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Measurement of Inclusive Production of Charmonium at BaBar*

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Measurement of Inclusive Production of Charmonium States at *BABAR*

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March 2001

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Doctor of Philosophy

Abstract

This thesis presents a study of inclusive production of charmonium mesons at the $\Upsilon(4S)$ resonance ($\sqrt{s} = 10.58$ GeV) and in the continuum up to 50 MeV below the resonance. The full dataset of *BABAR* Run 1 (an integrated luminosity of 23.3 fb^{-1}) is used in the analysis.

The branching fractions of B mesons to J/ψ, $\psi(2S)$, χ_{c1} and χ_{c2} are measured: $\mathcal{B}_{B\to J/\psi X} = (1.044 \pm 0.013 \pm 0.035)\%$, $\mathcal{B}_{B\to\psi(2S)X} = (0.274 \pm 0.020 \pm 0.029)\%$, $\mathcal{B}_{B\to\chi_{c1}X} = (0.378 \pm 0.034 \pm 0.026)\%$ and $\mathcal{B}_{B\to\chi_{c2}X} < 0.21\%$. By equating the $\psi(2S)$ production rates calculated using the $\psi(2S) \to \ell^+\ell^-$ final state to those using $\psi(2S) \to \pi^+\pi^- J/\psi$, we obtain competitive measurements of the $\psi(2S) \to \ell^+\ell^-$ branching fractions: $\mathcal{B}_{\psi(2S)\to e^+e^-} = (0.815 \pm 0.090 \pm 0.090)\%$ and $\mathcal{B}_{\psi(2S)\to\mu^+\mu^-} = (0.700 \pm 0.083 \pm 0.093)\%$. The cross-section for J/ψ production in e^+e^- annihilation in the continuum is measured to be: $\sigma_{e^+e^-\to J/\psi X} = (2.47 \pm 0.21 \pm 0.20)$ pb. This cross-section excludes J/ψ mesons from B decays, two-photon or initial state radiation processes. An upper limit on the inclusive non-$B\overline{B}$ J/ψ decays of the $\Upsilon(4S)$ is set at $\mathcal{B}_{\Upsilon(4S)\to J/\psi X} < 5.1 \times 10^{-4}$, for J/ψ with the center of mass momentum above 2 GeV/c. The helicity, the center of mass production angle distribution and the center of mass momentum distribution of the reconstructed J/ψ mesons are presented.

Résumé

Cette thèse présente une étude de la production inclusive de mesons 'charmonium' à la résonance $\Upsilon(4S)$ ($\sqrt{s} = 10.58$ GeV) et dans le 'continuum' jusqu'á 50 MeV sous la résonance. Les données de la 'Run 1' de *BABAR* (une luminosité integrée de 23.3 fb^{-1}) sont utilisées pour cette analyse.

Les taux de branchement de meson B à J/ψ, $\psi(2S)$, χ_{c1} et χ_{c2} sont mesurés: $\mathcal{B}_{B\to J/\psi X} = (1.044 \pm 0.013 \pm 0.035)\%$, $\mathcal{B}_{B\to\psi(2S)X} = (0.274 \pm 0.020 \pm 0.029)\%$,

$\mathcal{B}_{B\to\chi_{c1}X} = (0.378 \pm 0.034 \pm 0.026)\%$ et $\mathcal{B}_{B\to\chi_{c2}X} < 0.21\%$. En égalisant les taux de productions de $\psi(2S)$ calculés avec l'état final de $\psi(2S)\to\ell^+\ell^-$ aux taux calculés en utilisant la reaction $\psi(2S) \to \pi^+\pi^- J/\psi$, nous obtenons une mesure compétitive des taux de branchements: $\mathcal{B}_{\psi(2S)\to e^+e^-} = (0.815 \pm 0.090 \pm 0.090)\%$ et $\mathcal{B}_{\psi(2S)\to\mu^+\mu^-} = (0.700 \pm 0.083 \pm 0.093)\%$. La section efficace de production de particules J/ψ dans l'annihilation e^+e^- dans le 'continuum' est mesurée: $\sigma_{e^+e^-\to J/\psi X} = (2.47 \pm 0.21 \pm 0.20)$ pb. Cette section efficace exclut les mesons J/ψ qui parviennent de la désintégration de mesons B, d'états á deux photons ou de processus de rayonnement de photon initial. Une limite supérieure sur la chaine de désintégration inclusive de la résonance $\Upsilon(4S)$ à J/ψ, en excluant les états $B\bar{B}$ intermédiats, est placée à $\mathcal{B}_{\Upsilon(4S)\to J/\psi X} < 5.1 \times 10^{-4}$, pour les J/ψ avec impulsion du centre de masse sur 2 GeV/c. L'hélicité, la distribution d'angle de production au centre de masse, et la distribution d'impulsion au centre de masse, des mesons J/ψ reconstruits sont présentées.

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