H dibaryon in the chiral color dielectric model

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The mass of the H dibaryon with spin, parity $J^{\pi}=0^{+}$, and isospin $I=0$ is calculated in the framework of the chiral color dielectric model. The wave function of the H dibaryon is expressed as a product of two color-singlet baryon clusters. Thus the quark wave functions within the cluster are antisymmetric. Appropriate operators are then used to antisymmetrize intercluster quark wave functions. The radial part of the quark wave functions are obtained by solving the quark and dielectric field equations of motion obtained in the color dielectric model. The mass of the H dibaryon is computed by including the color magnetic energy as well as the energy due to meson interaction. The recoil correction to the H dibaryon mass is incorporated by Peierls-Yoccoz technique. We find that the mass of the H dibaryon is smaller than the $\Lambda-\Lambda$ threshold by over 100 MeV. The implications of our results on the present day relativistic heavy ion experiments are discussed. [S0556-2813(98)01909-8]

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I. INTRODUCTION

The possibility of the existence of a stable six quark dibaryon composed of two up (u), two down (d), and two strange (s) quarks confined in a single hadronic bag and having spin, parity $J^{\pi}=0^{+}$, and isospin $I=0$ was first proposed by Jaffe in 1977 [1]. This object is a singlet of color, flavor, and spin and thus results in a maximally attractive color magnetic interaction between the quarks. Jaffe's calculation predicted the mass of the H dibaryon (H_1) to be around 2150 MeV which is about 80 MeV less than the $\Lambda-\Lambda$ threshold. Such a state would then be stable against strong decays into three-quark baryons and can decay only by weak interaction into a pair of baryons. Jaffe's calculation was performed in the MIT bag model. Later, this calculation was refined by including the center-of-mass correction [2], SU(3)-flavor symmetry breaking [3], surface energy term in the bag model [4], coupling of pseudoscalar meson octet [5], etc. Calculations have also been performed in the nonrelativistic potential model [6–9,10–16] and Skyrmion model [17]. Production cross sections of H dibaryons in various experiments have also been estimated [18–21]. Most of these calculations predict the mass of H_1 to be very close to the $\Lambda-\Lambda$ threshold. Some of these calculations predict that H_1 is stable against strong decays with mass below the $\Lambda-\Lambda$ threshold where the others predict an unstable H_1. If the H-dibaryon mass is below the $\Lambda-\Lambda$ threshold, one expects that, unlike the deuteron, the H dibaryon would be a state of six quarks bound in a single bag and not a two-baryon state bound by meson exchange interaction. The reason for this is that in the deuteron the pion exchange interaction provides the bulk of the binding force where as in the H-dibaryon case, one-pion exchange is not possible in the $\Lambda-\Lambda$ channel and therefore the meson exchange contribution to the binding is expected to be small. Therefore the experimental determination of the H-dibaryon mass is expected to impose a strong constraint on the quark models used in hadron spectroscopy.

With these considerations, the experimental as well as theoretical investigations of H dibaryons in particular and dibaryons in general is of great interest. As is well known, QCD is the theory of strong interactions and in such a theory, six-quark color-neutral objects are expected to exist. Whether these are stable against strong decays depends on the details. Already a number of QCD-inspired models have been employed to investigate the properties of baryons, the three-quark color-neutral objects, and generally these models are quite successful. The calculations of the properties of H dibaryons and other dibaryons in these models and a comparison of these with the experimental results is needed as these models are likely to yield different results in the dibaryon sector. The experimental observation (or otherwise) of the H dibaryons will then be able to indicate which of these models are better.

