Partners of the SU(3) hadrons

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The hadrons of the SU(3) $J^P = 0^-$, $½^+$ and 1^- multiplets are shown to have partners of the same spin or of spin difference ½. Partnerships occur between hadrons with some quark content in common, there being no distinction between quarks and antiquarks. The partnerships are centred upon particle mass levels that descend in geometric progression from the Planck Mass. The mass differences characterising partnerships are equal to the masses of levels. Isospin doublets behave as single particles, represented by the geometric mean of the hadron masses. The K-meson isospin doublets and the electron are arranged as partnerships, as are the π^+ and π^- isospin triplet states and the muon.

1. Introduction

Particles of all kinds occupy mass levels that descend in geometric progression from the Planck Mass [1, 2, 3]. Two sequences of particle mass levels have been revealed: Sequence 1, of common ratio $1/\pi$, and Sequence 2, of common ratio $2/\pi$. Mass sublevels lie between mass levels, within sequences of common ratio $(1/\pi)^{1/p}$ and $(2/\pi)^{1/p}$, where p is a power of 2. Each particle occupies a level or sublevel within both sequences [4]. Isospin doublets are arranged symmetrically about mass levels. The mass sequences have been related to the geometry of warped extra dimensions [5].

The uds baryons Λ and Σ^0, which lie at the heart of the SU(3) ground state baryon octet, are arranged symmetrically about a mass level in Sequence 2 [1]. The mass difference of Λ and Σ^0 is precisely equal to the mass of a level in Sequence 2. Similar partnerships have been identified between several pairs of hadrons with the same strange quark content, there being no distinction between quarks and antiquarks [1].[2] Each partnership is centred upon a mass level or sublevel in Sequence 2, and is characterised by a mass difference equal to the mass of a level in Sequence 2. Other pairs of particles are arranged symmetrically about mass sublevels [4, 5], including the muon and the charged pions, and the neutral and charged pions. When Sequence 3, of common ratio 1/e, was discovered [5], the π^0 - $\pi^\pm$ and μ - $\pi^\pm$ mass differences were found to coincide precisely with sublevels which lay within sequences of common ratio $(1/e)^{1/3}$. The μ - $\pi^\pm$ mass difference is precisely e^2 times the π^0 - $\pi^\pm$ mass difference.

Since all particles occupy mass levels, any pair of particles will be symmetrically arranged about a level or sublevel. Partnerships are identified by the mass difference of the partners. Those mass differences are equal to the masses of levels, or sublevels characterised by small p. In a systematic study, evidence of partnerships has been sought amongst the hadrons of the SU(3) $J^P = 0^-$, $½^+$ and 1^- multiplets, and is presented below. All partnerships are centred upon levels or sublevels in Sequence 2. The errors, derived

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[2] An isospin doublet is not a partnership. Isospin doublets are represented in partnerships by the geometric mean of the two hadron masses: the doublet behaves as a single particle.

from the Particle Data Group evaluations [6], are mostly no larger than the markers. Larger error bars are displayed.

2. Partnerships involving hadrons with strange content

2.1 Λ (uds) - Σ^0 (uds); Ξ (uss, dss) - ϕ ($c_1(u\bar{u} + d\bar{d}) + c_2(s\bar{s})$)

See Figure 1.

Both of these partnerships are centred upon Level 97 in Sequence 2. Each partnership is characterised by a mass difference precisely equal to the mass of a level in Sequence 2.

