

Δ BARYONS

($S = 0, I = 3/2$)

$$\Delta^{++} = uuu, \quad \Delta^+ = uud, \quad \Delta^0 = udd, \quad \Delta^- = ddd$$

Δ(1232) P_{33}

$$I(J^P) = \frac{3}{2}(\frac{3}{2}^+)$$

Breit-Wigner mass (mixed charges) = 1231 to 1233 (≈ 1232) MeV

Breit-Wigner full width (mixed charges) = 116 to 120 (≈ 118) MeV

$$p_{\text{beam}} = 0.30 \text{ GeV}/c \quad 4\pi\lambda^2 = 94.8 \text{ mb}$$

Re(pole position) = 1209 to 1211 (≈ 1210) MeV

$-2\text{Im}(\text{pole position}) = 98$ to 102 (≈ 100) MeV

Δ(1232) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	100 %	229
$N\gamma$	0.52–0.60 %	259
$N\gamma$, helicity=1/2	0.11–0.13 %	259
$N\gamma$, helicity=3/2	0.41–0.47 %	259

Δ(1600) P_{33}

$$I(J^P) = \frac{3}{2}(\frac{3}{2}^+)$$

Breit-Wigner mass = 1550 to 1700 (≈ 1600) MeV

Breit-Wigner full width = 250 to 450 (≈ 350) MeV

$$p_{\text{beam}} = 0.87 \text{ GeV}/c \quad 4\pi\lambda^2 = 18.6 \text{ mb}$$

Re(pole position) = 1500 to 1700 (≈ 1600) MeV

$-2\text{Im}(\text{pole position}) = 200$ to 400 (≈ 300) MeV

Δ(1600) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	10–25 %	513
$N\pi\pi$	75–90 %	477
$\Delta\pi$	40–70 %	303
$N\rho$	<25 %	†
$N(1440)\pi$	10–35 %	82
$N\gamma$	0.001–0.02 %	525
$N\gamma$, helicity=1/2	0.0–0.02 %	525
$N\gamma$, helicity=3/2	0.001–0.005 %	525

$\Delta(1620) S_{31}$

$$I(J^P) = \frac{3}{2}(\frac{1}{2}^-)$$

Breit-Wigner mass = 1600 to 1660 (≈ 1630) MeVBreit-Wigner full width = 135 to 150 (≈ 145) MeV

$$p_{\text{beam}} = 0.93 \text{ GeV}/c \quad 4\pi\lambda^2 = 17.2 \text{ mb}$$

Re(pole position) = 1590 to 1610 (≈ 1600) MeV $-2\text{Im}(\text{pole position}) = 115 \text{ to } 120$ (≈ 118) MeV

$\Delta(1620)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	20–30 %	534
$N\pi\pi$	70–80 %	499
$\Delta\pi$	30–60 %	328
$N\rho$	7–25 %	†
$N\gamma$	0.004–0.044 %	545
$N\gamma$, helicity=1/2	0.004–0.044 %	545

 $\Delta(1700) D_{33}$

$$I(J^P) = \frac{3}{2}(\frac{3}{2}^-)$$

Breit-Wigner mass = 1670 to 1750 (≈ 1700) MeVBreit-Wigner full width = 200 to 400 (≈ 300) MeV

$$p_{\text{beam}} = 1.05 \text{ GeV}/c \quad 4\pi\lambda^2 = 14.5 \text{ mb}$$

Re(pole position) = 1620 to 1680 (≈ 1650) MeV $-2\text{Im}(\text{pole position}) = 160 \text{ to } 240$ (≈ 200) MeV

$\Delta(1700)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	10–20 %	581
$N\pi\pi$	80–90 %	550
$\Delta\pi$	30–60 %	386
$N\rho$	30–55 %	†
$N\gamma$	0.12–0.26 %	591
$N\gamma$, helicity=1/2	0.08–0.16 %	591
$N\gamma$, helicity=3/2	0.025–0.12 %	591

 $\Delta(1905) F_{35}$

$$I(J^P) = \frac{3}{2}(\frac{5}{2}^+)$$

Breit-Wigner mass = 1865 to 1915 (≈ 1890) MeVBreit-Wigner full width = 270 to 400 (≈ 330) MeV

$$p_{\text{beam}} = 1.42 \text{ GeV}/c \quad 4\pi\lambda^2 = 9.89 \text{ mb}$$

Re(pole position) = 1825 to 1835 (≈ 1830) MeV $-2\text{Im}(\text{pole position}) = 265 \text{ to } 300$ (≈ 280) MeV

