

Indian Science Congress
Physical Sciences
Advances in Photonics and Meta-materials

3-7 January, 2012 Bhubaneswar

**Electromagnetic Momentum and Energy inside Negative Refractive Indexed
Material: A new look at concept of photon**

Shantanu Das Reactor Control Division, BARC Mumbai shantanu@barc.gov.in

Summary

In the formulas of physics can I place negative numbers and get the answer? Well sometimes it is yes sometimes it is no. For instant in the wave equation if I place one of the quantities say either epsilon or mu as negative value, then solution to the wave equation I get 'bounded' solution instead of normal mode solution of 'travelling wave'. Fine at least I have got the solution let it be bounded. If I put both negatives, I get a travelling a wave solution as the square of wave vector is product of mu and epsilon and the Maxwell's wave equation thus is transparent to negative epsilon and negative mu. But what happens to index of refraction when the epsilon and mu are both negatives? The answer is I get a refractive index negative value (at near the frequency of electric and magnetic plasma). Well I have chosen a negative number to square root of product of two negative numbers, still mathematically impure; though I had to spend considerable ink to jot down why? Well somehow I have explained the need to choose this negative value of refractive index, not in my talk but in the detailed write-up; since topic is something different. Can I conclude now? I cannot, and also what I discussed in this talk I think and opine are ad hoc schemes. Though I tried to debate the controversy regarding the 'photon's' momentum a corpuscular and wave nature, tried to explain the reactive the imaginary part and active the real part energy of the same; and especially inside media and media with negative index of refraction. At least I cannot put value of index of refraction as negative in existing physics formulas! I need to carefully state the index of refraction as 'phase' and 'group' separately and use them. I need careful attention when there is media with refractive index negative, and reformulate the existing physics formulas. Experimental realization of negative index of refraction has as a result raised important questions about the validity of this negative value in well known formulas of physics. The question of corpuscular energy transport inside negative indexed material, formation of reactive (imaginary) energy inside the negative indexed substances, well the character of photon pulse especially its momentum (corpuscular and wave) is addressed along with duality of particle-wave nature of photon. Few new concepts regarding new wave-momentum inside slab and reactive energy inside negative indexed material, and new generalized wave equation is proposed; to meet the future theoretical advances on these realized negative indexed materials. I have several light years to go!