USE OF REPRESENTATIONS ABOUT TWO COMPONENTS OF ENERGY FLOW FOR DETERMINING ENERGY AND PULSE OF MOVING CHARGE FIELDS

V.A. Fogel, M.A. Shepsenvol

Let's consider physical sense of two components of energy flow with the help of some simple experiments. In laboratory there is a long massive table, on the left end of which the source of mechanical energy is installed, capable by our order to squeeze or to stretch subjects along an axis X. The axes passes from left to right parallel to the plane of the table, gouing exactly from the centre of the energy source. On the right end of the table coaxially with X two devices are fixed for independent control of different components of an energy flow: closer to the center there is a narrow ring-shaped calorimeter wich allows almost inertialessly to determine quantity of internal thermal energy in that part of the investigated body, which, in a given moment, is inside the ring, and closer to the end is a friction clutch capable with the help of frictional forces to transform the work of the bodies moving along the axis X into thermal energy with its following measurement. Measurements of thermal energy in the calorimeter and in the friction clutch are independent and do not influence on each other. One of major details that participates in the experiment, is the long thin rod made of material (for example, of diamand) with low heat- and electric conductivity and with great Young's modulus. The rod is mounted exactly along the axis X, and its left end enters the central aperture of the energy source where it can be fixed to the source or it can be in free sliding state. The right end of the rod passes through the internal apertures of the calorimeter and frictional clutch moving outside the limits of a laboratory table. The movement of the rod inside the calorimeter always occurs without friction, and inside frictional clutch it occurs either with friction if it is connected to the frictional clutch , by a fixing arm, or without friction if there is no friction arm. On the rod surface tensometers are installed which measure mechanical tension inside the rod. In the middle of the rod there is a joint, into which it is possible to insert other investigated objects, for example, sources of electrical and electromagnetic fields. In the parts of these sources there are always mechanical tensions balancing electrical forces. For example, the plates of the flat charged condenser are stretching in all directions along their planes. Dyelectric distance pieces between the plates appear to be compressed. The mechanical tensions in electromagnetic fields sources can be always observed with the tensometers. One of the important tasks of studying energy flows through field sources is the creation of such situation, when mechanical tension in them along an axis X will appear compensated by external forces. Only in this case it is possible to observe energy flows through the fields of sources in the pure state. The installation of an investigated source in the joint of a rod and its orientation relative to the axis X allows to fulfil this task.

In the first experiment the rod receives a single pulse from the energy source and the friction clutch remains disconnected. The rod moves from left to right with constant speed v without any mechanical tension. Together with it moves the energy connected its substance , in particular, thermal energy of its atoms, the flow of this energy can be measured with the help of a calorimeter:

$$S_T = [W_T]\cdot s\cdot v, \qquad (1)$$

Where S_T - flow of a the rod thermal energy,
[W_T] - density of a thermal energy in a rod,
s - cross section of a rod.
v - speed of movement of a rod along an axis X.

Let's notice, that in this case the total flow of internal energy S_{BH} of a rod is:

$$S_{BH} = [\ m]\cdot s\cdot v / c^2 \quad (2)$$

Where [m] - specific gravity of a rod,
[m] /c^2 - the total density of internal energy of a rod according to Einstein.
The flows of a type (1) and (2) are components of the total energy flow. Their feature is that they always move in the same direction and with the same speed, as investigated object because they are formed by the energy of this object.
In the second experiment the rod is connected to the friction clutch by a fixing arm. Now for its movement with speed v from left to right it is necessary to apply squeezing force F from the energy source, this fact will be measured by tensometers on the rod. In the friction clutch heat will releas, i.e. one more energy flow appears along a rod:

$$\Pi = F\cdot v = f\cdot s\cdot v, \qquad (3)$$

Where Π - flow of energy from a source of energy into the friction clutch ,
f - force acting on the unit of the rod surface perpendicular to an axis X
The flow Π is the second component of a total flow of energy essentially distinguished from S_T and S_{BH}. Its feature is that it is formed from the energy, which does not belong to a rod, but is only transferred through it with the help of force F. Thus the complete energy of a rod can not change at all. Its separate components in the second and first experiment practically coincide, as the Young's modulus of a rod is very great and its elastic energy is very small. In this case the flow of energy Π can be more S_T and even S_{BH} without any influence on them.

So, the complete flow of the energy coming on the right end of a laboratory table in the second experiment is equal:

$$S = S_T + \Pi \qquad (4)$$

However it does not mean at all, that the value S will be more essential for us , than S_T or Π. On the contrary, in the majority of the practical applications the main role will be played by Π, sometimes S_T and absolutely rare dy S. In other words, the knowledge of separate components of a flow of energy is more important, than their sum.
In the third experiment we shall switch on the drive of a source of energy so, that it will not squeeze a rod, but on the contrary, stretch it, dragging it through the friction from right to left. So the direction of vectors **v** and **F** will change, but the sign of their product will remain. It means, that the flow of energy Π will be as in the second

experiment directed from left to right but the flow S_T will change the direction to a reverse one. We can now achieve such situation, when the total flow of energy S will become equal 0, i.e. will be absent. However there will be two different physical processes :

1. The thermal energy of a rod together with a rod will move right to left.
2. From a source of energy from left to right mechanical energy will move transforming into thermal in the friction clutch.

