Properties of $J^P = 1/2^+$ baryon octets at low energy

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Abstract

The statistical model in combination with detailed balance principle is able to phenomenologically calculate and analyze spin and flavor dependent properties like magnetic moments (with effective masses, effective charge, with both effective mass and effective charge), quark spin polarization and distribution, strangeness suppression factor and $\overline{d}-\overline{u}$ asymmetry incorporating strange sea. The $s\overline{s}$ in the sea is said to be generated via the basic quark mechanism but suppressed by the strange quark mass factor $m_s > m_{u,d}$. The magnetic moments of the octet baryons are analyzed within the statistical model, by putting emphasis on the SU(3) symmetry breaking effects generated by the mass difference between the strange and non strange quarks. The work presented here assume hadrons with a sea having admixture of quark-gluon Fock states. The results obtained have been compared with theoretical models and experimental data.

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1. Introduction

Last two decades has witnessed the phenomenal discoveries in particle physics that were celebrated and honored by two Nobel Prizes. Francois Englert and Peter Higgs were jointly awarded with Nobel Prize in 2013 "for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider". The Nobel Prize of 2015 was awarded to Arthur McDonald and Takaaki Kajita "for the discovery of neutrino oscillations, which shows that neutrinos have mass", contradicting the Standard Model which states neutrinos are massless particles. Thus, physics beyond standard model can be studied by working on these new achievements. Also, a new state of matter called "pentaquarks" was reported in LHCb experiment at LHC bringing a glorious triumph in the study of baryon spectroscopy and "studying its properties may allow us to understand better how ordinary matter, the protons and neutrons from which we are all made, is constituted".

Brodsky, Hoyer, Peterson and Sakai (BHPS) model [1] suggested that there are two types of quark contribution to nucleonic sea: intrinsic and extrinsic. Intrinsic sea (valencelike) originates through nonperturbative fluctuations of nucleonic state to five quark state ($uudq\overline{q}$) and extrinsic sea (sealike) is produced perturbatively in the process of gluons splitting into $q\overline{q}$ pairs [2,3]. There is wide range of results available for intrinsic light quark distributions from meson cloud model [4–7], chiral quark model [8, 9] etc. Parton distribution functions (PDFs) has also been successful in extracting the probabilities of intrinsic charm quark in the nucleon [10, 11].

The study of internal structure of hadrons is still one of the unresolved issue despite being studied extensively over the globe in the form of experiments and theoretical developments over the past 50 years. The study of hadrons is a complication for physicists due to relativistic and non-perturbative nature of its constituents. The presence of quark-gluon interaction in valence quarks implies that $q\overline{q}$ pairs can be produced perturbatively by gluons emitted from valence quarks itself which are usually termed as "sea" [12]. The sea could be consisting of light-quarks as well as heavy ones and plays an important role in visualizing the hadronic structure. The distribution of $\overline{u}$ and $\overline{d}$ in sea have large asymmetry according to observations in deep inelastic scattering [13, 14] and Drell-Yan experiments [15,16]. The hadrons made of valence quarks and gluonic degrees of freedom in terms of "sea" have been modeled diversely to interpret its observed properties like magnetic moments, spin distributions, quadrupole moments etc. This class of models assumes nucleon consist of valence quarks surrounded by a sea which, in general, contains gluons and virtual quark-antiquark pairs, and is characterized by its total quantum number [17]. The domains of validity and stability of the results obtained can be checked by calculating maximum number of hadronic parameters or properties within these models. Various nucleonic parameters have been calculated theoretically using chiral quark soliton model [18], Skyrme model [19], sum rules etc [20].

An attempt by Zhang et. al. [21] was made to understand the flavor asymmetry of the proton in detailed balance model. The idea was, that proton is taken as ensemble of quark gluon Fock states and any two nearby Fock states should be balanced with each other under the principle of detailed balance in a way [22, 23]:

$$\rho_A R_{A\to B} = \rho_B R_{B\to A}$$

where ρ_A and ρ_B are the probabilities of finding the proton in state of A and B respectively, $R_{A\to B}$ and $R_{B\to A}$ are the transition probabilities of A to B and B to A respectively. The probabilities of finding every Fock state inside the proton were obtained in the same process. The detailed balance model was used to look into statistical effects of the nucleon and $\overline{d}-\overline{u}$ asymmetry. The model generated $\overline{d}-\overline{u}$= 0.124 which was in agreement with the predictions of E866/NuSea result of 0.118±0.012. We have computed $\overline{d}-\overline{u}$ asymmetry for all other octet baryons using the relation [33]:

$$\overline{d}-\overline{u} = \Big(\Big[\sum_{\substack{j=0,k=0\\ i=l=0}}^{j=2,k=3} \rho_{i,j,l,k}\Big] - \Big[\sum_{\substack{i=0,k=0\\ j=l=0}}^{i=2,k=3} \rho_{i,j,l,k}\Big]\Big) \tag{1.1}$$

