

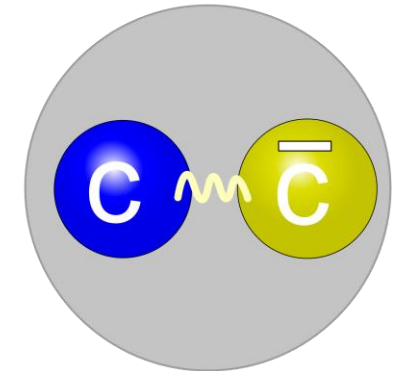
# $J/\psi$

## The hidden charm

GraSPA Summer School 2024

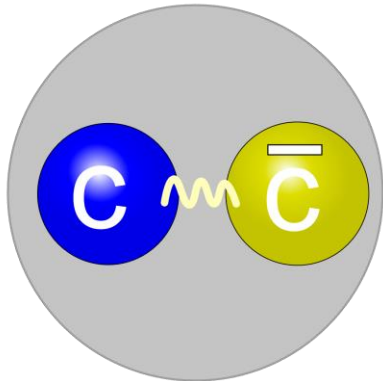
22/07/2024

Bárbara Lopes Pereira



# $J/\psi$ : Introduction

Charmonium



$J/\psi$

$$M_{J/\psi} = 3.098 \text{ GeV}$$

$J/\psi$  production mechanism

gluon – gluon fusion

$q - \bar{q}$  annihilation

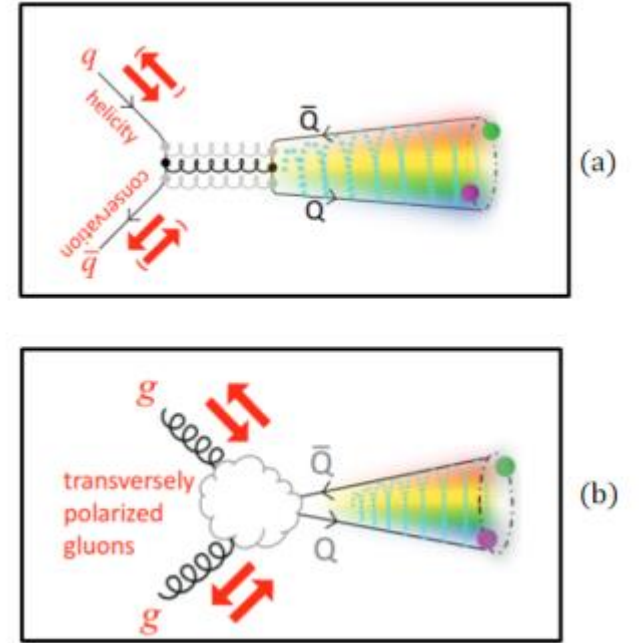
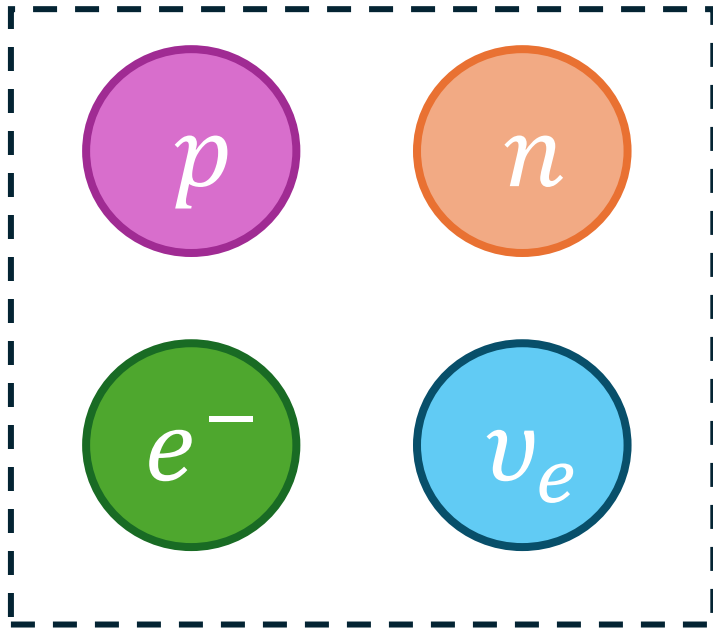


Figure 1 - Illustrative scheme of the production mechanisms of  $J/\psi$ : (a) quark-antiquark annihilation; (b) gluon-gluon fusion.

