Hypothesis about the formation of particles from fields

The hypothesis is an extension of field theory and an attempt to explain the internal structure of elementary particles.

Basic equations

Presumably, in three-dimensional space there is a field formed by vectors of electric intensity $\mathbf{E} = (E_x, E_y, E_z)$, magnetic intensity $\mathbf{H} = (H_x, H_y, H_z)$, and velocity $\mathbf{V} = (V_x, V_y, V_z)$. Also later in this article, the vectors of electrical induction in vacuum $\mathbf{D} = \varepsilon_0 \cdot \mathbf{E}$ and magnetic induction in vacuum $\mathbf{B} = \mu_0 \cdot \mathbf{H}$ can be used.

E and **H** are "energy carriers" local density of energy is expressed as follows:
$u = \varepsilon_0/2 \cdot E^2 + \mu_0/2 \cdot H^2$
where $E^2 = E_x^2 + E_y^2 + E_z^2$ and $H^2 = H_x^2 + H_y^2 + H_z^2$

Law of energy conservation: time derivative
$u' = -\operatorname{div} \mathbf{W}$
where $\mathbf{W} = (W_x, W_y, W_z)$ is the energy flux vector.
In this case, $\mathbf{W} = [\mathbf{E} \times \mathbf{H}] + \varepsilon_0 \cdot (\mathbf{E} \cdot \mathbf{V}) \cdot \mathbf{E}$
The scalar product $EV = \mathbf{E} \cdot \mathbf{V} = E_x \cdot V_x + E_y \cdot V_y + E_z \cdot V_z$
expresses the cosine of the angle between **E** and **V**.
In more detail,
$W_x = E_y \cdot H_z - E_z \cdot H_y + \varepsilon_0 \cdot EV \cdot E_x$
$W_y = E_z \cdot H_x - E_x \cdot H_z + \varepsilon_0 \cdot EV \cdot E_y$
$W_z = E_x \cdot H_y - E_y \cdot H_x + \varepsilon_0 \cdot EV \cdot E_z$
Respectively,
$\operatorname{div} \mathbf{W} = \mathbf{H} \cdot \operatorname{rot} \mathbf{E} - \mathbf{E} \cdot \operatorname{rot} \mathbf{H} + \varepsilon_0 \cdot \mathbf{E} \cdot \operatorname{grad} EV + \varepsilon_0 \cdot EV \cdot \operatorname{div} \mathbf{E}$

Derivatives of the magnetic and electric field by time:
$\mathbf{H}' = -1/\mu_0 \cdot \operatorname{rot} \mathbf{E}$
$\mathbf{E}' = 1/\varepsilon_0 \cdot \operatorname{rot} \mathbf{H} - \operatorname{grad} EV - \mathbf{V} \cdot \operatorname{div} \mathbf{E}$
In this case, div **E** is proportional to the local charge density q with a constant positive multiplier: $q \sim \operatorname{div} \mathbf{E}$, in the SI measurement system $q = \varepsilon_0 \cdot \operatorname{div} \mathbf{E}$.

Having performed the necessary transformations, we get:

$$u' = \varepsilon_0/2 \cdot (2 \cdot E_x \cdot E_x' + 2 \cdot E_y \cdot E_y' + 2 \cdot E_z \cdot E_z')$$
$$+ \mu_0/2 \cdot (2 \cdot H_x \cdot H_x' + 2 \cdot H_y \cdot H_y' + 2 \cdot H_z \cdot H_z')$$
$$= E_x \cdot (\partial H_z/\partial y - \partial H_y/\partial z - \varepsilon_0 \cdot \partial EV/\partial x - \varepsilon_0 \cdot V_x \cdot \text{div } E)$$
$$+ E_y \cdot (\partial H_x/\partial z - \partial H_z/\partial x - \varepsilon_0 \cdot \partial EV/\partial y - \varepsilon_0 \cdot V_y \cdot \text{div } E)$$
$$+ E_z \cdot (\partial H_y/\partial x - \partial H_x/\partial y - \varepsilon_0 \cdot \partial EV/\partial z - \varepsilon_0 \cdot V_z \cdot \text{div } E)$$
$$- H_x \cdot (\partial E_z/\partial y - \partial E_y/\partial z) - H_y \cdot (\partial E_x/\partial z - \partial E_z/\partial x) - H_z \cdot (\partial E_y/\partial x - \partial E_x/\partial y)$$
$$= \mathbf{E} \cdot \text{rot } \mathbf{H} - \mathbf{H} \cdot \text{rot } \mathbf{E} - \varepsilon_0 \cdot \mathbf{E} \cdot \text{grad } EV - \varepsilon_0 \cdot EV \cdot \text{div } \mathbf{E} = - \text{div } \mathbf{W}$$

