Radiative Heat Transfer at the Micro/Nanoscale

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Abstract:
Radiative heat transfer at the micro/nanoscale significantly deviates from the classical Planck theory of thermal radiation. Phenomena such as tunnelling of evanescent waves across micro/nanoscopic separation gaps, thermal emission of surface phonon and plasmon polaritons, and quantum confinement arise at the micro/nanoscale and drastically affect radiative heat transfer. These phenomena can result in radiative heat transfer coefficients several orders of magnitude larger than that for blackbodies and can provide an excellent opportunity for design and discovery of materials with novel thermal radiative properties. The enhanced heat transfer and the possibility of material design at the micro/nanoscale have been capitalized on for state-of-the-art technologies such as nano-gap thermophotovoltaic waste heat recovery, near-field photonic cooling, heat transfer rectification and modulation, and radiative cooling. Additionally, radiative heat transfer at the micro/nanoscale can become comparable to heat transport via forced convection even at low temperatures, and thus can play a significant role in thermal management of ultra-compact electronics and micro/nanoscale devices.

Exploiting the unique properties of radiative heat transfer at the micro/nanoscale requires addressing a few key computational and experimental challenges that will be discussed in this research seminar. The seminar will start with an introduction to radiative heat transfer at the micro/nanoscale and a discussion on its significance and applications. Research from my lab to address some key challenges related to numerical modeling and experimental measurement of radiative heat transfer at the micro/nanoscale will be presented next. My research on design and application of novel materials such as micro/nanostructures, quantum dots, and graphene for enhancing, tuning, and active control of radiative heat transfer will also be discussed. The seminar will conclude with my plans for research, teaching, and enhancing diversity in the Department of Mechanical Engineering at Iowa State University.

Biography:
Sheila Edalatpour is an Associate Professor of Mechanical Engineering and an Associate Member of the Frontier Institute for Research in Sensor Technologies at the University of Maine. She received her Ph.D. in Mechanical Engineering with a focus on Thermal Sciences from the University of Utah in 2016. Her research is focused on radiative heat transfer at the nanoscale. She develops theoretical frameworks, computational methods, and experimental techniques that enable understanding the physical mechanisms driving heat transfer via electromagnetic waves between micro/nanoscale media or across separation gaps of such order. Her research is supported by the National Science Foundation and the Department of Energy. She is a recipient of the National Science Foundation CAREER Award, Early Career Research Award from the College of Engineering at the University of Maine, and the University of Maine Faculty Mentor Impact Award.

***This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.**
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