Image courtesy of P. Faccioli

# $J/\psi$ : Before the Discovery

1930



1936

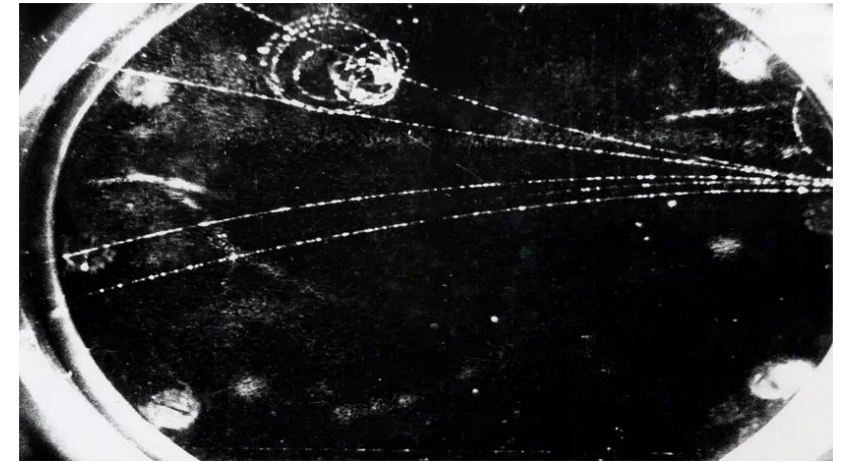


Figure 2 – Picture of a Cosmic Ray shower taken by Carl Anderson in 1930s.

# $J/\psi$ : Discovery

Burton Richter



SLAC National Accelerator  
Laboratory, California, USA

11/09/1974

Announcement of the discovery of a  
new heavy meson

1976

Ritcher and Ting receive jointly the  
Nobel Prize

Samuel Ting



MIT , Massachusetts, USA

# $J/\psi$ : Discovery

Samuel Ting



MIT, Massachusetts,  
USA

## AGS Experiment



Figure 2 - Brookhaven's Alternating Gradient Synchrotron (AGS). Image from 1960.

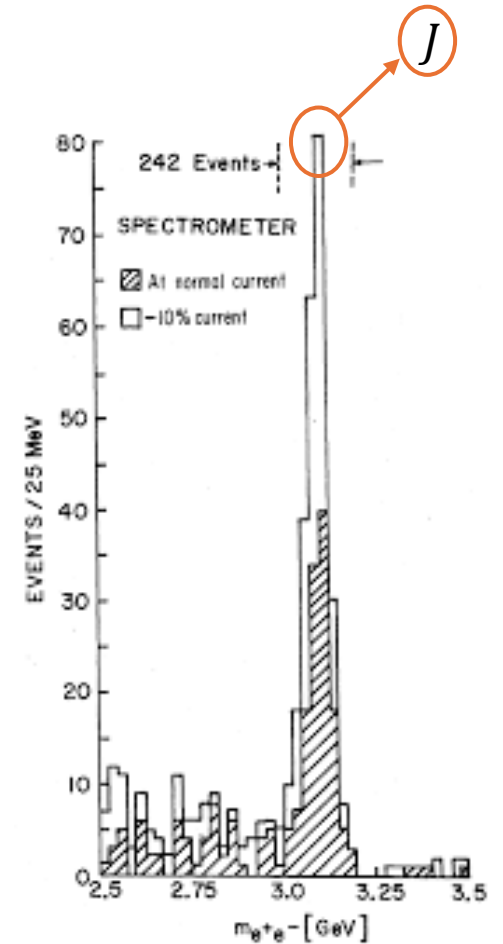
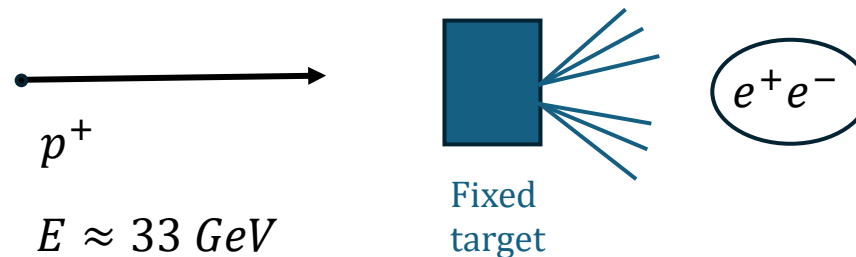


