CHARMED BARYONS

Figs. 1(a) and 1(b) show the SU(4) multiplets that have as their "ground floors" (a) the SU(3) octet that contains the nucleon, and (b) the 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 charmed baryons that have been discovered each contain one charmed quark and belong to the first floor of the multiplet shown in Fig. 1(a). Fig. 2 shows this first floor, pulled apart into two SU(3) multiplets, a $\overline{\mathbf{3}}$ that contains the $\Lambda_c(2285)$ and the $\Xi_c(2470)$, both of which decay weakly, and a **6** that contains the $\Sigma_c(2455)$, which decays strongly to $\Lambda_c\pi$, and the $\Omega_c(2710)$, which decays weakly. A second Ξ_c remains to be discovered to fill out the **6**, and a host of other baryons with one or more charmed quarks are needed to fill out the full SU(4) multiplets in Fig. 1. Furthermore, *every* N or Δ baryon resonance "starts" a multiplet like that in Fig. 1(a) or 1(b), so the woods are full of charmed baryons, most of which no doubt will forever remain undiscovered. The only candidates so far for more massive multiplets are the $\Lambda_c(2625)^+$ and perhaps the $\Lambda_c(2593)^+$.

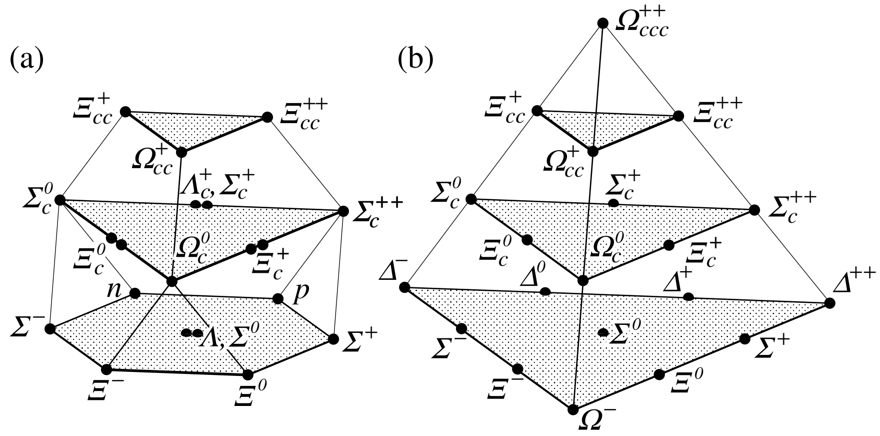

Fig. 1. SU(4) multiplets of baryons made of u, d, s, and c quarks. (a) The 20-plet with an SU(3) octet on the "ground floor." (b) The 20-plet with an SU(3) decuplet on the ground floor.

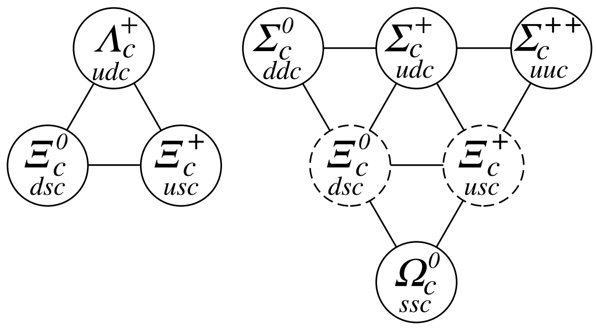

Fig. 2. The SU(3) multiplets on the "first floor" of the SU(4) multiplet of Fig. 1(a). The particles in dashed circles have yet to be discovered.

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