RADIATION IN FLUX: FROM STEAM TO NANO

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We strive on solar energy, which is essential for life on Earth. Yet, we still do not know how to effectively harvest solar energy for betterment of life, or, how to use it extensively to minimize the adverse effects of fossil fuels on the environment. To engineer better systems and processes, we need to understand the fundamentals, and one of the most fundamental concepts of energy engineering is radiative transfer. Innovative designs, diagnostics and applications developed with the use of radiative energy concepts are likely to impact this energy riddle more than anything else. To this extend, radiative transfer, its interactions with matter, and its spectral and directional behavior need to fully incorporated into the concepts of energy harvesting, storage, transport and use. There is no question that since the discovery of fire and later with the use of steam for power production, clever applications of radiation transfer have already helped significantly to the development of combustion chambers and engines. Further understanding of these concepts have allowed us to have innovative designs for effective insulation systems, architecturally pleasing solar houses, and more precise manufacturing and diagnostic tools, among many others. With the advances in our understanding of nano-scale sciences and the availability of nanotechnologies, radiation transfer is now bound to help us to discover unparalleled applications from energy harvesting to nanopatterning practices. In the midst of all these developments stand the radiation transfer community.

As recent studies proved, radiation transfer is the key for understanding the energy transfer between objects at nanoscale distances. When the separation gap drops below the wavelength of propagating waves, particularly to nanometer distances, the radiative enhancement can be orders of magnitude higher than the Plank blackbody radiation transfer due to the contributions of evanescent waves. This talk will encompass the changes in the field and potential applications of near-field radiation transfer in the future. The research emphasis on recent work on nanoscale energy transfer concepts will be highlighted. Discussion of near-field effects will be given and their impact on new ideas for energy harvesting and molecular sensing practices will be outlined. Particularly, the use of near-field radiation transfer for design of material and structure at the same time will be demonstrated. The solution techniques for radiation transfer will be summarized and parallels between the photon, phonon and electron transfer mechanisms will be provided. This talk will outline the challenges and the opportunities of radiation transfer for new designer materials along with the surfaces and realistic structures which make up the complicated systems. In addition, how the absorption and scattering by different objects are altered due to the presence of particles, agglomerates, probe tips or surfaces will be discussed. The possible use of these so called dependent absorption and scattering profiles for diagnostics of nano-particles and AFM-based patterning of nano-particles will be explained. Finally, discussion of future research directions will be presented.

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