Introduction to Planar Laser-Induced Fluorescence (PLIF)

Principal Investigator: Dr. Ronald K. Hanson

Research Associates: Dr. Jay Jeffries; Dr. David Davidson

What is PLIF?

PLIF stands for Planar Laser-Induced Fluorescence. Fluorescence indicates that an excited atom or molecule is spontaneously emitting light, and the rest specifies that a laser sheet is generating these excited atoms/molecules. Figure 1 below shows the heart of the PLIF technique from a macroscopic viewpoint: a laser sheet is passed through some flowfield, and the resulting fluorescence is captured on a digital camera. In Figure 2 the microscopic view of PLIF is shown via an energy diagram. A ground state atom or molecule is pumped to an excited state, in which a variety of energy transfer processes occur. Of interest is the resulting fluorescence and how the fluorescence is affected by various parameters.

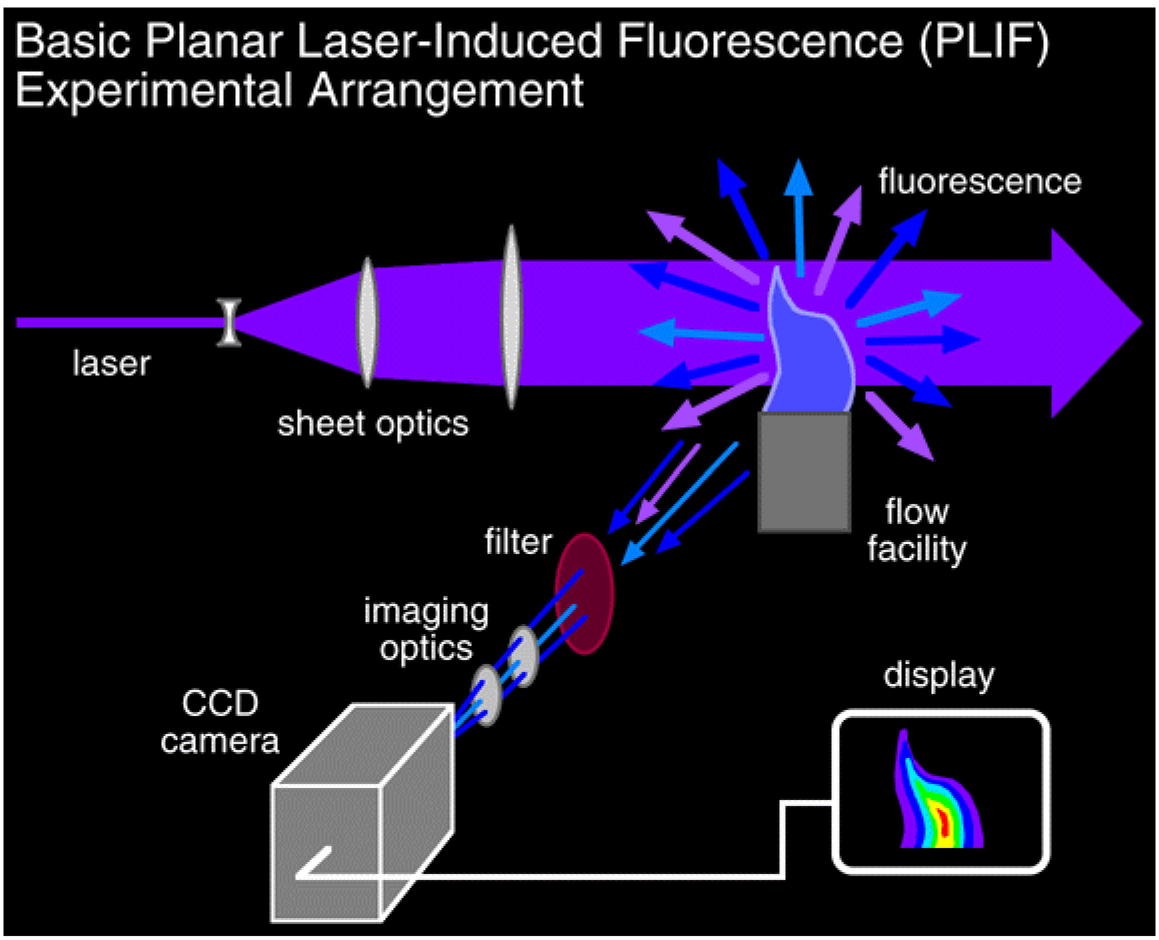

Figure 1: Experimental schematic

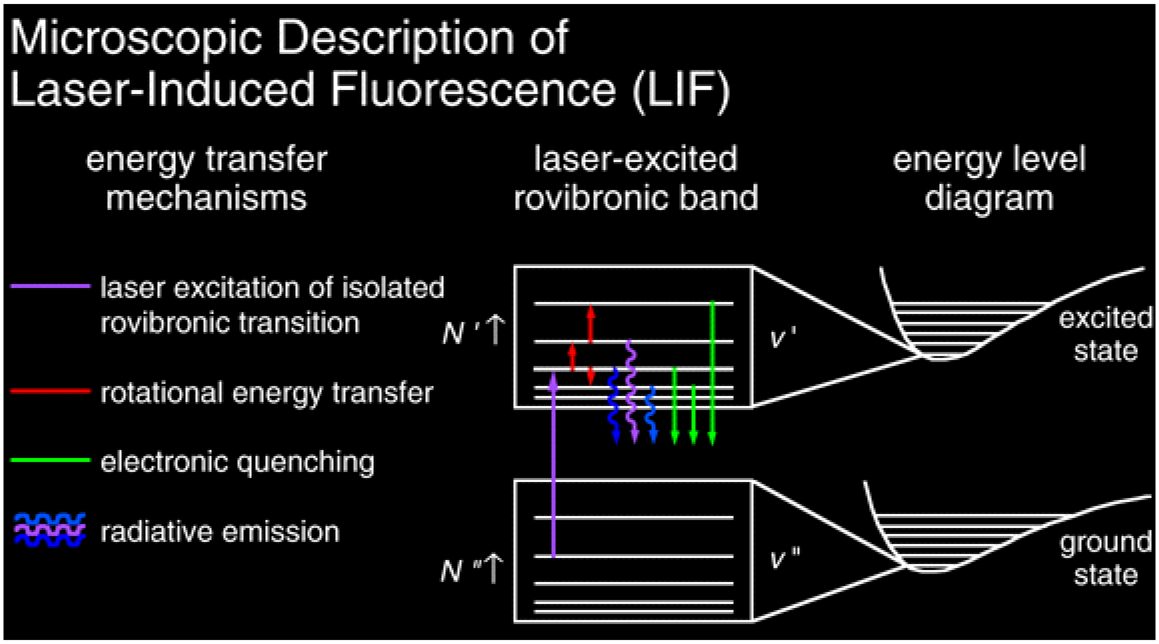

Figure 2: Energy diagram

What can PLIF Measure?

PLIF has been used in our lab to measure species concentration, temperature, and velocity in two- and three-dimensions (see PLIF Accomplishments). PLIF in its most direct form measures the concentration of a certain species in a certain energy state. The population in these states is a function of the species concentration and temperature. PLIF velocimetry takes advantage of the Doppler shift present when the absorbing species is in motion relative to the laser.

The fluorescence which results from the laser sheet excitation can be quantified through the fluorescence equation, shown in one of its many forms in Figure 3.. The form of this equation changes depending on the nature of the laser, the spectroscopic transition, and the experimental technique. Figure 4 shows how PLIF can extract temperature information (from relative populations of two rotational states) and velocity information (from Doppler shift).