The values for flavor asymmetry are shown in table 1 followed by list of average number of partons for all $J^P = \frac{1}{2}^+$ octet members. The total number of intrinsic partons inside every baryon of octet can be calculated as: $N' = u_{val} + d_{val} + s_{val} + \overline{u}u_{sea} + \overline{d}d_{sea} + \overline{s}s_{sea} + g$ and from the normalization condition, $\sum_{i,j,l,k} \rho_{i,j,l,k} = 1$, we can find the average number of partons for all baryons.

$J^P = \frac{1}{2}^+$ octets	$\overline{u}$	$\overline{d}$	$\overline{d} - \overline{u}^*$	Data*	Avg. no. of partons
p	0.33	0.46	0.134	0.124 [24]	4.84
n	0.46	0.33	-0.134	-	4.84
Λ^0	0.44	0.44	0	0	4.73
Σ^+	0.31	0.71	0.39	0.410 [34]	4.87
Σ^0	0.44	0.44	0	0	4.74
Σ^-	0.71	0.31	-0.39	-	4.87
Ξ^0	0.43	0.70	0.26	0.27 [34]	4.85
Ξ^-	0.70	0.43	-0.26	-	4.85

Table 1: $\overline{d} - \overline{u}$ asymmetry and average number of partons for octet baryons.

Later, J. P Singh et. al. [17] constructed Fock states of nucleon having specific color and spin quantum numbers with definite symmetry properties, using statistical ideas. With this approximation, they studied the quarks contribution to the spin of the nucleons, the ratio of the magnetic moments of the nucleons, their weak decay constant and the ratio of SU(3) reduced matrix elements for the axial current. We in this paper, have used the concept for other octet particles to reproduce the flavor asymmetry, quark spin polarization and distribution, magnetic moments (with various modifications) and SU(3) symmetry breaking in magnetic moments for octet particles, which may help in unraveling the hadronic structure. We have also computed the strangeness suppression for octet particles in the framework of the statistical model. Because masses of u and d quarks are fairly small compared with a typical energy scale in the deep inelastic scattering, the splitting processes are expected to occur almost equally for these quarks but a constraint is needed to be applied for strange quark-antiquark pair. The contribution of the $s\overline{s}$ pair is taken into account by applying a constraint resulting from gluon free energy distribution [23]. Orbital motion of the three valence quarks have not been taken into account, however, some of the previous studies shows inclusion of orbital motion preserves the success in describing the magnetic moments [25] , spin-averaged structure function and violation of Gottfried sum rules [26]. The motivation of this paper is to generalize the conjecture of detailed balance principle and statistical model, used earlier in the calculation of some low energy properties of octet particles.

2. Magnetic moments using constituent quark masses and Spin distribution of hyperons

Out of many approaches and models such as the lattice QCD, quark-diquark model, chiral constituent model, potential model, QCD sum rules etc., available for the three body systems, we employ here the statistical approach to study the bayons in $J^P = \frac{1}{2}^+$ state. Magnetic moments is low energy and long distance phenomenon. The magnetic moments of $J^P = \frac{1}{2}^+$ baryons are computed using the spin-flavor wave functions of the constituting quarks. Here, we have incorporated the effect of (a) quark effective masses, (b) quark effective charges and (c) both i.e quark effective mass plus effective charge, to compute the magnetic moments. The quark magnetic moments in terms of effective quark masses can be written as [28]:

$$\begin{aligned} \mu_u^{eff} &= 2[1-(\Delta M/M_B)]\mu_N, \\ \mu_d^{eff} &= -[1-(\Delta M/M_B)]\mu_N, \\ \mu_s^{eff} &= -M_u/M_s[1-(\Delta M/M_B)]\mu_N \end{aligned} \tag{2.1}$$

