Are relations $P=hk$ and $E=mc^2$ simultaneously compatible with principle of wave-particle duality?

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With the advent in scientific language the terms «negative refraction coefficient» or «negative refraction» as well as related terms, researchers put some questions, which generally speaking have a much broader significance than the above words. The notion of «negative refraction coefficient» was shown for the first time probably in our early work[1]. However, we have shown[2] that a simple substitution of negative values *n* in some formula of electrodynamics and optics often leads to grave mistakes. Moreover, if the phase and group velocity are antiparallel, you must be very careful with some other formulas, which are not directly included value of *n*. This applies, for example, to the very well known formula *P=hk*, linking the value of the photon linear momentum with its wave vector. It is obvious that in the case of negative wave vector *k*, this formula gives a negative value for the photon linear momentum, and thus in case of the light absorption light pressure should be replaced by light attraction. This is all the more imperative that, strangely enough, the value of the photon linear momentum, even for the usual matter with positive n case is a subject of debate for over 100 years[3]. This discussion is based on the existence of two completely different energy-momentum tensors for electromagnetic fields, namely tensors in Minkowski form and in the form of Abraham. They give different expression for the forces in the transparent body by passing it through the electromagnetic radiation. Interesting to note that the tensor of Abraham in fact is not a tensor, because it is not a relativistic invariant. As to the Minkowski tensor, its use leads to some unusual expression $M=E/\mathrm{v}_{\mathrm{gr}}\mathrm{v}_{\mathrm{ph}}$ for the masses, transferred by the radiation from the emitter to the receiver (values v*ph* and v*gr* are phase and group velocities accordingly). From this expression becomes clear, that in the case of negative refractive index the mass is transferred not from the radiator to the receiver, but in opposite direction from the receiver to the radiator The above considerations indicate that relations $P=hk$ and $E=mc^2$ are not simultaneously compatible with wave-particle duality principle[4].

This work was supported by Russian Foundation for Basic Research, grants №№ 06-02-16830-a, 07-02-00233-a, 09-02-01186-a and 09-02-01519-a

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