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ISSUES IN CHARMED PARTICLE SPECTROSCOPY

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Abstract: I list several questions which remain to be answered about charmed particles and their interactions.

Résumé: J'énumère plusieurs questions non résolues à propos des particules charmées et de leurs interactions.

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Within the past nine months the first examples of the feverishly-sought charmed mesons have been found, and here in Flaine we have been told by our colleagues who work at SPEAR and DORIS of the great strides made since the initial observations. I shall take a few minutes to indicate that finding the charmed particles represents a beginning, not an ending. To do so I list a number of outstanding questions we may hope to answer in the next year. In the interest of brevity and of informality I shall forego citations of the literature, but nothing I have to say is to be mistaken as original.

1. Is the spectrum what we expect from charm? The doublet of $D^+(c\bar{d})$ and $D^o(c\bar{u})$ has been established, so among the explicitly charmed mesons only the $F^+(c\bar{s})$ awaits discovery. Among its prominent nonleptonic decays will be $K^+\bar{K}^o$, $\pi^+\eta$, $\pi^+\pi^+\pi^-$, $\pi^+K^+K^-$. To complete the pseudoscalar hexadecimet requires as well the definitive observation of the hidden charm state η_c. The present candidate, the X(2830) observed at DORIS in the $\gamma\gamma$ mode, still has an ambiguous status. It has not yet been seen in any hadronic modes, and it has receded to a 2σ effect in the DESY-Heidelberg experiment. On the positive side, the signal in the DASP experiment is as prominent as ever, and the $\chi(3454)$ - now observed in γ-cascades at both SPEAR and DORIS - has also not been seen in hadronic modes. All the same, we should remain alert to the possibility that the η_c lies very near the ψ mass, as simple charmonium considerations suggested.

2. Does the weak current have the Glashow-Iliopoulos-Maiani form $J = (\bar{u}d + \bar{c}s)\cos\theta_C + (\bar{u}s - \bar{c}d)\sin\theta_C$? This issue can be addressed by comparing Cabibbo - allowed and suppressed semileptonic decays, such as $D^o \rightarrow K^-\ell^+\nu$ and $D^o \rightarrow \pi^-\ell^+\nu$.

H, if it fits

3. What is the form of the nonleptonic weak Hamiltonian? We expect the current-current form $H_W = J^+J + JJ^+$ with the SU(4) representation structure

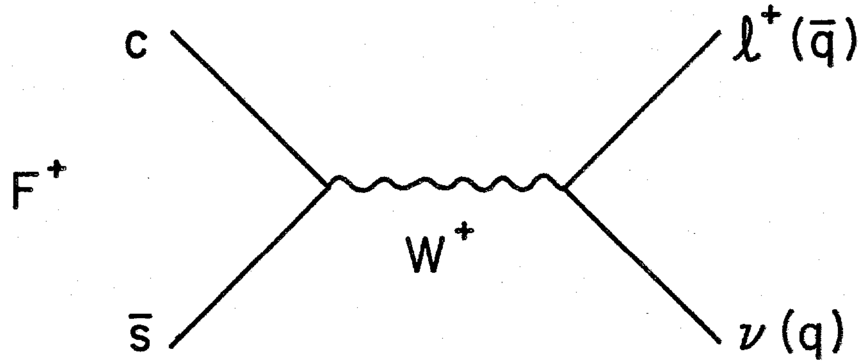
1 + 20 + 84. The 20 contains the [8] of SU(3) believed (from the success of the $|\Delta I| = 1/2$ rule for strange particle decays) to dominate charm-conserving charged-current interactions, whereas the 84 contains the [27] responsible for $|\Delta I| = 3/2$ transitions. Specific questions of interest are these: (a) To what extent does the 20 dominate over the 84 (in analogy with "octet enhancement")? In the absence of the 84 the decay $D^+ \to \overline{K}^o \pi^+$ and indeed all Cabibbo-favored two-body decays of D^+ are forbidden. (b) To what extent are nonleptonic decays enhanced over semileptonic decays? This is studied by a measurement of the semileptonic branching fractions of charmed mesons, which would be ~ 20% for electrons and for muons in the absence of any enhancement or other dynamical complication. (c) Does the SU(3) representation of the final-state hadrons matter? Specifically, are transitions leading to an SU(3) [10] less enhanced than those leading to an [8]? Comparison of the absolute rate $\Gamma(D^+ \to K^- \pi^+ \pi^+)$ with transitions leading to octet final states will help resolve this issue.

4. What are the lifetimes of the charmed mesons? Peculiar dynamical circumstances may lead to very different lifetimes for the three charmed pseudoscalars. For example, if only 20-induced transitions to octet final states should be important, there are no Cabibbo-favored decays of D^+, so that $\tau(D^+) >> \tau(D^o)$. A second possibility is that the contribution

to F^+ decay may be helicity-suppressed for light products. Consequently (unless there are energetically accessible heavy lepton channels), it is possible that $\tau(F^+) > \tau(D^o)$. One may hope to measure lifetimes directly in emulsions, if $\tau \sim 10^{-13}$ s., or to compare lifetimes by measuring branching ratios to particular semileptonic channels, e.g.

$$\tau(D^+)/\tau(D^o) = B(D^o \to K^- \ell^+ \nu)/B(D^+ \to \bar{K}^o \ell^+ \nu).$$

5. What is the nature of <u>many-body nonleptonic decays</u>? Unlike the previous questions this one is not especially well-posed, but having massive, weakly-decaying objects available for study permits us to begin to formulate systematics formerly inaccessible. The outcome may be quite rewarding in terms of an understanding and awareness of dynamics.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