The H dibaryon, if stable, is likely to be produced in relativistic heavy ion collisions due to the abundant strangeness production in the hot and dense hadronic matter formed in the collision. For example, calculations using a cascade code such as ARC [16] find that in a collision of Au ions with similarly heavy target nuclei, more than 20 hyperons are expected to be produced in central collisions at AGS energies. This implies that there is a large probability of $\Lambda-\Lambda$ coalescence leading to the formation of a H dibaryon. Furthermore, the formation of quark gluon plasma with large baryon density and its subsequent decay is also expected to enhance the strangeness production in the fragmentation region. This would lead to an enhancement in the formation of H dibaryons in the relativistic heavy ion collisions. So far, evidence for the existence of the H dibaryon or otherwise is rather scanty and inconclusive. An isolated H candidate has been

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reported in bubble chamber experiments [18]. Three *H* particle candidates have been observed in three different emulsion experiments [19]. In another experiment of the heavy ion collision of Au + Pt, E886 Collaboration has reported a null result for the search of the *H* particle [20]. On the other hand, in a more recent heavy ion experiment [21] a number of *H* dibaryons seem to have been detected. This experiment seems to give a *H*-dibaryon mass of about 2180 MeV and a lifetime of about 3.3×10^{-10} sec. Of course, it must be noted that this result is not yet conclusive enough.

In the present work the mass of the *H* dibaryon has been calculated in the framework of the chiral color dielectric (CCD) model. The CCD model has been used earlier in baryon spectroscopy [22] and for the investigation of static properties of nucleons in nuclear medium [23]. These calculations have shown that the model is able to explain the static properties of light baryons very well. Furthermore, when applied to the quark matter calculation, the model yields an equation of state which is quite similar to the one obtained from lattice calculations for the zero baryon chemical potential [24]. The CCD model differs from the bag model in several aspects. First of all, in the CCD model, the confinement of quarks and gluons is achieved dynamically through the color-dielectric field. In the bag model this is done by hand. Also the quark masses used in the CCD model are different than those used in the bag model. In the bag model, *u* and *d* masses are taken to be zero. The CCD model requires that these masses are nonzero. It has been found [22] that to fit baryon masses, the required *u* and *d* masses are ~100 MeV. It might be noted that similar masses are used in relativistic quark models [25]. Thus, the values of quark masses in the CCD model are closer to the constituent quark masses. The main difference between the present calculation and most of the earlier *H*-dibaryon calculations is the inclusion of the pseudoscalar meson coupling to the *H*-dibaryon state (however, see Refs. [5] and [9] which include meson self-energy). The meson self-energy corrections are expected to shift the masses of dibaryons by a few hundreds of MeV, just like the shifts produced in the baryon masses. Therefore one needs to include these self-energy contributions in a more realistic calculation. Furthermore, the explicit breaking of SU(3)-flavor symmetry, which arises from the difference between strange and $u(d)$ quark masses is included in our calculation.

The color dielectric model has been used earlier to compute the masses of dibaryons. Nishikawa, Aoki, and Hyuga [26] have computed the dibaryon mass without including the pseudoscalar meson interaction and Pal and McGovern [27] have included meson interactions but they do not fit the baryon masses. Our calculation of the meson self-energy is similar to that of Pal and McGovern but we compute the bare dibaryon wave functions using the cluster method (see later) whereas Pal and McGovern use the group theory technique. We believe our method of computing bare dibaryon wave functions has an advantage that it can be generalized for states having larger baryon numbers.

The paper is organized as follows. In Sec. II, the chiral color dielectric model is presented and the methodology of the calculation is described. In Sec. III, the dibaryon wave functions are constructed and the expression for the mass of the *H* dibaryon is given. Finally, the results of the calculation are discussed in Sec. IV.

II. THE CHIRAL COLOR DIELECTRIC MODEL

The CCD model Lagrangian density is given by [22]

$$\mathcal{L}(x)=\bar{\psi}(x)\Bigg\{i\partial\!\!\!/-\Bigg[m_0+\frac{m}{\chi(x)}\Bigg(1+\frac{i}{f_\pi}\lambda_a^f\phi^a(x)\Bigg)\Bigg]+\frac{g}{2}\lambda_a^c A\!\!\!/^a(x)\Bigg\}\psi+\frac{1}{2}[\partial_\mu\phi_a(x)]^2-\frac{1}{2}m_\phi^2\phi^2(x)-\frac{1}{4}\chi^4(x)[F^a_{\mu\nu}(x)]^2+\frac{1}{2}\sigma_v^2[\partial_\mu\chi(x)]^2-U(\chi), \tag{1}$$