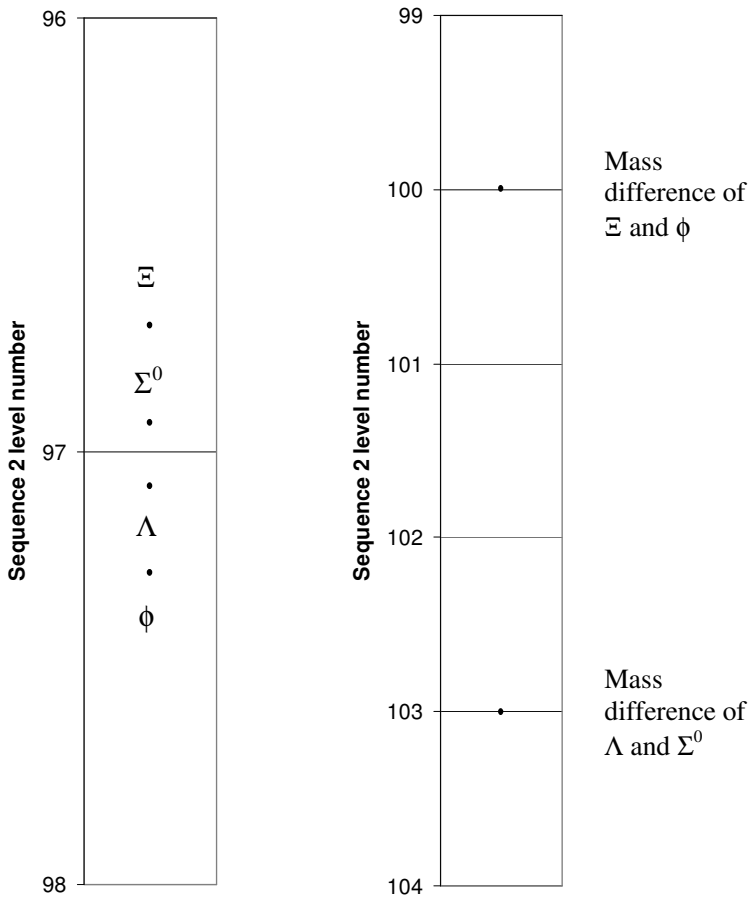

Figure 1: Λ-Σ^0 and Ξ-ϕ partnerships

2.2 Σ^+ (uus) - Σ^- (dds)

See Figure 2.

These two triplet states occupy mass sublevels in Sequence 2. The sublevels lie within a sequence of common ratio $(2/\pi)^{1/64}$. The two baryons are arranged symmetrically about a level within a sequence of common ratio $(2/\pi)^{1/128}$. Many baryons populate these 'high order' sublevels [2]. The mass difference of Σ^+ and Σ^- is equal to the mass of a level in Sequence 2.

