Tata Institute of Fundamental Research
Survey No. 36/P, Gopanpally Village, Serilingampally, Ranga Reddy Dist., Hyderabad – 500 046

Seminar

Space-time Metamaterials

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Carefully designed sub-wavelength structuring creates metamaterials with exotic properties that are not found in nature. The field of metamaterials has exploded this century, with applications involving waves in electromagnetics, acoustics, and elastics - such as negative refraction, cloaking, and super-resolution imaging. However, spatially structured linear metamaterials are limited in their ability to control wave phenomena as they are bound by energy conservation and reciprocity.

Modulating the constitutive properties of materials in time removes these constraints and permits wave phenomena that were previously inaccessible. Research on time-varying metamaterials was previously limited to theoretical investigations and experiments in fields such as acoustics and elastics, where the required modulations are slower. Space-time modulation and synthetic motion has been theorised to result in a wide range of interesting phenomena including Fresnel drag, amplification, Cherenkov radiation, and Hawking radiation. Recent advances in nonlinear optics have opened up the field of time-varying photonics, where constitutive parameters can be modulated on time scales comparable to that of light. In particular, epsilon-near-zero (ENZ) materials, whose plasma frequency can be modulated, provide a very promising platform for time-varying photonics.

I will present our theoretical and experimental results on diverse electromagnetic phenomena in electromagnetic space-time metamaterials based on ENZ media. I will discuss the theory behind our experimental demonstration of light scattering from modulation with faster-than-light synthetic motion. I will also present novel results on plasmons in space-time media and amplifying modes in realistic space-time crystals.

Friday, Jan 17th 2025

11:30 Hrs (Tea / Coffee 11:15 Hrs)

Auditorium, TIFRH