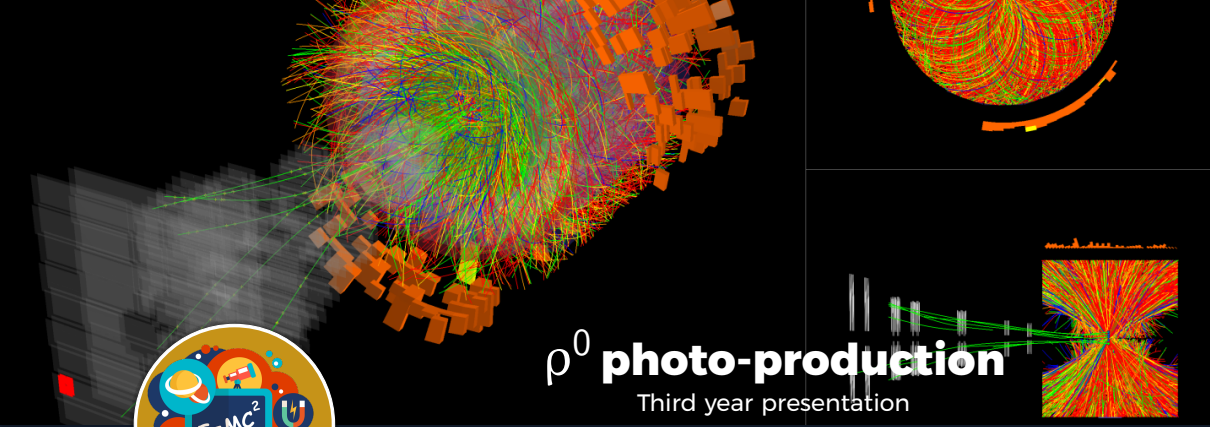


ρ^0 photo-production

Third year presentation

Gitika Bhalla

January 17, 2020

The ρ^0 meson

Vector meson

Quark content

$$\frac{1}{\sqrt{2}}(u\bar{u} - d\bar{d})$$

Rest Mass

$775.49 \pm 0.34 \text{MeV}$

Mean Life

$\sim 4.5 \times 10^{-24}$

The ρ^0 meson

Vector meson

$J^P = 1^{--}$

Quark content

$$\frac{1}{\sqrt{2}}(u\bar{u} - d\bar{d})$$

Rest Mass

$775.49 \pm 0.34 \text{MeV}$

Mean Life

$\sim 4.5 \times 10^{-24}$

Vector meson cross sections

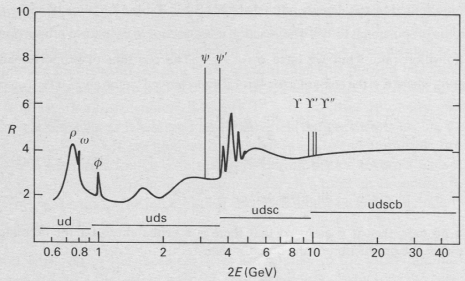
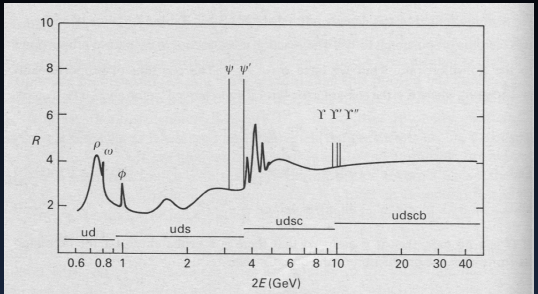


Fig. 10.11 The ratio

$$R = \frac{\text{cross-section for } e^+e^- \to \text{hadrons}}{\text{cross-section for } e^+e^- \to \mu^+\mu^-}$$

as a function of the total centre-of-mass energy $W = 2E$ (each beam has energy E). The curve is drawn through many measured points and represents only a rough average; however, it does reproduce the major features. The peaks are labelled by the conventional symbol representing that vector meson. The narrow peaks due to the ψ and Υ families are shown as vertical lines; the actual values of the peak cross-section are not represented. The above-$B\bar{B}$ threshold Υ states are omitted. The horizontal lines marked with quark flavours are the values expected away from resonances and in the absence of colour.

Vector meson cross sections



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1. Large ρ^0 width
2. Overlap with ω resonance

The photoproduction process

Photon Flux

The bigger the better. We want lots of virtual photons.

1

Color dipole

Ultra-periferal collision. Virtual photons from one nucleus interact with the other. QCD happens here. This is what we want to probe.

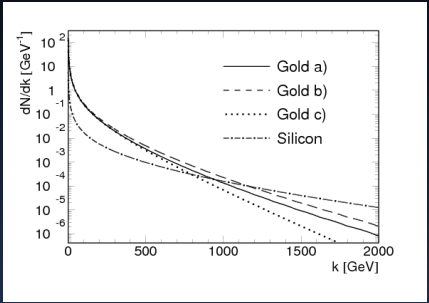
2

Extra Processes

Nuclei still interact with each other after the ”main event”. Sometimes we use these for triggering. Sometimes they mess everything up.