where $\psi(x)$, $A_\mu(x)$, $\chi(x)$, and $\phi(x)$ are quark, gluon, scalar (color dielectric), and meson fields, respectively, m and m_ϕ are the masses of the quark and mesons, f_π is the pion decay constant, $F_{\mu\nu}(x)$ is the usual color electromagnetic field tensor, g is the color coupling constant, and λ_a^c and λ_a^f are the usual Gell-Mann matrices acting in color and flavor space, respectively. The flavor symmetry breaking is incorporated in the Lagrangian through the quark mass term $m_0+[m/\chi(x)][1+(i/f_\pi)\lambda_a^f\phi^a(x)]$ where $m_0=0$ for u and d quarks. Therefore, the masses of u, d, and s quarks are m, m, and m_0+m, respectively. The meson matrix consists of a singlet η, a triplet of π, and a quadruplet of K.

The self-interaction $U(\chi)$ of the scalar field is assumed to be of the form

$$U(\chi)=\alpha B\chi^2(x)[1-2(1-2/\alpha)\chi(x)+(1-3/\alpha)\chi^2(x)] \tag{2}$$

so that $U(\chi)$ has an absolute minimum at $\chi=0$ and a secondary minimum at $\chi=1$. The parameters of the CCD model are quark masses (m and m_0), the ''bag constant'' (B), strong coupling constant ($\alpha_s=g^2/4\pi$), pion decay constant (f_π), glueball (or dielectric field) mass ($m_{\rm GB}$), and the constant α in $U(\chi)$. Of these parameters, the value of α is chosen to be 24 since from our earlier calculations [22] the results are not sensitive to it. Also, we choose the experimental value of the pion decay constant ($f_\pi=93$ MeV) in our calculations. Thus we are left with five free parameters to be adjusted. In our earlier calculations [22] we found that a reasonably good fit to the baryon masses is obtained for m and $B^{1/4}$ ranging between 100 and 140 MeV. We therefore choose m and $B^{1/4}$ in this range and adjust $m_{\rm GB}$, α_s, and m_0 to fit the nucleon, Δ, and Λ masses. Computed masses of other octet and decuplet baryons are within a few percent of their experimental masses.

The methodology adopted in the present work is similar to the one followed in the baryon spectroscopy calculations [22] or, for that matter, the one followed in the cloudy bag model calculations [28]. Thus we first compute the quark wave functions in the mean field approximation by solving coupled quark and dielectric field equations obtained in the CCD model. These equations are

$$\left(\vec{\alpha}\cdot\vec{p}-m_0-\frac{m}{\chi(r)}\right)\psi(r)=E\psi(r), \tag{3}$$

$$\chi''(r)+\frac{2}{r}\chi'(r)-\frac{\partial U(\chi)}{\partial\chi}+\frac{m}{\sigma_v^2\chi^2(r)}\langle\overline{\psi}(r)\psi(r)\rangle=0. \tag{4}$$

Here $\psi(r)$ is the four-component Dirac spinor, $\chi(r)$ is the color dielectric field, the m's are the u and d quark masses, m_0 is the mass difference between s and u quarks, $\sigma_v^2=2\alpha B/m_{\rm GB}^2$, $m_{\rm GB}$ is the mass of the dielectric field, and $U(\chi)$ is the self-interaction of the dielectric field.

In the mean field equations above, we have assumed a spherically symmetric and time-independent dielectric field generated by the quarks present in the $s_{1/2}$ orbital. (For details of the CDM Lagrangian, field equations, mean field solutions, etc., the reader is referred to Ref. [22].) The bare wave functions of the dibaryon states are constructed by putting six quarks in the $s_{1/2}$ orbitals obtained by solving the field equations given above. The details of constructing the antisymmetric six-quark wave function are given in the following section. The mass of this state is computed by evaluating the matrix element of the CCD model Hamiltonian

