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A 7 Comment on Chan Hong-Mos Talk: Quasinuclear States in Baryon–Antibaryon Systems

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We would like to emphasize that the bound and resonant states of the quasinuclear type in baryon-antibaryons systems have been predicted about ten years ago[1] (for review see ref. 2).

We can resume the main predictions of theory as follows: (a) the theory predicts the existence of a large number of heavy mesons ($M\sim 2m$, m-mass of baryon) strongly coupled to the $B\bar{B}$ channel. The latter means that the ratio of the elastic $B\bar{B}$ channel width (real or virtual) to the total width must be close to the unitary limit, *i.e.*, $\Gamma_{B\bar{B}}/\Gamma\sim 1$: (b) the radii at the quasinuclear baryonium states must be large enough: the inequality $R\gg 1/m$ needs to be satisfied: (c) $B\bar{B}$ interaction provides (mainly due to spin-orbit forces) the existence of a rich spectrum of quasinuclear states of baryonuim. Their number must be of about 10 near each $B\bar{B}$ threshold. Thus, the theory predicts several tens of $B\bar{B}$ states in the $1.5\sim 3$ GeV mass range, in particular, exotic states, *e.g.*, $\bar{\Sigma}N$ (Isospin $I=3/2$) and $\Sigma\bar{\Sigma}$ ($I=2$); (d) the annihilation widths and level shifts of the baryonium can be reliably estimated[2] (in order of magnitude) provided the theory contains a certain smallness parameter. It has been already mentioned that the ratio of the annihilation radius to the average distance between B and $\bar{B}$ ($\tau_a/R\sim 0.1$) may serve as a smallness parameter. This means that for bound states the probability to find B and $\bar{B}$ in the annihilation region is estimated as $|\psi(0)|^2/m^3$ and should be considerably lower than unity. At the same time the annihilation of slow B and $\bar{B}$ from the continuum may be large (compared to the unitary limit) due to strong attraction between baryons (the dimensionless enhancement factor is in this case proportional to $|\psi_v(0)|^2$, where $\psi_v(0)$ is the wave function of the continuum state). According to theoretical estimates the annihilation width of the quasinuclear baryonium level may vary from 0.1 to 100 MeV (in order of magnitude) and mainly depends upon the relative orbital momentum of the $B\bar{B}$ pair (roughly, the higher the orbital momentum, the smaller is the width). (e) existence of the baryonium quasinuclear spectrum must manifest itself in a lot of nearthreshold phenomena, for instance, discrete γ-spectrum in $p\bar{p}$ annihilation at rest, large p-wave annihilation from atomic p-states etc, which were predicted theoretically. Most of them have been observed in recent years; (f) the theory predicts that besides the simplest two-particle $B\bar{B}$ (baryonium) system there exist more complicated three- and four-particle quasinuclear systems—the baryons $2B\bar{B}$ and bosons $2B2\bar{B}$. The masses of these systems must be about 3 and 4 GeV, respectively.

References

1. O. D. Dalkarov, V. B. Mandelzweig and I. S. S. Shapiro: JETP Letters **10** (1969) 257; Nucl. Phys. **B21** (1970) 88.
2. I. S. Shapiro: Phys. Rep. **35** (1978) 129.