Figure 3 - Invariant Mass spectrum of electron-positron pairs, from Samuel Ting experiment.

# $J/\psi$ : Discovery

Burton Richter



SLAC National Accelerator  
Laboratory, California, USA

## Stanford Positron-Electron Asymmetric Ring (SPEAR)

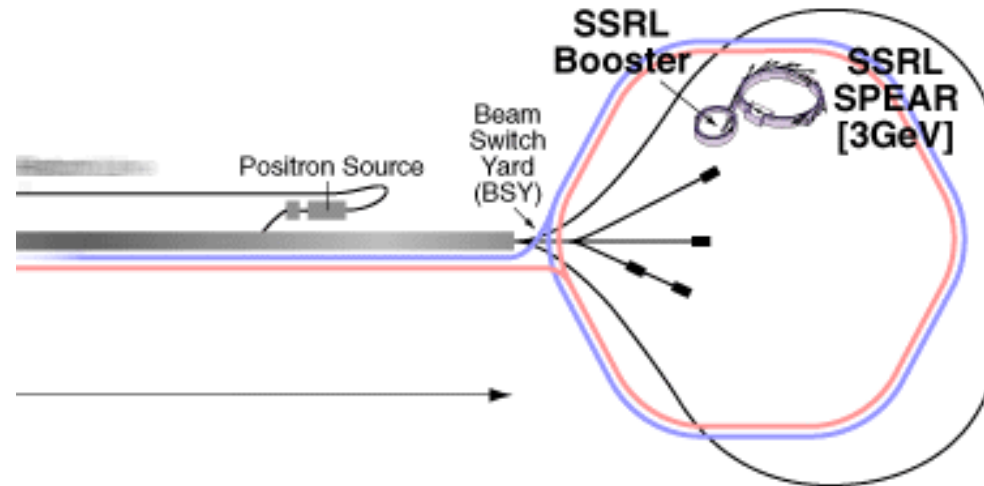


Figure 4 – Stanford Positron-Electron  
Asymmetric Ring (SPEAR) .