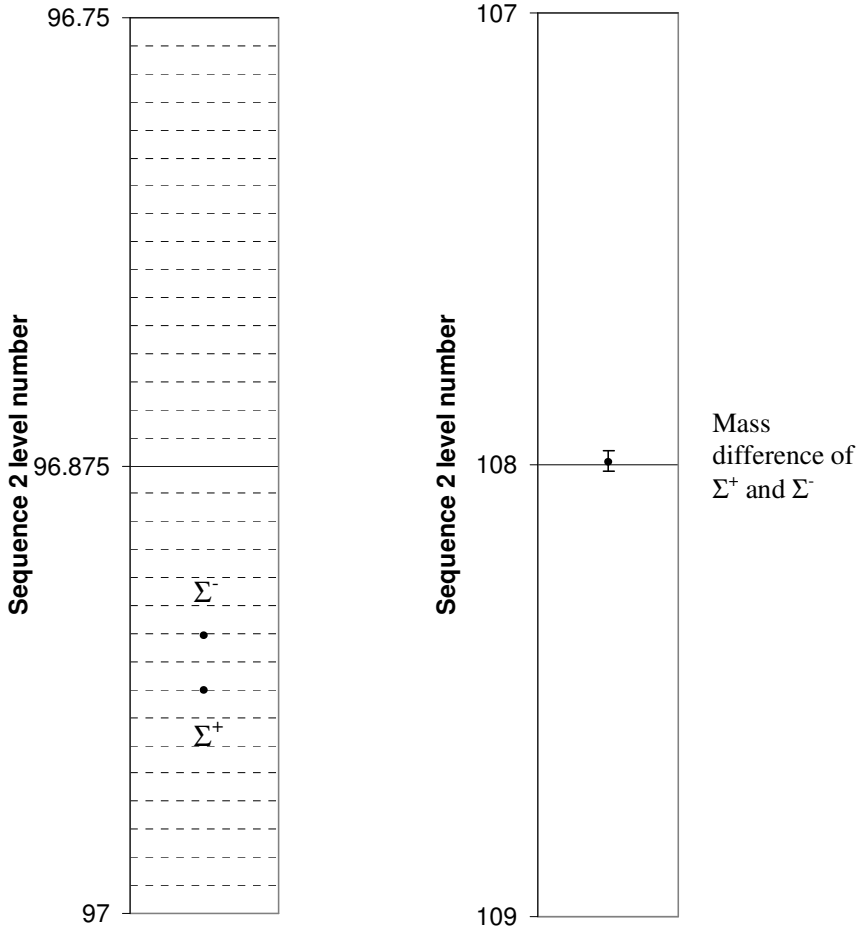

Figure 2: Σ^+-Σ^- partnership

2.3 Σ^0 (uds) – K* ($u\bar{s}$, $d\bar{s}$; $\bar{u}s$, $\bar{d}s$)

See Figure 3.

These partnerships are centred upon a sublevel in Sequence 2. The geometric mean of the two masses is shown by a diamond. The mass difference of Σ^0 and K* is precisely equal to the mass of Level 100 in Sequence 2.

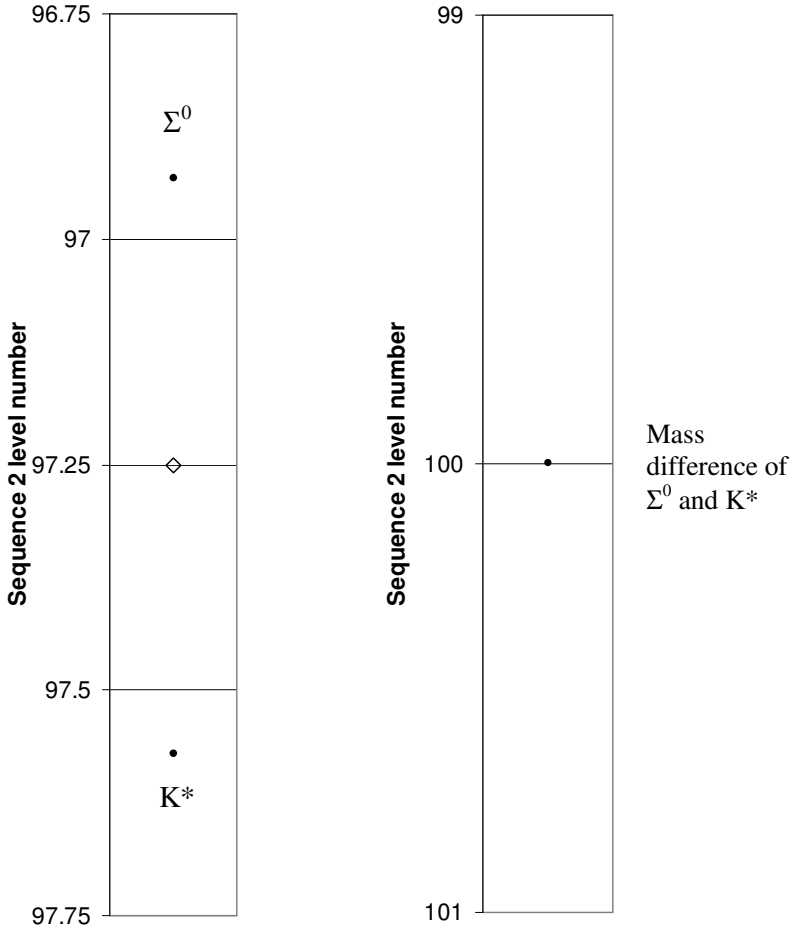

Figure 3: Σ^0-K* partnership

2.4 e – K ($u\bar{s}$, $d\bar{s}$; $\bar{u}s$, $\bar{d}s$)

See Figure 4.