where M_B is the mass of the baryon obtained additively from the quark masses and ΔM is the mass difference between the experimental value and M_B. The expressions for magnetic moments for all octet particles can be expressed in terms of effective quark magnetic moments ($\mu_u^{eff}, \mu_d^{eff}, \mu_s^{eff}$) and two parameters α and β statistically, as shown in table 3. The values of α and β are calculated by including the strange quark-antiquark pairs in sea [27]. For baryons at ground state, the magnetic moments is a vector sum of quark magnetic moments,

$$\mu_{baryon} = \sum_{i=1,2,3} \mu_i \sigma_i \tag{2.2}$$

where σ_i is the pauli matrix representing the spin term of i^{th} quark and μ_i represents magnitude of quark magnetic moments and therefore, values of magnetic moments are different for different baryons. Also,

$$\mu_i = \frac{e_i}{2m_i} \tag{2.3}$$

for i = u, d, s and e_i represents the quark charge. We have applied the magnetic moment operator ($\widehat{O} = \mu_i \sigma_i$) to the octet wave function in a way:

$$\mu_B = \sum_{u,d,s} \langle \Psi_B | \frac{e_i \sigma_Z^i}{2m_{eff}} | \Psi_B \rangle \tag{2.4}$$

In general,

$$\begin{aligned} \langle \Phi_{1/2}^{(\uparrow)} | \hat{O} | \Phi_{1/2}^{(\uparrow)} \rangle = \frac{1}{N^2} [\langle \Phi_1^{(1/2\uparrow)} | \hat{O} | \Phi_1^{(1/2\uparrow)} \rangle + \sum_{i=8,10} a_i^2 \langle \Phi_i^{(1/2\uparrow)} | \hat{O} | \Phi_i^{(1/2\uparrow)} \rangle + \sum_{i=1,8,10} b_i^2 \langle \Phi_{bi}^{(1/2\uparrow)} | \hat{O} | \Phi_{bi}^{(1/2\uparrow)} \rangle + \\ 2 b_8 c_8 \langle \Phi_{b8}^{(1/2\uparrow)} | \hat{O} | \Phi_{c8}^{(1/2\uparrow)} \rangle + c_8^2 \langle \Phi_{c8}^{(1/2\uparrow)} | \hat{O} | \Phi_{c8}^{(1/2\uparrow)} \rangle + d_8^2 \langle \Phi_{d8}^{(1/2\uparrow)} | \hat{O} | \Phi_{d8}^{(1/2\uparrow)} \rangle] \end{aligned} \tag{2.5}$$

The magnetic moment relations obtained after applying operator for $J^P = \frac{1}{2}^+$ particles in terms of parameters α, β and quark effective masses are shown in column 1 of table 2. We repeat our computations by varying the effective masses of quarks (in MeV) from 370 to 390 for u and d quarks and 500 to 530 for strange quark, to have an idea about the most suitable set of effective quark masses that yields the magnetic moments of baryons. As the values of effective masses are model dependant so the magnetic moments of quarks are also model dependent and one has to take their values consistent with the constituent quark masses.

In addition to the calculation of magnetic moments with effective mass, we have also computed magnetic moments with effective charge. Here, we have applied the magnetic moment operator ($\widehat{O} = \mu_i \sigma_i$) to the octet wave function in a way:

$$\mu_B = \sum_{u,d,s} \langle \Psi_B | \frac{e_i^{(eff)} \sigma_Z^i}{2m_{eff}} | \Psi_B \rangle \tag{2.6}$$

We have taken the effective charge to depend linearly on the charge of the shielding quarks. Thus, the effective charge e_a of quark a in the baryon B(a,b,c) is written as [29]:

$$e_a^B = e_a + \alpha_{ab} e_b + \alpha_{ac} e_c \tag{2.7}$$

where e_a is the bare charge of quark a. Taking isospin symmetry, we have

$$\begin{aligned} \alpha_{uu} = \alpha_{ud} = \alpha_{dd} = \beta \\ \alpha_{us} = \alpha_{ds} = \alpha \\ \alpha_{ss} = \gamma \end{aligned}$$

The screened quark charges for various baryons in terms of the three parameters α, β, γ can be expressed as:

$$\begin{aligned} e_u^p = \frac{2}{3}(1 + \frac{1}{2}\beta), e_d^p = -\frac{1}{3}(1 - 4\beta), \\ e_u^n = \frac{2}{3}(1 - \beta), e_d^n = -\frac{1}{3}(1 - \beta)... \end{aligned} \tag{2.8}$$

Substituting these values of effective charge and applying the magnetic moment operator to wave function as in equation (2.4) and using the unknown parameters in effective charge relations i.e. α= 0.248, β=0.025, γ= 0.018 to 0.029, as input, we determine the magnetic moments and are shown in table 3.

