EXPERIMENTS IN COMBUSTION
Lecture 1
M. G. MUNGAL

1. Introduction

This series of four lectures entitled "Experiments in Combustion" are revised versions of similar lectures presented in 1999 at the VKI Lecture Series "Introduction to Turbulent Combustion". Since they are the only lectures devoted to experimental aspects in the current lecture series, they serve the purpose of introducing the reader to a broad range of experiments in combustion. Some of these use conventional measurement techniques now several years old, while others use the very latest in laser-based diagnostic approaches. Always, the results of the experiment are of primary interest, and in particular, what we learn about the mixing and combustion process in turbulent reacting flows. In every case the diagnostic technique used to obtain the results will first be discussed as it is introduced, to provide limitations and bounds upon the results themselves, thus allowing the reader to develop a sense of their applicability and reliability. Rather than introduce a series of experimental techniques and provide examples of their use, the approach taken here is phenomenological in nature so that the reader may develop a sense of:

1. How does entrainment, mixing and reaction take place in turbulent flows?
2. What is the structure of a turbulent mixing layer?
3. What is the structure of a jet diffusion flame?
4. How does fuel and air mix and burn in such flames?
5. What is the role of heat release upon the flame itself?
6. How do such flames stabilize themselves?

Given this approach, it should be stated that these lectures do not have the aim of providing broad-brush overviews of the many on-going experiments in combustion; the biannual International Combustion Symposium is useful for this purpose. Instead, the four lectures will only be able to provide some limited insight into such complex questions posed above, and it is to be recognized that full answers will only be provided by a combination of theoretical investigations, numerical modeling and modern experimentation, all taken together. As such, these lectures provide a portion of the overall understanding and should be considered in the context of the other lectures presented in the VKI Lecture Series.

The schedule of the four lectures is as follows:

Lecture 1 will first examine the mixing and combustion process in two-dimensional turbulent mixing layers, a flow configuration common in many combustion devices. The use of simplified combustion chemistry will be highlighted as well as the probability density function (*pdf*) of mixture fraction. The challenges associated with accurately measuring the *pdf* will be described, thus motivating the need for chemically reacting experiments. Some essential differences between conventional mean and conditioned mean concentrations will be