$$H_0=\int d^3x\left[\sum_i \psi^\dagger\left(-i\vec{\alpha}\cdot\nabla+\frac{m}{\chi}+m_0\right)\times\psi+\frac{\sigma_v^2}{2}[(\nabla\chi)^2+\Pi^2]+U(\chi)\right] \tag{5}$$

between the dibaryon state. Here ψ is an annihilation operator of a quark in the state computed in Eq. (3) and Π is the momentum conjugate to the dielectric field χ. The method of coherent states [29] has been used to better account for the energy associated with the dielectric field. To this the color-magnetic interaction between the quarks is added perturbatively (see Refs. [22,30] for details). The bare mass of the dibaryon is then

$$M_B^0=\langle B(\vec{0})|H_0|B(\vec{0})\rangle+E_M, \tag{6}$$

where $|B(\vec{0})\rangle$ is the bare dibaryon state having zero momentum. This state is constructed by using Peierls-Yoccoz projection technique [31,32] which helps in removing the energy due to the spurious motion of the center of mass. Note that the first term in the bare mass is same for all dibaryons having same number of strange quarks and the second term, representing the color-magnetic interaction, depends on the spin-color wave function of the dibaryon. The color magnetic energy E_M is given by

$$E_M=\frac{1}{2}\sum_{i<j}\int d^3r\,\vec{j}_i^a(\vec{r})\cdot\vec{A}_j^a(\vec{r}), \tag{7}$$

where $\vec{A}_j^a(\vec{r})$ is the (color) vector potential generated by jth quark and $\vec{j}_i^a(\vec{r})$ is the color current of ith quark. The vector potential $\vec{A}$ is obtained by using the Green's function technique [22,29]. Thus, we have

$$E_M=\frac{\alpha_s}{3}\sum_{i<j}\left\langle H_1\left|\lambda_i^c\cdot\lambda_j^c\vec{\sigma}_i\cdot\vec{\sigma}_j\int rdrr'dr'\times\frac{g_i(r)f_i(r)}{\chi^4(r)}\frac{g_j(r')f_j(r')}{\chi^4(r')}G_1(r,r')\right|H_1\right\rangle, \tag{8}$$

where g and f are the upper and lower components of Dirac spinor, χ^4 is the color dielectric function, and the Green's function $G_1(r,r')$ is defined in Refs. [22,29].

In order to compute the correction due to meson interaction, we evaluate the matrix element of meson-quark interaction Hamiltonian

$$H_{\rm int}=\frac{i}{f}\int d^3x\frac{m}{\chi(x)}\overline{\psi}(x)\gamma_5\lambda_i^f\psi(x)\phi_i(x) \tag{9}$$

between bare dibaryon states. Thus, the meson interaction contribution to the dibaryon mass is given by

$$E_{\rm meson}=\sum_{B',\phi}\int d^3k\frac{\langle B|H_{\rm int}|B',\phi(\vec{k})\rangle\langle B',\phi(\vec{k})|H_{\rm int}|B\rangle}{M_B-E_{B'}(k)-\omega_\phi(k)}. \tag{10}$$

Note that one needs to sum over all dibaryon states (B') which couple to B via the octet of mesons. Fortunately, the H dibaryon has spin zero and color and flavor neutral. Therefore B', in this case, are the flavor-octet, spin-1 dibaryon states. Also, the dibaryon masses appearing in the energy denominator in Eq. (10) are the physical masses (including the meson correction). In our calculation we approximate these by the bare masses. This approximation is likely to introduce an error of less than 10% in the meson interaction contribution. Since the meson interaction contribution itself is a few hundreds of MeV, we expect an error of ten MeV or less in the H dibaryon mass. The dibaryon mass is then given by

$$M_B=\langle B(\vec{0})|H_0|B(\vec{0})\rangle+E_M+E_{\rm meson}. \tag{11}$$

III. *H*-DIBARYON WAVE FUNCTION

The wave function of a six-quark cluster is then constructed as a product of a six-quark space wave function and a spin-flavor-color wave function. Since all six quarks are in the $s_{1/2}$ orbital, the space wave function is symmetric. We find it convenient to express the spin-flavor-color wave function as a product of two color-neutral three-quark wave functions and then antisymmetrize the wave function with respect to the exchange of quarks between the two clusters:

