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Guo-jun Li, Lin-Yang Wei

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Chebyshev collocation spectral method for radiative transfer in participating media with variable physical properties

Guo-jun Li*[1], Lin-Yang Wei[2]

(1. School of Metallurgy, Northeastern University, Shenyang 110004, PR China;

School of Energy Science and Engineering, Harbin Institute of Technology, Harbin 150001, PR China)

Abstract

Chebyshev collocation spectral method based on discrete ordinates equation is employed to solve radiative heat transfer problems in participating media with variable physical prosperities (including space-dependent or temperature-dependent refractive index, absorption coefficient and scattering coefficient). Discrete ordinates method is employed to discretize the solid angle domain. Chebyshev polynomial and collocation spectral method are adopted to express and discretize space domain, respectively. Numerical results obtained by the Chebyshev collocation spectral-discrete ordinates method (CCS-DOM) are presented in this paper and the results show the CCS-DOM has a good accuracy and efficiency for radiative heat transfer problems in participating media. At last, the effects of variable physical properties on radiative heat transfer are analyzed and it can be found that the distributions of refractive index, absorption coefficient and scattering coefficient have a significant effect on radiative transfer and energy distribution.

Keywords: Radiative heat transfer, Chebyshev collocation spectral method, Variable physical properties, Participating media

Nomenclature

I	radiative intensity, W/(m^2 sr)
I_b	blackbody radiative intensity, W/(m^2 sr)
n	refractive index
x	axial coordinate, m
M	the direction number
N	total number of solution number

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