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FDTD study of the formation of optical vortices associated with core-shell nanoparticle cluster[1] MD MAHFUZUR RAHMAN, JIN YOU LU, Masdar Institute of Science and Technology, GEORGE NI, NICHOLAS XUANLAI FANG, Massachusetts Institute of Technology, TIEJUN ZHANG, AMAL AL GHAFERI, Masdar Institute of Science and Technology — Light absorbing plasmonic metal-dielectric nanoparticles suspended in water, or nanofluids have recently been experimentally demonstrated to produce steam at high efficiencies upon solar illumination. This approach localizes high temperatures to the interior of the liquid through efficient trapping of incoming light via scattering and absorption mechanisms. In suspensions, nanoparticles may form clusters due to surface wetting properties, and little work has focused on understanding the optical properties of clusters. In this work, we use the FDTD method to accurately visualize the optical power flow through various plasmonic metal-silica core-shell nanoparticle pairs at different inter-particle separations (10-100 nm). At these separations phase singularities of the power flow can occur, such as vortices of light inside the dielectric core which can enhance the absorption cross-section of the cluster. We study the conditions required to form these vortices. We also consider titanium nitride as shell, other than the widely studied noble metals to visualize the extinction cross-section of a cluster which depends on the separation, and the permittivity of the dielectric core.

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