

# Δ BARYONS

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

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

### Δ(1232) P<sub>33</sub>

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

Breit-Wigner mass (mixed charges) = 1230 to 1234 ( $\approx 1232$ ) MeV

Breit-Wigner full width (mixed charges) = 115 to 125 ( $\approx 120$ ) MeV

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

Re(pole position) = 1209 to 1211 ( $\approx 1210$ ) MeV

−2Im(pole position) = 98 to 102 ( $\approx 100$ ) MeV

Δ(1232) DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	>99 %	227
$N\gamma$	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<sub>33</sub>

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

Breit-Wigner mass = 1550 to 1700 ( $\approx 1600$ ) MeV

Breit-Wigner full width = 250 to 450 ( $\approx 350$ ) MeV

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

Re(pole position) = 1500 to 1700 ( $\approx 1600$ ) MeV

−2Im(pole position) = 200 to 400 ( $\approx 300$ ) MeV

Δ(1600) DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	10–25 %	512
$N\pi\pi$	75–90 %	473
$\Delta\pi$	40–70 %	301
$N\rho$	<25 %	†
$N(1440)\pi$	10–35 %	74
$N\gamma$	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 ( $\approx 1620$ ) MeVBreit-Wigner full width = 120 to 180 ( $\approx 150$ ) MeV

$$p_{\text{beam}} = 0.91 \text{ GeV}/c \quad 4\pi\lambda^2 = 17.7 \text{ mb}$$

Re(pole position) = 1580 to 1620 ( $\approx 1600$ ) MeV $-2\text{Im}(\text{pole position}) = 100$  to 130 ( $\approx 115$ ) MeV

<b><math>\Delta(1620)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	20–30 %	526
$N\pi\pi$	70–80 %	488
$\Delta\pi$	30–60 %	318
$N\rho$	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 ( $\approx 1700$ ) MeVBreit-Wigner full width = 200 to 400 ( $\approx 300$ ) MeV

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

Re(pole position) = 1620 to 1700 ( $\approx 1660$ ) MeV $-2\text{Im}(\text{pole position}) = 150$  to 250 ( $\approx 200$ ) MeV

<b><math>\Delta(1700)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	10–20 %	580
$N\pi\pi$	80–90 %	547
$\Delta\pi$	30–60 %	385
$N\rho$	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 ( $\approx 1905$ ) MeV  
 Breit-Wigner full width = 280 to 440 ( $\approx 350$ ) MeV  
 $p_{\text{beam}} = 1.45 \text{ GeV}/c$        $4\pi\lambda^2 = 9.62 \text{ mb}$   
 Re(pole position) = 1800 to 1860 ( $\approx 1830$ ) MeV  
 $-2\text{Im}(\text{pole position}) = 230 \text{ to } 330$  ( $\approx 280$ ) MeV

<b><math>\Delta(1905)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	5–15 %	713
$N\pi\pi$	85–95 %	687
$\Delta\pi$	<25 %	542
$N\rho$	>60 %	421
$N\gamma$	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 ( $\approx 1910$ ) MeV  
 Breit-Wigner full width = 190 to 270 ( $\approx 250$ ) MeV  
 $p_{\text{beam}} = 1.46 \text{ GeV}/c$        $4\pi\lambda^2 = 9.54 \text{ mb}$   
 Re(pole position) = 1830 to 1880 ( $\approx 1855$ ) MeV  
 $-2\text{Im}(\text{pole position}) = 200 \text{ to } 500$  ( $\approx 350$ ) MeV

<b><math>\Delta(1910)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	15–30 %	716
$N\gamma$	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 ( $\approx 1920$ ) MeV  
 Breit-Wigner full width = 150 to 300 ( $\approx 200$ ) MeV  
 $p_{\text{beam}} = 1.48 \text{ GeV}/c$        $4\pi\lambda^2 = 9.37 \text{ mb}$   
 Re(pole position) = 1850 to 1950 ( $\approx 1900$ ) MeV  
 $-2\text{Im}(\text{pole position}) = 200 \text{ to } 400$  ( $\approx 300$ ) MeV

<b><math>\Delta(1920)</math> DECAY MODES</b>	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	5–20 %	722

**$\Delta(1930) D_{35}$** 

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

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

$\Delta(1930)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (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 ( $\approx 1950$ ) MeV  
 Breit-Wigner full width = 290 to 350 ( $\approx 300$ ) MeV  
 $p_{\text{beam}} = 1.54 \text{ GeV}/c$        $4\pi\lambda^2 = 8.91 \text{ mb}$   
 Re(pole position) = 1880 to 1890 ( $\approx 1885$ ) MeV  
 $-2\text{Im}(\text{pole position}) = 210 \text{ to } 270$  ( $\approx 240$ ) MeV

$\Delta(1950)$ DECAY MODES	Fraction ( $\Gamma_i/\Gamma$ )	$p$ (MeV/c)
$N\pi$	35–40 %	741
$N\pi\pi$		716
$\Delta\pi$	20–30 %	574
$N\rho$	<10 %	469
$N\gamma$	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 ( $\approx 2420$ ) MeV  
 Breit-Wigner full width = 300 to 500 ( $\approx 400$ ) MeV  
 $p_{\text{beam}} = 2.64 \text{ GeV}/c$        $4\pi\lambda^2 = 4.68 \text{ mb}$   
 Re(pole position) = 2260 to 2400 ( $\approx 2330$ ) MeV  
 $-2\text{Im}(\text{pole position}) = 350 \text{ to } 750$  ( $\approx 550$ ) MeV

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