A term in the form of "grad EV" for **E′** arises from the need to make an adequate expression of the energy conservation law, and although in the "natural" structures discussed below **E** is everywhere perpendicular to **V**, that is, EV = 0, it can play a role in maintaining the stability of field formations.

Velocity derivative by time

From the point of the energy-flux view, the time derivative **V′** can be any expression, but should not contain a common multiplier **V** or $1 - V^2/c^2$, since when approaching zero or the speed of light, the vector would practically cease to change locally, which contradicts many experimental facts and theoretical studies. The most likely are the two-membered constituents for **V′**, where one part contains **V** as a multiplier in the scalar or vector product, the second does not.

For example, the pure field similarity of the Lorentz forces is of interest:
$$\mathbf{V}' \sim (\mathbf{D} \cdot V^2 - [\mathbf{H} \times \mathbf{V}]) \cdot \text{div } \mathbf{E}$$
where $V^2 = V_x^2 + V_y^2 + V_z^2$

The expressions $\mathbf{D} \cdot V^2$ and $\mathbf{H} \times \mathbf{V}$ have the same dimension, A/s in SI, and after multiplying by the div **E**, it is still necessary to enter a coefficient to convert the resulting units into acceleration m/s^2. The numerical value of the coefficient will probably have to be determined experimentally.

Although there are no strict restrictions on the absolute value of **V**, as we shall see later, for field formations common in nature, it is uncharacteristically $|\mathbf{V}| > c$, and the speed of light is achieved at a mutually perpendicular arrangement of **E**, **H**, and **V**, when the local "E-energy" is equal to "H-energy", that is, $\mathbf{E}^2 \sim 1/\varepsilon_0$, $\mathbf{H}^2 \sim 1/\mu_0$.

The exception is artificially created or simulated on the computer situations. Another hypothetical set of terms for the velocity derivative over time is **V′** ~ **W** - u · **V**. In the models of particles discussed below, in this case, there is a "longitudinal" effect on the velocity vector, in contrast to the "transverse" one under the influence of an electric and magnetic field, with the mutual perpendicularity of all three vectors.

If indeed **V′** ~ **W** - u · **V**, then although there is still no hard limit $|V| \le c$, the unlimited increase of the velocity in the absolute value is more explicitly limited by the member u · **V** with a negative sign. If the magnetic or electric field somehow disappears, the velocity will rush to zero, although the energy density may remain non-zero. Modulus of **V** reaches its maximum value (= c) when **E** and **H** are perpendicular and $\varepsilon_0/2 \cdot E^2 = \mu_0/2 \cdot H^2$.

When the charged particle is in an external electric field, like created by another particle in the vicinity, due to the multiplier V^2 in the expression
$\mathbf{V'} \sim (\mathbf{D} \cdot V^2 - [\mathbf{H} \times \mathbf{V}]) \cdot \mathrm{div}\, \mathbf{E}$
is independent of the sign of **V**, and the presence of significant velocities close to the speed of light inside the particle, the total acceleration acts in one direction (on average, although internal deformations may occur).

In an external magnetic field the velocity vector is involved in the first degree, in any projection about half of the currents are directed in one direction, and about half in the opposite direction, so only internal deformations occur. The shift of a particle as a whole is observed when it moves in an external magnetic field.

