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Production of the Doubly Strange H Dibaryon*

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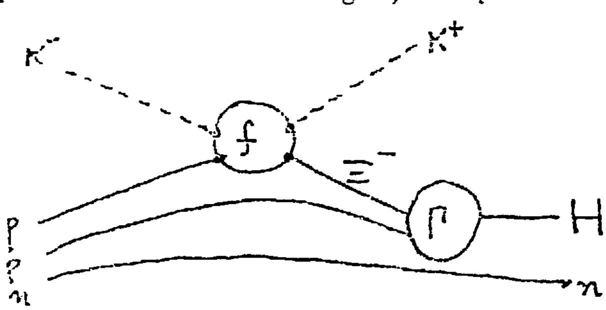
There is much current interest in the spectroscopy of multiquark states. Predictions abound for the existence of baryonium ($Q^2\bar{Q}^2$) and six-quark dibaryon (Q^6) resonances[1], for instance. In the strangeness S = −2 sector of Q^6, the MIT bag model[2] predicts a dibaryon H with quantum numbers $J^\pi = 0^+$, isospin I = 0, and mass $M_H \approx 2150$ MeV $\approx 2M_\Lambda - 80$ MeV. The H has quark composition uuddss, so all quarks can occupy the 1s state; it is unique in that it possesses <u>no strong decay modes</u>. The fact that the H mass is considerably below the $\Lambda\Lambda$ or ΞN thresholds precludes its interpretation as a deuteron-like object bound by conventional long-range meson exchange forces.

The H has been searched for in the reaction $p+p \rightarrow K^+ + K^+ + H$ by Carroll et al.[3], with an upper limit of about 100 nb/sr^2 for two K^+'s at ± 18° in the lab system. Some crude cross section estimates we have made for this process indicate much smaller cross sections than this limit.

A more natural way to produce the H, in our view, is via the (K^-,K^+) reaction on a diproton in a nuclear target, i.e. $K^- + (pp) \rightarrow K^+ + H$. For the simplest case of a ^3He target, the process is shown in the figure.



$^3He(K^-, K^+)Hn$

The differential cross section for the $K^-p \to K^+\Xi^-$ reaction at 0° has a peak value of about $|f|^2 \approx 35$ μb/sr around $p_{K^-} \approx 1.8$ GeV/c. The (pp) pair must be in the $^1S_0$ state, so no spin flip is required to produce the H (also $^1S_0$). The vertex function (decay amplitude) Γ is calculated in a non-relativistic quark model, and describes the fusion of two 3 quark systems (p and Ξ^-) into a six quark state (H) of radius R. When we use harmonic oscillator wave functions for the quarks, we find

$$\Gamma_{(\vec{p}_1,\vec{p}_2)} = \Gamma_0 \, e^{-\frac{R^2}{12}(\vec{p}_1-\vec{p}_2)^2}$$

depending only on the <u>relative</u> momentum $\vec{p}_1-\vec{p}_2$ of the p and Ξ^-. Γ_0 includes a geometrical factor and also a color, spin and flavor recoupling coefficient obtained from the approximate wave function $\psi_H = \sqrt{4/5}\,|8_c x 8_c\rangle + \sqrt{1/40}\,|\Lambda\Lambda\rangle + \sqrt{3/[illegible]}\,|[illegible]\rangle + \sqrt{1/20}\,|\Xi N - N\Xi\rangle$ for the H. Since the Ξ^- typically has a lab momentum $|[illegible]|$ of about 400 MeV/c, nuclear Fermi motion enables us to reach the region of phase space where $|\vec{p}_1-\vec{p}_2|$ is fairly small, and $\Gamma \approx \Gamma_0$. This is not the case in the $pp \to K^+K^+H$ reaction, where the analogous ΛΛ or $\Xi^-p \to H$ quark fusion processes correspond to large values of $|\vec{p}_1-\vec{p}_2|$ and hence tiny cross sections for H production. Using oscillator wave functions for ^3He, we estimate $(d\sigma/d\Omega_{K^+})_{0°} \approx 2$ μb/sr for the $^3He(K^-,K^+)Hn$ cross section at 1.9 GeV/c in the closure approximation, using plane waves[4]. One could also detect the neutron in coincidence with the K^+, to more clearly pin down the H. Such cross sections are accessible experimentally. Since the H represents a very important prediction of the Bag Model, we urge that a (K^-,K^+) experiment on a nuclear target be done in order to search for it.

References

1. For a survey of bag model predictions, see for example A. Aerts, Nijmegen University Thesis (Institute for Theoretical Physics, Nijmegen, 1979); for a recent review, see R. L. Jaffe, Rapporteurs Talk presented at the 1981 Lepton-Photon Symposium, Bonn, Germany, 1981, MFT-CTP(81)951.

2. R. L. Jaffe, Phys. Rev. Lett. 38, 195 (1977).

3. A. Carroll et al., Phys. Rev. Lett. 41, 777 (1978).

4. A. T. Aerts and C. B. Dover, in preparation.