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Search for the decay J/psi->gam+invisible

XIAO Suyu from IHEP

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Introduction

- A search for J/psi rediative decay to weakly interacting neutral final states was performed using the CLEO-c detector at the Cornell Electron Storage Ring.
- J/psi events were selected by observing the hadronic decay psi(2S)->π+π-J/psi.
- A total of 3.7*10^6 J/psi events were used to study the decay J/psi->gam+X, where X is a narrow state that is invisible to detector.

Selection

- J/psi events were tagged by measuring the charged pions from psi(2S)->π+π- J/psi.
- All events with additional charged tracks beyong the tagging pions were rejected.
- Transition pions were required to have differential energy loss signatures consistent with a pion, and their trajectories were required to form a single decay vertex close to the ee interaction point.
- individual pion momentum vectors were required to lie in the central region of the detector with $|\cos\theta| < 0.83$, where θ is measured relative to the beam axis, and the summed momentum vector for each pion pair was required to have $|\cos\theta'| < 0.95$.

Selection

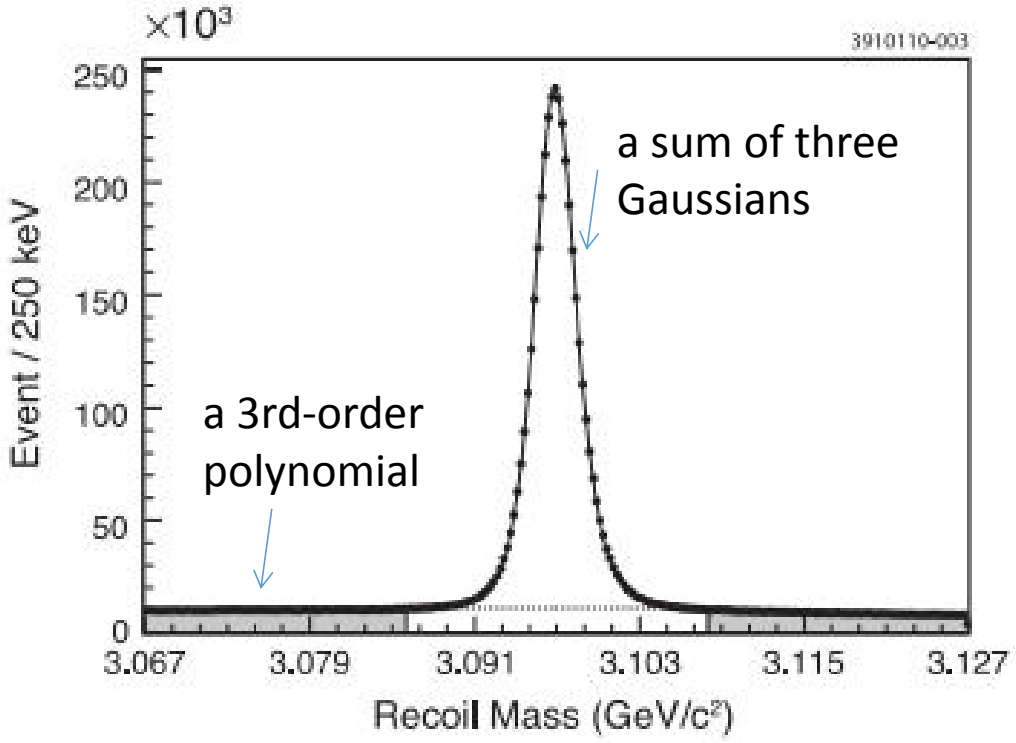

FIG. 1. Recoil mass calculated from the di-pion four-momentum, after pion selection. A fit to the unshaded region of the spectrum was used to extract the tagged J/ψ yield. The solid line shows the results of the fit and the dotted line shows the background contribution. Data in the shaded regions were used to study background.

Maximizing S^2/B:

- Recoil mass was required to be within ± 5 MeV/c2 of the J/psi mass for the selected invisible decay candidates.
- Further background reduction was achieved by requiring the invariant mass of the pion pair to be between 460 and 590 MeV/c2, and requiring charged tracks to have momentum component transverse to the beam in excess of 100 MeV/c.