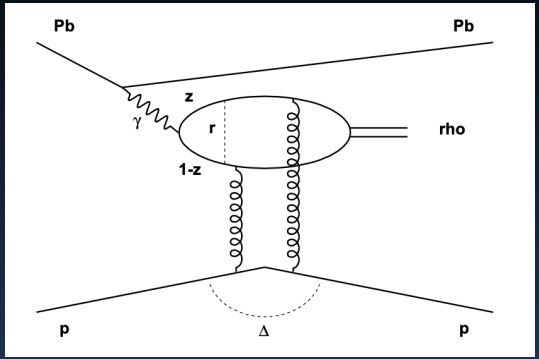
3

Photon Flux



$$\frac{dN_\gamma(\omega)}{d\omega} = \frac{2Z^2\alpha}{\pi\omega}(XK_0(X)K_1(X) - \frac{X^2}{2}(K_1^2(X) - K_0^2(X))$$

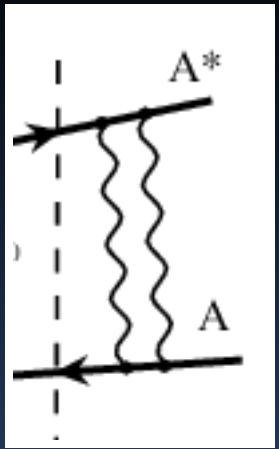
Color dipole



1. Coherent interaction with whole nucleus → meson with low p_T and nucleus remains

2. Incoherent interaction with only one nucleon. → high p_T meson and nucleus breakdown

Mutual Coulomb Excitation

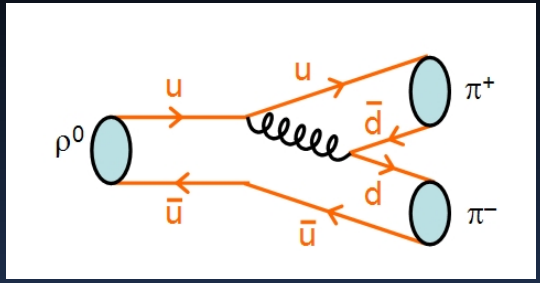


1. Nuclei exchange photons and excite each other
2. Excited nuclei breakdown and forward neutrons at very forward rapidities

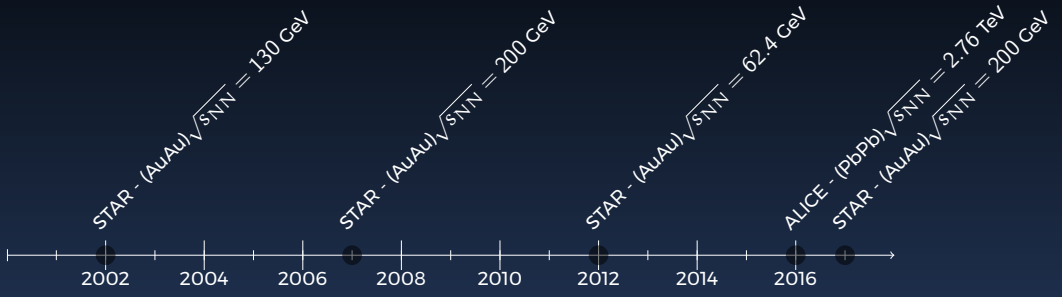
^{0}life

$\rho(770)^0$ decays

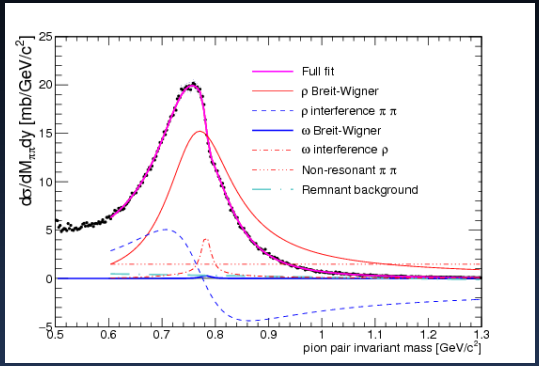
Γ_6	$\pi^+\pi^-$		$\sim$ 100	%	
Γ_7	$\pi^+\pi^-\gamma$		(9.9 $\pm$1.6)	$\times 10^{-3}$	
Γ_8	$\pi^0\gamma$		(4.7 $\pm$0.6)	$\times 10^{-4}$	S=1.4
Γ_9	$\eta\gamma$		(3.00$\pm$0.21)	$\times 10^{-4}$	
Γ_{10}	$\pi^0\pi^0\gamma$		(4.5 $\pm$0.8)	$\times 10^{-5}$	
Γ_{11}	$\mu^+\mu^-$	[a]	(4.55$\pm$0.28)	$\times 10^{-5}$	
Γ_{12}	e^+e^-	[a]	(4.72$\pm$0.05)	$\times 10^{-5}$	
Γ_{13}	$\pi^+\pi^-\pi^0$		($1.01^{+0.54}_{-0.36}\pm0.34$)	$\times 10^{-4}$	
Γ_{14}	$\pi^+\pi^-\pi^+\pi^-$		(1.8 $\pm$0.9)	$\times 10^{-5}$	
Γ_{15}	$\pi^+\pi^-\pi^0\pi^0$		(1.6 $\pm$0.8)	$\times 10^{-5}$	
Γ_{16}	$\pi^0 e^+ e^-$		< 1.2	$\times 10^{-5}$	CL=90%
Γ_{17}	$\eta e^+ e^-$				



Previous Research



Fitting data



The Breit-Wigner, Söding interference and momentum dependent width

$$BW = \frac{M_{\pi\pi} M_\rho \Gamma_\rho}{(M_\rho^2 - M_{\pi\pi}^2)^2 + M_\rho^2 \Gamma_\rho^2},$$

$$I(M_{\pi\pi}) = \frac{M_\rho^2 - M_{\pi\pi}^2}{(M_\rho^2 - M_{\pi\pi}^2)^2 + M_\rho^2 \Gamma_\rho^2}$$

$$\Gamma_\rho = \Gamma_0 \cdot (M_\rho / M_{\pi\pi}) \frac{M_{\pi\pi}^2 - 4m_\pi^2}{(M_\rho^2 - 4m_\pi^2)^{3/2}}$$

Where are we now?

Thank you

Especially to those whose art and graphs and everything else I stole.