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Beyond classical heat transfer

Unlike the past century that was blessed with ever-abundant cheap oil, this century energy has been rated as the single most important issue faced by humanity. Over 80% of all the energy we are using today is produced in or through the form of heat. Engineering heat-transfer process and medium with super thermal performance is thus vital for addressing the terawatt challenge faced by us. Driving force for heat transfer can be direct or indirect. The former is temperature gradient with conduction, convection and radiation as its three fundamental ways of heat transport. The latter comes from cross-coupling among different transport processes in the medium and transports heat in thermal waves which can be in various forms and tunable via manipulating the cross coupling. The first part of this talk is on developing a universal relation between heat flux and temperature gradient in temperature-gradient-driven heat transfer by finding both the necessary and sufficient conditions in a systematic, rigorous way for a heat transfer process to satisfy fundamental laws like the second Law of Thermodynamics. This leads to a generalized Fourier law that provides effective means for engineering temperature-gradient-driven heat-transfer processes with super thermal performance. It is normal that two or more transport processes occur simultaneously in heat-transfer media. Examples include mass, heat, chemical, electrical and magnetic transports. These processes may couple (interfere) and cause new induced effects of flows occurring without or against its primary thermodynamic driving force, which may be a gradient of temperature, or chemical potential, or reaction affinity. Two classical examples of coupled transports are the Soret effect (also known as thermodiffusion) in which directed motion of a particle or macromolecule is driven by flow of heat down a thermal gradient and the Dufour effect that is an induced heat flow caused by the concentration gradient. While the coupled transport is well recognized to be very important in thermodynamics, it has not been well appreciated yet in the society regarding its potential of generating and manipulating thermal waves and resonance.

Biography

L Q Wang received his PhD from University of Alberta (Canada) in 1995 and is a Full Professor in the Department of Mechanical Engineering, the University of Hong Kong. He is also the Qianren Scholar (Zhejiang) and serves as the Director and the Chief Scientist for the Laboratory for Nanofluids and Thermal Engineering, Zhejiang Institute of Research and Innovation (HKU-ZIRI), the University of Hong Kong. He has secured over 70 projects funded by diverse funding agencies and industries including the Research Grants Council of Hong Kong, the National Science Foundation of China and the Ministry of Science and Technology of China, and has published 10 books/monographs and over 340 book chapters and technical articles, many of which have been widely used by researchers all over the world. He is on the list of the top 1% most cited scholars. He has also filed 22 patent applications and led a team in developing a state-of-the-art thermal control system for the Alpha Magnetic Spectrometer (AMS) on the International Space Station. He was Visiting Professor of Harvard University (2008) and Duke University (2003). He has presented over 35 invited plenary/keynote lectures at international conferences, and serves/served as the Editor-In-Chief for the *Advances in Transport Phenomena*, the Editor for the *Scientific Reports*, the Associate Editor for the Current Nanoscience, the Guest Editor for the *Journal of Heat Transfer,* the *Nanoscale Research Letters* and the *Advances in Mechanical Engineering*, and serves on the Editorial Boards of 19 international journals.

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