

Δ BARYONS

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

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

Δ(1232) 3/2⁺

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

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

−2Im(pole position) = 98 to 102 (≈ 100) MeV

Breit-Wigner mass (mixed charges) = 1230 to 1234 (≈ 1232) MeV

Breit-Wigner full width (mixed charges) = 114 to 120 (≈ 117) MeV

Δ(1232) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	99.4 %	229
$N\gamma$	0.55–0.65 %	259
$N\gamma$, helicity=1/2	0.11–0.13 %	259
$N\gamma$, helicity=3/2	0.44–0.52 %	259
pe^+e^-	$(4.2 \pm 0.7) \times 10^{-5}$	259

Δ(1600) 3/2⁺

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

Re(pole position) = 1470 to 1590 (≈ 1520) MeV

−2Im(pole position) = 150 to 320 (≈ 280) MeV

Breit-Wigner mass = 1500 to 1640 (≈ 1570) MeV

Breit-Wigner full width = 200 to 300 (≈ 250) MeV

Δ(1600) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	8–24%	492
$N\pi\pi$	58–84 %	454
Δ(1232)π	58–82 %	276
Δ(1232)π, P-wave	72–82%	276
Δ(1232)π, F-wave	<2%	276
$N(1440)\pi$	17–27%	†
$N\gamma$	0.001–0.035 %	505
$N\gamma$, helicity=1/2	0.0–0.02 %	505
$N\gamma$, helicity=3/2	0.001–0.015 %	505

$\Delta(1620) 1/2^-$

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

Re(pole position) = 1590 to 1610 (≈ 1600) MeV
 $-2\text{Im}(\text{pole position}) = 80$ to 140 (≈ 110) MeV
 Breit-Wigner mass = 1590 to 1630 (≈ 1610) MeV
 Breit-Wigner full width = 110 to 150 (≈ 130) MeV

$\Delta(1620)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	25–35 %	520
$N\pi\pi$	>67 %	484
$\Delta(1232)\pi$, <i>D</i> -wave	44–72 %	311
$N\rho$	23–32%	†
$N\rho$, $S=1/2$, <i>S</i> -wave	23–32%	†
$N\rho$, $S=3/2$, <i>D</i> -wave	<0.04%	†
$N(1440)\pi$	<9 %	98
$N\gamma$, helicity=1/2	0.03–0.10 %	532

$\Delta(1700) 3/2^-$

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

Re(pole position) = 1640 to 1690 (≈ 1665) MeV
 $-2\text{Im}(\text{pole position}) = 200$ to 300 (≈ 250) MeV
 Breit-Wigner mass = 1690 to 1730 (≈ 1710) MeV
 Breit-Wigner full width = 220 to 380 (≈ 300) MeV

$\Delta(1700)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	10–20 %	588
$N\pi\pi$	>31 %	557
$\Delta(1232)\pi$	9–70 %	394
$\Delta(1232)\pi$, <i>S</i> -wave	5–54 %	394
$\Delta(1232)\pi$, <i>D</i> -wave	4–16 %	394
$N\rho$, $S=3/2$, <i>S</i> -wave	22–32%	†
$N(1520)\pi$, <i>P</i> -wave	1–5 %	133
$N(1535)\pi$	0.5–1.5 %	113
$\Delta(1232)\eta$	3–7 %	†
$N\gamma$	0.22–0.60 %	598
$N\gamma$, helicity=1/2	0.12–0.30 %	598
$N\gamma$, helicity=3/2	0.10–0.30 %	598

$\Delta(1900) 1/2^-$

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

Re(pole position) = 1830 to 1900 (≈ 1865) MeV–2Im(pole position) = 180 to 300 (≈ 240) MeVBreit-Wigner mass = 1840 to 1920 (≈ 1860) MeVBreit-Wigner full width = 180 to 320 (≈ 250) MeV

$\Delta(1900)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	4–12%	685
ΣK	seen	367
$N\pi\pi$	> 52%	660
$\Delta(1232)\pi$, D -wave	30–70%	509
$N\rho$	22–60 %	360
$N\rho$, $S=1/2$, S -wave	11–35%	360
$N\rho$, $S=3/2$, D -wave	11–25%	360
$N(1440)\pi$	3–32%	353
$N(1520)\pi$	2–10%	288
$\Delta(1232)\eta$	< 2%	251
$N\gamma$, helicity=1/2	0.06–0.43 %	693

 $\Delta(1905) 5/2^+$

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

Re(pole position) = 1750 to 1800 (≈ 1770) MeV–2Im(pole position) = 260 to 340 (≈ 300) MeVBreit-Wigner mass = 1855 to 1910 (≈ 1880) MeVBreit-Wigner full width = 270 to 400 (≈ 330) MeV

