הטכניון - מכון טכנולוגי לישראל

TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

הפקולטה להנדסה כימית
ע״ש וולפסון
The Wolfson Department of Chemical Engineering

Wolfson Department of Chemical Engineering Seminar

Wednesday, February12th, 2025 at 13:00

Room 4

LBM Inspired Approach to Modelling Radiative Heat Transfer with Applications to Crystal Growth

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MSc Seminar

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Radiative heat transfer becomes the dominant mode of heat transfer at high temperatures and/or in low-pressure environments, such as those found in outer space, furnaces, combustion chambers, fires, nuclear reactors, and large-scale industrial crystal growth processes. The governing equation for radiative heat transfer is an integro-differential equation, and its solution is computationally expensive. As a result, various numerical methods have been developed to address this challenge. One such method is the Lattice Boltzmann Model (LBM), initially developed to solve the Navier-Stokes equations through particles probability distributions at discrete nodes.

In this talk a variant of LBM applied to thermal radiation heat transfer will be presented. Specifically, the solution of the radiation transport equation (RTE) in 1, 2 and 3 dimensions via this approach will be discussed where different boundary conditions will be examined (specular, diffusive and black boundaries).

The accuracy of the numerical solution of the RTE is influenced by a number of numerical parameters in a nontrivial manner, which is difficult to discern. Here a machine learning-based approach for conducting sensitivity analysis of the accuracy to these parameters, when using our LBM-based approach, will be presented.

Issues related to the application of our numerical approach to modeling of crystal growth processes will be discussed. For example, when crystal growth of bismuth germanate ($Bi_4Ge_3O_{12}$ – an important scintillator material) is modeled, it should be considered that the crystal is strongly transparent in a specific range of wavelengths, while it is opaque outside this range. A demonstration of combining wavelength-dependent properties in our analyses will be provided. In addition, challenges related to using our approach to modeling transport across melt/crystal interface will be discussed.

Refreshments will be served at 12:45.