

EIGHTFOLD WAY

(an arrangement of strongly interacting particles)

M.Sc. (Physics) 4th Semester

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Hadron Classification Scheme

❖ By 1960, plethora of strongly interacting particles were divided into two families :

Baryons (fermion) and Mesons (boson)

❖ Members of each family were distinguished by :

charge(hypercharge (Υ)), strangeness (S) and mass

BUT LARGELY THERE WASN'T ANY ORDER OR SYSTEM

❖ In 1961, Gell-Mann & Ne'evman independently proposed an arrangement "*Eight-fold Way*" based on :

$SU(3)$ symmetry, Isospin(I), charge(Q) & Strangeness

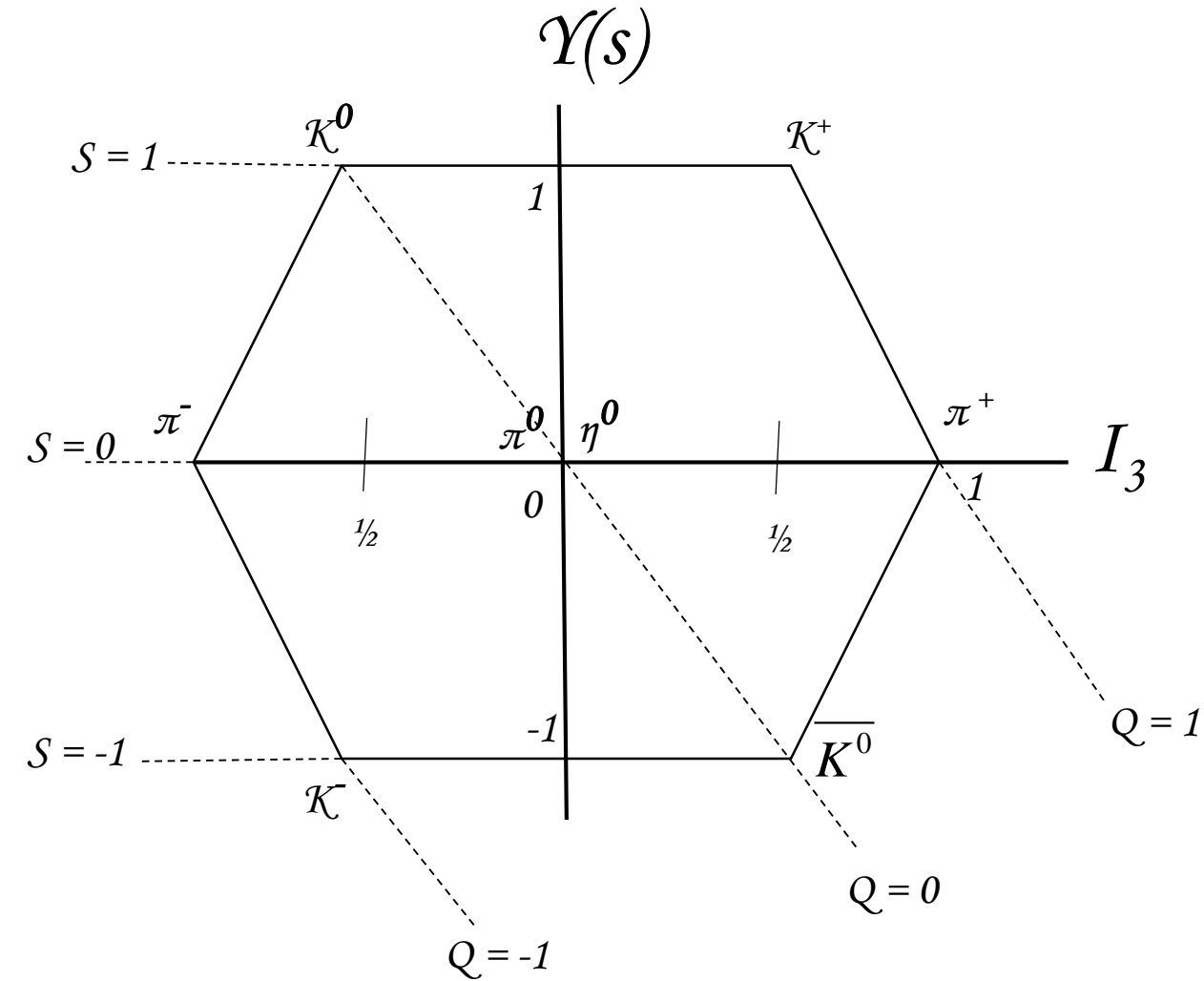
❖ These were :