SU(3) symmetry breaking effects is also applied in sea and valence quarks. This breaking is due to the mass difference between strange and non-strange light quarks. Symmetry breaking is applied to the magnetic moments in the form of the parameter $r = m/m_s$ [35] where m is the mass of u and d quarks. The value of "r" lies in the range 0.70 to 0.78, depending upon the respective effective quark masses. The results for magnetic moments with SU(3) broken symmetry for hyperons are shown in table 4.

Recently, CLAS Collaboration [30] reported the strangeness suppression in the proton from the production rates of baryon-meson states in exclusive reactions, i.e. without the production of an intermediate baryon resonance. We are also interested in measuring how often, compared with pairs of light quarks, strange quarks are made. For this purpose, we define the strangeness suppression factor as $\lambda_s = \frac{2(s\bar{s})}{(u\bar{u}+d\bar{d})}$. This ratio implies the existence of strange quarks in sea. So, we have calculated the strangeness suppression factor for all particles in $J^P = \frac{1}{2}^+$ state in the framework of principle of detail balance. The calculation of strangeness suppression factor includes various sub processes like $g \Leftrightarrow q\bar{q}$, $g \Leftrightarrow gg$, $q \Leftrightarrow qg$. The results are presented in Table 5. The value for the strangeness suppression factor is in good agreement with both the values determined in exclusive reactions and in high-energy production.

Baryon octet magnetic moments	Magnetic moments (μ_N)						
	With effective quark mass		With effective quark charge		With effective quark mass+ effective quark charge		
	(2 gluons)	(3 gluons)	(2 gluons)	(3 gluons)	(2 gluons)	(3 gluons)	Exp. Results [36]
$\mu_p = 3(\mu_u^{eff}\alpha - \mu_d^{eff}\beta)$	2.79	2.29	1.81	1.73	2.74	2.62	2.79
$\mu_n = 3(\mu_d^{eff}\alpha - \mu_u^{eff}\beta)$	-1.83	-1.50	-0.85	-0.84	-1.38	-1.37	-1.91
$\mu_\Lambda = \frac{1}{2}(\alpha - 4\beta)(\mu_u^{eff} + \mu_d^{eff}) + (2\alpha + \beta)\mu_s^{eff}$	-0.634	-0.60	-0.41	-0.36	-0.59	-0.52	-0.613
$\mu_{\Sigma^+} = 3(\mu_u^{eff}\alpha - \mu_s^{eff}\beta)$	2.464	2.11	1.99	1.78	3.0	2.77	2.458
$\mu_{\Sigma^0} = \frac{3}{2}(\mu_u^{eff}\alpha + \mu_d^{eff}\alpha - 2\mu_s^{eff}\beta)$	0.775	0.680	0.82	0.76	1.31	1.19	0.775
$\mu_{\Sigma^-} = 3(\mu_d^{eff}\alpha - \mu_s^{eff}\beta)$	-0.974	-0.82	-0.83	-0.75	-1.29	-1.17	-1.160
$\mu_{\Xi^0} = 3(\mu_s^{eff}\alpha - \mu_u^{eff}\beta)$	-1.388	-1.203	-0.933	-0.84	-1.36	-1.23	-1.250
$\mu_{\Xi^-} = 3(\mu_s^{eff}\alpha - \mu_d^{eff}\beta)$	-0.615	-0.53	-0.422	-0.403	-0.57	-0.55	-0.6507

Table 2: Magnetic moments of $J^P = \frac{1}{2}^+$ baryons with (a) effective quark masses, (b) quark effective charge and (c) both i.e quark effective mass plus quark effective mass. The results of magnetic moments with various modifications are shown taking two and three gluons in sea respectively.

