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Advances in micro/nano fluid flows: In Memory of Professor Jason Reese FREE

Special Collection: Advances in Micro/Nano Fluid Flows: In Memory of Prof. Jason Reese

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This special issue is dedicated to Professor Jason M. Reese, who died suddenly at the early age of 51 on 8 March 2019. Professor Reese was an internationally renowned Engineering Scientist, respected academic, and a valued mentor to many. At the time of his death, he was Regius Professor of Engineering at the University of Edinburgh. His research has delivered a new understanding of unusual behavior of gases and liquids at ultra-small length-scales, which is helping engineers to develop a diverse range of technologies, including ultra-efficient water filtration systems using carbon nanotubes, nano-structured surface coatings for drag reduction in ships, spacecraft hypersonic reentry systems, and lab-on-a-chip devices. He also made contributions through a spin-off company, government advisory roles, and the support of the Learned Societies, for which he was a Fellow. Therefore, the University of Edinburgh created the Jason Reese Chair in honor of his academic leadership and scientific achievements.

Owing to emerging micro/nano-electromechanical systems (MEMS/NEMS) and lab-on-a-chip devices, the knowledge of fluid flow and heat transfer at ultra-small length-scales has significantly advanced during the last decade. Heat and flow at the micro- and nano-scales exhibit peculiarities different from the intuition of macroscopic continuum fluid dynamics. For example, micro/nano gas flows at the ambient pressure can be rarefied and experience velocity slip and temperature jump at the flow boundaries.

In this special issue, readers can find contributions made by leading researchers in the fields of micro- and nano-fluid mechanics, applied and theoretical mathematics, and rarefied gas dynamics, covering a broad range of topics, including theoretical, numerical, and experimental studies. Advancement in extending the applicability of continuum-based Navier–Stokes–Fourier equations toward a non-equilibrium state through improved boundary conditions and constitutive relations is reported in Ref. 1. Gas flows induced by temperature gradients along the walls[2–4] or even by uniform but different temperatures on the opposite walls[5] are other features of rarefied micro- and nano-scale flows that are also considered in this special issue. Nanofluids[6] and flow in microchannels[7] and nanotubes[8] are reported together with investigation of discontinuities in rarefied gas flows such as shock waves and their affiliated phenomenon.[9–11] Flow in the porous media exhibits unique features at the pore scale different from the macroscopic flow domain, which should be treated with the tools appropriate for micro/nano scale flows.[12–15] Classical problems of viscous fluid flow such as Couette flow exhibit peculiarities at the micro/nano scales.[16,17] The experimental study of gas mixture and binary mixture separation in capillary tubes[18] and the analytical study of fluid flow in the free molecular regime[19,20] are also included.

In this special issue, researchers also report on the derivation of the transport coefficients of multicomponent mixtures of the noble gases,[21,22] studies of the Mpemba effect,[23] the rotational–translational relaxation process of diatomic molecules,[24] the multi-temperature vibrational energy relaxation rates in CO_2,[25] the solid boundary's influence on the propagation of thermodynamic disturbances,[26] flows through micro/nano-nozzles,[27] the derivation of thermal slip coefficients,[28] and the plume expansion.[29] The other topics are analysis of breakdown criteria for the hybrid solvers,[30] non-equilibrium effects with the membrane boundaries,[31] development of the unified gas-kinetic wave-particle solver,[32] study of the planar gas expansion under pulsed evaporation,[33] the molecular dynamics study on energy accommodation coefficient,[34] use of the moment method to model the Boltzmann equation,[35] development of the rotational relaxation model for nitrogen,[36] Langmuir evaporation of polyatomic liquids,[37] and extension of the discrete unified gas kinetic scheme for incompressible flow.[38]

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