(i). Pseudo scalar mesons ($J^P = 0^-$) (ii). Vector Mesons ($J^P = 1^-$)

(iii). Baryons ($J^P = \frac{1}{2}^+$) (ii). Baryon Resonances ($J^P = 3/2^+$)

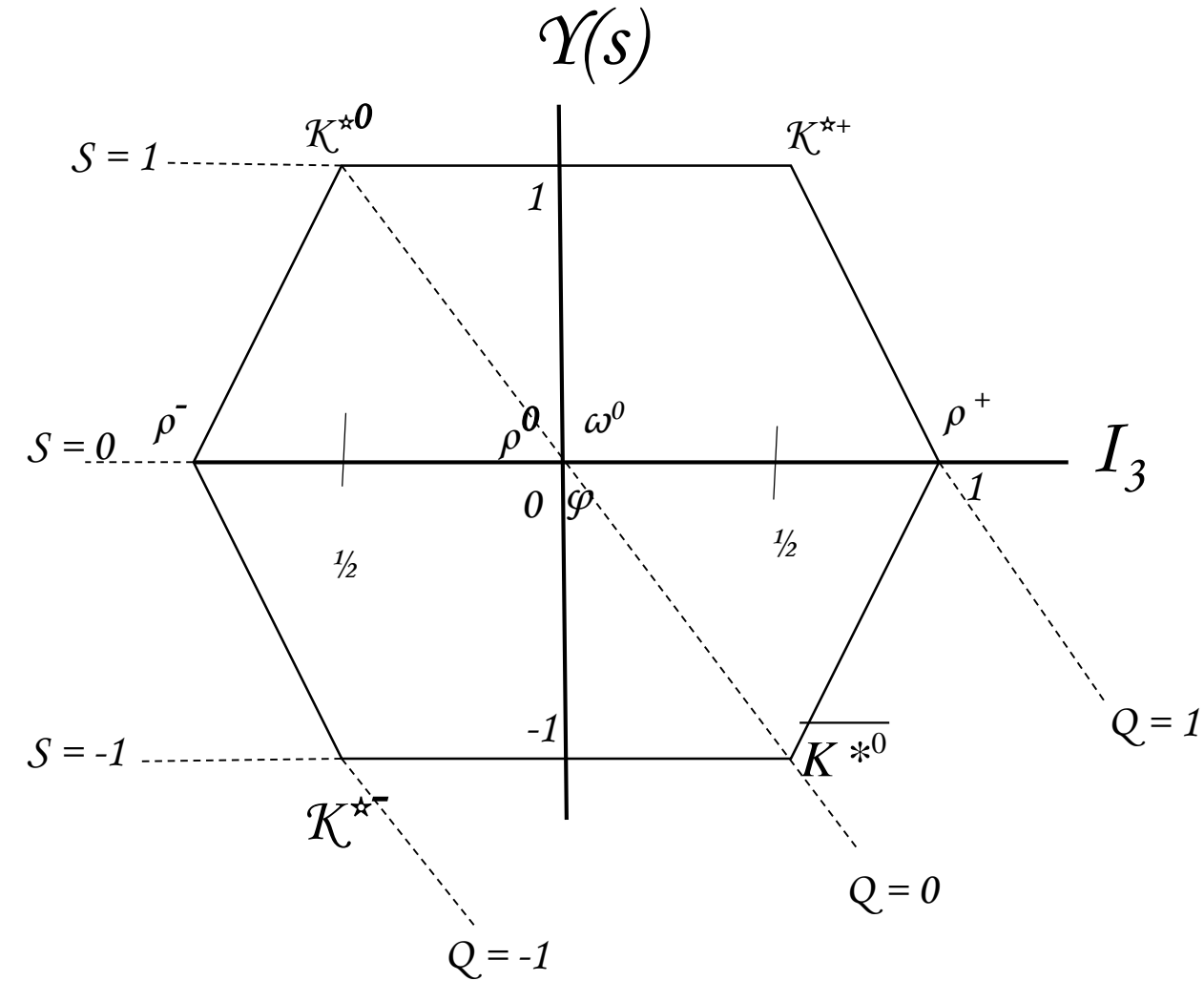
[**J** denotes spin and **p** denotes parity]

