Guiding Invisible Light by Plasmonic Resonant Solitons in Metallic Nanosuspensions

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Abstract:
We demonstrate the guiding of invisible light by visible-light in plasmonic nanosuspensions. A low-power (40-60 mW) visible green laser beam (532 nm) penetrates through a colloidal suspension of gold spheres by nonlinear self-trapping (optical soliton), which creates a waveguide that allows guidance of an invisible infrared laser beam (1064 nm) of different power levels (20-500 mW). Although the infrared beam itself has very weak or no nonlinear self-action, the green beam undergoes self-trapping at an even lower power due to the presence of and interaction with the infrared beam.

How does a soliton work? How does light move metallic nanoparticles?
Answer: Gradient Forces!
A soliton is a non-linear wave that propagates with minimal diffraction through any linear or non-linear medium.

Experimental Set up

What are waveguides, solitons and nanoparticles important?
In telecommunications the soliton concept is used for fiber optics and pulse compression. Solitons in nanosuspensions aid in the exploration of the light/matter interaction of nanoparticles, and are applied in optofluiddic systems (micro-sized optical systems using fluids). Nanoparticles are actively used in the medical field (ex. to treat and study cancer [1], physical therapies).

Results: Green Plasmonic Resonant Soliton (self focusing )

Fig. 6. (a) The Green laser beam 60 mW interacts with the gold Nano spheres and creates a soliton which allows self focusing. Above is a side view image of the green laser beam propagating through the 40 mm metallic nanoparticle solution. (a) The Gaussian profile of the beam’s output intensity.

Guidance of Infrared by Green

Fig. 7. (a) Above is a side view of the unguided Infrared laser beam 50 mW. (b) The Gaussian is not sharp which corresponds to a diffuse output intensity.

Enhanced Guidance

Fig. 9. (a) Green at 60 mW creates a sharp soliton. (b) Green at 60 mW and infrared at 50 mW becomes less focused, resembling sinc3 profile. (c) Green 40 mW and IR 50 mW, the infrared helps the green create a soliton at lower power.

Conclusion
We have effectively shown that one wavelength of light can be guided by another through metallic nanosuspensions. This can open up applications to transportation of information and exploration of nanoparticles interaction with light. Special thanks to Dr. Roger Bland. This work is supported by the NSF, AFOSR, and NIH.