Let us consider the alleged structure of some elementary particles. To do this, we will use a cylindrical coordinate system (ρ,φ,z), where $\rho^2 = x^2 + y^2$, φ is the angle counted from the positive direction of the x-axis counterclockwise if it is directed to the right, the y-axis upwards, and the z-axis is directed towards us (the right coordinate system). Also, for the particles under consideration, we will set the condition of cylindrical symmetry, that is, $\partial/\partial\varphi = 0$ for any variables.

Neutral particles moving at the speed of light

Consider the motion of an "almost point" charge, spherically symmetrical at rest, along the z-axis with a constant velocity $\mathbf{V} = V_z$. If the field structure moves as a whole unit, then
$\partial/\partial t = - V_z \cdot \partial/\partial z$ for all variables.
As mentioned earlier, with cylindrical symmetry, $\partial/\partial\varphi = 0$.

Let the scalar potential at rest to be
$a = E_0 / s$, where $s^2 = R^2 + \rho^2 + K \cdot z^2$
Here, the letter "a" is used to avoid confusion with the angle φ, the constant E_0 expresses the amplitude of the field, the constant R characteristic dimensions (similarity of the wavelength or frequency of the wave), the constant K shows the likely deformation of the field along the axis of motion, as "compression" or "stretching" of the lines of force.
Note that $\partial s/\partial\rho = \rho / s$, $\partial s/\partial z = K \cdot z / s$

The vector potential $\mathbf{A} = A_z = E_0 / s \cdot V_z / c^2$ is directed along the z-axis,
$A_\rho = 0$, $A_\varphi = 0$. $\mathbf{H} = 1/\mu_0 \cdot \text{rot}\,\mathbf{A}$ forms closed rings around z-axis,
$H_\rho = 1/\mu_0 \cdot (- \partial A_\varphi/\partial z) = 0$
$H_\varphi = 1/\mu_0 \cdot (\partial A_\rho/\partial z - \partial A_z/\partial\rho) = E_0/\mu_0 \cdot V_z / c^2 \cdot \rho / s^3 = E_0 \cdot \varepsilon_0 \cdot V_z \cdot \rho / s^3$
$H_z = 1/\mu_0 \cdot (\partial A_\varphi/\partial\rho + A_\varphi / \rho) = 0$,
since $\varepsilon_0 \cdot \mu_0 = 1 / c^2$.

Let be $d = 1/\mu_0 \cdot \text{div}\,\mathbf{A} = 1/\mu_0 \cdot \partial A_z/\partial z$
$= - E_0/\mu_0 \cdot V_z / c^2 \cdot K \cdot z / s^3 = - E_0 \cdot \varepsilon_0 \cdot V_z \cdot K \cdot z / s^3$
Obviously $a' = - 1/\varepsilon_0 \cdot d = - c^2 \cdot \text{div}\,\mathbf{A}$,
since $a' = - V_z \cdot \partial a/\partial z = E_0 \cdot V_z \cdot K \cdot z / s^3$
that corresponds to the classical field equations.

$\mathbf{E}$ we will find from the field equation $\mathbf{A}' = - \mathbf{E} - \mathbf{G}$
where $\mathbf{G} = \text{grad}\, a$
$G_\rho = \partial a/\partial\rho = - E_0 \cdot \rho / s^3$
$G_\varphi = 0$
$G_z = \partial a/\partial z = - E_0 \cdot K \cdot z / s^3$
$E_\rho = - A_\rho' - G_\rho = V_z \cdot \partial A_\rho/\partial z - G_\rho = E_0 \cdot \rho / s^3$
$E_\varphi = 0$
$E_z = - A_z' - G_z = V_z \cdot \partial A_z/\partial z - G_z = E_0 \cdot (1 - V_z^2 / c^2) \cdot K \cdot z / s^3$
As can be seen, when V_z raises to the speed of light, E_z "disappears" and only the non-zero radial E_ρ, perpendicular to the z-axis, remains.

The time derivatives $\mathbf{G}'$, d', $\mathbf{H}'$ are computed trivially, and the time derivative $\mathbf{E}'$ requires special attention.