Pseudo Scalar Mesons octet



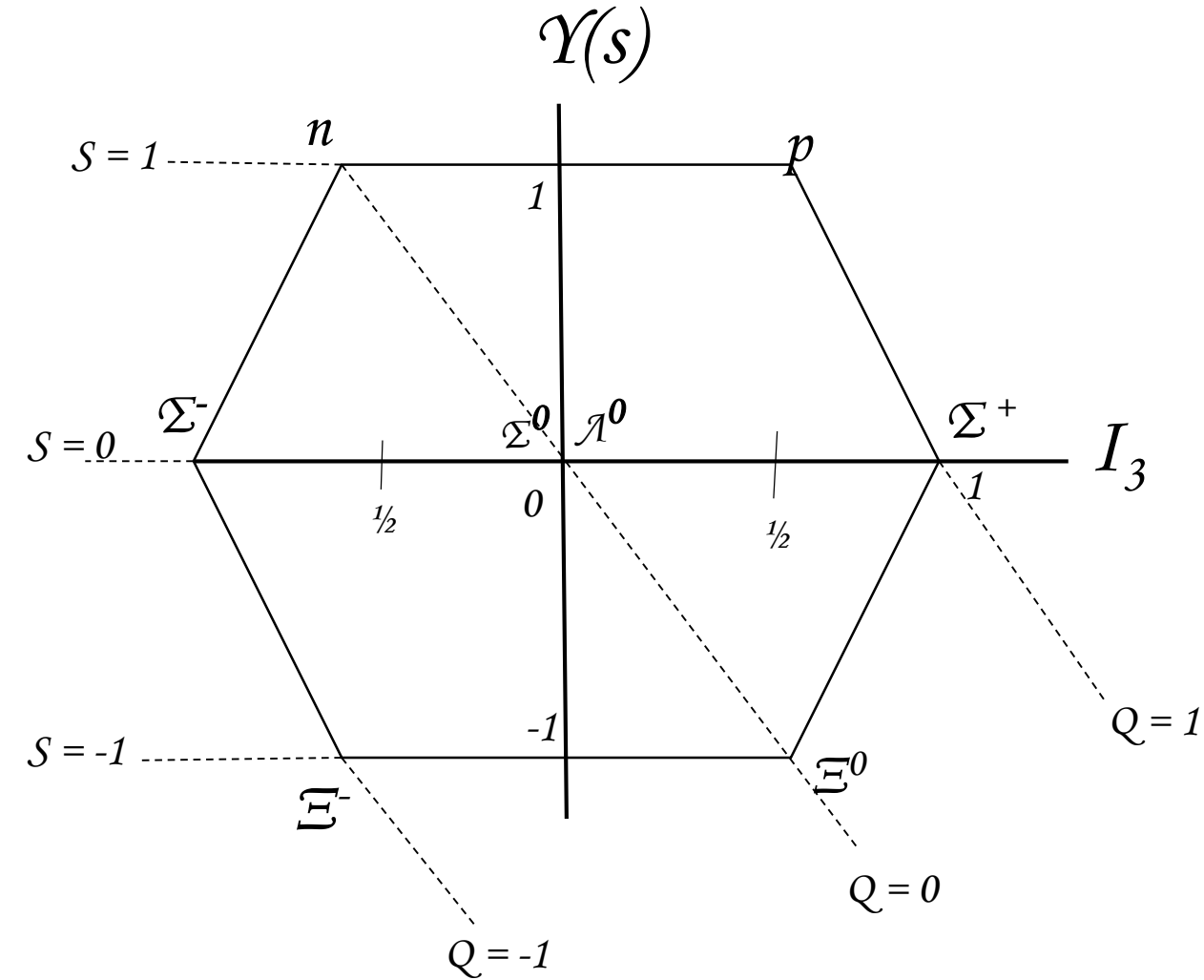
Particles	I	I_3	\mathcal{B}	S	$Y(=\mathcal{B}+S)$
π^+	1	1	0	0	0
π^0	1	0	0	0	0
π^-	1	-1	0	0	0
K^+	$1/2$	$1/2$	0	1	1
K^0	$1/2$	$-1/2$	0	1	1
K^-	$1/2$	$-1/2$	0	-1	-1
\bar{K}^0	$1/2$	$1/2$	0	-1	-1
η^0	0	0	0	0	0

