8. NAMING SCHEME FOR HADRONS

8.1. Introduction

We introduced in the 1986 edition [1] a new naming scheme for the hadrons. Changes from older terminology affected mainly the heavier mesons made of the light (u, d, and s) quarks. Old and new names were listed alongside until 1994. Names also change from edition to edition because some characteristic like mass or spin changes. The Summary Tables give both the new and old names whenever a change occurred.

8.2. “Neutral-flavor” mesons (S = C = B = T = 0)

Table 8.1 shows the names for mesons having the strangeness and all heavy-flavor quantum numbers equal to zero. The scheme is designed for all ordinary non-exotic mesons, but it will work for many exotic types too, if needed.

Table 8.1: Symbols for mesons with the strangeness and all heavy-flavor quantum numbers equal to zero.

<table>
<thead>
<tr>
<th>JPC</th>
<th>J/ψ</th>
<th>J/ψ</th>
<th>J/ψ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0^+</td>
<td>1^+</td>
<td>1^-</td>
<td>0^+</td>
</tr>
<tr>
<td>2^-</td>
<td>3^-</td>
<td>2^-</td>
<td>1^+</td>
</tr>
</tbody>
</table>

\[ q \bar{q} \text{ content} \]

These combinations correspond one-to-one with the angular-momentum and/or spin quantum numbers of the \( q \bar{q} \) system:

- \( 0^+ \) and \( 1^+ \) are the spin, orbital, and total angular momenta of the \( q \bar{q} \) system.
- \( 2^- \) and \( 3^- \) are the spin, orbital, and total angular momenta of the \( q \bar{q} \) system.
- \( 1^- \) and \( 0^+ \) are the spin, orbital, and total angular momenta of the \( q \bar{q} \) system.
- \( 1^+ \) and \( 0^+ \) are the spin, orbital, and total angular momenta of the \( q \bar{q} \) system.

8.3. Mesons with nonzero S, C, B, and/or T

Since the strangeness or a heavy flavor of these mesons is nonzero, none of them are eigenstates of charge conjugation, and in each of them one of the quarks is heavier than the other. The rules are:

1. The main symbol is an upper-case italic letter indicating the heavier quark as follows:

\[ s \rightarrow \bar{K} \quad c \rightarrow D \quad b \rightarrow B \quad t \rightarrow T \]

We use the convention that the flavor and the charge of a quark have the same sign. Thus the strangeness of the s quark is negative, the charm of the c quark is positive, and the bottom of the b quark is negative. In addition, \( I_3 \) of the \( u \) and \( d \) quarks is positive and negative, respectively. The effect of this convention is as follows: Any flavor carried by a charged meson has the same sign as its charge. Thus the \( K^+, D^+, \) and \( B^+ \) have positive strangeness, charm, and bottom, respectively, and all have positive \( I_3 \). The \( D_s^+ \) has positive charm and strangeness. Furthermore, the \( \Delta(\text{flavor}) = \Delta Q \) rule, best known for the kaons, applies to every flavor.

2. If the lighter quark is not a \( u \) or a \( d \) quark, its identity is given by a subscript. The \( D_s^+ \) is an example.

3. If the spin-parity is in the “normal” series, \( J^P = 0^+, 1^-, 2^+, \ldots \), a superscript \( ^+ \) is added.

4. The spin is added as a subscript except for pseudoscalar or vector mesons.

8.4. Baryons

The symbols \( N, \Delta, A, \Sigma, \Xi, \) and \( \Omega \) used for more than 30 years for the baryons made of light quarks (\( u, d, \) and \( s \) quarks) tell the isospin and charge quantum number, and the same information is conveyed by the symbols used for the baryons containing one or more heavy quarks (c and \( b \) quarks). The rules are:

1. Baryons with three \( u \) and/or \( d \) quarks are \( N \)'s (isospin 1/2) or \( \Delta \)'s (isospin 3/2).

2. Baryons with two \( u \) and/or \( d \) quarks are \( A \)'s (isospin 0) or \( \Sigma \)'s (isospin 1). If the third quark is a \( c, b, \) or \( t \) quark, its identity is given by a subscript.

3. Baryons with one \( u \) or \( d \) quark are \( \Xi \)'s (isospin 1/2). One or two subscripts are used if one or both of the remaining quarks are heavy: thus \( \Xi_c, \Xi_{cc}, \Xi_{cc}, \) etc.

4. Baryons with no \( u \) or \( d \) quarks are \( \Omega \)'s (isospin 0), and subscripts indicate any heavy-quark quantum number.

5. A baryon that decays strongly has its mass as part of its name. Thus \( \Sigma^-, \Omega^-, \Lambda^+_c, \) etc., but \( \Delta(1232)^0, \Sigma(1385)^-, \Xi_c(2645)^+, \) etc.

In short, the number of \( u \) plus \( d \) quarks together with the isospin determine the main symbol, and subscripts indicate any content of heavy quarks. A \( \Sigma \) always has isospin 1, an \( \Omega \) always has isospin 0, etc.

Footnote and Reference:

* Sometimes a prime is necessary to distinguish two \( \Xi \)'s in the same SU(3) multiplet. See the “Note on Charmed Baryons” in the Charmed Baryon Listings.