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IMPACT OF COMPUTATIONAL RADIATION TRANSFER ON SCIENCE, ENGINEERING AND SOCIETY

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ABSTRACT

In this presentation, we will present a journey on the development of physics of radiation transfer and the related computational methodologies. We will highlight many applications of radiation transfer on fundamental sciences and engineering disciplines. This talk will not be on the details of a single computational scheme, but on the impact of a fundamental area, developed over the decades by different communities, on the society in general. We will first give a historical outline about the use of optics and radiation transfer (light and heat) over the centuries. Then, we will outline a summary of computational techniques for different physical systems used in pre- and post-digital ages, and comment on how some of these areas cross-pollinated other fields.

Among all heat transfer sub-disciplines, radiation transfer is the only one directly related to and grew together with quantum mechanics. Computational radiative transfer has been reliable and credible probably because of this connection. Yet, because of integro-differential nature of the governing equations, radiation transfer problems were always oversimplified making some of the predictions physically questionable. The inherent difficulty in solving the radiative transfer equation made the diffusion of more complex and accurate computational methodologies for radiation transfer to the mainstream computational packages slow. We will discuss some of these problems and suggest solutions for both future software and hardware developments.

On the other hand, radiation transfer solutions always require the reliable data for surfaces as well as the particles and gases within a given a medium. We will comment on the importance of computational radiation transfer methodologies in determining these properties from carefully conducted experiments, which require the understanding of both the physics and computational techniques. To this end, we will briefly discuss the development of inverse radiation transfer concepts. We will also highlight the computational techniques needed for the near-field radiation transfer, which are essential for the understanding of pathways for new devices and processes at the nano-scale levels. Finally, the impact of computational radiation transfer methods on energy efficiency research related to sustainable buildings and cities is to be highlighted. Here, specific emphasize will be given to the new-developed concepts on radiative cooling and the visual comfort.

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