Proceedings of the 4th World Congress on Momentum, Heat and Mass Transfer (MHMT'19)
Rome, Italy – April 10 - 12, 2019
DOI: TBA

Laser Diagnostics in Combustion: Opportunities and Challenges

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Combustion is and will remain a key technology for humankind in the foreseeable future. However, there are severe issues associated with combustion such as the consumption of fossil fuels and the emission of pollutants. Developing a better understanding of the underlying mechanisms of combustion processes opens up possibilities to improve the efficiency, to mitigate pollutants, and to replace fossil fuels by renewables. This calls for analytical approaches to study the chemistry, fluid dynamics, and heat and mass transfer in flames.

The advent of the laser in the 1960s has transformed combustion research. The use of optical diagnostics for flow, concentration, and temperature measurements offers the advantage of a non-intrusive analysis of the complex phenomena occurring inside a combustion environment. This includes the mixing of fuel and oxidizer, their chemical conversion involving multiple steps and intermediates, and the formation of pollutants such as nitric oxides and soot. The development of advanced lasers and detectors have driven the field of laser combustion diagnostics over the last five decades. Nowadays, measurements with high temporal and spatial resolution in multiple dimensions are possible.

This keynote will provide an overview of existing laser-based approaches to combustion diagnostics and analyse the challenges and opportunities. Special attention will be paid to methods that allow multidimensional and multi-parameter measurements. Such methods are particularly useful as they facilitate recording data that are correlated in space and/or time and hence enable studying transient phenomena such as ignition and extinction as well as turbulent combustion.