RADIATIVE TRANSFER AT MESOSCOPIC SCALE : THE BASIC CONCEPTS REVISITED

R. Carminati and J.-J. Greffet
Laboratoire d'Energétique, Moléculaire et Macroscopique, Combustion
Ecole Centrale Paris, Centre National de la Recherche Scientifique
92295 Châtenay-Malabry Cedex, France

With the rapid development of micro and nanotechnologies, it has become necessary to deal with radiation transfer at sub-wavelength scales[1]. At such scales, wave and coherence effects may substantially influence the properties of the thermally emitted light[2,3,4] as well as the radiation transfer[5]. When dealing with radiative transfer between opaque bodies exhibiting sub-micronic scales, one needs to compute emitted and reflected fluxes. The key concepts in classical transfer are the specific intensity and the local radiative properties of the surfaces (emissivity and reflectivity). Two important questions arise : 1) can we still use such concepts at sub-wavelength scales ? 2) If not, is there a general approach to radiation transfer at mesoscopic scale (i.e. when wave effects are important but the matter is still continuous) ?

In a first part, we will discuss the validity of the classical concepts at small scales, starting from a definition of the specific intensity, the reflectivity and the emissivity based statistical optics[6]. The relevant length scales will be discussed on a physical basis. The role of coherence and interferences will be particularly put forward.

In a second part, we will describe a general approach to compute thermal fields and radiative fluxes in mesoscopic systems[7], which is not limited by the size of the objects. Some simple examples will be described and discussed. These examples will illustrate the main peculiarities of thermal emission at small scales and their influence on radiation transfer between opaque bodies.

REFERENCES

1. Tien, C.L. and Chen, G. *, J. Heat Transfer*, Vol. 116, pp. 799-807, 1994.
2. Carminati, R. and Greffet, J.J. , *Phys. Rev. Lett.* Vol. 82, pp. 1660-1663, 1999.
3. Shchegrov, A.V., Joulain, K., Carminati, R. and Greffet, J.J., *Phys. Rev. Lett.* Vol. 85, pp. 1548-1551, 2000.
4. Greffet, J.J., Carminati, R., Joulain, K., Mulet, J.P., Mainguy, S. and Chen, Y., *Nature* Vol. 416, p. 61, 2002.
5. Mulet, J.P., Joulain, K., Carminati, R. and Greffet, J.J., *Appl. Phys. Lett.* Vol. 78, pp. 2931-2933, 2001.
6. Apresyan, L.A. and Kravtsov, Yu.A., *Radiation Transfer, Statistical and Wave Aspects*, Gordon and Breach, Amsterdam, 1996.
7. Rytov, S.M., Kravtsov, Yu.A. and Tatarskii, V.I., *Principles of Statistical Radiophysics*, Vol. 3, Springer, Berlin, 1989.