The partnerships of the electron and the K meson doublets are suggested by the data. Both the electron and the K meson doublets occupy levels in Sequence 1, and are arranged symmetrically about Level 42. As required for a partnership, the constituents are arranged symmetrically about a sublevel in Sequence 2. The geometric mean of the two masses is shown by a diamond. The mass difference of the partners is equal to the mass of a sublevel in Sequence 2.

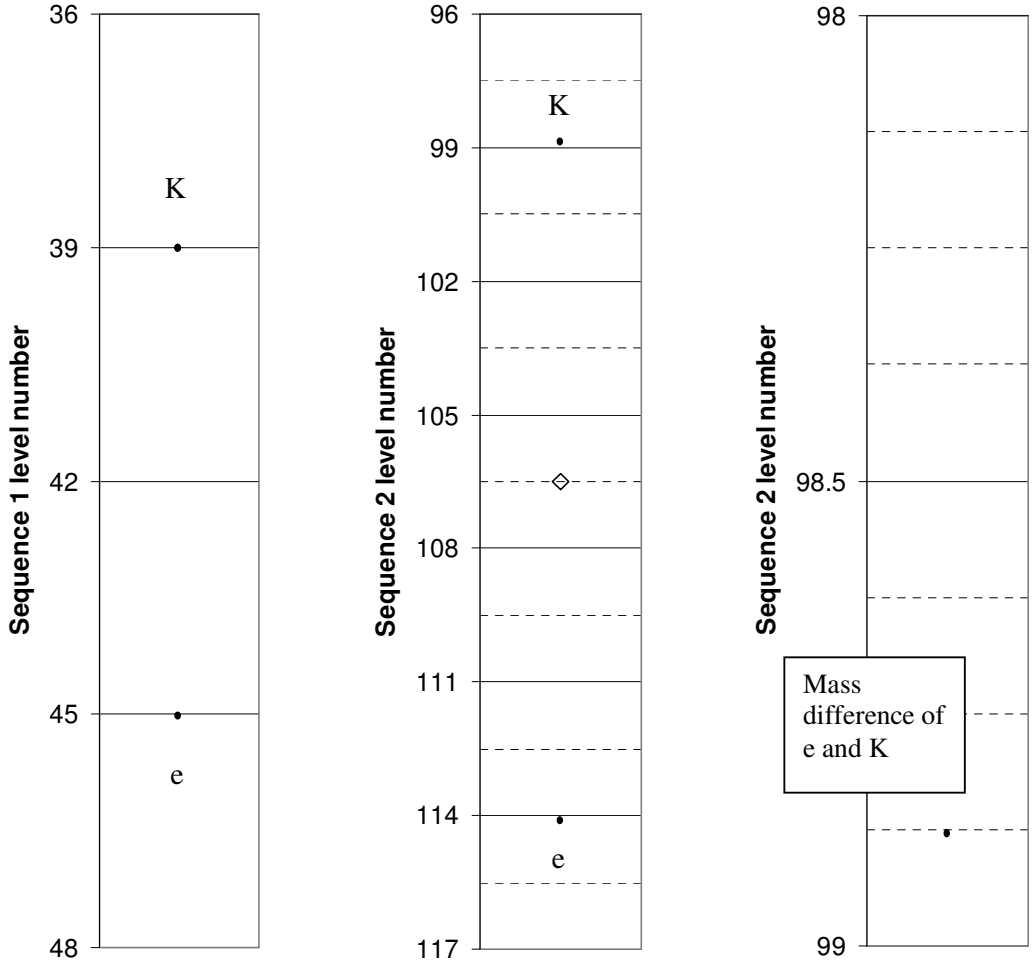

Figure 4: e-K partnership

2.5 Λ (uds) - K (u $\bar{s}$, d $\bar{s}$; $\bar{u}$ s, $\bar{d}$ s)

See Figure 5.