Let be $\mathbf{J} = \mathrm{rot}\,\mathbf{H}$,
$J_\rho = -\,\partial H_\varphi/\partial z = E_0 \cdot \varepsilon_0 \cdot 3 \cdot V_z \cdot K \cdot \rho \cdot z / s^5$
$J_\varphi = 0$
$J_z = \partial H_\varphi/\partial \rho + H_\varphi / \rho = E_0 \cdot \varepsilon_0 \cdot V_z \cdot (2 / s^3 - 3 \cdot \rho^2 / s^5)$

$\mathrm{div}\,\mathbf{E} = \partial E_\rho/\partial \rho + E_\rho / \rho + \partial E_z/\partial z$
$= E_0 \cdot \{2 / s^3 - 3 \cdot \rho^2 / s^5 + (1 - V_z^2 / c^2) \cdot K \cdot (1 / s^3 - 3 \cdot K \cdot z^2 / s^5)\}$

Must be observed equality
$E_\rho' = -\,V_z \cdot \partial E_\rho/\partial z = E_0 \cdot 3 \cdot V_z \cdot K \cdot \rho \cdot z / s^5$
According to a hypothetical equation, and since $\mathbf{E}$ is perpendicular to $\mathbf{V}$ ($\mathbf{E} \cdot \mathbf{V} = 0$), and $V_\rho = 0$:
$E_\rho' = 1/\varepsilon_0 \cdot J_\rho - \partial EV/\partial \rho - V_\rho \cdot \mathrm{div}\,\mathbf{E}$
$= 1/\varepsilon_0 \cdot E_0 \cdot \varepsilon_0 \cdot 3 \cdot V_z \cdot K \cdot \rho \cdot z / s^5 = E_0 \cdot 3 \cdot V_z \cdot K \cdot \rho \cdot z / s^5$

Also must be observed equality
$E_z' = -\,V_z \cdot \partial E_z/\partial z = -\,E_0 \cdot V_z \cdot (1 - V_z^2 / c^2) \cdot K \cdot (1 / s^3 - 3 \cdot K \cdot z^2 / s^5)$
According to the hypothetical equation, and since $\mathbf{E}$ is perpendicular to $\mathbf{V}$ (EV = 0):
$E_z' = 1/\varepsilon_0 \cdot J_z - \partial EV/\partial z - V_z \cdot \mathrm{div}\,\mathbf{E}$
$= 1/\varepsilon_0 \cdot E_0 \cdot \varepsilon_0 \cdot V_z \cdot (2 / s^3 - 3 \cdot \rho^2 / s^5)$
$- V_z \cdot E_0 \cdot \{2 / s^3 - 3 \cdot \rho^2 / s^5 + (1 - V_z^2 / c^2) \cdot K \cdot (1 / s^3 - 3 \cdot K \cdot z^2 / s^5)\}$
$= -\,E_0 \cdot V_z \cdot (1 - V_z^2 / c^2) \cdot K \cdot (1 / s^3 - 3 \cdot K \cdot z^2 / s^5)$

The equations for $\mathbf{E}'$ are true for any V_z, E_0, R and K, but if $V_z = c$ and $E_z = 0$, the all-space integral of div $\mathbf{E}$ multiplied by volume unit is zero:

$$\int_{-\infty}^{+\infty}\int_0^{2\cdot\pi}\int_0^{\infty} (2 / s^3 - 3 \cdot \rho^2 / s^5) \cdot \rho\, \partial\rho\, \partial\varphi\, \partial z = 0$$

That is, when accelerating to the speed of light, the whole field formation will be charged neutrally, although locally the charge density changes.

Probably a similar structure, relatively simple, have neutrinos, and we will also use the given example of the direct motion of a particle to check the adequacy of expressions for $\mathbf{V}'$.

