

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) = 1230 to 1234 (≈ 1232) MeV

Breit-Wigner full width (mixed charges) = 115 to 125 (≈ 120) 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)
$N\pi$	>99 %	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 = 1615 to 1675 (≈ 1620) MeV
 Breit-Wigner full width = 120 to 180 (≈ 150) MeV
 $p_{\text{beam}} = 0.91 \text{ GeV}/c$ $4\pi\chi^2 = 17.7 \text{ mb}$
 Re(pole position) = 1580 to 1620 (≈ 1600) MeV
 $-2\text{Im}(\text{pole position}) = 100 \text{ to } 130$ (≈ 115) MeV

$\Delta(1620)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	20–30 %	527
$N\pi\pi$	70–80 %	492
$\Delta\pi$	30–60 %	320
$N\rho$	7–25 %	†
$N\gamma$	0.004–0.044 %	538
$N\gamma$, helicity=1/2	0.004–0.044 %	538

$\Delta(1700) D_{33}$

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

Breit-Wigner mass = 1670 to 1770 (≈ 1700) MeV
 Breit-Wigner full width = 200 to 400 (≈ 300) MeV
 $p_{\text{beam}} = 1.05 \text{ GeV}/c$ $4\pi\chi^2 = 14.5 \text{ mb}$
 Re(pole position) = 1620 to 1700 (≈ 1660) MeV
 $-2\text{Im}(\text{pole position}) = 150 \text{ to } 250$ (≈ 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 = 1870 to 1920 (≈ 1905) MeV
 Breit-Wigner full width = 280 to 440 (≈ 350) MeV
 $p_{\text{beam}} = 1.45 \text{ GeV}/c$ $4\pi\chi^2 = 9.62 \text{ mb}$
 Re(pole position) = 1800 to 1860 (≈ 1830) MeV
 $-2\text{Im}(\text{pole position}) = 230 \text{ to } 330$ (≈ 280) MeV

$\Delta(1905)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	5–15 %	714
$N\pi\pi$	85–95 %	690
$\Delta\pi$	<25 %	542
$N\rho$	>60 %	414
$N\gamma$	0.01–0.03 %	721
$N\gamma$, helicity=1/2	0.0–0.1 %	721
$N\gamma$, helicity=3/2	0.004–0.03 %	721

$\Delta(1910) P_{31}$

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

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
 $-2\text{Im}(\text{pole position}) = 200 \text{ to } 500$ (≈ 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
 $-2\text{Im}(\text{pole position}) = 200 \text{ to } 400$ (≈ 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 = 1920 to 1970 (≈ 1930) MeV
 Breit-Wigner full width = 250 to 450 (≈ 350) MeV
 $p_{\text{beam}} = 1.50 \text{ GeV}/c$ $4\pi\lambda^2 = 9.21 \text{ mb}$
 Re(pole position) = 1840 to 1940 (≈ 1890) MeV
 $-2\text{Im}(\text{pole position}) = 200 \text{ to } 300$ (≈ 250) MeV

$\Delta(1930)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	10–20 %	729
$N\gamma$	0.0–0.02 %	737
$N\gamma$, helicity=1/2	0.0–0.01 %	737
$N\gamma$, helicity=3/2	0.0–0.01 %	737

$\Delta(1950) F_{37}$

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

Breit-Wigner mass = 1940 to 1960 (≈ 1950) MeV
 Breit-Wigner full width = 290 to 350 (≈ 300) MeV
 $p_{\text{beam}} = 1.54$ GeV/c $4\pi\chi^2 = 8.91$ mb
 Re(pole position) = 1880 to 1890 (≈ 1885) MeV
 $-2\text{Im}(\text{pole position}) = 210$ to 270 (≈ 240) MeV

$\Delta(1950)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	35–40 %	742
$N\pi\pi$		719
$\Delta\pi$	20–30 %	575
$N\rho$	<10 %	463
$N\gamma$	0.08–0.13 %	749
$N\gamma$, helicity=1/2	0.03–0.055 %	749
$N\gamma$, helicity=3/2	0.05–0.075 %	749

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

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

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

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