Baryon octet magnetic moments	Magnetic moments (μ_N)		
	With SU(3) symmetry breaking	With SU(3) symmetry	Exp. Results [36]
Λ^0	-0.44	-0.634	-0.613
Σ^+	2.40	2.464	2.458
Σ^0	0.644	0.775	0.775
Σ^-	-1.018	-0.974	-1.160
Ξ^0	-1.063	-1.388	-1.250
Ξ^-	-0.35	-0.615	-0.6507

Table 3: Magnetic moments of particles with SU(3) symmetry breaking, SU(3) symmetry and comparison with experimental data available.

Baryon octet	$\frac{s\bar{s}}{d\bar{d}}$	$\frac{u\bar{u}}{d\bar{d}}$	$\lambda_s = \frac{2(s\bar{s})}{(u\bar{u}+d\bar{d})}$
p	0.32/0.26*/0.22**	0.71/0.57*/0.74**	0.38/0.34*/0.29**
n	0.46	1.40	0.38
Λ^0	0.28	1	0.29
Σ^+	0.19	0.43	0.277
Σ^0	0.28	1	0.28
Σ^-	0.45	2.26	0.276
Ξ^0	0.17	0.62	0.21
Ξ^-	0.28	1.61	0.21

Table 4: Strangeness suppression for all particles in octet are shown in this table. The values in the second row with single * shows the results from UQM [31] and with double ** are the experimental results [30] for strangeness suppression in proton.

The individual spin polarization due to quarks for hyperons are calculated and compared with data of other available model. In application, the individual spin polarization is defined as, $\Delta q = n(q\uparrow) - n(q\downarrow) + n(\bar{q}\uparrow) - n(\bar{q}\downarrow)$ for q=u, d, s, where $n(q\uparrow)$ is the number of spin-up and $n(q\downarrow)$ is the number of spin down quarks of flavor q for both quarks and anti-quarks. In addition, total spin distributions of baryon is also determined by applying the operator $\frac{1}{2}e_i^2\sigma_Z^i$ where e_i and σ_Z^i are the charge of quark and spin projection operator respectively, to the baryonic wave function. The results from statistical model and comparison with other models are shown in table 2.

A well known and important problem for physicists over last 20 years i.e. proton spin crisis suggested that proton's spin is built from constituent quarks plus sea of quark-antiquark pairs and gluons. Deep inelastic experiments and European Muon Collaboration predicted that total spin of proton is very little contributed by quark's intrinsic spin, which was contrary to the results of non-relativistic quark model. The whole story led the phenomenologist as well as experimentalist to think beyond the already known facts. Various experiments [37] measured spin structure function (g_1) at x=0.1 to x=0.01 concluded that, the proton is a system of three massive constituent quarks interacting self-consistently with cloud of virtual pions and condensates generated from spontaneous breaking of chiral symmetry between left and right handed quarks. On the other other hand, when probed at high resolution, the structure of proton seems to be combination of three valence quarks plus sea of quark-antiquark pairs and gluons. Thus, we conclude that nucleonic spin is distributed among gluons, valence and sea quarks plus their angular momenta.

Table 5: Spin distribution from individual quarks and total spin distribution computed in statistical model. We have defined all the properties in terms of parameters α and β.

Baryon	Quark spin polarizations and distribution	Calculated Values	Experimental data [38]
Λ	$\Delta u = \frac{\alpha}{2} - 2\beta$	-0.02	-0.03
	$\Delta d = \frac{\alpha}{2} - 2\beta$	-0.02	-0.03
	$\Delta s = 2\alpha + \beta$	0.70	0.74
	$I_1^{\Lambda} = \frac{1}{4}(\alpha - 2\beta)$	0.041	0.027
Σ^+	$\Delta u = 3\alpha$	0.91	0.98
	$\Delta d = 0$	-7.40×10^{-17}	-0.02
	$\Delta s = -3\beta$	-0.21	-0.29
	$I_1^{\Sigma^+} = \frac{2}{3}\alpha - \frac{1}{6}\beta$	0.191	-
Σ^0	$\Delta u = \frac{3}{2}\alpha$	0.46	0.48
	$\Delta d = \frac{3}{2}\alpha$	0.46	0.48
	$\Delta s = -3\beta$	-0.22	-0.29
	$I_1^{\Sigma^0} = \frac{5}{12}\alpha - \frac{1}{6}\beta$	0.117	-
Σ^-	$\Delta u = \frac{1}{6}\alpha - \frac{1}{6}\beta$	0.03	-0.02
	$\Delta d = 3\alpha$	0.91	0.98
	$\Delta s = -3\beta$	-0.22	-0.29
	$I_1^{\Sigma^-} = \frac{1}{6}\alpha - \frac{1}{6}\beta$	0.0389	-
Ξ^0	$\Delta u = -3\beta$	-0.22	-0.29
	$\Delta d = 0$	0	-0.02
	$\Delta s = 3\alpha$	0.95	0.98
	$I_1^{\Xi^0} = \frac{1}{2}\alpha - \beta$	0.0838	-
Ξ^-	$\Delta u = -3\beta$	-0.2	-0.020
	$\Delta d = \alpha - 4\beta$	0.017	-0.29
	$\Delta s = 3\alpha$	0.95	0.98
	$I_1^{\Xi^-} = \frac{1}{6}\alpha - \frac{1}{6}\beta$	0.0404	-