$$|c_1c_2\rangle_{f,s,c}=\mathcal{P}\sum_{1,2}\alpha_{1,2}|c_1\rangle_f|c_1\rangle_s|c_1\rangle_c\times|c_2\rangle_f|c_2\rangle_s|c_2\rangle_c, \tag{12}$$

where the subscripts f, s, c denote the flavor, spin, and color wave functions of three-quark clusters and c_1 and c_2 denote the first and second clusters, respectively. The color wave function $|c_i\rangle_c=\Sigma_{l,m,n}\epsilon_{l,m,n}|l\rangle|m\rangle|n\rangle$ is antisymmetric (color-singlet) with respect to exchange and that is ensured by the Levi-Civita symbol $\epsilon_{l,m,n}$. $\Sigma_{1,2}$ includes the summation over possible spins, isospins, and hypercharges of the clusters 1 and 2 so as to give a dibaryon state of definite spin, parity, isospin, and strangeness. The permutation operator

$$\mathcal{P}=\frac{1}{\sqrt{8}}[1+\mathcal{S}^{c}{}_{14}\mathcal{A}^{fs}{}_{14}][1+\mathcal{S}^{c}{}_{25}\mathcal{A}^{fs}{}_{25}][1+\mathcal{S}^{c}{}_{36}\mathcal{A}^{fs}{}_{36}] \tag{13}$$

is required for proper antisymmetrization of quark wave functions between two clusters. Note that since the color wave function of a cluster is a color singlet, we need to symmetrize the intercluster color wave function and therefore antisymmetrize the spin-flavor wave function. Also, the spin and flavor cluster wave functions are symmetric and therefore are simply the octet and decuplet baryon wave functions. The state thus constructed is a bare dibaryon state and corrections due to gluon and pseudoscalar meson interactions need to be included.

The *H*-dibaryon state we want to consider in this work is a color-, flavor-, and spin-singlet state. In terms of the cluster wave function described above, the spin-flavor-color wave function of the *H* dibaryon is

$$|H_1\rangle=\frac{1}{4}\mathcal{P}\{|p\Xi^-\rangle+|\Xi^-p\rangle-|n\Xi^0\rangle-|\Xi^0n\rangle-|\Sigma^+\Sigma^-\rangle -|\Sigma^-\Sigma^+\rangle+|\Sigma^0\Sigma^0\rangle+|\Lambda\Lambda\rangle\}\{\uparrow\downarrow-\downarrow\uparrow\}|C_1\rangle_c|C_2\rangle_c, \tag{14}$$

where the first term on the right-hand side of Eq. (14) consists of a combination of baryon octet flavor wave functions and the second bracket is the antisymmetric (two baryon) spin wave function. Note that the baryon wave functions themselves consist of the product of SU(3) color and SU(6) flavor-spin wave functions of quarks. The fact that the wave function $|H_1\rangle$ is a singlet of color and spin is obvious. One can convince oneself that it is a flavor singlet as well by showing that the operation of (quark) isospin, *V* spin and *U* spin raising and lowering operators on $|H_1\rangle$ gives zero.

Let us now consider the mass of the *H* dibaryon. In the cloudy bag model approach, the mass is given by

$$M_{H_1}=M_B^0+M_{\text{meson}}, \tag{15}$$

where, from Eq. (6), one can write $M_B^0=M_0+M_c$. M_0 is the contribution to the *H*-dibaryon mass from quarks and dielectric field, whereas M_c is the contribution due to color magnetic field and is evaluated using Eq. (8).

The meson self-energy M_{meson} is computed by coupling the pseudoscalar meson octet to the *H* dibaryon. The meson coupling to the *H* dibaryons leads to an octet of dibaryon states and the meson energy calculation requires the wave functions and masses of these states. The octet dibaryon wave functions are obtained by operating $\Sigma_i\lambda_i^a\vec{\sigma}_i$ on the *H*-dibaryon state. Here λ_i^a are the (flavor) SU(3) Gell-Mann matrices for *i*th quark and $\vec{\sigma}_i$ is the spin operator. The masses of the dibaryon octet have been calculated by using the procedure outlined in the preceding paragraphs.

