[Energy Distinguished Lecture Series]

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Giant Nonlinearity in Nanomaterials

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Abstract

Avalanche effects, where a small input is amplified to produce an enormous output, have found various applications in industries such as lasers and avalanching photodiodes. Photon avalanche, an optical avalanche process that exhibits an extremely nonlinear response in lanthanide-doped materials, has garnered significant interest due to its potential impact on numerous applications, including phase-conjugate imaging, infrared quantum counting, and efficient upconverted lasing. Recently, photon avalanche has been observed in single nanoparticles, offering building blocks for a wide range of applications in high-sensitivity pressure and temperature sensing, super-resolution imaging, and high-density optical data storage.

In this talk, I will discuss my recent research on the photon avalanche behavior of Tm3+-doped NaYF4 nanocrystal. First, I will address the unique photophysical properties of these avalanching nanocrystals. Next, I will discuss the photoswitching behavior of these nanomaterials, and present the robustness of the bidirectional optical control. Following that, I will explain a photoswitching mechanism associated with color center generation. I will then introduce several applications of these avalanching nanoparticles including 2D and 3D optical patterning as well as super-resolution imaging of single nanoparticles with sub-angstrom localization accuracy. I will conclude this talk by discussing potential future applications of these highly nonlinear nanomaterials.

Brief Bio



Changhwan Lee received his PhD in Mechanical Engineering from Columbia University in 2022, working under the supervision of Prof. P. James Schuck. His doctoral research focuses on lanthanide-doped avalanching nanoparticles.
Following a postdoctoral fellowship in the same group, he joined the Korea Advanced Institute of Science and Technology (KAIST) as an Assistant Professor in 2024.
His research interests include the optical characterization and application of lanthanide-doped nanomaterials.

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