1 Honors Seminor S

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1.1 The Monopole fields and Gauge symmetricity

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1.2 Summary

The former model of monopoles are have some problem of absense of explanation about electric charge-monopole interaction. Our group studied about following tree models: U(1) gauge model on interaction of identical particles[1] , SU(2) gauge model on general interactions and U(1)×U(1) for action-reaction symmetry breaking.

U(1) Gauge groups Here we suppose that each electron, dyon, monopole are spin $s = \frac{1}{2}$ particle system. Then we denote the Lagrangian density of system by considering interaction with scalar particles[2] like:

$$\mathcal{L}_{\mathrm{U}(1)} = -\frac{1}{4(q_e^2+q_g^2)}[D^\mu, D^\nu]^2 + \bar{\psi}(i\not{D} - m)\psi + (D_\mu\Phi)^*(D^\mu\Phi) - m^2(\Phi^*\Phi). \tag{1}$$

Here we define the Covariant derivate:

$$D_\mu \equiv \partial_\mu + iq_e A_\mu + iq_g B_\mu. \tag{2}$$

where, A_μ, B_μ are each four-vectors from electron and monopole.

SU(2) Gauge groups Here we define the SU(2) gauge field $\mathbf{W}_\mu$ of general interaction model following:

$$\mathbf{W}_\mu = (W_\mu^1, W_\mu^2, W_\mu^3) = (q_e A_\mu + q_g B_\mu, 0, q_e A_\mu + q_g B_\mu)\ , \tag{3}$$

$$D_\mu = \partial_\mu + i\begin{pmatrix} W_\mu^3 & W_\mu^1 - iW_\mu^2 \\ W_\mu^1 + iW_\mu^2 & -W_\mu^3 \end{pmatrix}. \tag{4}$$

Then, the Lagrangian density also given by:

$$\mathcal{L}_{\mathrm{SU}(2)} = \bar{\psi}_e\left(i\not{\partial} - q_e\not{A} - q_g\not{B} - m\right)\psi_e - \bar{\psi}_e(q_e\not{A} + q_g\not{B})\psi_{\nu_{eg}}$$

$$+ \bar{\psi}_{\nu_{eg}}\left(i\not{\partial} + q_e\not{A} + q_g\not{B} - m\right)\psi_{\nu_{eg}} - \bar{\psi}_{\nu_{eg}}(q_e\not{A} + q_g\not{B})\psi_e - \frac{1}{8(q_e^2+q_g^2)}[D^\mu, D^\nu]^2.$$

From using Hamilton's principles, we get the generalized Maxwell equations.

[1] electron-electron or dyon-dyon, etc.
[2] But, we ignore Yukawa interaction.

U(1)×U(1) Gauge groups To determine the gauge group, here we adopt differential forms on Lorentz manifold $\mathcal{M}_L(\dim(\mathcal{M}_L) = 4)$. Then, Electromagnetic tensor on Dyon field $G = \frac{1}{2!}G_{\mu\nu}\, dx^\mu \wedge dx^\nu$ only possible for[3]:

$$G = \mathrm{d}A - \star\mathrm{d}B = \frac{1}{2!}\left(\partial_{[\mu}A_{\nu]} - \frac{\sqrt{-g}}{2}\theta(x)\epsilon_{\mu\nu\rho\sigma}\partial^\rho B^\sigma\right)\, dx^\mu \wedge dx^\nu. \tag{5}$$

The Lagrangian density of gauge field also given by

$$\mathcal{L}^{\text{field}}_{\mathrm{U}(1)\times\mathrm{U}(1)} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} - \frac{\theta^2(x)}{4}E_{\mu\nu}E^{\mu\nu} + \frac{1}{2}\partial_\mu(\theta(x))B_\nu\tilde{F}^{\mu\nu}. \tag{6}$$

Here we can check "Witten effects" again.

We need to examine each model on Scattering calculation, next semester.

[3]by Hodge decomposition Theorem