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CONSTRAINED PHOTONS

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We can combine Maxwell's equations in vacuum with the evolution of an immaterial fluid (corresponding to the velocity vector field $\mathbf{V}$), by using the following set of model equations (see [2]):

$$\frac{\partial \mathbf{E}}{\partial t} = c^2 \mathrm{curl}\mathbf{B} - \rho \mathbf{V} \tag{1}$$

$$\frac{\partial \mathbf{B}}{\partial t} = -\mathrm{curl}\mathbf{E} \qquad\qquad \mathrm{div}\mathbf{B} = 0 \tag{2}$$

$$\frac{D\mathbf{V}}{Dt} = -\mu(\mathbf{E} + \mathbf{V} \times \mathbf{B}) - \frac{\nabla p}{\rho} \tag{3}$$

where $\mathbf{E}$ is the electric field and $\rho = \mathrm{div}\mathbf{E}$, $\mathbf{B}$ is the magnetic field, c is the speed of light, μ is a dimensional constant, and p is some kind of pressure.

We would like to show the results obtained in [1], corresponding to the numerical simulation of electromagnetic waves trapped in bounded 3-D regions of space. In the framework of fluid dynamics, these structures are perfectly similar to vortex rings, where, instead of a rotating fluid, we have an electromagnetic wave. The geometry of the regions may display a shape varying from the one of a standard annulus to that of a spherical Hill's type vortex (a toroid-shaped domain where the central hole is reduced to a segment).

REFERENCES

[1] C. Chinosi, L. Della Croce, D. Funaro, Rotating Electromagnetic Waves in Toroid-shaped Regions, submitted.

[2] D. Funaro, *Electromagnetism and the Structure of Matter*, World Scientific, Singapore (2008).