Mesoscale Priority Research Direction

Photon Funneling

Opportunity

Sunlight is a major energy source that remains largely untapped due to limitations in efficiency and affordability of technologies for capture, transport and conversion into storable energy forms. A new paradigm may be needed that bridges the length scales of the "photon size" or wavelength and the nano-scale of photon-excitable electron systems.

Meso Challenge

The process of conversion of visible light into electric energy crosses the meso-scale because scattering and diffraction phenomena are defined by the near-micrometer wavelength of visible photons while absorbing structures with commensurate electronic excitations are on the nano-scale. The most efficient biological photon antennas approach the size-scale of photon wavelengths; it is presently unknown whether this coincidence has a deeper theoretical significance.

Approach

Optical techniques integrated with structural analysis by microscopy, X-ray, neutron diffraction and scattering

Structural dynamics observed in situ with concurrent optical spectroscopy

Computational approaches to model multi-scale structural complexity and dynamics. Potentially new theoretical paradigm for optical/electronic "coherence"

Impact

Fundamental breakthroughs in understanding photon funneling can lead to new materials and devices for efficient and affordable technologies for capture, transport and conversion into storable energy forms. This would greatly advance using sunlight as a major energy source that is clean and sustainable.

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