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Experimental study of droplets in evaporating regime by 2D scattering analysis

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ABSTRACT

The characterisation of droplets in terms of velocity, size and composition is fundamental in the analysis of several industrial process and natural phenomena. A lot of efforts has hence been made by the scientific community to develop non-intrusive techniques based on the properties of the scattered light. In 1990, Ragucci et al., originally developed a planar sizing technique based on the measurement of the angular spacing between fringes in out-of-focus images. In fact, in out-of-focus images (fig. 1) the scattering intensity oscillations, whose spacing is inversely proportional to droplet size, are clearly visible.

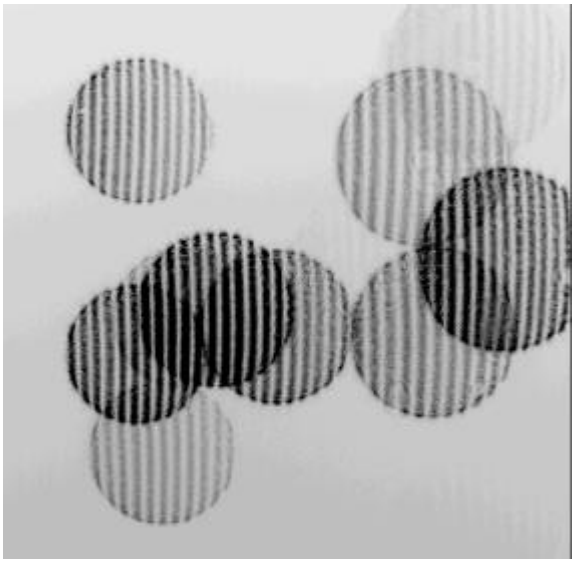

Fig.1 Out-of-focus image of 40 mm isopropyl alcohol droplets.

However, the application of the *Mie Scattering Imaging* technique has been limited to homogeneous droplets untill now. On the contrary, in practical systems, homogeneous droplets represent a limit case. The aim of the paper is to establish the theoretical basis and to experimentally test the generalisation of the technique to non-homogeneous spheres. Thus the scattering of radially inhomogeneous droplets was carefully examined in addition to that of homogeneous droplets.

The theoretical analysis of the scattering patterns permits us to conclude that the best angular region to generalise the out-of-focus technique is around $\vartheta=60°$. At this scattering angle the spacing between intensity oscillations is extremely regular and depends only slightly on the refractive index profile. The generalising law for all the refractive indexes is:

$$(\ , n(r), D) = 1.129\ (180° / \alpha) \text{ at } \vartheta=60°.$$

By means of the previous relation, the measure of angular oscillation spacing in out of focus images permits the determination of droplet size within 4%, even if the refractive index is completely unknown. That can represent a powerful tool to study reactive non-isothermal sprays where the hypothesis of homogeneous droplets has to be relaxed. The *Generalised Scattering Image* technique has been successfully applied to homogeneous droplets and droplets in non-stationary vaporisation regime (i.e., with internal variation of refractive index).

Ragucci R., Cavaliere A. and Massoli P. (1990). Drop sizing by laser light scattering exploiting intensity angular oscillation in the Mie regime" Part. Part. Syst. Charact., 7, pp. 221-225.