K-MESON RESONANCES IN THE ENERGY REGION 1700 - 2000 MeV

O. D. Dal'karov and V. B. Mandel'tsveig
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We have investigated nonrelativistic bound states in the $N\bar{\Lambda}$ system, i.e., quasinuclear levels with a binding energy small compared with the mass of the particles contained in the system. The determination of such levels reduces to a solution of a Schrodinger equation with a potential describing the experimental data on $N\bar{\Lambda}$ scattering. Since now such potential is known at present, we obtain it from the Deloff $N\Lambda$ potential [1] with the aid of the charge-conjugation operation.

It should be noted that the Deloff potential has been compared with the experimental data only up to energies on the order of 120 MeV in the lab, i.e., up to 50 MeV in the c. m. s., where satisfactory agreement with the experimental data was obtained. This potential can apparently be used up to energies at which formation of the nearest resonant state of the πN system or KN system is possible [2] (we note that conservation of the total spin forbids

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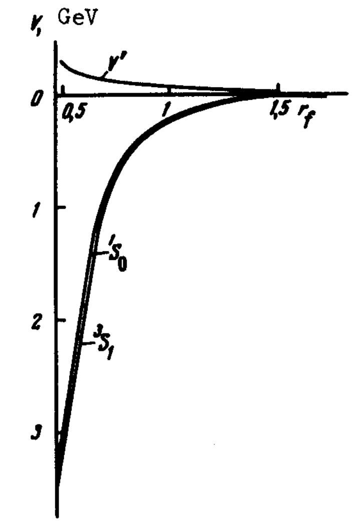
1) In our samples, the He^4 concentration could reach $\sim$0.1%.

2) Further increase of the voltage on the crystal is quite feasible, but it called for further improvement of our instrument.

the production of the Δ_{33} resonance, so that the nearest possible resonances are N(1400) and γ(1520), corresponding to the applicability of the $N\bar{\Lambda}$ potential employed by us up to energies on the order of 400 MeV in the c.m.s.



$N\bar{\Lambda}$ potential. V' - centrifugal barrier for p state.

As shown in [1], the octets 0^+, 0^-, and 1^- contribute to the single-boson $N\Lambda$ potential. It is obvious that in the case of the $N\bar{\Lambda}$ potential no exchange of bosons with nonzero spin is possible. Therefore the $N\bar{\Lambda}$ potential consists only of three parts corresponding to exchange of η, σ_0, and ω mesons. The form of the central potentials for the $^1S_0$ and $^3S_1$ states is shown in the figure. The coupling constant and the mass σ_0 were taken from [1].

Unlike the real $N\Lambda$ potential, the $N\bar{\Lambda}$ potential should contain an imaginary part corresponding to allowance for annihilation. However, by using the arguments of [2], it can be shown that allowance for the annihilation effects has little effect on the level position.

Since the potential corresponding to the tensor forces in the $^3S_1$ state is very small ($\leq$ 10 MeV in the region r>0.485 F) and since the potential curves for the $^1S_0$ and $^3S_1$ states, as seen from the figure, lie very close to each other, we confine ourselves to an estimate of the level position in the $^1S_0$ state only.

It has turned out that in this potential there is only one level with binding energy

$$50 \text{ MeV} \leqslant \epsilon(^1S_0) \leqslant 250 \text{ MeV}$$

corresponding to the K-meson resonance 0^- with mass 1800 - 2000 MeV.

In the same energy region there should be observed also a $^3S_1$ level corresponding to a 1^- K-meson resonance.

It should be noted that investigations of such variations of the potential form, for which the scattering phases at low energies remain practically unchanged (see [2]), have shown that the position of the level changes insignificantly (by an amount on the order of several dozen MeV).

Taking this uncertainty into account, and also the possibility of changing the level position by annihilation, and the unaccounted-for non-static terms in the interaction potential, it can be assumed that when all the aforementioned effects are taken into account the level position changes in fact by about 100 MeV in either direction, leading to an uncertainty in the binding energy ($^1S_0$) in formula (1).

In the same region, owing to the smallness of the centrifugal barrier, there should also be observed K-meson resonances corresponding to levels with higher orbital angular momenta ($^1P_1$, $^1D_1$, etc.).

From SU(3) symmetry, the level widths should be of the same order as the widths of the corresponding nucleon-antinucleon levels [2]. An estimate of the level width without the use of unitary symmetry is impossible at present because of the lack of data on the $N\bar{\Lambda}$ annihilation cross section.

Since the widths of the nucleon-antinucleon levels are of the order of several dozen MeV, the K-meson resonances predicted by us in the 1700 - 2000 MeV region will overlap. An analysis of the form of the curves obtained by experimental study of the $K\pi$ resonances in this energy region should be carried out with the aid of the formula for overlapping levels [3].

So far, only one resonance was observed in the 1700 - 2000 MeV region, namely $K_A(1780)$ with $T = 1/2$ and $J^P = 1^+$ or 2^- and with width on the order 80 - 100 MeV. In our scheme it may correspond to the $^1P_1$ state of $N\bar{\Lambda}$. Observation of the remaining resonances predicted by us will confirm the correctness of the proposed mechanism for resonance production. An analysis of the relative level positions and a more exact estimate of their widths will be presented in a detailed article.

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