$\Delta(1905)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	9–15%	698
$N\pi\pi$	>65%	673
$\Delta(1232)\pi$	>48%	524
$\Delta(1232)\pi$, P -wave	8–43%	524
$\Delta(1232)\pi$, F -wave	40–58%	524
$N\rho$, $S=3/2$, P -wave	17–35%	385
$N(1535)\pi$	< 1 %	293
$N(1680)\pi$, P -wave	5–15%	133
$\Delta(1232)\eta$	2–6%	282
$N\gamma$	0.012–0.036 %	706
$N\gamma$, helicity=1/2	0.002–0.006 %	706
$N\gamma$, helicity=3/2	0.01–0.03 %	706

$\Delta(1910) 1/2^+$

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

Re(pole position) = 1800 to 1900 (≈ 1850) MeV–2Im(pole position) = 200 to 500 (≈ 350) MeVBreit-Wigner mass = 1850 to 1950 (≈ 1900) MeVBreit-Wigner full width = 200 to 400 (≈ 300) MeV

$\Delta(1910)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	10–30%	710
ΣK	4–14%	410
$\Delta(1232)\pi$	34–66%	539
$N(1440)\pi$	3–45%	386
$\Delta(1232)\eta$	5–13%	310
$N\gamma$, helicity=1/2	0.0–0.02 %	718

 $\Delta(1920) 3/2^+$

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

Re(pole position) = 1850 to 1950 (≈ 1900) MeV–2Im(pole position) = 200 to 400 (≈ 300) MeVBreit-Wigner mass = 1870 to 1970 (≈ 1920) MeVBreit-Wigner full width = 240 to 360 (≈ 300) MeV

$\Delta(1920)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	5–20 %	723
ΣK	2–6 %	431
$N\pi\pi$	>46 %	699
$\Delta(1232)\pi$	>46 %	553
$\Delta(1232)\pi$, <i>P</i> -wave	2–28 %	553
$\Delta(1232)\pi$, <i>F</i> -wave	44–72 %	553
$N(1440)\pi$, <i>P</i> -wave	4–86 %	403
$N(1520)\pi$, <i>S</i> -wave	<5 %	341
$N(1535)\pi$	<2 %	328
$N a_0(980)$	seen	41
$\Delta(1232)\eta$	5–17 %	336
$N\gamma$	0.01–0.84 %	731
$N\gamma$, helicity=1/2	0.0–0.42 %	731
$N\gamma$, helicity=3/2	0.01–0.42 %	731

$\Delta(1930) 5/2^-$

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

Re(pole position) = 1820 to 1880 (≈ 1850) MeV $-2\text{Im}(\text{pole position}) = 300$ to 450 (≈ 320) MeVBreit-Wigner mass = 1900 to 2000 (≈ 1950) MeVBreit-Wigner full width = 200 to 400 (≈ 300) MeV

$\Delta(1930)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	5–15 %	742
$N\gamma$	0.0–0.01 %	749
$N\gamma$, helicity=1/2	0.0–0.005 %	749
$N\gamma$, helicity=3/2	0.0–0.004 %	749

 $\Delta(1950) 7/2^+$

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

Re(pole position) = 1870 to 1890 (≈ 1880) MeV $-2\text{Im}(\text{pole position}) = 220$ to 260 (≈ 240) MeVBreit-Wigner mass = 1915 to 1950 (≈ 1930) MeVBreit-Wigner full width = 235 to 335 (≈ 285) MeV

$\Delta(1950)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	35–45 %	729
ΣK	0.3–0.5 %	441
$N\pi\pi$	37–77 %	706
$\Delta(1232)\pi$, <i>F</i> -wave	1–9 %	560
$N(1680)\pi$, <i>P</i> -wave	3–9 %	191
$\Delta(1232)\eta$	< 0.6 %	349
$N\gamma$	0.06–0.14 %	737
$N\gamma$, helicity=1/2	0.03–0.05 %	737
$N\gamma$, helicity=3/2	0.04–0.09 %	737

$\Delta(2200) 7/2^-$

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

Re(pole position) = 2050 to 2150 (≈ 2100) MeV
 $-2\text{Im}(\text{pole position}) = 260$ to 420 (≈ 340) MeV
 Breit-Wigner mass = 2150 to 2250 (≈ 2200) MeV
 Breit-Wigner full width = 200 to 500 (≈ 350) MeV

$\Delta(2200)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	2–8 %	894
ΣK	1–7 %	672
$N\pi\pi$	>45 %	876
$\Delta\pi$	>45 %	747
$\Delta\pi, D\text{-wave}$	>40 %	747
$\Delta\pi, G\text{-wave}$	5–25 %	747
$\Delta\eta, D\text{-wave}$	seen	614

$\Delta(2420) 11/2^+$

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

Re(pole position) = 2300 to 2500 (≈ 2400) MeV
 $-2\text{Im}(\text{pole position}) = 350$ to 550 (≈ 450) MeV
 Breit-Wigner mass = 2300 to 2600 (≈ 2450) MeV
 Breit-Wigner full width = 300 to 700 (≈ 500) MeV

$\Delta(2420)$ DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$N\pi$	5–10 %	1040