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Recent Results from the KEDR Detector

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Abstract. We describe recent results from the KEDR detector at the VEPP-4M collider. They include: a search for narrow resonances between 1.85 and 3.1 GeV, a test of leptonic universality by comparing partial widths of the J/ψ resonance into electron and muon pairs, a determination of the main parameters of the $\psi(2S)$ and a measurement of $\psi(3770)$ parameters.

1 VEPP-4M collider

The electron-positron accelerator complex VEPP-4M is designed for high-energy physics experiments in the c.m. energy range (W) from 2 to 12 GeV. The luminosity in the J/ψ region in an operation mode with 2 by 2 bunches reaches 1.5×10^{30} cm^{-2}s^{-1}.

One of the main features of the VEPP-4M is its capability to precisely measure beam energy using two techniques [1]: resonant depolarization and infrared light Compton backscattering.

2 Search for narrow resonances

A search for narrow resonances was performed with automatic decrease of the c.m. energy by about $2\sigma_W$ (1.4 to 1.9 MeV) steps after collection of required integrated luminosity at each point [2]. In order to get energy-independent sensitivity in terms of Γ^R_{ee}, the integrated luminosity per energy point varied from 0.3 nb^{-1} in the upper part of the energy range to 0.12 nb^{-1} in the lower one. The total integrated luminosity $\int Ldt \simeq 300$ nb^{-1} was collected.

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The energy-dependent 90% C.L. upper limits on $\Gamma_{ee}^{J/\Psi} \cdot Br(J/\Psi \to hadr)$ with the highest value of about 105 eV, obtained from such a fit, are shown in Fig. 1. Variation of σ_W within its 10% systematic uncertainty could increase the limit to 120 eV. This upper limit is four to five times more stringent than that obtained in this energy range in earlier experiments at ADONE.

3 Measurement of the J/ψ parameters

A data sample used for this analysis comprises 2.2 pb^{-1} collected at 2007–2009 in the J/ψ energy range. From the direct measurements of the products $\Gamma_{ee} \times \Gamma_{ee}/\Gamma$ and $\Gamma_{ee} \times \Gamma_{\mu\mu}/\Gamma$ one can test leptonic universality. Our preliminary results without systematic errors:

$$\Gamma_{ee}/\Gamma_{\mu\mu} = 0.9969 \pm 0.0047(stat.)$$

We expect that a systematic error will be comparable to the statistical one.

4 Measurement of main parameters of the $\psi(2S)$ resonance

A high-precision determination of the main parameters of the $\psi(2S)$ resonance has been performed using a data sample of $1.6 \cdot 10^5$ decays into hadrons collected in three scans of the $\psi(2S)$–$\psi(3770)$ energy range [3].

Fitting the energy dependence of the multihadron cross section in the vicinity of the $\psi(2S)$ we obtained the mass value

$$M = 3686.114 \pm 0.007 \pm 0.011^{+0.002}_{-0.012}\ \text{MeV},$$

and the product of the electron partial width by the branching fraction into hadrons

$$\Gamma_{ee} \times \mathcal{B}_h = 2.233 \pm 0.015 \pm 0.037 \pm 0.020\,\text{keV},$$

where the first and second uncertainties are statistical and systematic, respectively. The third uncertainty quoted is an estimate of the model dependence of the result due to assumptions on the interference effects in the cross section of the single-photon e^+e^- annihilation into hadrons.

The mass value obtained is consistent with and much more precise than all previous measurements as well as the recent result from LHCb. The value of the product is consistent with the only previous direct measurement of this quantity at Mark I and an order of magnitude more precise.

Using the world average values of the electron and hadron branching fractions, we also determine the electron partial width and total width of the $\psi(2S)$:

$$\Gamma_{ee} = 2.282 \pm 0.015 \pm 0.038 \pm 0.021\,\text{keV},$$
$$\Gamma = 296 \pm 2 \pm 8 \pm 3\,\text{keV}.$$

5 Measurement of $\psi(3770)$ parameters

The same three energy scans from 3.67 to 3.92 GeV were used to study the $\psi(3770)$ meson [4]. The data analysis takes into account the interference between the resonant and non-resonant $D\bar{D}$ production, where the latter is related to the non-resonant part of the energy-dependent form factor F_D. The vector dominance approach and several empirical parameterizations have been tried for the nonresonant $F_D^{\text{NR}}(s)$.

Our results for the mass and total width of $\psi(3770)$ are

$$M = 3779.2^{+1.8}_{-1.7}\,{}^{+0.5}_{-0.7}\,{}^{+0.3}_{-0.3}\ \text{MeV},$$
$$\Gamma = 24.9^{+4.6}_{-4.0}\,{}^{+0.5}_{-0.6}\,{}^{+0.2}_{-0.9}\ \text{MeV},$$

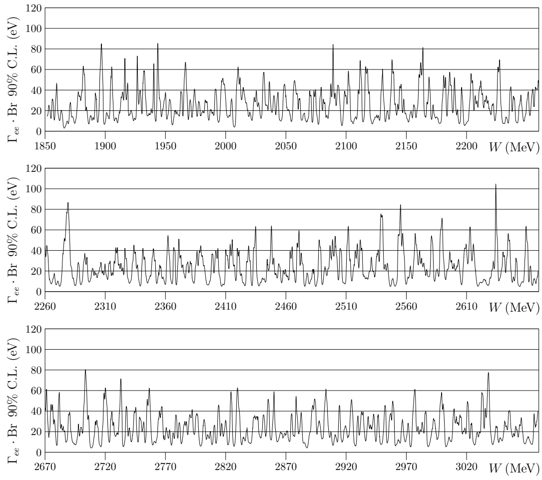

Fig. 1. W-dependence of 90% C.L. upper limit on $\Gamma_{ee}^{R} \cdot Br(R \to hadr)$.

where the first, second and third uncertainties are statistical, systematic, and model, respectively. The mass value obtained is consistent with that of BaBar [5], which also took interference into account, not incompatible with the mass measurements in B meson decays and significantly higher than that of BES [6], which did not take into account interference effects.

For the electron partial width two possible solutions have been found:

$$(1) \quad \Gamma_{ee} = 154 \, {}^{+79}_{-58} \, {}^{+17}_{-10} \, {}^{+13}_{-25} \text{ eV},$$
$$(2) \quad \Gamma_{ee} = 414 \, {}^{+72}_{-80} \, {}^{+44}_{-26} \, {}^{+90}_{-10} \text{ eV}.$$

Our statistics are insufficient to prefer one solution to another. The solution (2) mitigates the problem of non-$D\bar{D}$ decays but is disfavored by potential models.

It is shown that taking into account the resonance–continuum interference in the near-threshold region affects resonance parameters, thus the results presented can not be directly compared with the corresponding PDG values obtained ignoring this effect.

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