

Flare Removal in Gas Phase PIV: Optimization of Fluorescent Tracers

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1. Background and Motivation

Fluorescent tracer particles have found a number of uses in PIV. A light sheet produces flare when it impinges upon an object within the field of view, preventing particle images from being obtained and hence preventing velocity measurements in that locality. An example is shown in figure 1 where 532nm light is used for excitation and imaging. Whilst in some situations flare may be minimized by careful experiment setup, in some applications flare is difficult to avoid and prevents information from being obtained, e.g. in boundary layer measurements. A further application has been explored where fluorescent tracers are used to optically label one phase or constituent of a flow and thereby enable simultaneous multi-constituent PIV [1-3].

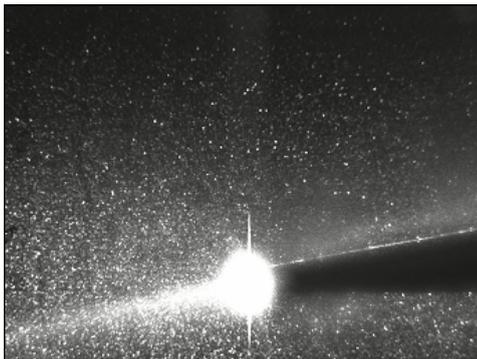


Fig. 1 Example of image flare with Mie scattering

The general application of fluorescent tracers to gas phase flow seeding requires sufficient fluorescence emission from micron sized tracers when imaged over 10's of mm field of view. For multi-constituent and multi-phase flows sufficient chromatic separation is also required between the illumination and the fluorescence and between the fluorescence and any wavelengths used for Mie scattering.

2. Fluorescent Tracer Selection

The use of UV excitation, e.g. tripled Nd:YAG, at 355nm, with 'blue' fluorescence emission, at ~450nm, has been selected to remove the excitation and emission wavelengths from the spectral regions conventionally used with PIV. Furthermore, emission at 450nm lies near the centre of the 'blue' image layer of color CCD cameras. A series of suitable dyes were evaluated for fluorescence yield and linearity (absence of quenching) at high concentrations. The study showed that Bis-MSB provides the best performance when dissolved in either olive oil, or for higher yield in paraffin oil. The dye was further evaluated using an oil in water emulsion to simulate the effect of small tracer

particles before experimenting with atomized droplets.

3. Experiments and Results

The dye was evaluated using a twin cavity pulsed Nd:YAG laser (Continuum Surelite II-10) with a common external frequency tripler. Images were recorded onto a La Vision Imager Intense camera. Droplets of paraffin oil were atomized and the drop size measured as 0.6–1.6 μ m using an interferometric technique. It was found that satisfactory images could be obtained with ~30mJ of 355nm excitation using a lens F# of 2. An example image is shown in figure 2 and the vector map from a double pulse image pair is shown in figure 3.

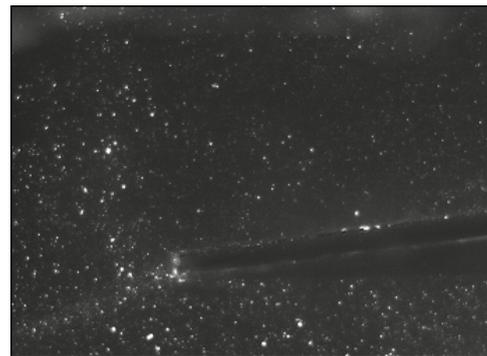


Fig. 2 fluorescence emission at ~450 nm from UV (355 nm) excitation

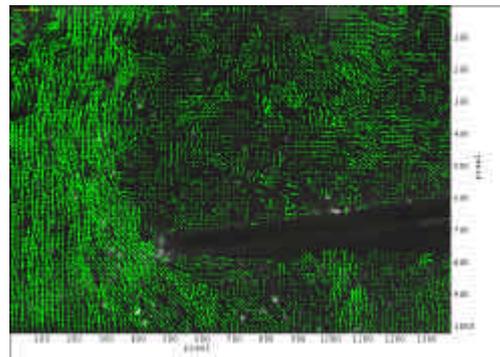


Fig. 3 vector map obtained from a double pulse image pair of fluorescence images.

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