3. Discussion of result and conclusion

Statistical models provides physical simplicity in describing the various properties of the baryonic states which includes the "sea". Baryonic structure is considered to be consisting of valence quarks and sea limited by a few number of quark-antiquark pairs multiconnected non-perturbatively through gluons. In the present article, the baryon octet wave function is studied, by looking at the concept of effective mass and effective charge to analyze various baryonic properties like magnetic moments, flavor asymmetry and quark spin distribution.

The explicit numerical values of quark effective mass and quark effective charge, contributing to the magnetic moments of $J^P = \frac{1}{2}^+$ octet baryons are calculated. Effective quark masses and effective quark charges for quarks u, d, and s are calculated using fixed inputs for baryon masses (PDG) and statistical parameters (α, β) as input in the respective formulae. These effective masses and effective charges of u, d and s are acting as an input to the magnetic moment of $J^P = \frac{1}{2}^+$ baryon octet. The contribution of quark effective charge can be added by taking the concerned parameters as α= 0.248, β=0.025, γ= 0.018 to 0.029, as discussed in the previous section. SU(3) breaking is studied for the magnetic moment by using a parameter "r" which plays an important role by providing the basis to understand the extent to which sea quarks contribute to the structure of the baryon.

We have also investigated the flavor asymmetry of all the octet baryons. It can be seen from table 1 that, there exist simple relations between the flavor asymmetries, e.g., the excess of $\overline{d}$ over $\overline{u}$ in the proton is equal to excess of $\overline{u}$ over $\overline{d}$ in the neutron, and similarly for other hyperons. The isospin symmetry leads to these relations among the flavor asymmetries of octet baryons.

The magnetic moments of the baryon octet is studied in the framework of the statistical model along with principle of detailed balance in which the effect of "sea" is taken into account via inclusion of quark effective mass and quark effective charge. It is interesting to observe that our results for the magnetic moments of J/P=1/2+ octet particles give a good match with the experimental values specifically when calculated with quark effective mass (with 2 gluons) are taken whereas magnetic moments deviate when quark effective charge is considered, as seen in table 2. Though in all the cases, the contribution of quark sea is quite significant. The calculated values of magnetic moments with SU(3) breaking is compared when magnetic moments with SU(3) symmetry is taken and can be seen in table 3. The listed values shows that the strange quark contribution to the magnetic moment due to its mass is almost an order of magnitude smaller than the up and down quarks thus leading to a very small contribution from the heavy quarks when compared with the contribution coming from the light quarks. The results with SU(3) symmetry breaking is not in much agreement with the experimentally observed values. Plausibly, due to poor role at such a high energy where s=u=d is applicable.

To appreciate the strange quark in sea, a factor called strangeness suppression factor is calculated for all the octet particles (in table 4). This suppression factor suggests the probability of accommodation of $s\overline{s}$ pairs in sea for singly or doubly strange octet baryons. Though the data for this factor is experimentally available only for proton, but we have calculated this strangeness suppression factor for all the particles in octet. Hence, this suppression factor suggests that $s\overline{s}$ sea accomodability enhances for particles with higher strangeness in their valence part.

Importance of sea with effective mass and charge of the quark content has been studied and its various effects have been shown through the above properties, which provide rich information about the structure of all the octets thereby motivating experiments for further inspection. Hence, the validity of the statistical model in the hadronic structure has been proved for various cases.

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