The expression for the meson self-energy is [from Eq. (10)]

$$M_{\text{meson}}=\frac{3}{2f_\pi^2\pi^2}\left[3\int\frac{k^4dkv_\pi^2(k)}{\epsilon_\pi(k)[M_0-M_\Sigma-\epsilon_\pi(k)]}+2\int\frac{k^4dkv_K^2(k)}{\epsilon_K(k)[M_0-M_N-\epsilon_K(k)]}+2\int\frac{k^4dkv_K^2(k)}{\epsilon_K(k)[M_0-M_\Xi-\epsilon_K(k)]}\times\int\frac{k^4dkv_\eta^2(k)}{\epsilon_\eta(k)[M_0-M_\Lambda-\epsilon_\eta(k)]}\right]. \tag{16}$$

Here *M*'s are the masses of the dibaryon states excluding the meson self-energy[1] $v_i(k)$ $(i=\pi,K,\eta)$ is the form factor for the *i*th meson coupling to the quark in the dibaryon states and $\epsilon_i(k)$ is the energy of the corresponding meson. Since the *H*-dibaryon state is a spin-flavor singlet, the pseudoscalar meson octet induces a transition between the *H* dibaryon and the (flavor) octet of the dibaryon states having spin 1. The dibaryon octet states, in turn, couple to other dibaryon states through the coupling of the pseudoscalar meson octet. Thus, in a complete calculation, the coupling of the octet dibaryons with other dibaryon states should be included and the masses of all the dibaryon states should be determined in a consistent fashion. Such a somewhat formidable calculation is being done. Here we want to present the results of a restricted calculation described above.

IV. RESULTS AND DISCUSSION

We now come to the discussion of the results of our calculation. The parameters of the CCD model are the quark masses (m_0 and m), the strong coupling constant α_s, the bag pressure B, the meson-quark coupling constant f_π, the mass of the dielectric field M_{GB}, and the constant α. Of these, we have fixed $f_\pi=93$ MeV (the experimental pion decay constant) and $\alpha=24$. The rest of the parameters have been chosen by fitting the octet and decuplet baryon masses. Earlier [22] we have shown that the fitting procedure yields a limited range of values of m_0, B, and m ($m_0\sim100$ MeV, $m\sim200$ MeV, and 100 MeV$<B^{1/4}<140$ MeV) whereas the strong coupling constant α_s is essentially determined by the nucleon-Δ mass difference. But equally good fits to the baryon masses are obtained for a wide range of the glueball mass (0.8 GeV$<m_{\text{GB}}<$1.5 GeV). However, it has been found that the lower values of glueball mass yield better values of charge radii and magnetic moments. In the present calculation the *H*-dibaryon mass has been computed for a large set of the parameter values which fit the masses of nucleon, Δ, and Λ masses. For these sets, the difference between calculated masses of other octet and decuplet baryons and the experimental masses is within few %. This is reflected in the $\chi^2=\Sigma_{\text{baryons}}[M(\exp)-M(\text{CCD})]^2/M(\exp)$ given in Table I. This clearly shows that the quality

[1]The notation used for the dibaryon octet is same as that of the baryon octet. Thus, M_N is the mass of the dibaryon with isospin 1/2, hypercharge 1, and spin 1. It should not be confused with the nucleon mass.

TABLE I. The dependence of H-dibaryon mass (M_{H_1}) on the parameters of the CCD model. α_s is dimensionless, the proton rms radius (column 6) is in units of fm, the proton magnetic moment (column 7) is in units of nuclear magneton, and the masses are in the units of MeV. The H-dibaryon mass is given in the last column.

