# Comment on “Effective Refractive Index Tensor for Weak-Field Gravity” by P. Boonserm, C. Cattoen, T. Faber, M. Visser and S. Weinfurtner

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## Abstract

P. Boonserm et. al have tried to describe some anisotropic optical effects in the gravitation field in frame of the general relativity and by introducing the so-called “effective refractive index tensor” similarly to anisotropic crystals. We suppose that this approach is inconsequent because of the following: if one develops this claim, it would be necessary to attribute the gravitation field to the properties of matter, including its electric properties, the refractive index is not a tensorial quantity and the analogy to the situation in anisotropic crystals does not lead to artificial “effective refractive index tensor” but to naturally introduced tensor of optical-frequency dielectric impermeability of matter.

**Key words:** weak-field gravity, refractive index

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P. Boonserm et. al [1] have tried to describe some anisotropic optical effects in the gravitation field in frame of the general relativity and by introducing the so-called “effective refractive index tensor”. It has been noted in [1] that early in [2,3] the gravitational field has been assigned to an “effective refractive index”. Similar approach has been also offered in a lot of reports. In particular, in [4-7] it has been demonstrated a possibility of application of the optical-mechanical analogy and a refractive medium characterized with some effective refractive index for description of the phenomena related to general relativity. The relations for the dielectric permittivity or the refractive index change as functions of the distance from the mass centre of spherically symmetric mass obtained in all the mentioned works have the same form.

The authors of the mentioned paper [1] have extended this idea to an “effective refractive index tensor” similarly to anisotropic crystals. We suppose that this approach is inconsequent because of the following:

1. If one develops this claim, it would be necessary to attribute the gravitation field to the properties of matter, including its electric properties, which are not peculiar for the gravitation, i.e. the refractive index leads to the necessity of introducing of the optical-frequency dielectric impermeability of the gravitation field and the dipole moment of the gravitation field.

2. It would be necessary to emphasize also that the refractive index is not a tensorial quantity, while the optical-frequency dielectric impermeability represents a second-rank polar tensor (see, e. g., [8]).

3. The analogy to the situation in anisotropic crystals, mentioned by the authors in [1], does not lead to artificial “effective refractive index tensor” but to naturally introduced tensor of optical-frequency dielectric

impermeability of matter (which is linked to the refractive indices of the matter [9-11]), but not the gravitation field. Of course, one can say that this is only non-important terminological inaccuracy. Nevertheless, this, on the first blush, non-essential missing in definition draws a serious physical meaning.

The optical-frequency impermeability tensor is used for coupling two polar vectors: the electric induction and the electric field: $D_i = \eta_{ij} E_j$. In this relation, the polar tensor $\eta_{ij} = \left( \frac{1}{n^2} \right)_{ij}$ represents the property of matter and it should obey the *Neumann* principle, i.e. the symmetry elements of any physical property of a matter must include all the symmetry elements of the point group of the matter. From the assumption that the quantity $\eta_{ij}$ is a tensor with different components it follows immediately that the matter is anisotropic. Moreover, the anisotropy of matter, which is in fact a physical vacuum that surrounds a massive body, can appear under the action of fields of different nature, in particular, a gravitation one. Lowering of matter symmetry should obey the *Curie* symmetry principle. But for applicability of these principles to a physical vacuum perturbed by a gravitation field it would be necessary to attribute the physical vacuum by polarization properties, that is quite natural (for polarizable vacuum approach one can see the work [9]). The application of symmetry principles to the polarizable vacuum and the description of light propagation near the massive body under the effect of gravitation field have been proposed in our recent papers [10,11]. From these reports it follows that the gravitation field of spherically symmetric mass cannot produce any optical anisotropy [10], but it can lead to a change in already existing birefringence of anisotropic matter [11].

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