This partnership is centred upon a high order sublevel adjacent to Level 98 in Sequence 2. The geometric mean of the two masses is shown by a diamond. The mass difference of Σ^0 and K* is equal to the mass of a sublevel in Sequence 2.

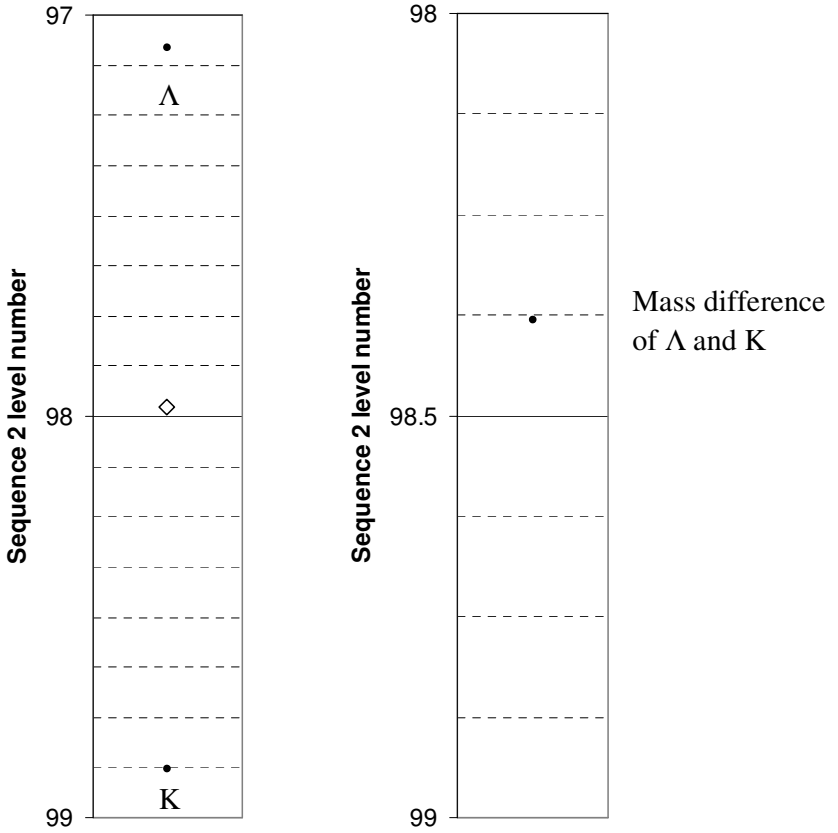

Figure 5: Λ-K partnership

2.6 $\rho\ (u\bar{d}, (u\bar{u} - d\bar{d})/\sqrt{2}, d\bar{u}) - \omega\ (c_1(u\bar{u} + d\bar{d}) + c_2(s\bar{s}))$

See Figure 7.

The mass-degenerate ρ mesons and the ω meson are arranged symmetrically about a sublevel in Sequence 2. The mass difference of ρ and ω is consistent with the mass of a sublevel in Sequence 2.

