UNDERSTANDING RADIATION TRANSPORT IN STOCHASTIC MIXTURES

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In inertial confinement fusion (ICF), the presence of very different materials in the fusion pellets' structure produces Rayleigh-Taylor instabilities near the interfaces. These hydrodynamic instabilities create multi-material mixing zones, which is believed to greatly modify radiation transport and ultimately affect the implosion performance. In this context, understanding radiation transport in stochastic mixtures is important.

In this talk, we develop an accurate massively-parallel code for simulating radiation transport in binary stochastic mixtures in two dimensions (2D). The developed tool is validated by reported benchmark results. Based on our proposed simple relationship, we have clarified inconsistent results between different research groups in the field. It is found that decreasing the opacity or the mixing length should enhance or suppress the impact of stochastic mixtures on the radiation transport, which is further corroborated by extra 2D simulations. Finally, we derive a new analytical formalism of the effective opacity by taking into account the two-point spatial correlations of opacity fluctuations. A systematic comparison with existing models is made. For more than 50 different sets of physical parameters of random media, including constant and temperature-dependent opacities, it shows that present model is the most accurate one, which can predict the benchmark values within a relative error of 5% in most cases. Our work is expected to improve the understanding of radiation transport through stochastic mixtures in the ICF applications.