Branching Fractions for Transitions of ψ(2S) to J/ψ

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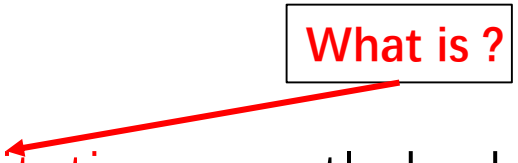
Motivation



- About 4/5 of all ψ(2S) decays are through de-excitation, mostly by hadronic transition to the J/ψ, but also through radiative decay to the χ_{cJ} states.
- The transitions listed in the article can be used to isolate and study lower-lying ccbar states, which are ψ(2S)→h+ J/ψ, h denotes $\pi^+\pi^-$, $\pi^0\pi^0$, η(→γγ, $\pi^+\pi^-\pi^0$), π^0), ψ(2S)→anything+ J/ψ, and ψ(2S)→γ+χ_{cJ}→ γ+ γ+ J/ψ.(I will only talk about ψ(2S)→anything+ J/ψ here)
- The first comprehensive look at all transitions simultaneously by a single experiment was reported by CLEO in 2005; absolute measurements were limited by a 3% uncertainty in the number of ψ(2S) produced, and many ratios of rates were limited by statistics.
- Further investigations with a larger dataset and improved systematic uncertainties are certainly warranted.

Data Sets

- We use e^+e^- collision data at and below the ψ(2S) resonance, E_{cm} = 3.686GeV ($\int Ldt = 53.8pb^{-1}$, corresponding to 27M ψ(2S) decays) and E_{cm} = 3.670GeV ("continuum" data, $\int Ldt = 20.6pb^{-1}$).

ψ(2S)→anything+J/ψ

Can't understand the meaning of this sentence and why we have to take E/p as a criteria as well as the difference between electron and muon.

- the J/ψ is identified through its decay to $\mu^+\mu^-$ or e^+e^-.

➢ Selection criteria

- $|cos\theta_{trk}| < 0.83$ for both lepton tracks, where the polar angle θ is measured with respect to the positron direction of incidence.
- The ratios of calorimeter shower energy to track momentum, E/p, for the lepton candidates, taken to be the two tracks of highest momentum in the event, must be larger than 0.85 for one electron and above 0.5 for the other, or in the case of muons smaller than 0.25 for one and below 0.5 for the other.

ψ(2S)→anything+ J/ψ

➢ Selection criteria

How can we regard this photon as bremsstrahlung photon safely? And how can we determine which candidate need to be dealt?

- In order to salvage lepton pairs that have radiated photons and would hence lose too much energy to remain identifiable as a J/ψ, we add bremsstrahlung photon candidates found within a cone of 100mrad to the three-vector of each lepton track at the interaction point (IP). The J/ψ candidate is retained only if constrained fits to the two tracks and bremsstrahlung candidates to a common vertex and to the mass of the J/ψ fulfil χ^2_V /d.o.f. < 20 and χ^2_M/d.o.f. < 20, respectively. The χ^2_M/d.o.f. restriction corresponds roughly to demanding that the dilepton mass lie between 3.03 and 3.16 GeV.

What is ?

- Cosmic ray background is rejected based on the distance of the track impact parameters to the event interaction point (< 2mm), and on the J/ψ momentum ($p_{J/\psi}$> 50MeV/c).

Why should we require J/ψ momentum instead of TOF?

ψ(2S)→anything+ J/ψ

➢ Selection criteria

Why?

- To suppress background from continuum reactions we require $p_{J/\psi}$<570MeV.
- Radiative lepton pair production and radiative returns to the J/ψ (e^+e^-→γJ/ψ) are suppressed by requiring $|cos\theta_{J/\psi}| < 0.98$ and for the dielectron mode by demanding $|cos\theta_{e^+}| < 0.5$.

- After these requirements, the event samples are clean. This is demonstrated for ψ(2S)→anything+J/ψ (next page).

How can we see that from picture?

ψ(2S)→anything+ J/ψ

In this picture, I don't understand that why we require $|cos\theta_{e+}|<0.5$, there still are events beyond that?