Vector Mesons(nonet)



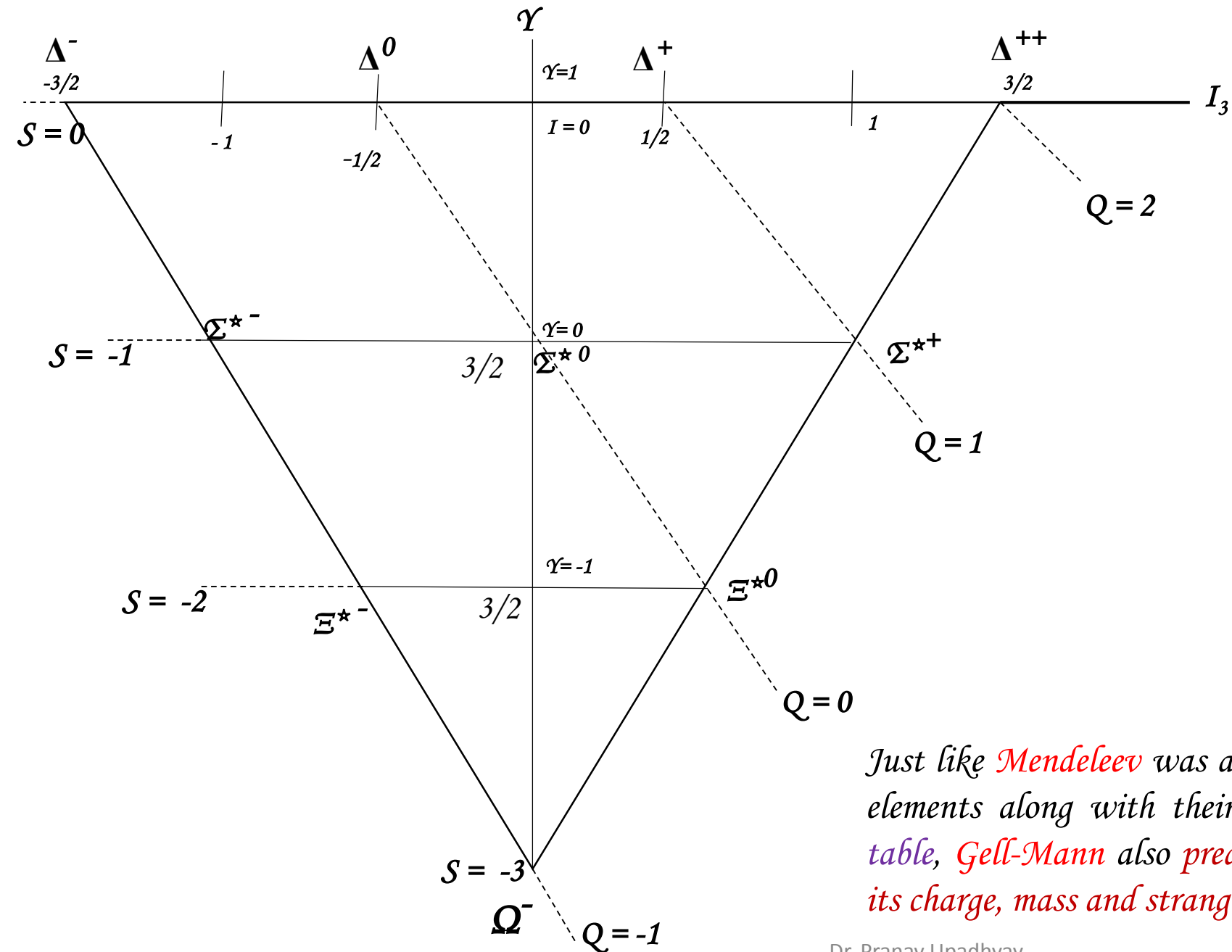
Particles	I	I_3	\mathcal{B}	S	$Y(=\mathcal{B}+S)$
ρ^+	1	1	0	0	0
ρ^0	1	0	0	0	0
ρ^-	1	-1	0	0	0
K^{*+}	$\frac{1}{2}$	$\frac{1}{2}$	0	1	1
K^{*0}	$\frac{1}{2}$	$-\frac{1}{2}$	0	1	1
K^{*-}	$\frac{1}{2}$	$-\frac{1}{2}$	0	-1	-1
\overline{K}^{*0}	$\frac{1}{2}$	$\frac{1}{2}$	0	-1	-1
ω^0	0	0	0	0	0
ϕ (after 1964)	0	0	0	0	0