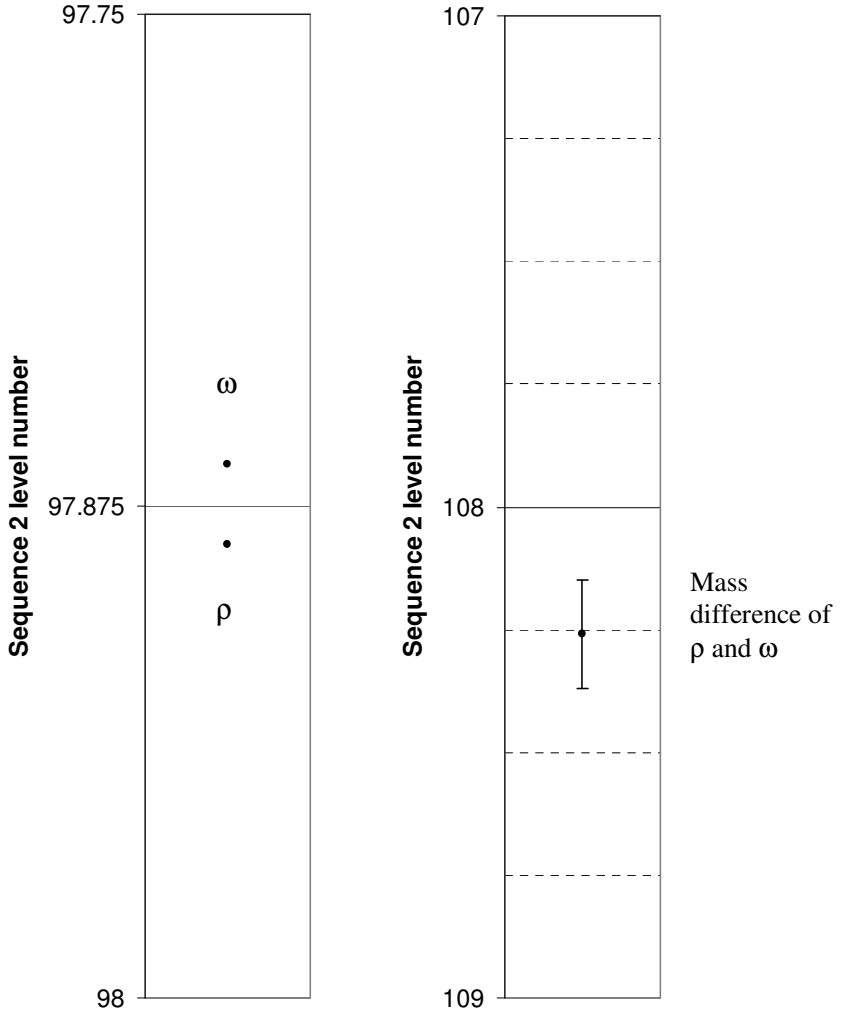

Figure 6: ρ-ω partnership

2.7 $\eta\,(c_1(u\bar{u} + d\bar{d}) + c_2(s\bar{s})) - \eta'\,(c_1(u\bar{u} + d\bar{d}) + c_2(s\bar{s}))$

The η and η' mesons form a partnership. The η-η' partnership is centred upon a high order sublevel adjacent to Level 98 in Sequence 2. The mass difference of η and η' is equal to the mass of a sublevel in Sequence 2.