$e^+e^-$  Colisions

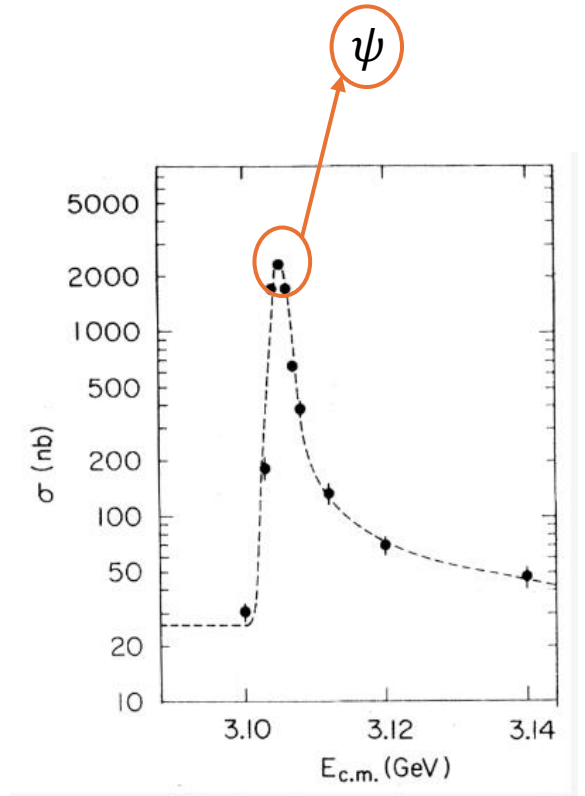


Figure 4 – Cross section for  $e^+e^-$   
annihilation at Stanford Positron-  
Electron Asymmetric Ring  
(SPEAR) .

# J/ $\psi$ : How it affected Particle Physics

## “November Revolution”

- Discovery of a new quark flavor ( charm ,  $c$ )
- Reshape of Standard Model

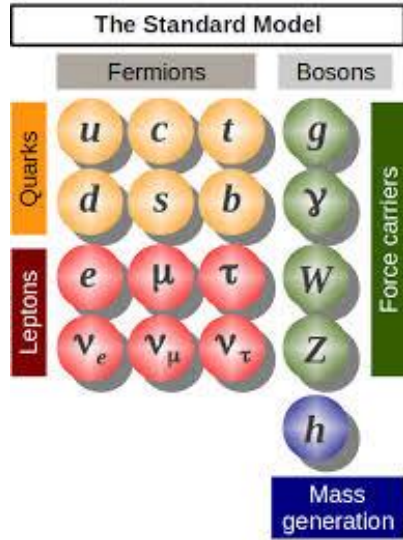


Figure 5 – Scheme that illustrates the Standard Model

## COMPASS&AMBER approach

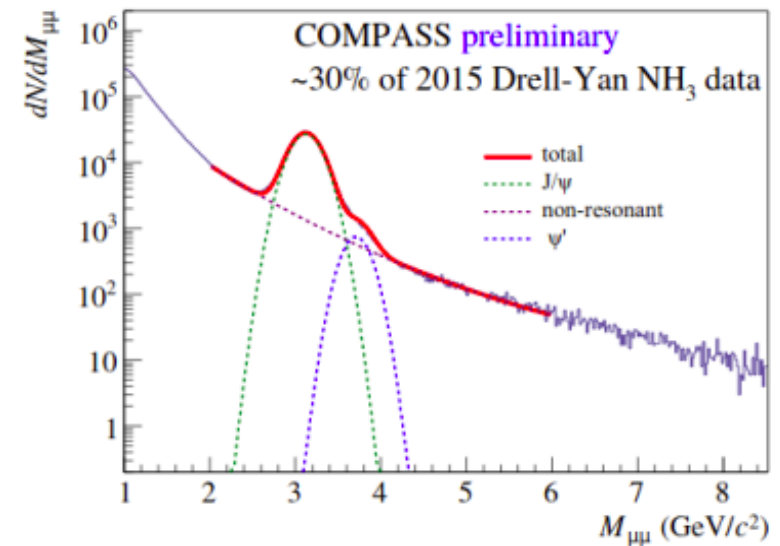


Figure 6 - Dimuon invariant mass spectrum from the NH<sub>3</sub> target, obtained by the COMPASS experiment in 2015.

# Bibliographic References

1. J. W. Qiu, X. P. Wang and H. Xing, Chin. Phys. Lett. 38 (2021) no.4, 041201 doi:10.1088/0256-307X/38/4/041201 [arXiv:2005.10832 [hep-ph]]



Thank you!

Questions?

# Back-up Slides

# Ting Character



# COMPASS Dimuon Mass Fit