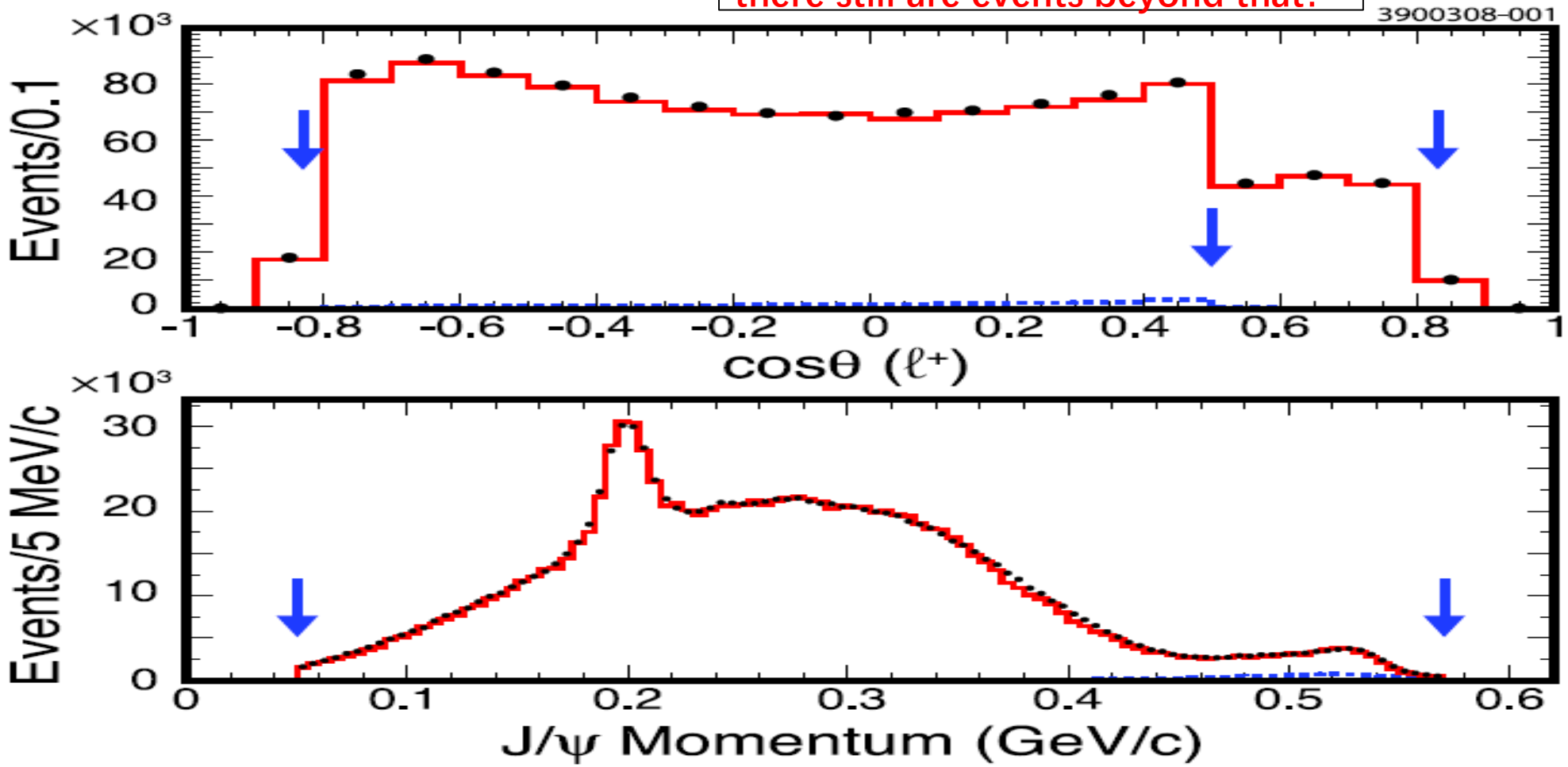


FIG. 1: Distributions relevant to any + J/ψ. Top: polar angle of the positive lepton. For e^+e^- only, we demand $\cos\theta_{e^+} < 0.5$ to suppress Bhabha events with initial/final state radiation or bremsstrahlung in detector material. Bottom: J/ψ momentum. Solid circles show the on-$\psi(2S)$ data, dashed histogram the continuum data (scaled by luminosity and $1/s$) taken at $E_{\rm cm}$ =3.67 GeV, the solid histogram represents the sum of all MC exclusive channels (scaled to match the data in signal modes). Arrows appear at nominal selection values.

What is?