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Heat Transfer with Thermal Waves and Resonance

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ABSTRACT Unlike the past century that was blessed with ever-abundant cheap oil, this century energy has been rated as the single most important issue facing humanity. Over 80% of all the energy we are using today is produced in or through the form of heat. Engineering heat-transfer medium with super thermal performance is thus vital for addressing the terawatt challenge facing us.

Driving force for heat transfer can be direct or indirect. The former is the temperature gradient with conduction, convection and radiation as its three fundamental ways of heat transport. The latter comes from the cross-coupling among different transport processes in the medium and transports heat in thermal waves/resonance, the fourth fundamental heat-transfer mode. Unlike the other three modes that transport heat always from high temperature to low temperature with temperature gradient as the driving force, this mode of heat transfer comes from the cross-coupling among different transport processes in the medium and can transport heat isothermally or even from low temperature to high temperature. This mode of heat transfer is characterized by its wave-type distributions (spatial, temporal, or both) of temperature depending on and tunable by the cross coupling. Thermal waves/resonance has also shown the strong predominance over the other three modes of heat transfer. This talk will discuss the origin and manipulation of thermal waves and resonance, show some unique, super features of heat transfer with thermal waves/resonance from experiments, and shed light on the challenge associated with numerical simulation of heat transfer with thermal waves and resonance.