Recent results obtained by BES in Charmonium Physics

Xinhua Li
(Representing the BES Collaboration)
lixh@hpws3.ihep.ac.cn
Institute of High Energy Physics, Beijing 100039, China

Running at the BEPC e^+e^- storage ring, the BES detector has collected 8.0 ± 1.2 million J/ψ data prior to the participation of US members of the BES Collaboration, and 3.8 ± 0.3 million $\psi(2S)$ data which is the largest statistics $\psi(2S)$ sample at present.

A precise measurement has been performed in the process of $\psi(2S) \rightarrow \pi^+\pi^- J/\psi$: $B(J/\psi \rightarrow e^+e^-) = (5.90 \pm 0.05 \pm 0.10)\%$ and $B(J/\psi \rightarrow \mu^+\mu^-) = (5.84 \pm 0.06 \pm 0.10)\%$, where the first error is statistical and the second is systematic.

On the basis of perturbative QCD, branching fractions of J/ψ and $\psi(2S)$ decays into light hadrons via $3g$, or γ^*, or γgg follow the "15% *rule*"

$$Q_h \equiv \frac{B(\psi(2S) \rightarrow h)}{B(J/\psi \rightarrow h)} \cong \frac{B(\psi(2S) \rightarrow e^+e^-)}{B(J/\psi \rightarrow e^+e^-)} = (14.6 \pm 2.2)\%.$$

The BES measurements of $\psi(2S)$ decays and the corresponding J/ψ decays of PDG 96' are compared with the above expectation.

- Decays into vector pseudoscalar mesons

  The MARK II observations of the suppression of $\psi(2S)$ to $\rho\pi$ and $K^{*+}K^- + c.c.$ have been confirmed at much higher levels of sensitivity. The $\omega\eta$ is also suppressed by a factor of > 7 in the $\psi(2S)$ decay.

  The decay rate of isospin-violating decay $\psi(2S) \rightarrow \omega\pi^0$ is as large as, or even larger than, the isospin-conserving $\psi(2S) \rightarrow \rho\pi$ decay. Large isospin violations are also seen in $\psi(2S) \rightarrow K^+\bar{K}^*(892)^- + c.c.$ and $K^0\bar{K}^*(892)^0 + c.c.$

- New suppression beyond vector pseudoscalar decays

  The $\psi(2S)$ decays into vector tensor final states, ωf_2, ρa_2, $K^{*0}\overline{K_2}^{*0}$ and $\phi f_2'$, are suppresed with respect to "15% *rule*" which poses an additional challenge to current understanding of charmonium physics.

- Radiative decays

  The $\psi(2S)$ radiative decays into γf_2, $\gamma\eta$ and $\gamma\eta'$ have been measured. While the γf_2 observes the "15% *rule*" which is contrary to ωf_2, a suppression relative to "15% *rule*" occurs for the $\gamma\eta$ and $\gamma\eta'$ but not as strongly as $\rho\pi$. The $\psi(2S) \rightarrow \gamma\eta'$ result is consistent with expectation of a model that considers the possibility of η' - η_c mixing.

The helicity amplitudes analysis has been applied to $J/\psi \to \gamma\pi^+\pi^-$ and $\gamma\pi^0\pi^0$. The measured helicity ratios $x = \lambda_1/\lambda_0$ and $y = \lambda_2/\lambda_0$ of $f_2(1270)$ are not consistent with expectation of a model that considers the $f_2(1270)$ as a pure $q\bar{q}$ state.

The partial-wave analysis has been applied to $J/\psi \to \gamma\eta\pi^+\pi^-$ by including the $\eta\sigma$ amplitudes as well as the $a_0(980)\pi$, where the σ stands for the entire $\pi\pi$ S-wave amplitude. A structure of $\eta(1440)$ is observed in the $\eta\pi^+\pi^-$ mass spectrum with statistic significance 4.7σ, $M = 1415 \pm 10$ MeV and $\Gamma = 44 \pm 6$ MeV. $J^P = 0^-$ is preferred over 1^+. It decays into both $\eta\sigma$ and $a_0(980)\pi$ with

$$\frac{B(a_0(980)\pi, a_0 \to \eta\pi)}{B(\eta\sigma, \sigma \to \pi\pi)} = 0.7 \pm 0.12(stat) \pm 0.20(syst).$$