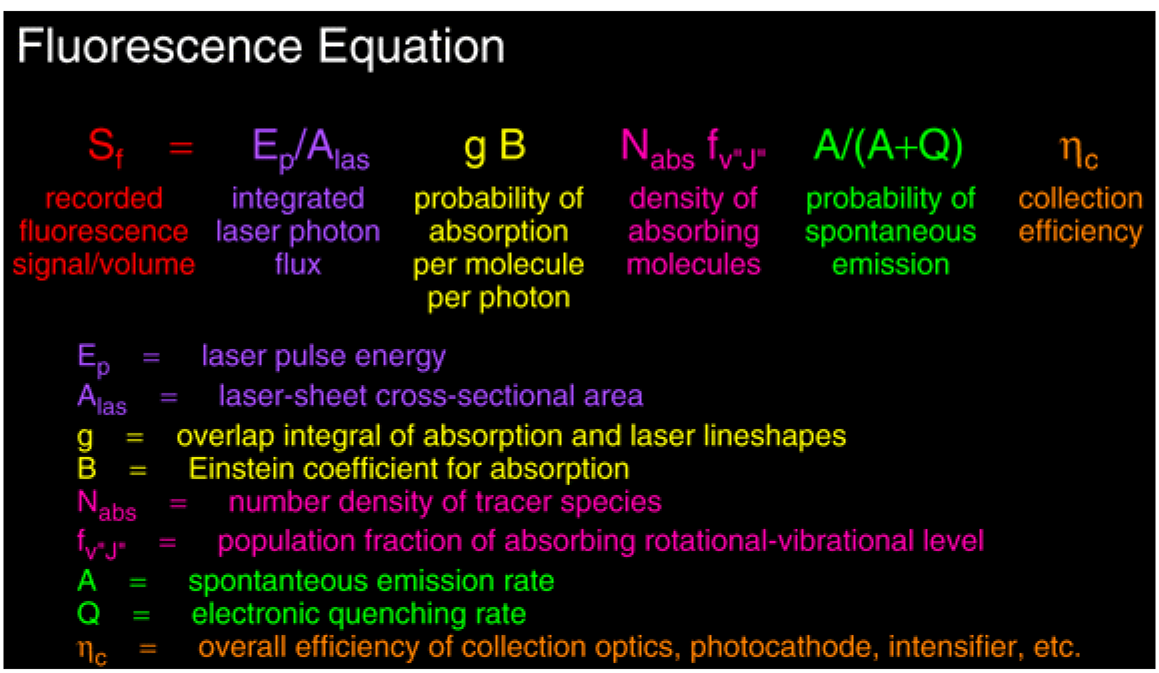

Figure 3: Flourescence equation

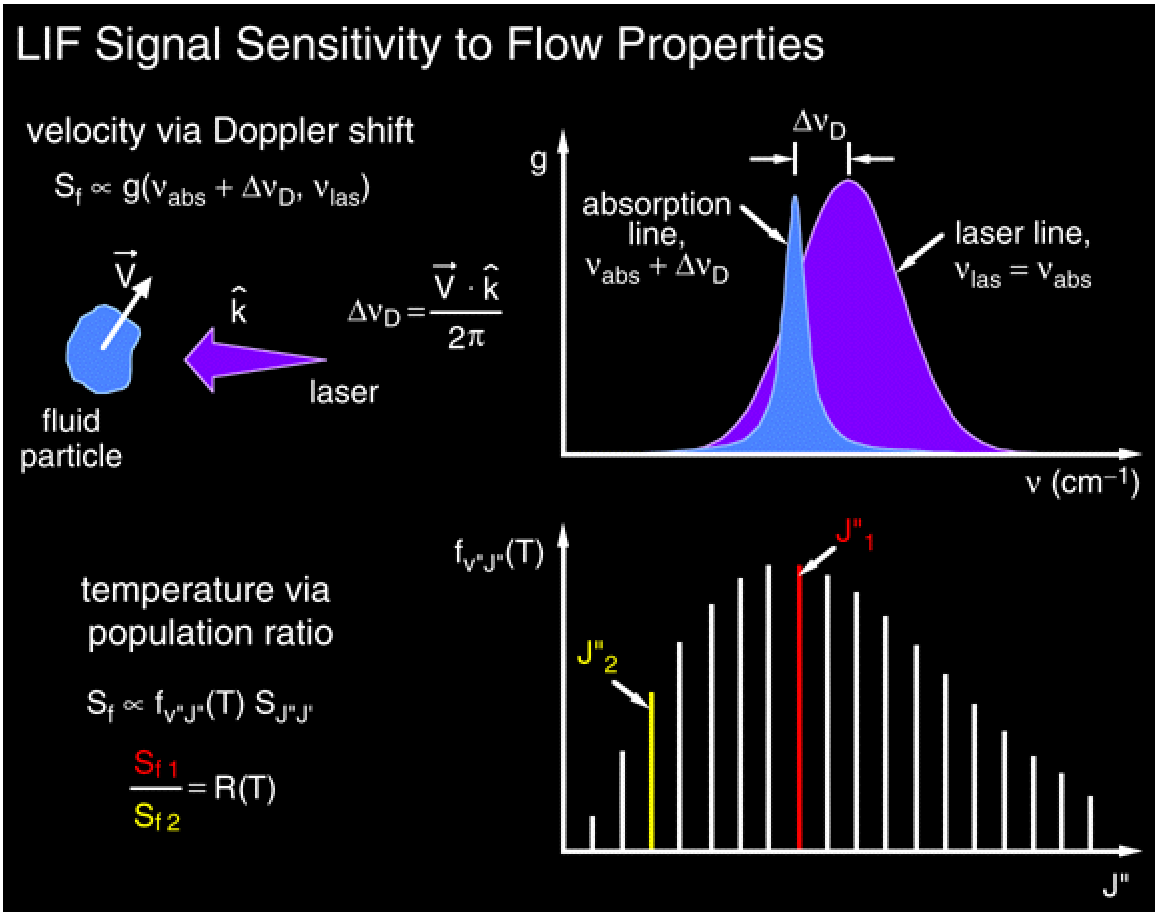

Figure 4: Signal sensitivity

Why use PLIF?

PLIF can provide accurate information which is both temporally resolved (usually to nanoseconds) and spatially resolved (routinely under 1 mm). In contrast, other techniques, e.g., emission and absorption spectroscopy and schlieren/shadowgraph techniques are averaged over a line of sight, and other spatially resolved techniques e.g., CARS, Raman scattering, and Rayleigh scattering typically have very low signal levels and have not been used to obtain 2-D spatial information.

References

1. Seitzman, J.M. and Hanson, R.K. "Planar Fluorescence Imaging in Gases," in Experimental Methods for Flows With Combustion ed. A. Taylor. Academic Press, London (1993).