If $\mathbf{V}' \sim (\mathbf{D} \cdot V^2 - [\mathbf{H} \times \mathbf{V}]) \cdot \text{div } \mathbf{E}$
then $V_\rho' \sim (\varepsilon_0 \cdot E_\rho \cdot V_z^2 - H_\varphi \cdot V_z) \cdot \text{div } \mathbf{E}$
$= (\varepsilon_0 \cdot E_0 \cdot \rho / s^3 \cdot V_z^2 - E_0 \cdot \varepsilon_0 \cdot V_z \cdot \rho / s^3 \cdot V_z) \cdot \text{div } \mathbf{E} = 0$
and the radial velocity remains zero. If $\mathbf{D} \cdot \text{div } \mathbf{E}$ would be used in the "similarity of the Lorentz forces" without multiplication by V^2, like the classical effect of an electric field on charge, equality would not be observed.

Also $V_z' \sim (\varepsilon_0 \cdot E_z \cdot V_z^2 + H_\varphi \cdot V_\rho) \cdot \text{div } \mathbf{E}$
$= \{\varepsilon_0 \cdot E_0 \cdot (1 - V_z^2 / c^2) \cdot K \cdot z / s^3 \cdot V_z^2\} \cdot \text{div } \mathbf{E}$
$V_z' = 0$ and the velocity V_z remains constant only at $V_z = c$.
Apparently, this is related to the fact that experimentally detected neutrino-like particles move at the speed of light, while the movement of massive particles at low speeds is a much more complex process at the field level.

When $V_z = c$ and the electrical energy density $uE = \varepsilon_0/2 \cdot E^2$ is equal to the magnetic energy density $uH = \mu_0/2 \cdot H^2$, the equality $\mathbf{W} = u \cdot \mathbf{V}$ is also fulfilled, which is an argument in favor of considering the hypothesis $\mathbf{V}' \sim \mathbf{W} - u \cdot \mathbf{V}$. The same fact occurs in field structures with zero electric field divergence (electromagnetic waves and presumably photons).

Stable charged particles with cylindrical symmetry

Probably, the basis of electrons and other leptons is the **E**, **H**, **V** field in the form of closed rings of energy flow and velocity vector. The structure of the particle is not similar to the classical "infinitely thin" circuit with an electric current, where on the elements of the ring the electric and magnetic field differ from zero, due to the fields created by other parts of the circular current.

On the line of "main circuit", the electric and magnetic field is zero, whereas the charge density (~ div **E**) is close to the local maximum.

In computer modeling in a cylindrical coordinate system, the following field values can be a good initial approximation (with $s^2 = R^2 + \rho^2 + z^2$):
vector potential $\mathbf{A} = A_\varphi \sim \rho^3 / s^5$

$H_\rho \sim - \partial A_\varphi/\partial z \sim 5 \cdot \rho^3 \cdot z / s^7$
$H_\varphi = 0$
$H_z \sim \partial A_\varphi/\partial\rho + A_\varphi / \rho \sim 4 \cdot \rho^2 / s^5 - 5 \cdot \rho^4 / s^7$
$J_\rho = 0$
$J_\varphi = \partial H_\rho/\partial z - \partial H_z/\partial\rho \sim - 8 \cdot \rho / s^5 + 10 \cdot \rho^3 / s^7 + 35 \cdot \rho^3 \cdot R^2 / s^9$
$J_z = 0$
scalar potential $a \sim \rho^4 / s^5$
$E_\rho \sim - \partial a/\partial\rho \sim - 4 \cdot \rho^3 / s^5 + 5 \cdot \rho^5 / s^7$
$E_\varphi = 0$
$E_z \sim - \partial a/\partial z \sim 5 \cdot \rho^4 \cdot z / s^7$
div $\mathbf{E} = \partial E_\rho/\partial\rho + E_\rho / \rho + \partial E_z/\partial z$
$\sim - 16 \cdot \rho^2 / s^5 + 20 \cdot \rho^4 / s^7 + 35 \cdot \rho^4 \cdot R^2 / s^9$

Note that $E_\rho \cdot H_\rho + E_z \cdot H_z = 0$, **E** is perpendicular to **H** everywhere.

Near the center of the particle is a region where the values div **E** and rot **H** are opposite in sign to those found in the rest of space. Meanwhile, **V** has the same sign everywhere. If the conditional magnetic dipole is directed along the z-axis, with a positive multiplier for **A** and **H**, and the total charge of the particle is positive, then near the center there will be a region with a negative divergence **E** and a negative rotor **H**, but at the great distance these values are positive.