Fit

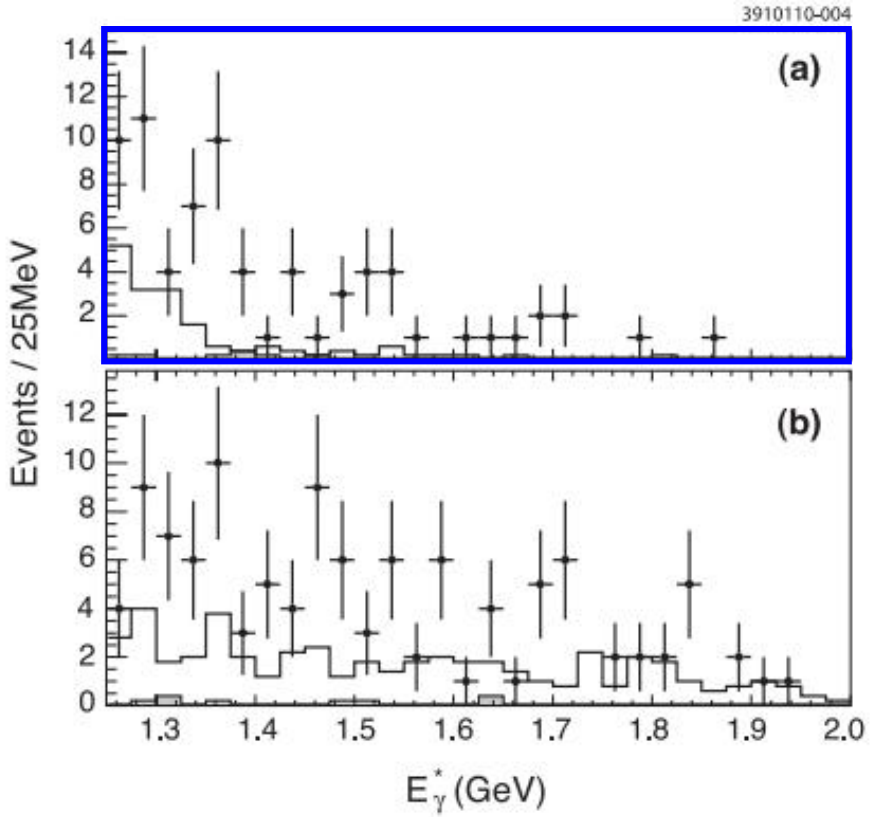

FIG. 2. (a) Invisible-decay events as a function of photon energy in the J/ψ rest frame, and (b) the antineutron-enhanced spectrum obtained by selecting calorimeter showers with large lateral extent. The solid points are data and the unshaded histograms show the results of Monte Carlo simulations. The shaded histograms show the small contributions from events that have di-pion recoil mass adjacent to the J/ψ mass window.

- A total of 73 data events were measured with $E_\gamma^* \geq 1.25$ GeV.
- A sharp peak in this spectrum would be evidence for J/psi radiative decay to a narrow final state.
- No obvious peak corresponding to J/psi->γ+invisible is apparent in the data.
- A Monte Carlo simulation of the background spectrum, normalized to integrated beam luminosity, is also shown.

Fit

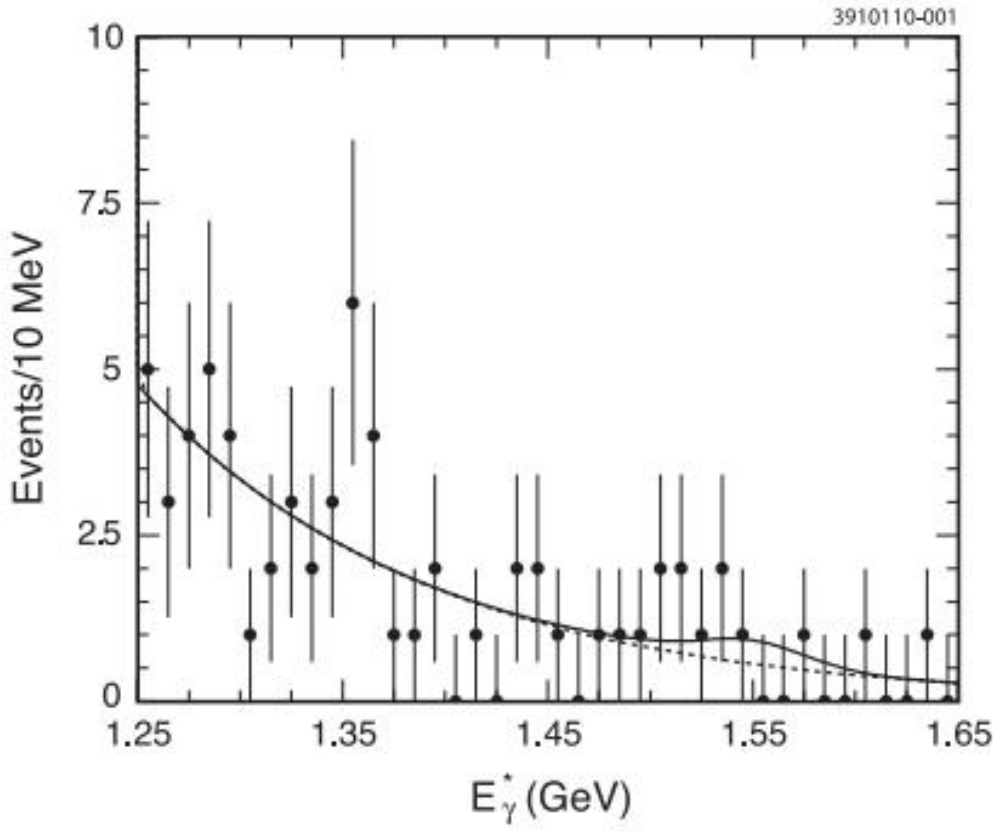

FIG. 3. Fit to determine the branching fraction at $E^*_\gamma = 1.548$ GeV, corresponding to $m_\chi = 0$. The data are the same as in Fig. 2(a) but with finer binning. The solid line is the total fitted spectrum, and the dashed line shows the background contribution to the fit.

