Metamaterials

The Purpose of a Proposal:

Finding a way to reduce electricity consumption, and substitute it by Natural light emitted through fiber optics, and for that reason a material to store natural light during the day is required in order to emit it at night

Material proposal:

Metamaterials are engineered materials having properties that may not be found in nature. They usually gain their properties from structure rather than composition. It allows us to work between basic and applied science, and experiment a wide area and explore unlimited capabilities. Those materials have negative index of refraction which does not exist in nature which allows us to explore the other half of optical field that has not been studied. The negative refractive index can be used to efficiently bring light to a complete standstill.

Consequently, I went through some research material that explains the original scientific concept of bringing light speed to zero, in order to comprehend how it works in the scale of atoms, so that I would be able to employ it in the metamaterial properties I need.

Researched material:

Harvard-Smithsonian Center for Astrophysics:

Researchers at Harvard-Smithsonian Center for Astrophysics led by Ron Walsworth and Mikhail Lukin managed to get the light speed to zero by sending a light pulse into specially prepared rubidium (Rb) vapor.

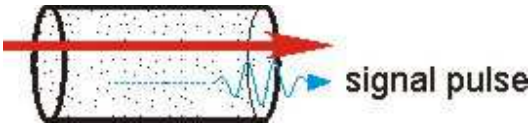
Light pulse passes through a medium that slows the group velocity of light to zero then stores it in the form of an atomic "spin wave" a collective excitation in the Rb atoms and can be visualized as a collective pattern in the orientation of the atoms which spins like tops and hence act like tiny bar magnets. The atomic spin wave enables researchers to store the light pulse's into the material and then convert it back into light pulse with the same properties at the original pulse. This new light storage method is much less sensitive to dissipation and losses.

In brief:

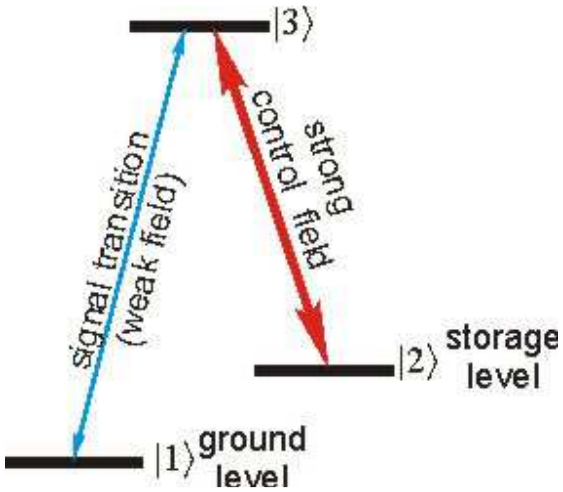
1. The length of a light pulse is compressed from kilometers to centimeters in a properly-prepared rubidium vapor

2. The information carried by the light pulse is then imprinted upon the ensemble of rubidium atoms in the form of long-lived spin waves

3. The light pulse can later be read out on demand.



Phenomenon electromagnetically-induced transparency (EIT)



Consider a glass cell filled with a Rb vapor atoms, we assume the gas to be optically dense on the transition between levels 1 and 3, that is, a laser beam of the transition wavelength will be absorbed by the gas. then apply an additional, strong laser field to the transition 2 - 3 to exhibit a narrow transparency window in the absorption spectrum. When the blue laser is *pulsed*, the pulse will propagate through the cell at a speed much less than the vacuum speed of light – possibly slower than a bicycle!

Conclusion

Metamaterials proved to have interesting unlimited branching qualities that are not present in natural materials, thus I decided to explore this area which allows us to customize the material according to our needs which in this case a material that can actually store light and emit it.

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