УДК 531/533; 530.145; 531.18; 539.12

Yu.Yaremko
Institute for Condensed Matter Physics of NASU, Ukraine

INTERFERENCE OF OUTGOING ELECTROMAGNETIC WAVES GENERATED BY TWO POINT-LIKE SOURCES

The principle of least action is formulated for a composite system of point-like charges and their field:

$$I = I_{part} + I_{\rm int} + I_{field}.$$

Variation with respect to field variables gives wave equation. Variation with respect to particle ones leads to particle motion equations. Substituting the solutions of the first subset for "true" fields in the second subset yields *action-at-a-distance* theory: the equations of motion in terms of particle variables only.

Since the solutions of wave equation with a point-like source diverge in the neighbourhood of its world line, the motion equations will always be ill defined in the immediate viciniti of the particles. The renormalization procedure can be performed within two different approaches: (i) one if wave solutions are used in "variational" motion equations; (ii) the other if wave solutions are used in Noether conservation laws.

To find out Noether quantities G^{α}_{em} carried by field, we integrate Maxwell stress-energy tensor over a spacelike three-surface. We obtain terms of two quite different types: (i) "bound", G^{α}_{bnd}, which are permanently "attached" to the sources and carried along with them; (ii) "radiative", G^{α}_{rad}, detach themselves from the charges and exist independently:

$$G^{\alpha}_{em} = G^{\alpha}_{bnd} + G^{\alpha}_{rad}.$$

Within renormalization procedure the bound terms are coupled with energy-momentum and angular momentum of a "bare" source, so that already renormalized characteristics of a charged particle, G^{α}_{part}, are proclaimed to be finite. Conservation laws become

$$G^{\alpha} = G^{\alpha}_{part} + G^{\alpha}_{rad}.$$

The total electromagnetic stress-energy tensor of two charges looks as follows:

$$T^{\mu\nu} = T^{\mu\nu}_{(1)} + T^{\mu\nu}_{(2)} + T^{\mu\nu}_{\rm int},$$

where

$$4\pi T^{\mu\nu}_{(a)} = f^{\mu\lambda}_{(a)} f^{\nu}_{(a)\lambda} - 1/4\eta^{\mu\nu} f^{\kappa\lambda}_{(a)} f^{(a)}_{\kappa\lambda},$$

and "interference" term

$$4\pi T^{\mu\nu}_{\rm int} = f^{\mu\lambda}_{(1)} f^{\nu}_{(2)\lambda} + f^{\mu\lambda}_{(2)} f^{\nu}_{(1)\lambda} - 1/4\eta^{\mu\nu}(f^{\kappa\lambda}_{(1)} f^{(2)}_{\kappa\lambda} + f^{\kappa\lambda}_{(2)} f^{(1)}_{\kappa\lambda}).$$

The sum of work done by Lorentz forces of point-like charges acting on one another constitute the radiative part of the integral of $T_{\rm int}^{\mu\nu}$ over hyperplane $x^0 = t$. (The bound terms appear too: they can be interpreted as usual deformation of electromagnetic "clouds" of charged particles due to mutual interaction.)

Changes in energy-momentum and angular momentum carried by electromagnetic field should be balanced by changes in corresponding particles' quantities. Differentiation of G^α results the relativistic generalization of Newton's second law where loss of energy due to radiation is taken into account. Therefore, **an interference of outgoing electromagnetic waves** (retarded Lienard-Wiechert fields) leads to the **interaction between the sources.**

Yu.Yaremko, *J.Phys.A: Math.Gen.*, 2002 **35** 831, 9441; 2003 **36** 5149, 5159; 2004 **37** 1079.