Baryon Octet



Particles	I	I_3	\mathcal{B}	S	$\mathcal{Y}(=\mathcal{B}+S)$
p	$\frac{1}{2}$	$\frac{1}{2}$	1	0	1
n	$\frac{1}{2}$	$-\frac{1}{2}$	1	0	1
Σ^+	1	1	1	0	0
Σ^0	1	0	1	-1	0
Σ^-	1	-1	1	-1	0
Λ^0	$\frac{1}{2}$	$-\frac{1}{2}$	1	-1	0
Ξ^0	$\frac{1}{2}$	$\frac{1}{2}$	1	-2	-1
Ξ^-	$\frac{1}{2}$	$-\frac{1}{2}$	1	-2	-1

Baryon Resonances (Decuplet/Decimet)



Particles	I	I ₃	S	B	Y(=B+S)
Δ^{++}	3/2	3/2	0	1	1
Δ^+	3/2	1/2	0	1	1
Δ^0	3/2	-1/2	0	1	1
Δ^-	3/2	-3/2	0	1	1
Σ^{*+}	1	1	-1	1	-1
Σ^{*0}	1	0	-1	1	-1
Σ^{*-}	1	-1	0	1	0
Ξ^{*0}	1/2	1/2	-2	1	-1
Ξ^{*-}	1/2	-1/2	-2	1	-1
Ω^-	0	0	1	-3	-2

Just like *Mendeleev* was able to predict some of yet to be discovered elements along with their physical properties through his *periodic table*, *Gell-Mann* also predicted existence of omega (Ω^-) along with its charge, mass and strangeness with the help of 8-fold way.

Bibliography

- 1). *Introduction to Elementary Particles* by Griffiths D.
- 2). *Modern Physics* by Beiser A.
- 3). *Quarks* by Fritzsch H.
- 4). *Introduction to High Energy Physics* by Perkins D.H.