Poverty of JMP

Тензор спина возникает в лагранжевом формализме вследствие теоремы Нётер. Однако физики как-то двусмысленно уничтожили его с помощью Белинфанте-Розенфельда. Тем не менее, тезор спина остается в фундаменте классической теории поля.

Я направил в JMP порядка десяти статей, в которых рассматривается проблема спина. Этот Bruno Nachtergaele, осознавая ничтожество журнала, отклонял статьи практически молча: "I regret to inform you that we do not find your manuscript suitable for publication in the Journal of Mathematical Physics". Однако я все же сумел однажды заставить его дать рецензию. Тут-то лицо журнала естественно проявилось; без лжи и глупости не может обходиться!

Reply to the referee report by Journal of Mathematical Physics

Inevitability of the electrodynamics' spin tensor

MS #08-0578 by Radi I. Khrapko

Dear Bruno Nachtergaele:

The only objection of the referee is a presence of the magnetic vector potential A_i in my result

$$\underset{c}{\Upsilon}^{\lambda\mu\nu} + 2A^{[\lambda}\partial^{\mu]}A^{\nu} = 2A^{[\lambda}\partial^{|\nu|}A^{\mu]}, \qquad (2.2)$$

$$\Upsilon^{\lambda\mu\nu} = A^{[\lambda}\partial^{|\nu|}A^{\mu]} + \Pi^{[\lambda}\partial^{|\nu|}\Pi^{\mu]}. \qquad (2.3)$$

However, I gave notice this paper conveys new physics. The paper presents a series of theoretical and experimental evidences that the magnetic vector potential A_i, as well as the electric vector potential Π_i *is really required* for consideration in classical electrodynamics if $\partial_\nu A^\nu = \partial_\nu \Pi^\nu = 0$. The referee can't face these evidences. He shuts his eyes.

For that matter, the standard energy-momentum tensor (1.15), as well as the canonical energy-momentum tensor (1.4) and all energy momentum tensors in Table 2, are obviously invalid if currents are present. Therefore they are of no interest. And the Lagrange formalism, as well as the Belinfante-Rosenfeld procedure, is incapable of deriving a true electrodynamics energy-momentum tensor. Such a tensor, i.e. the Maxwell tensor (1.1), cannot be obtained by the Lagrange formalism. The coincidence of the standard energy-momentum tensor and the Maxwell tensor in free space is of no importance.

However, the Belinfante-Rosenfeld procedure is not simply useless, it is extremely harmful because it deprives electrodynamics of spin, (1.17). We modify the Belinfante-Rosenfeld procedure. Our procedure (2.1), (2.2) gives the Maxwell tensor and the electrodynamics spin tensor, which are valid if currents are present.

Some details

1. The referee claims that Y.N. Obukhov shows the Minkowski energy-momentum tensor is exactly the canonical one if one takes the covector A as basic variable and not its components.

But it is a lie. There is no word "canonical" in Y.N Obukhov et al. "Electrodynamics of moving magnetoelectric media:variational approach," Phys.Lett.A371 (2007)11-19, arXiv:0708.1153, and in Y.N Obukhov "Electromagnetic energy and momentum in moving media," arXiv:0808.1967.

And the referee's claim is a stupidity because a covector *A* is the same thing as the totality of its components. Any covector is an exterior differential 1-form and is a geometrical quantity. A covector is depicted by a double plane element or by a multi-plane element or by a multi-plane element.

One can specify a covector only by giving its components. The replacement of components by one character changes nothing. The statement that the Minkowski tensor is the canonical one is a pathology.

The geometric images of F, D, H, and B are

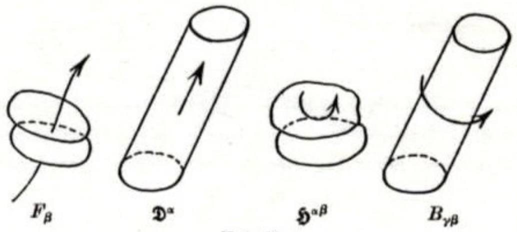
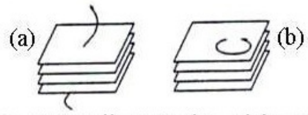


Fig. 23.

This figure is from J. A. Schouten, Tensor Analysis for Physicists (Clarendon, Oxford, 1951)

Now consider a covector. This should be familiar to most students in terms of a gradient. We can picture a gradient best in terms of the equipotential surfaces to which it refers, and this is the basis of the pictorial representation. That is, draw the surfaces themselves, along with some sense of direction, which might be indicated by a wavy line with an arrow at the end, or with a whorl on one of the sheets:



This figure is from J. Napolitano and R. Lichtenstein "Answer to Question #55 Are the pictorial examples that distinguish covariant and contravariant vectors?" Am. J. Phys. 65, 1037-1038 (1997) The authors refer to this pictorial representation of a covector as a "lasagna vector". Covector (a) has an outer orientation. (b) represents a pseudo covector; it has an inner orientation.

2. The referee wrote,

"The author's claim that the symmetry of the Minkowski energy-momentum tensor contradicts experiment is invalid."

I can only exclaim, "ravings of a madman!" I show in detail that the **canonical** energy-momentum tensor, which is NONSYMMETRIC, contradicts experiment, (1.9) – (1.12). I show that only the symmetric Maxwell-Minkowski tensor (1.1) is true electrodynamics energy-momentum tensor, but it cannot be obtained by the Lagrange formalism. And I show that the Belinfante-Rosenfeld procedure is not simply useless, but is extremely harmful because it deprives electrodynamics of spin, (1.17). I modify the Belinfante-Rosenfeld procedure. My procedure (5.1), (5.2) gives the Maxwell tensor and an electrodynamics spin tensor, which are valid if currents are present.