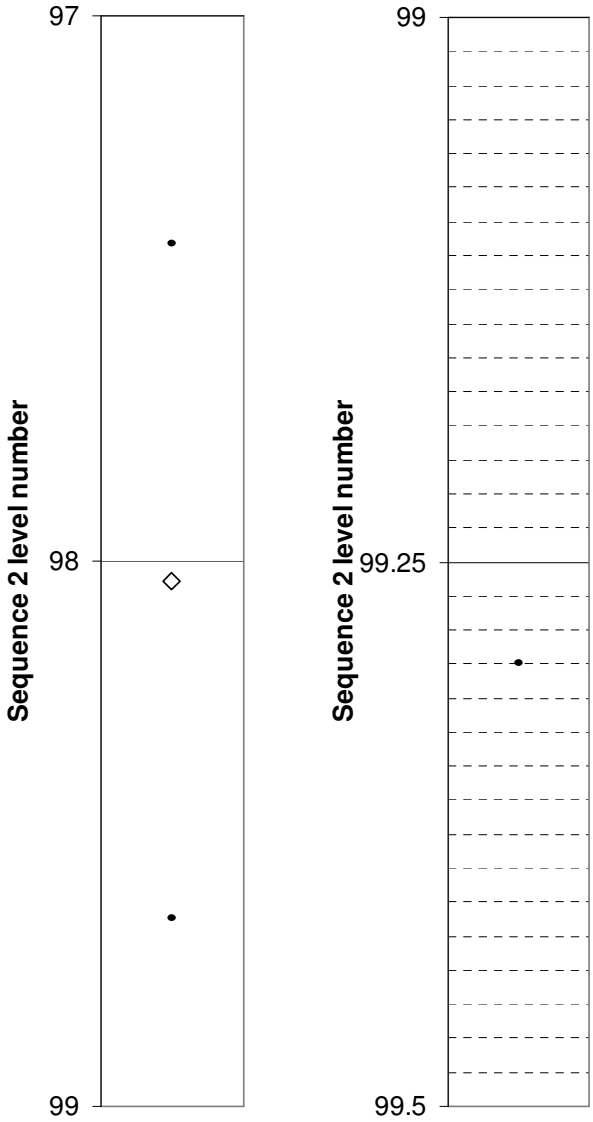

Figure 7: η-η' partnership

3. Partnerships involving pions

3.1 $\pi^0 (u\bar{u} - d\bar{d})\sqrt{2}) - \pi^{\pm} (u\bar{d}, d\bar{u})); \mu - \pi^{\pm}$

See Figure 8.

The neutral and charged pions are arranged symmetrically about a sublevel in Sequence 2. The geometric mean of the two masses is shown by a diamond. The mass difference of π^0 and $\pi^{\pm}$ is equal to the mass of a sublevel in Sequence 3. The sublevels lie within a sequence of common ratio $(1/e)^{1/3}$.

The partnerships between the muon and the charged pions are suggested by the data. The muon and the charged pions are arranged symmetrically about a sublevel in Sequence 2. The geometric mean of the two masses is shown by a diamond. The mass difference of μ and $\pi^{\pm}$ is equal to the mass of a sublevel in Sequence 3. The sublevels lie within a sequence of common ratio $(1/e)^{1/3}$.

