namely, that it was a bound state of $c\bar{c}$ quarks, which had been predicted earlier.[16] while the narrowness of the ψ was explained by the Okubo-Zweig-Iizuka or OZI rule. If this was so, one expected to see particles with "naked charm.[17] Yet it took from November 1974 to May 1976 to find a clear peak[18] in the $K^- \pi^+$ and $K^-\pi^+\pi^-\pi^+$ mass distributions[19,20] at M = 1865 MeV. It was immediately clear that we had discovered a new meson M^0, and soon thereafter the charged mode M^+. The remaining questions were: could this be yet another K*? Was this particle indeed the predicted charmed meson? What led to the belief, and general acceptance, that we had something new and very different from a K* here?

The Case for Charmed Mesons

(i) Threshold. For a new K*(1865) we also expect a threshold. But that is expected at ~2.360 GeV [K*(1865) + K] or even ~2.755 GeV [K*(1865) + K*(890)]. However the experimental threshold lies above 3.7 GeV (see Fig. 9). In the charm theory a threshold is expected at $E_{cm} = 2\,M_D \simeq 3.73$ GeV, corresponding to $e^+e \rightarrow D^0\,\bar{D}^0$. In fact, the ψ'' (3770) discovered later,[11] is a resonance just above threshold which decays predominantly into $D^0\,\bar{D}^0$ and D^+D^-.

(ii) Associated Production. For a new K*(1865) we expect associated production with K or perhaps with K*(890) but there is no known reason to expect K*(1865) + $\bar{K}$*(1865) associated production. Experimentally we find that all observed events corresponding to the 1865 MeV/c^2 peak occur in associated production with either equal or higher mass objects. Figure 10 shows the experimental recoil mass spectrum in which we use the measured momentum of the $K\pi$ system together with the measured $K\pi$ invariant mass as well as a fixed mass with the nominal value M = 1865 MeV/c^2.

(iii) The charged decay mode. For a K* with I = 1/2 we also expect a charged decay mode. For three-body decays this would have to be the nonexotic† mode $K^\mp\,\pi^+\,\pi^-$. Experimentally we observe the exotic decay mode $K^\mp\,\pi^\pm\,\pi^\pm$ but do not observe the nonexotic decay mode (see Figure 11); neither do we observe the I = 5/2 triply-charged $K^\mp\,\pi^\mp\,\pi^\mp$ decay mode (not shown here). Thus if the peak corresponds to a K* it must have I = 3/2; i.e., an exotic K*, which (incidentally) would be the first clear case of an exotic meson state. If we adopt the point of view that we are dealing with an exotic K*, we would still have to invent an explanation for the peculiar fact that the $I_z = \pm\,1/2$ states (the nonexotic combinations $K^\mp\,\pi^+\,\pi^-$) are suppressed.

On the other hand our observations are in good agreement with charm theory in which Cabibbo-enhanced hadronic weak decays obey a $\Delta C = \Delta S$ rule, that is the charmed quark c decays weakly to $s\bar{d}u$. Thus in $D^+(C = 1, S = 0)$ decay, for example, the final state has $C = 0$, $S = -1$ together with $Q = +1$; i.e., the charged final state is predicted to be exotic. This point holds explicitly for the charm model and would not necessarily be true for other new types of mesons M composed of $\bar{q}Q$.

(iv) Experimental width. For a K* of mass 1865 MeV/c^2 we might expect a width $\Gamma \approx 50-200$ MeV/c^2, although admittedly for an exotic K* we have no clear prediction. Experimentally, we find $\Gamma < 40$ MeV/c^2 from the mass spectrum; however, by making use of the information from the recoil spectrum as well this limit becomes $\Gamma < 2$ MeV/c^2.

Charm theory predicts that the decays we are dealing with are weak decays and estimates are: $\tau \sim 10^{-13}$ sec. or roughly $\Gamma \sim 10^{-2}$ eV.

(v) Evidence for parity nonconservation or the "$\tau - \theta$ puzzle" revisited. For a K* we expect parity conservation in the decay; this should hold even for an exotic K*. Experimentally we find evidence for parity nonconservation. This is based on a study of the

†Here exotic refers to the fact that the strangeness is opposite to the charge of the $K^\mp\,\pi^\pm\,\pi^\pm$ object, an impossibility for a quark-antiquark combination of the conventional quarks.