Charmonium spectroscopy above thresholds

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Charmonium spectroscopy is being a challenge for experimentalists and theorists. From the experimental point of view a number of discoveries are puzzling. From the theoretical point of view an assumed simple non-relativistic two-body problem has become rather involved. It has been long ago suggested the potential contributions of higher order Fock space components [1]. In a trial to disentangle the role played by multiquark configurations we undergone an exact solution of the four-body problem based on an infinite expansion of the wave function in terms of hyperspherical harmonics. Being the method exact, it has problems dealing with states that are close below the threshold. We have attacked this problem when working with the baryon spectra by means of the Fredholm determinant solution of the Faddeev equations. In this case we study the scattering problem of two mesons. In order to account for all bases states we allow for the coupling to charmoniun-light two meson systems. We solve the Lippmann-Schwinger equation calculating the Fredholm determinant. It allows us to order in energy all J^{PC} four–quark states, even when working very close to threshold and therefore avoiding the uncertainties associated to the slow convergence of the hyperspherical harmonic method for large values of the grand angular momentum. This is the first combined analysis of four quark hidden charm states studied as four-quark bound states or meson-meson scattering. Our results clarify the situation of charmonium spectroscopy [2].

[1] R.L. Jaffe, Phys. Rep. **409**, 1 (2005).

[2] T. Fernández-Caramés, A. Valcarce, and J. Vijande, Phys. Rev. Lett. **103**, 222001 (2009).

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