Each of these flows of energy can be used independently, or can't be used at all.
It is obvious, that such result cannot be identified with the case of absence of processes when the resulting flow of energy S equals zero. Once again we come to a conclusion, that for a correct prediction and description of results of experiments it is necessary to know both components of a flow of energy separately. This statement was emphasized in original works on hydrodynamics and mechanics, in particular in classical work dy Umov /1 /, and some works on theoretical physics /2/. Nevertheless, up today in electrodynamics representation of only resulting flow, so-called Poynting's vector is used :

$$\mathbf{S} = (\mathbf{E}\times\mathbf{H}) \cdot c / 4\pi \qquad (5)$$

Quite often it results in obvious misunderstanding. For example, from (5) it is possible to come to a conclusion, that at absence of a magnetic field (H) any flows of energy through an electrical field (E) are impossible. It is not so.
To show this, , we shall carry out the fourth experiment. Let's take the charged flat condenser with rigid dielectric distance piece, protect the plates from adherence. A tensometer on it will show force of compression equal by the value but revers by sign to force of electrical interaction between plates $F = E^2 \cdot s / 8\pi$, where s - area of plates of the condenser. Let's insert the condenser into the joint on the rod so that the force lines of an electric field will be parallel to the axis X. Then we shall apply through the rod a stretching force equal $F = E^2 \cdot s / 8\pi$ to the consider . The dielectric distance piece between the plates of the condenser will be unloaded entirely and the plates will be held by the left and right parts of a rod. In the gap of the condenser only electric forces and fields will be left, so obtained data on flows will refer only to them. As well as in the third experiment, the rod will move together with the condenser and energy, contained in it from right to left, but flow of energy Π according to (3) - from left to right. In this case flows of energy Π and S_{BH} will appear to be precisely equal in value $E^2 \cdot s \cdot v / 8\pi$, but opposite in sign. The resulting flow of energy through the condenser will be equal to zero, this corresponds to the formula (5) for Poynting's vector . However again, as well as in the third experiment, this zero sign will mean two real physical processes . One of them is the transfer of energy from an external source along force lines of an electrical field at absence of a magnetic field. The possibility of such energy transferring in today's electrodynamic is not allowed, though some works expecting it and effects, close to it, already have appeared /3,4,5,6/. It is essential, that the flow of energy along force lines of an electric field can be objectively fixed and used in practice for energy transfer between the removed points of space:

$$\Pi_{II} = E^2 \cdot s \cdot v / 8\pi \qquad (6)$$

$$\text{or } \mathbf{\Pi}_{II} = E \cdot \mathbf{\Phi} \cdot v \cdot c / 8\pi \; ; \; \mathbf{\Phi} = (d\varphi/dt) \cdot \mathbf{E}/E \cdot c \qquad (7)$$

Where Π_{II} - component of a flow of energy along force lines of an electric field;
Φ - Vector describing speed of change of potential in the given point of a field;
φ- Potential;
s - section of the condenser, perpendicular to the axes X.
In the fifth experiment we shall mount a condenser in the joint of the rod, so that its plates will be exactly parallel to the axes X.. As it has been already said above, they experience stretching mechanical tension, the total value of wich along an axis X is equal $E^2 \cdot s / 8\pi$, where s is the condenser section perpendicular to the axis X. To have only electric field forces left inside the condenser , we'll have to compress a rod with the force $F = E^2 \cdot s / 8\pi$, , after this tensometers on plates will stop fixing any essential tension. The compressed rod will start moving through the friction clutch, releasing heat in it and thus fixing flow of energy Π through a field in the condenser . Besides together with the condenser the internal energy of its field will move, wich forms flow $S_{ВН}$. In this case, both of the flows will be equal in value and direction:

$$S_{ВН} = E^2 \cdot s \cdot v / 8\pi = \Pi \; ;$$
$$S = S_{ВН} + \Pi = E^2 \cdot s \cdot v / 4\pi \qquad (8)$$

As the condenser in this experiment moves perpendicularly to field E, in its gap there wil appear the field $H = E \cdot v/c$ and that's why (8) can be transformed into

$$\mathbf{S} = (\mathbf{E} \times \mathbf{H}) \cdot s \cdot c / 4\pi, \qquad (9)$$

This exactly corresponds to a Poynting's vector. Now it is reasonable to notice, that at any orientation of the condenser relative to the axis X the speed of its movement v can be determined with the help of vectors H and Φ, in this connection in final equations for flows of energy, for example (7) and (9), it can be absent /6/.
So, we have tried to convince our readers of necessity to have the separate formulas and separate physical images for two different components of energy flows electrodynamics. As we have seen, representation of Poynting's vector not always appear to be enough..

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