- Fits were performed on the data in the E_γ^* range from 1.25 to 1.65 GeV, with fixed peak energies chosen from 1.400 GeV to 1.548 GeV in 5 MeV steps.
- The data in this range are well described by an exponential background curve alone, showing no evidence for a signal.
- Peak around 1.36GeV is much narrower than the expected photon-energy resolution, and is therefore attributed to a statistical fluctuation in the data.

Selection

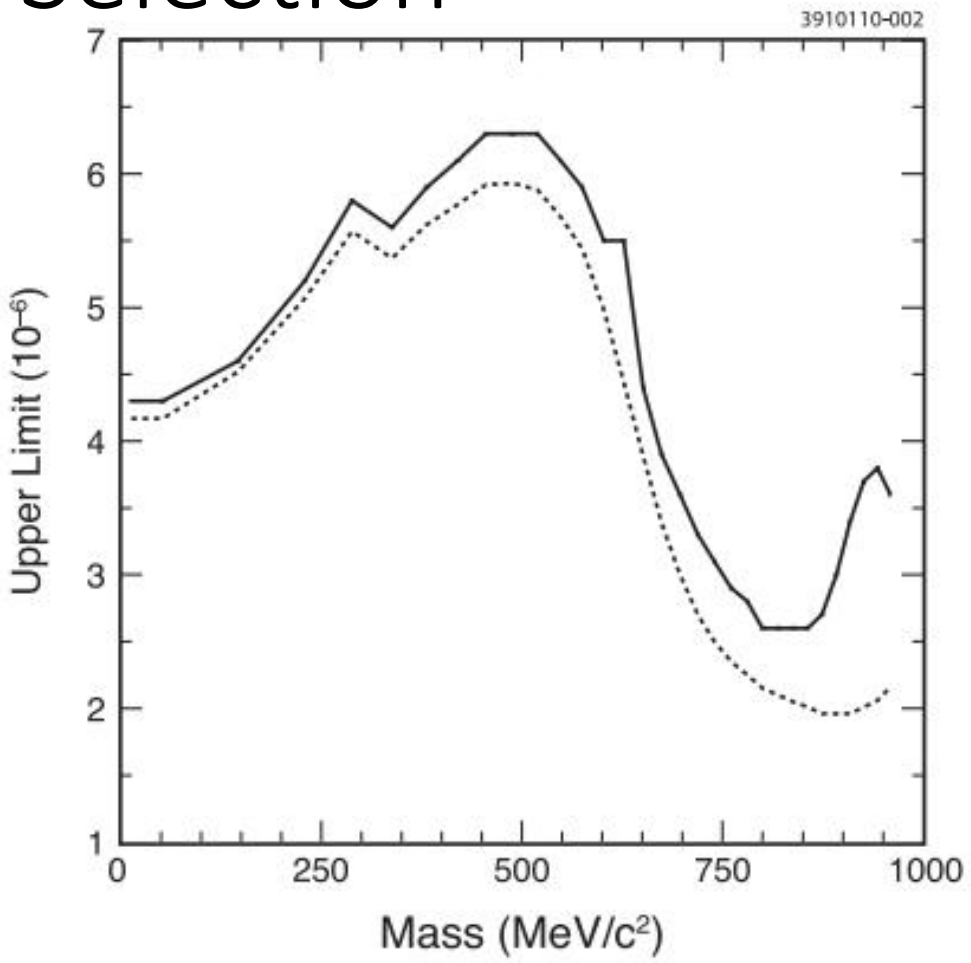

FIG. 4. The 90% confidence-level upper limits for $J/\psi \to \gamma X$, where X is invisible to the detector. The dashed line shows the results for statistical uncertainties alone, and the solid line includes systematic and statistical uncertainties.

- As there were no strong peaks in any of the fits, branching fraction upper limits were extracted at the 90% confidence level at each m_X.
- The limits are dominated by statistical uncertainties but vary somewhat depending on the shape of the background function (exponential or polynomial), the range of the fit, and reasonable variations in event selection criteria.
- Statistical uncertainties are dominant for the full mass range in the plot, and systematic uncertainties are negligible for the low-mass points.

Results

- No significant signal was observed, and upper limits on the branching fraction were set for masses m_X up to 960MeV/c^2.
- The present data yield a branching fraction for J/psi->γ+ invisible of (1.5±2.4)*10^6 at m_X = 0, and an upper limit of 4.3*10^-6 at the 90% confidence level.
- The error quoted here (2.4*10^6) is from the statistical error in the fitted peak only.

Thanks!