$\Delta(1905)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	0.09 to 0.15	704
$N\pi\pi$	85–95 %	680
$\Delta\pi$	<25 %	531
$N\rho$	>60 %	397
$N\gamma$	0.01–0.03 %	712
$N\gamma$, helicity=1/2	0.0–0.1 %	712
$N\gamma$, helicity=3/2	0.004–0.03 %	712

 $\Delta(1910) P_{31}$

$$I(J^P) = \frac{3}{2}(\frac{1}{2}^+)$$

Breit-Wigner mass = 1870 to 1920 (≈ 1910) MeV
 Breit-Wigner full width = 190 to 270 (≈ 250) MeV
 $p_{\text{beam}} = 1.46 \text{ GeV}/c$ $4\pi\lambda^2 = 9.54 \text{ mb}$
 Re(pole position) = 1830 to 1880 (≈ 1855) MeV
 $-2\text{Im}(\text{pole position}) = 200$ to 500 (≈ 350) MeV

$\Delta(1910)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	15–30 %	717
$N\gamma$	0.0–0.2 %	725
$N\gamma$, helicity=1/2	0.0–0.2 %	725

 $\Delta(1920) P_{33}$

$$I(J^P) = \frac{3}{2}(\frac{3}{2}^+)$$

Breit-Wigner mass = 1900 to 1970 (≈ 1920) MeV
 Breit-Wigner full width = 150 to 300 (≈ 200) MeV
 $p_{\text{beam}} = 1.48 \text{ GeV}/c$ $4\pi\lambda^2 = 9.37 \text{ mb}$
 Re(pole position) = 1850 to 1950 (≈ 1900) MeV
 $-2\text{Im}(\text{pole position}) = 200$ to 400 (≈ 300) MeV

$\Delta(1920)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	5–20 %	723
ΣK	(2.10 ± 0.30) %	431

$\Delta(1930) D_{35}$

$$I(J^P) = \frac{3}{2}(\frac{5}{2}^-)$$

Breit-Wigner mass = 1900 to 2020 (≈ 1960) MeV
 Breit-Wigner full width = 220 to 500 (≈ 360) MeV
 $p_{\text{beam}} = 1.56 \text{ GeV}/c$ $4\pi\lambda^2 = 8.76 \text{ mb}$
 Re(pole position) = 1840 to 1960 (≈ 1900) MeV
 $-2\text{Im}(\text{pole position}) = 175 \text{ to } 360$ (≈ 270) MeV

$\Delta(1930)$ DECAY MODES	Fraction (Γ_i/Γ)	ρ (MeV/c)
$N\pi$	0.05 to 0.15	748
$N\gamma$	0.0–0.02 %	755
$N\gamma$, helicity=1/2	0.0–0.01 %	755
$N\gamma$, helicity=3/2	0.0–0.01 %	755

 $\Delta(1950) F_{37}$

$$I(J^P) = \frac{3}{2}(\frac{7}{2}^+)$$

Breit-Wigner mass = 1915 to 1950 (≈ 1930) MeV
 Breit-Wigner full width = 235 to 335 (≈ 285) MeV
 $p_{\text{beam}} = 1.50 \text{ GeV}/c$ $4\pi\lambda^2 = 9.21 \text{ mb}$
 Re(pole position) = 1870 to 1890 (≈ 1880) MeV
 $-2\text{Im}(\text{pole position}) = 220 \text{ to } 260$ (≈ 240) MeV

$\Delta(1950)$ DECAY MODES	Fraction (Γ_i/Γ)	ρ (MeV/c)
$N\pi$	0.35 to 0.45	729
$N\pi\pi$		706
$\Delta\pi$	20–30 %	560
$N\rho$	<10 %	442
$N\gamma$	0.08–0.13 %	737
$N\gamma$, helicity=1/2	0.03–0.055 %	737
$N\gamma$, helicity=3/2	0.05–0.075 %	737

 $\Delta(2420) H_{3,11}$

$$I(J^P) = \frac{3}{2}(\frac{11}{2}^+)$$

Breit-Wigner mass = 2300 to 2500 (≈ 2420) MeV
 Breit-Wigner full width = 300 to 500 (≈ 400) MeV
 $p_{\text{beam}} = 2.64 \text{ GeV}/c$ $4\pi\lambda^2 = 4.68 \text{ mb}$
 Re(pole position) = 2260 to 2400 (≈ 2330) MeV
 $-2\text{Im}(\text{pole position}) = 350 \text{ to } 750$ (≈ 550) MeV

$\Delta(2420)$ DECAY MODES	Fraction (Γ_i/Γ)	ρ (MeV/c)
$N\pi$	5–15 %	1023