m_{GB}	α_s	m_0	m	$b^{1/4}$	r_{rms}	μ_p	χ^2	M_{H_1}
819.0	0.269	103.0	211.0	103.0	0.781	2.44	4.32	2071.0
893.0	0.472	122.0	210.0	103.0	0.760	2.37	3.84	2073.0
927.0	0.288	108.0	212.0	108.0	0.751	2.37	4.37	2087.0
968.0	0.578	133.0	209.0	106.0	0.740	2.34	3.80	2083.0
1008.0	0.216	102.0	214.0	113.0	0.731	2.33	4.81	2103.0
1059.0	0.271	111.0	213.0	115.0	0.717	2.30	4.68	2109.0
1118.0	0.261	112.0	213.0	118.0	0.703	2.27	4.85	2119.0
1167.0	0.430	132.0	211.0	118.0	0.689	2.24	4.59	2121.0
1208.0	0.232	112.0	214.0	123.0	0.683	2.23	5.19	2133.0
1251.0	0.214	111.0	215.0	125.0	0.673	2.20	5.41	2140.0

of fit is the same for all the parameter sets so long as the baryon masses are considered. We have also shown the proton rms radius and magnetic moment for these parameter sets. It is clear that these values are closer to experimental values for smaller values of glueball mass.

The calculated H-dibaryon masses are displayed in Table I. In the results shown here the glueball mass has been varied from 800 to 1250 MeV, the u and d quark mass is varied between 100 and 135 MeV and $B^{1/4}$ is varied between 100 and 125 MeV. It is interesting to note that the H-dibaryon mass increases almost linearly with the glueball mass and does not show any systematic dependence on the other parameters. Furthermore, the variation in the H-dibaryon mass is quite large. For example, the H-dibaryon mass changes by about 70 MeV when the glueball mass is increased from about 800 to 1250 MeV. This variation in the dibaryon mass arising from the change in m_{GB} is about an order of magnitude larger than the variation found in the baryon octet and decuplet masses. Here we would like to note that the lower values of the glueball masses ($m_{GB}<1$ GeV) yield better agreement with the static properties of baryons (charge radii, magnetic moments, etc.) [22]. Furthermore, it has been observed that a better agreement with the πN scattering data is obtained for $m_{GB}\sim 1$ GeV or smaller [33]. We therefore feel that results with $m_{GB}\leqslant 1$ GeV are somewhat more realistic.

The results in Table I show that the computed H-dibaryon masses are smaller than the $\Lambda-\Lambda$ threshold. Thus, the H dibaryon is stable against strong decays in the CCD model. The binding energy of the H dibaryon varies between 160 MeV (for m_{GB} of 800 MeV) and 90 MeV (for m_{GB} of 1250 MeV). These values are larger than the result of Ahmed *et al.* [21] as well as Jaffe's prediction [1]. Similar values of H-dibaryon masses have been obtained by Nishikawa, Aoki, and Hyuga [30] (100−200 MeV of binding) and Pal and McGovern [31] (100 MeV of binding) in color dielectric model. However, our calculation is better than these calculations in several respects. For example Nishikawa, Aoki, and Hyuga do not include meson interactions. We also compute meson corrections and center of mass corrections more accurately.

To conclude, we have calculated the H-dibaryon mass using the CCD model. Along with the color magnetic energy, we have also investigated the effect of the quark-meson coupling on the H-dibaryon mass. The correction due to the spurious motion of the center of mass is included in the calculation. The projection technique is used to project out the good momentum states and these states are used in the computation of the dibaryon-meson form factors. It is found that the H-dibaryon is stable against the strong decays for the parameters of the CCD model considered in the calculations with the binding energy of about 100 MeV or more. The determination of the H dibaryon width (due to the weak interaction), masses of other dibaryons, and their strong decay widths (due to their decay into a pair of baryons) in the CCD model needs to be done. These calculations are in progress.

Our results are significant in the context of the ongoing search for the quark-gluon plasma in the laboratory. One of the possible unambiguous ways to detect the transient existence of a temporarily created QGP might be the experimental observation of exotic remnants such as the formation of strange matter or strangelets [34,35]. The six-quark H-dibaryon state is supposed to be the lightest strangelet state. Therefore, the fact that such states are found to be stable for the reasonable parameter ranges in the present study makes it imperative to put more experimental efforts to detect such objects.

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