The $Y(3940)$, $Z(3930)$ and the $X(4160)$ as dynamically generated resonances from the vector-vector interaction

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We apply a unitary approach together with a set of hidden-gauge Lagrangians to study the vector-vector interaction. Concretely, we focus on the sector with quantum numbers charm $C = 0$ and strangeness $S = 0$ in the region around 4000 MeV. We get five poles, three of which could be identified with the Y(3940), Z(3930) and X(4160). These poles appear with quantum numbers $I = 0$ and $J^{PC} = 0^{++}, 2^{++}$ and 2^{++}, respectively, and can be considered as hadronic molecules made of $D^*\overline{D}^*$, $D_s^*\overline{D}_s^*$.

1 Introduction

The B-factories at SLAC, KEK and CESR, which were originally constructed to test matter-antimatter asymmetries or CP violation, have discovered new hidden-charm states around the energy region of 4000 MeV. Generally speaking, these states cannot be accomodated in the $c\bar{c}$ spectrum. They are naively called as XYZ particles.

In this talk we study the case of a system of two vector meson with charm $C = 0$ and strangeness $S = 0$ around 4000 MeV (hidden charm sector).

2 Formalism

Within the theorical framework, there are two main ingredients: first, we take the Lagrangians for the interaction of vector mesons among themselves, that come from the hidden gauge formalism of Bando-Kugo-Yamawaki [1]. Second, we introduce the potential V obtained from these Lagrangians (projected in s-wave, spin and isospin) in the Bethe Salpeter equation, $T = (\hat{1} - VG)^{-1}V$, where G is the loop function. Finally, we look for poles of the unitary T matrix in the second Riemann sheet. All this procedure is well explained in [2,3].

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$I^G[J^{PC}]$	Theory (Mass, Width)	Name	Experiment Mass	Width	J^{PC}
$0^+[0^{++}]$	(3943, 17)	$Y(3940)$	3943 ± 17	87 ± 34	J^{P+}
			$3914.3^{+4.1}_{-3.8}$	33^{+12}_{-8}	
$0^-[1^{+-}]$	(3945, 0)	"$Y_p(3945)$"			
$0^+[2^{++}]$	(3922, 55)	$Z(3930)$	3929 ± 5	29 ± 10	2^{++}
$0^+[2^{++}]$	(4157, 102)	$X(4160)$	4156 ± 29	139^{+113}_{-65}	J^{P+}
$1^-[2^{++}]$	(3912, 120)	"$Y_p(3912)$"			

Table 1: Comparison of the mass, width and quantum numbers with the experiment. All the quantities are in units of MeV.

The results for the pole position obtained together with a possible assignment with some of the XYZ particles observed in the energy region of 4000 MeV is given in Table 1. While the Y(3940) and Z(3930) couple more to $D^*\overline{D}^*$ in the model, the X(4160) couples to $D_s^*\overline{D}_s^*$ mostly. The other two states, one with $I = 1$ and $J = 2$ and the other with $I = 0$ and $J = 1$ are predictions of the model.

3 Conclusions

We find five states with quantum numbers $I^G[J^{PC}] = 0^+[0^{++}], 0^-[1^{+-}], 0^+[2^{++}], 0^+[2^{++}]$ and $1^-[2^{++}]$ that are bound states or resonances made of $D^*\overline{D}^*$ and $D_s^*\overline{D}_s^*$ mostly. The states with $I^G[J^{PC}] = 0^-[1^{+-}]$ and $1^-[2^{++}]$ are predictions of the model whereas the others can be associated to the Z(3930), Y(4140) and X(4160). The region around 3940 MeV is very interesting and there could be more resonances not yet seen in this region.

References

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