DISCUSSION

R. Viskanta[4]

The author's paper is an interesting application of the radiative transfer theory to an engineering radiant heat-transfer problem. There seems to be some discrepancies and errors in the basic equations used, however. The specific comments are as follows:

1 The right-hand side of Equation (1) represents the rate of change of the total energy flux with position; therefore the radiant energy flux F, appearing in Equation (1), should be defined as

$$F = \int_{\Omega=4\pi} I_\mu \mu d\Omega, \quad (14)$$

where Ω is the solid angle. The intensity of radiation I_μ must be integrated over-all solid angles ($\Omega = 4\pi$) and not only over-all polar angles. If azimuthal symmetry is assumed, as it is done in the paper, F can be expressed as

$$F = \int_0^{2\pi}\int_0^{\pi} I_\mu \mu \sin\theta \, d\theta \, d\phi = 2\pi \int_{-1}^{1} I_\mu \mu d\mu, \quad (15)$$

where ϕ is the azimuthal angle.

2 The second term on the right-hand side of Equation (2) seems to be in error. Kourganoff [8, p. 7] has shown it to be $n_\nu^2 \alpha_{A,\nu} B_\nu$, where the subscript ν refers to the frequency interval $(\nu, \nu + d\nu)$ and B_ν is Planck's function. Thus the beam of radiation is strengthened in intensity due to the emission of radiation from the medium to the amount $n^2\alpha_A\sigma T^4/\pi$ and not to the amount $2n^2\alpha_A\sigma T^4$, as can readily be shown by integrating B_ν over-all frequencies (or all wave lengths).[5]

3 In view of the discussion in the previous paragraph and the definitions for F and J used in the paper, Equation (3) should be

$$\frac{\partial F}{\partial x} = -\alpha_A(J - J_e/2\pi). \quad (16)$$

If J is defined as

$$J = \int_{\Omega=4\pi} I_\mu d\Omega = 2\pi \int_{-1}^{1} I_\mu d\mu \quad (17)$$

and F as in Equation (15), Equation (3) given in the paper would then be correct.

How, if any, will the results and conclusions be affected by these changes? Clarification of the points raised in the foregoing discussion will be appreciated by those interested in radiant heat-transfer problems.

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[5] M. Jakob, "Heat Transfer," John Wiley & Sons, Inc., New York, N. Y., 1949, vol. I, pp. 33, 37–40.

Author's Closure

I can best answer Dr. Viskanta's question by indicating that there was a somewhat unfortunate choice of notation at the beginning of my paper. I used the symbol I_μ to represent the total intensity of radiation traveling with direction cosine μ. This intensity is then the result of an integration of the intensity per unit solid angle over-all azimuthal angles. On the other hand, Kouvganoff (and Viskanta) define I_μ to be the intensity per unit solid angle. Thus their I_μ differs by a factor of 2π from my quantity I_μ.

However, Viskanta points out that my definition of J and F differ by a factor of 2π from the J and F that he would define, if he started from his I_μ. This extra factor of 2π is just a result of the difference in our initial definitions of I_μ. Thus my J and F are really identical to the quantities Viskanta defines by Equations (15) and (17).

Thus, once one recognizes that I have defined I_μ in a slightly unconventional manner, it becomes clear that all my equations are quite correct.