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Hadronic Molecules in Charmonium Spectrum

The discovery of the J/ψ meson in 1974 was the experimental confirmation of the existence of the charmed quark introduced theoretically in 1970 by Glashow, Iliopoulus and Maiani to explain the cancellation of loop diagrams in K^0 weak decays. Consisting of a charmed c quark and a $\bar{c}$ antiquark the J/ψ particle became the starting point of a whole family of bound states called charmonium.
A further milestone in the knowledge of the charmonium structure began in 2002 with the new data coming from high luminosity experiments at B factories. Since then more than ten new states have been observed, most of them being difficult to understand in a quark-antiquark framework.
Meson-antimeson molecular states may represent an alternative explanation to these states.

Meson-antimeson pairs containing one heavy and one light quark can exchange pions which may contribute to bind the system. In Ref.~[1] we have performed a calculation of the $X(3872)$ state as a DD^* molecule in the framework of
a constituent quark model [2]. The one pion exchange interaction is not enough to bind the system and only when we mix the molecular state with the $\chi_{c1}(2P)$ $q\bar{q}$ pair we get the $X(3872)$ as a bound state. The original $\chi_{c1}(2P)$ $q\bar{q}$ state adquires a significant DD^* component and can be identified with the $X(3940)$.

Following these ideas we have started a program to study the influence of possible molecular structures in the charmonium spectrum.Based on the formalism developed by Baru et al. [3], we perform a coupled channel calculation in which the mass and the width of the resonances can be determined nonperturbatively. The interactions in the molecular channels are calculated using the Resonating Group Method and the $q\bar{q}$ interaction of Ref.~[2. Two and four quark states are coupled through the $^3P_0$mechanism .

We focus on the 0^{++} and 1^{--} sectors. In the first one, coupling the DD,$J/\psi\omega$, D_sD_s and $J/\psi\phi$ channels to the ^2^3P_0 $q\bar{q}$ pair we obtain two states compatibles with the
$X(3915)$ and the $Y(3940)$ mesons .

In the 1^{--} sector we include the 3^3S_1 and 2^3D_1 charmonium states
coupled to DD, DD^*, D^*D^*, D_sD_s, $D_sD_s^*$ and $D_s^*D_s^*$. In this calculation we obtain the
controversial Y(4008) as a new molecular state and two $c\bar{c}$ states dressed by the molecular components. One important outcome of the calculation is that the new $\psi(4040)$
has a bigger probability of 2^3D_1 state and the $\psi(4160)$ of the
3^3S_1 state. To test this new structure,
we calculate the decay branching ratios measured by BABAR [4]. As already notice the result
using the bare states are in clear disagreement with the experiment while we find a
good agreement for the couple channel calculation.

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{\small\begin{description}
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