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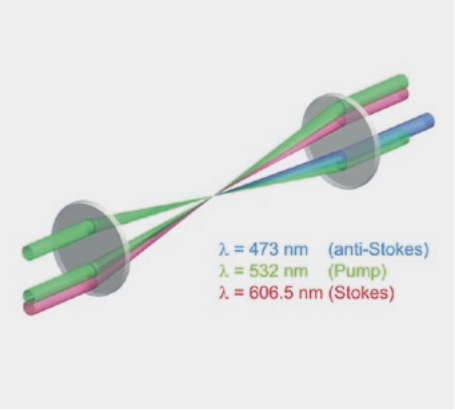
Spectroscopic Temperature Measurements



Motivation

The knowledge of heat, mass and momentum transport in boundary layers is essential for many technical applications. A better understanding of this matter will only be achieved by further investigations on common and new combinations of miscellaneous measurement technologies. The relatively poor spatial resolution and the intrusive character of many sensors can be avoided by the application of optical measurement technologies. This research topic therefore deals with two principal non-invasive techniques.

- Thermograhic phosphors are applied to detect the surface temperature distribution whereas
- the temperature of the boundary layer itself is determined by coherent anti-Stokes Raman spectroscopy.

Method and Theory

- Thermographic phosphors (TP) are activator-doped ceramics, whose temperature dependent emission properties are exploited for remote thermometry. In a first step the surface has to be coated with the phosphor material. Following an excitation of ultraviolet light the subsequently emitted phosphorescence is recorded by a CMOS high speed camera. Based on a previously performed calibration, the determined decay times of the phosphorescence can be used to obtain the planar temperature distribution over the surface.
- The coherent anti-Stokes Raman spectroscopy (CARS) is based on a nonlinear optical process in which three laser beams are involved (fig). By focusing these beams into the sample volume the coherent anti-Stokes signal is generated. The scattered light is transmitted into a spectrometer and finally detected by a CCD-camera. In order to obtain the temperature information the theoretical spectra has to be fitted to the measured data.

Outlook

- One of the prospective steps with the actual CARS system is the extension to double pulse CARS measurements to enable the detection of temperature variations within turbulent time scales. Through this extension to a higher temporal resolution a more profound understanding of the temperature distribution of turbulent flame structures can be achieved.
- A combination of thermographic phosphors and the coherent anti-Stokes Raman spectroscopy to the field of micro combustion and the analysis of the according boundary layers will contribute to the advancement of this new technology.