CHARMED BARYONS

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Figure 1 shows the SU(4) multiplets that have as their lowest levels (a) the $J^P = \frac{1}{2}^+$ SU(3) octet that contains the nucleon, and (b) the $J^P = \frac{3}{2}^+$ SU(3) decuplet that contains the $\Delta(1232)$; all the particles in a given SU(4) multiplet have the same spin and parity. The only known charmed baryons each contain one charmed quark and thus belong to the second level of an SU(4) multiplet. Figure 2 shows this level for the SU(4) multiplet of Fig. 1(a). The level splits apart into two SU(3) multiplets, a $\overline{\mathbf{3}}$ that contains the Λ_c^+ and the Ξ_c, both of which decay weakly, and a **6** that contains the $\Sigma_c(2455)$, which decays strongly to $\Lambda_c\pi$, the Ξ_c', which decays electromagnetically, and the Ω_c^0, which decays weakly. (Our naming scheme includes masses in names only when the particle decays strongly.) A host of other baryons with one or more charmed quarks are needed to fill out the full SU(4) multiplets. Furthermore, *every* N or Δ baryon resonance "starts" another SU(4) multiplet, so the woods are full of charmed baryons, most of which no doubt will forever remain undiscovered. A few such higher charged baryons have, however, been discovered: the $\Lambda_c(2593)$ and the $\Lambda_c(2625)$, the $\Sigma_c(2520)$, and the $\Xi_c(2645)$; see the Listings below.

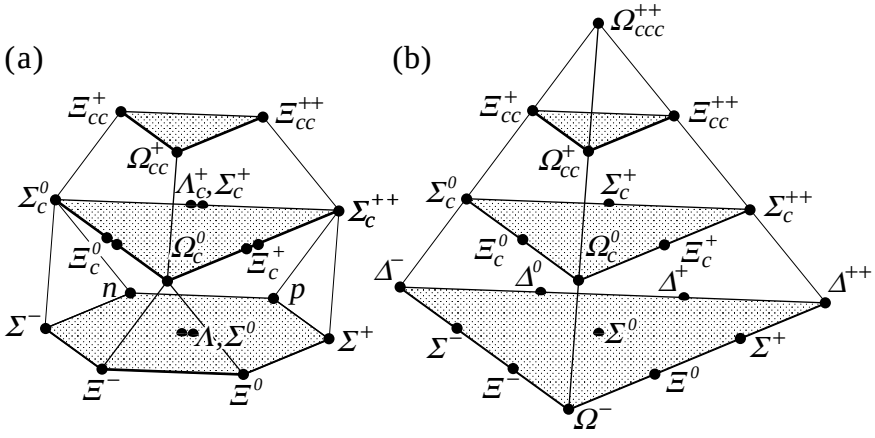

Fig. 1. SU(4) multiplets of baryons made of u, d, s, and c quarks. (a) The 20-plet with an SU(3) octet on the

lowest level. (b) The 20-plet with an SU(3) decuplet on the lowest level.

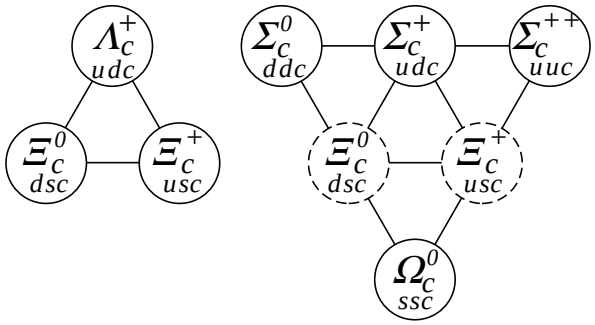

Fig. 2. The SU(3) multiplets on the second level of the SU(4) multiplet of Fig. 1(a).

The states of the $\overline{\mathbf{3}}$ multiplet in Fig. 2 are antisymmetric under interchange of the two light quarks (the u, d, and s quarks), whereas the states of the **6** multiplet are symmetric under interchange of these quarks. Actually, there may be some mixing between the pure $\overline{\mathbf{3}}$ and **6** Ξ_c states (they have the same I, J, and P quantum numbers) to form the physical Ξ_c and Ξ_c' states.

It need hardly be said that the flavor symmetries Fig. 1 displays are very badly broken, but the figure is the simplest way to see what charmed baryons should exist.

For a review of theory and experiment, see Ref. 1.

References

1. J.G. Körner, M. Krämer, and D. Pirjol, Prog. in Part. Nucl. Phys. **33**, 787 (1994).