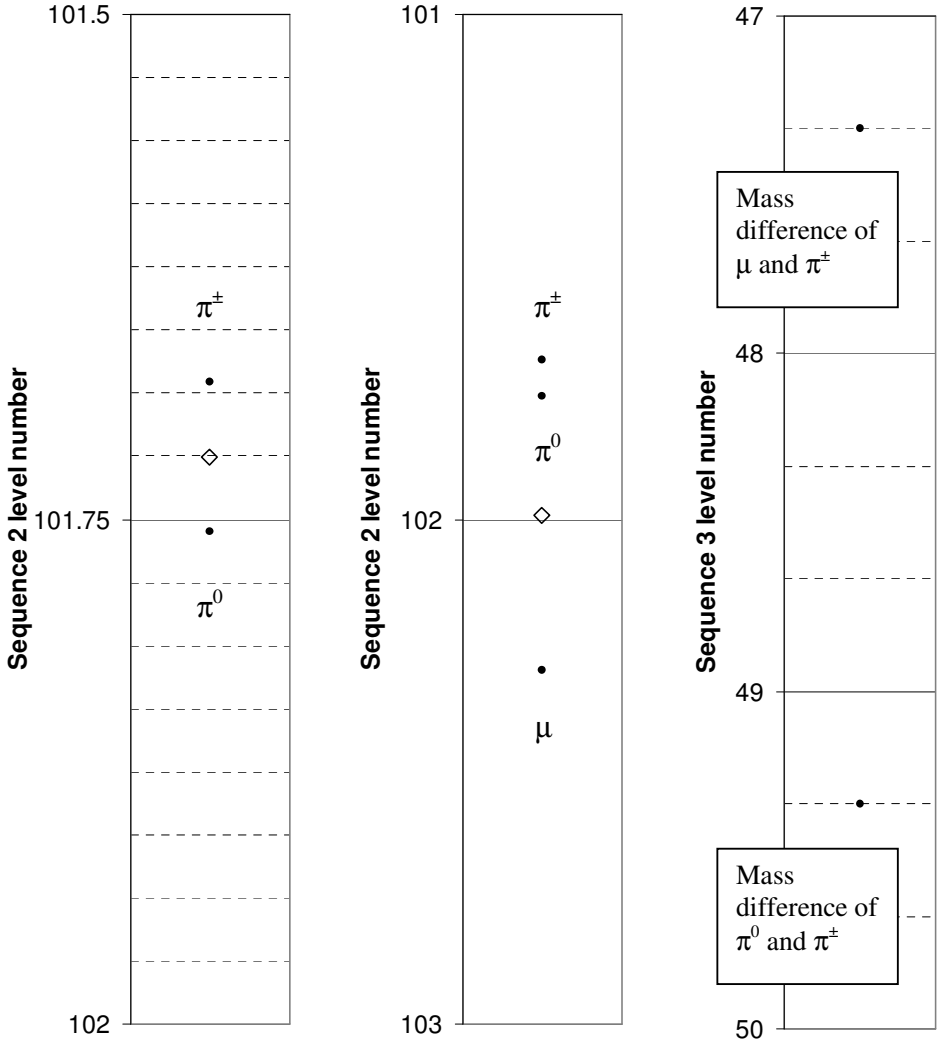

Figure 8: π^0-$\pi^{\pm}$ and μ-$\pi^{\pm}$ partnerships

4. Partners of the SU(3) $J^P = 0^-, ½^+$ and 1^- hadrons

All partnerships described above are shown in Figure 9. Partners are joined by lines. Isospin doublets behave as single particles and are shown in brackets. Partnerships in which one or both particles have some strange content are characterised by mass differences which are equal to the masses of levels or sublevels in Sequence 2. The partnerships involving pions are characterised by mass differences which are equal to the masses of sublevels in Sequence 3. Vertical relationships amongst the particles of Figure 9 have been described previously [1].

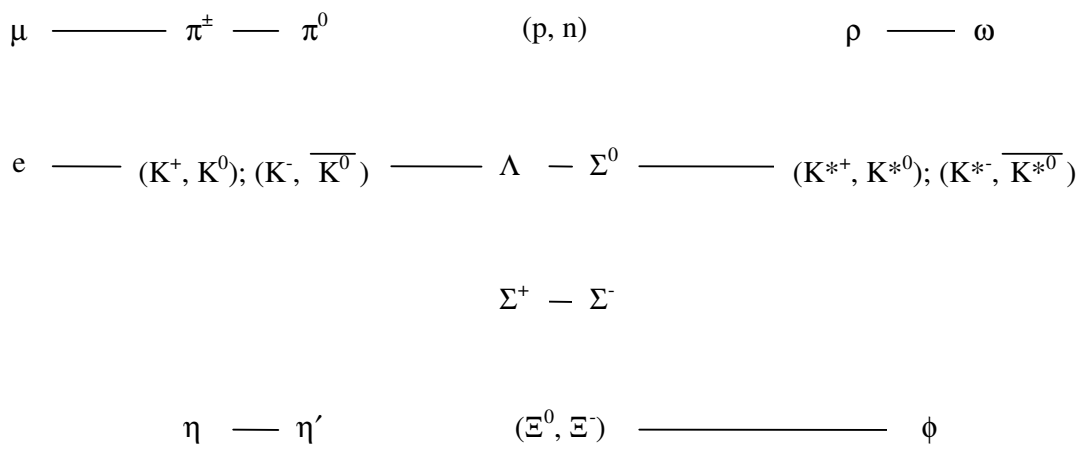

Figure 9: Partnerships described in this paper

Those baryon-baryon and baryon-vector meson partnerships in which both participants have strange content are characterised by mass differences equal to the masses of levels in Sequence 2. The Λ-Σ^0 and Ξ-ϕ partnerships are centred upon a level in Sequence 2 and may be deemed perfect partnerships. The uds baryons Λ and Σ^0 lie not only at the heart of the ground state baryon octet but also at the centre of a network of partnerships.

5. References

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