Partial Width Calculation of ψ's OZI-allowed Decays by Complex Scaling Method

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So far we have studied the masses and total decay widths of ψ and Υ states by using effective quark-quark interactions proposed by [1] and [2]. This effective interaction is written as

$$H_{\rm int} = \frac{3}{8}\int d\boldsymbol{x}d\boldsymbol{x}'\bar{\Psi}_{f'}(\boldsymbol{x}')\Gamma^i\frac{\lambda^\alpha}{2}\Psi_{f'}(\boldsymbol{x}')V(|\boldsymbol{x}'-\boldsymbol{x}|)\bar{\Psi}_f(x)\Gamma^i\frac{\lambda^\alpha}{2}\Psi_f(\boldsymbol{x}). \tag{1}$$

The $\Psi_f(\boldsymbol{x})$ stands for the second quantized quark field operator with the flavor f and is a vector in color. The SU(3) matrices for the color degree of freedom are expressed by λ^α. As for $V^i(\boldsymbol{r})$, we take the short-range Coulombic potential ($i=1$) and the linear-plus-constant potential ($i=2$)

$$V^1(\boldsymbol{r}) = -\frac{\alpha(ff')}{r}, \tag{2}$$

$$V^2(\boldsymbol{r}) = -\lambda r + b. \tag{3}$$

Furthermore, Γ^i is either a unit matrix or γ^0 corresponding to the Lorentz property (scalar or vector) of $V^i(\boldsymbol{r})$. The interactin Hamiltonian, Eq. (1), brings about not only the static quark(Q)-antiquark($\bar{Q}$) potential but also potentials for the transition of $Q\bar{Q}$ states to open meson and antimeson states. The effective interaction has turned out to be viable in simultaneous understanding of the total width of the OZI-allowed decay and the mass spectrum.

Together with the effective quark interaction, Eq. (1), effect of the pseudo-scalar meson exchange interaction between heavy meson in the open decay channels is considered. They are assumed to be calculated microscopically from quark-level OBE dynamics only between light quarks (u,d,s) in open channel heavy mesons. Our analysis turned out qualitatively quite successful[3]. Thus the pseudo-scalar meson exchange ineraction between heavy mesons was found very important to grasp experimental features of mass and total decay width of ψ and Υ states.

In this study, we discuss the partial widths due to OZI-allowed decay channels for ψ by the same model used previously in our analysis.

References

[1] E. Eichten, K. Gottfried, T. Kinoshita, K. D. Lane and T. M. Yan, Phys. Rev. **107** (1978) 3090; Phys. Rev. **D21** (1980) 203.

[2] J. H. Barbour and J. P. Gilchrist, Z. Phys. **B399** (1984) 357.

[3] N. Yabusaki, K. Katō, M. Hirano, M. Sakai and Y. Matsuda, Few-Body Systems **28** (2000) 1; Prog. Theor. Phys. **106** (2001) 389.