of the two photons is off the mass shell; by contrast, it is totally absent in the untagged events where both photons are real and hence they cannot produce a spin-1 meson, because of the Yang-Landau theorem. This clearly implies $J = 1$ and $C = +1$. As for the parity, AIHARA 88B, 88C (same analysis as AIHARA 86C, with 25% more events) and BEHREND 89 all find angular distributions with positive parity preferred, but negative parity not excluded.

Although some uncertainties still remain, the state seen in hadronic interactions and that seen in spacelike virtual photon fusion from e^+e^- annihilations are often identified with one another since there are more similarities than differences. In particular, all experiments agree that this state appears only in $K^*(892)\overline{K}$. The same conclusions are obtained from partial wave analyses of $J/\psi(1S) \to \gamma K\overline{K}\pi$ (BAI 90C, AUGUSTIN 91).

BITYUKOV 88 studied the radiative decay $1^{++} \to \phi\gamma$. Since the ϕ is (almost) a pure $s\overline{s}$ state, the $\phi\gamma$ decay seems to be a good analyser to extract the $s\overline{s}$ component in the

wave function of the decaying meson. Finding the $f_1(1285)$ but not the $f_1(1420)$, BITYUKOV 88 concludes that the $f_1(1420)$ cannot be the $s\overline{s}$ isoscalar member of the $q\overline{q}$ nonet containing the $f_1(1285)$. On the other hand, AIHARA 88C argues that, assuming they both belong to the same nonet and using several hypotheses, the octet-singlet mixing angle obtained is compatible with the $f_1(1420)$ being mostly $s\overline{s}$ and the $f_1(1285)$ being mostly $(u\overline{u}+d\overline{d})/\sqrt{2}$, although both require large admixtures of other $q\overline{q}$ components.

Arguments favoring the possibility the $f_1(1420)$ is a hybrid $q\overline{q}g$ meson or a four-quark state are put forward by ISHIDA 89 and by CALDWELL 90, respectively.

LONGACRE 90 argues that this particle is inconsistent with a QCD arrangement of quarks and gluons. He then develops a final-state rescattering mechanism with successive interactions between a K, a $\overline{K}$, and a π. The $f_1(1420)$ would then be a molecular state formed by the π orbiting in a P wave around an S-wave $K\overline{K}$ state.