The velocity is positive everywhere, that is, it is directed counterclockwise with the direction of the z-axis towards us and the x-axis (the start of the counting φ) to the right. div **E** and rot **H** must change the sign synchronously so that equality is observed:
$\mathbf{E}' = 1/\varepsilon_0 \cdot \text{rot}\, \mathbf{H} - \text{grad EV} - \mathbf{V} \cdot \text{div}\, \mathbf{E} = 0$
since in a more or less stable particle all fields derivatives in time are zero.
EV = 0, **V** is perpendicular to **E** and **H**, that is, we are talking about a mutually perpendicular triple of vectors in any combination.

A model with a field arrangement closer to the z-axis, for example:
$\mathbf{A} = A_\varphi \sim \rho / s^3$
$H_\rho \sim 3 \cdot \rho \cdot z / s^5$
$H_\varphi = 0$
$H_z \sim 2 / s^3 - 3 \cdot \rho^2 / s^5$
$a \sim \rho^2 / s^3$

$E_\rho \sim - 2 \cdot \rho / s^3 + 3 \cdot \rho^3 / s^5$
$E_\varphi = 0$
$E_z \sim 3 \cdot \rho^2 \cdot z / s^5$
where on the z-axis there is a pronounced maximum of H_z
and $\mathbf{J} = J_\varphi = \partial H\rho/\partial z - \partial Hz/\partial\rho \sim 15 \cdot R^2 \cdot \rho / s^7$
does not fit, because rot **H** is positive everywhere, and div **E** changes sign in the central part. Models with a spherically symmetric scalar potential and electric field are even more inadequate:
$a \sim 1 / s$
$E_\rho \sim \rho / s^3$
$E_\varphi = 0$
$E_z \sim z / s^3$
div $\mathbf{E} \sim 3 \cdot R^2 / s^5$
there **E** is not even perpendicular to **H**, if we take **A** and **H** from the previous model.

If $\mathbf{V}' \sim (\mathbf{D} \cdot V^2 - [\mathbf{H} \times \mathbf{V}]) \cdot \text{div}\, \mathbf{E}$
then the multiplier V^2 prevents the destruction of the particle due to electrical repulsion near the z-axis, although exactly onto it can be also $\mathbf{D} = 0$. With $\mathbf{V} = V_\varphi$, $V_\rho = 0$ and $V_z = 0$, there must inevitably be a zone with zero velocity near the z-axis, since the values of the existing quantities in the physical world are finite and only smooth functions with continuous derivatives are permissible.

Precise solutions in degrees of s for real lepton-like particles seem impossible, numerical simulations are required. In the first time after setting the initial approximation, occurs a rapid adaptation of the fields to more accurate values, further stability depends on the adequacy of the model and the accumulation of numerical errors.

Let's try to estimate the magnitudes of what order are the fields at a considerable distance from the z-axis in the perpendicular plane ($z = 0$, $s \approx r$, $r^2 = \rho^2 + z^2$). From experimental data and works on classical physics it is known that $\mathbf{E} = E_\rho \sim 1 / r^2$, $\mathbf{H} = H_z \sim - 1 / r^3$, $u \approx E^2 \sim 1 / r^4$
$\mathbf{D} \cdot V^2 - [\mathbf{H} \times \mathbf{V}]$ will tend to zero if $\mathbf{V} = V_\varphi \sim 1 / r$
The same order of $V_\varphi \sim 1 / r$ follows from the equation
$\mathbf{W} - u \cdot \mathbf{V} = 0$, given that $\mathbf{W} = W_\varphi = - E_\rho \cdot H_z \sim 1 / r^5$

Further directions of research

All the above mentioned equations are linear in **E** and **H**. That is, when these vectors are both multiplied by the same number, they remain true. Since the particles observed in the physical world have strictly defined charges and masses (internal energies), it is logical to assume that the expression **V′** may contain nonlinear terms with relatively small factors. Although due to statistical factors, greater resistance to random disturbances, some field formations may be more stable than others.

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