An Attempt to Colour Confinement

Deep Jyoti Dutta

American Physical Society, College Park, Maryland

Abstract

This note is presented with a single aim; the aim is to deduce a mathematical method to simply interpret the phenomena of color confinement. The derivation is something that arises from profound theoretical mechanisms of strong interaction.

Keywords: QCD, Asymptotic Freedom, Color Confinement

Quantum Chromodynamics (QCD) is the quantum field theory with SU(3) gauge group that attempts to understand the strong nuclear force in deeper levels. Quarks [1] are the fundamental fermions that makes up ordinary matter the other being electrons (first generation lepton, a fermion). The necessary of color charge is very crucial in constructing QCD, the two important properties of QCD is 1. Colour confinement and 2. Asymptotic freedom. The gauge field (and consequently eight gauge bosons, gluon) of QCD carry colour charge means apart from mediating the strong force, the strong quanta also participate in self colour interaction. Quarks are never observed in isolated state it is found in composite states called hadrons, this paradox is explained using the discovery called asymptotic freedom [2], it means that the closer the quarks are the weaker the force is between them and as the distance between the quarks grows the force gets stronger and stronger. In other words, for QCD the beta function explains that as the energy scale increases (length scale decreases) the strong coupling gets weaker and as the energy scale decreases (length scale increases) the coupling or interaction strength gets stronger. Gluon –Gluon self interaction due to color charge constrains a narrow tube or color gauge fields called flux tube or QCD strings, this stretching of gauge fields exerts force thus generating confinement of quarks.

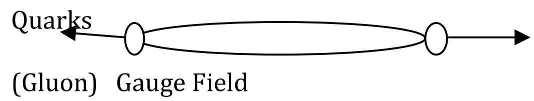

Fig.A explains that gluon field stretches and tension increases which causes color confinement between quarks

The beta function in terms of energy Q and coupling α_s is

$$\beta = \partial \alpha_s / \partial \ln Q$$

For QCD define that

$$C_{\psi}{}' \propto \ln Q$$

And

$$\alpha_s \propto 1/\ln Q.$$

Combining we obtain that $C_{\psi}{}' \propto \frac{1}{\alpha_s}$

The parameter $C_{\psi}{}'$ is to be identified as the variable to denote the *numerical chance or numerical possibility* of deconfined or dehadronised quark and gluons. Free parton parameter ($C_{\psi}{}'$) means or defined by freely observed fractional charged particle with fractional baryon number (quarks) and strong gauge gluons.

$$C_{\psi}{}' = \begin{pmatrix} Q_1 & Q_2 & B \\ +\frac{2}{3}e & -\frac{1}{3}e & \frac{1}{3} \end{pmatrix} \textit{charge two types}$$

The equation to mathematically explain the confinement is therefore found to be

$$C_{\psi}{}' = -\left[\gamma_{\beta} + \alpha_s(Q)\right]$$

Where $\gamma_{\beta} = q_{\mu} + C_{\tau}{}^2 - \frac{1}{2}S_{\mu}C_{\mu\sigma}{}^2$ q_{μ} is the total number of quarks in nature in bound or non-isolated state=6, C_{τ} is the color charge parameter in nature=3, S_{μ} is the ratio of quark to gluon spin = ½ and $C_{\mu\sigma}$ is the overall gauge fields states means bound gluons = 8. This equation is relatively simple and states that as coupling is 1 or > 1 the isolated parameter becomes 0 or lies in negative (for coupling >1), the interpretation of this result is that as coupling increases in low energy the chance to observe isolated partons (as Feynman coined) is completely zero or not at all possible and negative in case of >1 means super impossibility to observe the free partons, and as the coupling decreases (at extremely high energy) possibly to zero the value of the parameter is positive simply the chance to observe free partons is extremely high, means at low coupling the increasing positive value or the outcome of the parameter must be interpreted as the high chance for possible observation of free partons outside hadrons. The interpretation can be summarized as follows: *as the coupling increases the numerical parameter runs from zero to negative value means numerical possibility is impossible and super impossible to observe free partons and as the coupling decreases the numerical parameter or numerical possibility reads positive values means very high chance to observe free partons*. The negative sign of the equation is very crucial in QCD and this equation is very much consistent and in agreement with asymptotic freedom. This equation is *highly basic* but *very simple* to interpret confinement of quarks mathematically at least in chance theory, and therefore this can also be considered as the basic attempt to prove confinement. This equation can therefore be identified as a simple *mathematical chance to observe partons.*

References

[1] [1] M. Gell-Mann, Phys. Letters 8, 214 (1964)

[2] Reliable Perturbative Results for Strong Interactions?* H. David Politzer 25th June 1973