3. An idea about a spin tensor of **massive** matter is well known (see F.W. Hehl "On the energy tensor of spinning **massive** matter in classical field theory and general relativity" Reports on Mathematical Physics **9** 55 (1975), F.W. Hehl, P. Heyde, and G.D. Kerlick "General relativity with spin and torsion: foundation and prospects" Rev. Mod. Phys. **48** 393 (1976)). However, there were no announcements about an electrodynamics spin tensor. And this fact is very strange because electromagnetic waves obviously have spin.

By the way, the referee referred to the Hehl's paper. But he omitted the word "massive." His reference is: "F.W. Hehl, On the energy tensor of spinning matter …, Reports on Math. Phys. **9** (1976) 55-82."

This is not honest.

Suggestion to the Editor

I think you must change the referee.

Referee report to the paper "Inevitability of the electrodynamis' spin tensor" by R.I. Khrapko, submitted to JMP

September 17, 2008

1 Summary of classical electrodynamics

The electromagnetic field $F_{\mu\nu} = (E, B)$ describes, via the Lorentz force density

$$\mathfrak{f}_\mu = F_{\mu\nu}\mathfrak{J}^\nu, \tag{1}$$

the force acting on a (moving) charge. Moreover, with the energy-momentum tensor

$$\mathfrak{T}_\mu{}^\nu = \frac{1}{4}\delta^\nu_\mu F_{\rho\sigma}\mathfrak{G}^{\rho\sigma} - F_{\mu\rho}\mathfrak{G}^{\nu\rho}, \tag{2}$$

here $\mathfrak{G}^{\mu\nu} = (D, H)$, the energy-momentum densities and flux densities of the electromagnetic field can be determined, provided one solves the Maxwell equations

$$\partial_\nu\mathfrak{G}^{\mu\nu} = \mathfrak{J}^\mu, \qquad \partial_{[\mu}F_{\nu\rho]} = 0, \qquad \mathfrak{G}^{\mu\nu} = \frac{1}{2}\chi^{\mu\nu\rho\sigma}F_{\rho\sigma}, \tag{3}$$

together with their boundary conditions, see E.J. Post, Formal Structure of Classical Electromagnetics, Dover 1995.

It should be clear by this summary of classical electrodynamics that all measurable quantities in classical electrodynamics can be expressed in terms of

$E, B; D, H$. No other quantities are really needed. In particular, also wave equations can be found for $F_{\mu\nu}$ and $\mathfrak{G}^{\mu\nu}$.

It can be convenient for certain purposes to solve the homogeneous Maxwell equation by a potential ansatz according to $F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$, with A_μ as the components of the 4-potential. However, A_μ, being a convenience, *is not really required* for considerations in classical electrodynamics. In particular, all observable quantities must be invariant under a gauge transformation

$$A_\mu \longrightarrow A'_\mu = A_\mu + \partial_\mu \Phi. \tag{4}$$

with some scalar function Φ

2 The Minkowski energy-momentum tensor (2) is the canonical one — provided the covector $A = A_\mu dx^\mu$ is taken as electromagnetic field variable and not its components A_μ

The author claims, together with the main literature, Rohrlich, Landau-Lifshitz, Jackson, etc. that the canonical energy-momentum tensor of the electromagnetic field is not gauge invariant. However, he neglects the more recent literature. It has been shown in the meantime[1] that the Minkowski energy-momentum tensor (2) is exactly the canonical one if one takes the covector A as basic variable and not its components. Clearly the former option is superior because it is related to a coordinate independent procedure.

In vacuum, the energy-momentum tensor (2) turns out to be symmetric. However, *in matter,* it is **a**symmetric in general and the author's claim that the symmetry of the energy-momentum tensor contradicts experiment is invalid.

[1]See Y.N Obukhov et al., Electrodynamics of moving magnetoelectric media: variational approach, Phys. Lett. A371 (2007) 11-19, arXiv:0708.1153, and Y.N Obukhov, Electromagnetic energy and momentum in moving media, Ann. Physik (Berlin), in press, arXiv:0808.1967, and the literature cited therein.

3 Some details

1. I have no basic objections against the author's equations before (1.4). However, as pointed out above, (1.4) is incorrect if one insists on a coordinate independent procedure. By the same token, Eqs.(1.5), (1.6), and (1.7) are incorrect, too. In particular, neither of these equations is gauge invariant. Thus, they are at variance with (4). This recognizes the author himself. Still, the whole discussion in the author's Sec.1 is based on the wrong energy-momentum tensor (1.4) and is invalid.

2. The authors discussion in (1.8) is well-known, see, e.g., F.W. Hehl, On the energy tensor of spinning matter..., Reports on Math. Phys. 9 (1976) 55-82.

3. Clearly, all quantities displayed in the author's Table 2 are unphysical, since gauge dependent.

4. In his Sec.2, the author introduces other energy-momentum and spin tensors. However, being not gauge invariant, we can forget them. The author considers the spin tensor, defined in (2.3), as his main achievement. We can only repeat: being gauge dependent, this quantity is not observable and we can forget it.

5. In his Sec.3, the author suddenly leaves vacuum electrodynamics and turns to electrodynamics in matter. However, he doesn't specify the Maxwell equations in matter and his considerations are without relevance. He talks about some results in the literature. However, it is not clear how this is related to the authors results.

6. Since gauge variant unobservable quantities, as defined by the author in (2.3), cannot be observed, the considerations in Sec.4 are without foundation.

4 Suggestion to the Editor

According to the author "This paper conveys new physics." I am sorry to say, but it rather communicates incorrect results. For this reason I have only one option to suggest: The Editor of the Journal of Mathematical Physics should reject this paper because of fundamental mistakes.