On the Electric and Magnetic Forces

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The electric and magnetic forces would be produced by a polarization of the vacuum.

Key words: polarization of the vacuum.

An electric charge would induce an electric polarization in the vacuum:

$$(-, +) \ldots (-, +) \text{ or } (+, -) \ldots (+, -) \tag{1}$$

depending on whether the electric charge is $+q$ or $-q$, respectively, and where (-, +) and (+, -) represent the induced electric dipoles in the vacuum space.

A magnetic body would induce a magnetic polarization in the vacuum:

$$[-, +] \ldots [-, +] \text{ and } [+, -] \ldots [+, -] \tag{2}$$

correspondingly to the magnetic poles N (north) and S (south), respectively, and where [-, +] and [+, -] represent the induced magnetic dipoles in the vacuum space.

From (1) and (2), we see, by construction, that the charges / poles of the same (different) sign repel (attract) each other.

The induced dipoles, (1) and (2), form the lines of force, then, we define the corresponding vector field, $\vec{\Phi}$, for an electric charge or a magnetic body or an electric current, as proportional, k, to the number of lines of force per unit area, N/S, per solid angle, S/r^2:

$$\vec{\Phi} = k \frac{N}{S} \frac{S}{r^2} \vec{u}_r = k \frac{N}{r^2} \vec{u}_r \tag{3}$$

Thus, for the electric vector field produced by the source electric charge, q_1, it would be

$$\vec{E}_1 = k_e \frac{N}{S} \frac{S}{r_1^2} \vec{u}_r = k_e \frac{N}{r_1^2} \vec{u}_r = \frac{1}{4\pi\varepsilon_0} \frac{q_1}{r_1^2} \vec{u}_r \tag{4}$$

ε_0 being the electric permittivity of the vacuum, with

$$k_e N = \frac{1}{4\pi\varepsilon_0} q_1 \tag{5}$$

And the electric force on a test electric charge, q_2, would be

$$\vec{F}_{e12} = q_2 \vec{E}_1 = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r_{12}^2} \vec{u}_r \tag{6}$$

which is the Coulomb's electric force between two electric charges q_1 and q_2 separated by a distance r_{12}.

For the magnetic vector field, it would be the same:

$$\vec{B}_1 = -k_m \frac{N}{S} \frac{S}{r_1^2} \vec{u}_r = -k_m \frac{N}{r_1^2} \vec{u}_r = -\frac{\mu_0}{4\pi} \frac{i_1 l_1}{r_1^2} \vec{u}_r \tag{7}$$

μ_0 being the magnetic susceptibility of the vacuum, i_1 the source electric current and l_1 the conductor length, with

$$k_m N = \frac{\mu_0}{4\pi} i_1 l_1 \tag{8}$$

And the magnetic force on a test electric current, i_2, of conductor length, l_2, would be

$$\vec{F}_{m12} = i_2 l_2 \vec{B}_1 = -\frac{\mu_0}{4\pi} \frac{i_1 l_1 i_2 l_2}{r_{12}^2} \vec{u}_r \tag{9}$$

which is the Biot-Savart's magnetic force between two electric currents i_1 and i_2 of conductor lengths l_1 and l_2, respectively, separated by a distance r_{12}. Two parallel conductors attract if the currents go in the same direction and repel otherwise, hence the minus sign in (9).

The electric force lines are anchored to the electric charges. If an electric charge, *q*, moves, an electric current, *q/t* (where *t* is the time), is produced and circular magnetic force lines are generated around the trajectory of the electric charge. The tangents to the electric and magnetic force lines are perpendicular between themselves. If the electric charge is accelerated, the recoil generated by the inertial force produce the liberation of the anchored electric force lines, and also the circular magnetic force lines expands because the electric current, *q/t*, increases since *t* decreases. The liberated electric force lines and the expanding magnetic force lines form an electromagnetic wave that propagates in the vacuum, at a speed of approximately three hundred thousand kilometers per second, perpendicularly to the trajectory of the accelerated charge.

In summary, the electric and magnetic forces would be produced by a polarization of the vacuum.