Preface

The 4th International Workshop on the Physics of Compressible Turbulence was held at Downing College, Cambridge over a four day period at the end of March 1993. Approximately 100 scientists attended from around the world, with strong representations from France, Russia, the UK, and the US. This Workshop follows on from a sequence of Workshops held previously at Princeton and Pleasanton in the US and Royamont in France at approximately two year intervals. A total of 62 papers including both oral and poster presentations were presented over the four day period of the meeting.

In recent years much of the stimulus for the work on compressible turbulence has come from a desire to understand the interactions of shock phenomena with density variations within a fluid. These shocks may be induced intentionally by imposing a sharp pressure change on a fluid or may arise naturally in turbulent flow at high Mach number. The interaction of the large pressure gradients with the density gradients produces baroclinic generation of vorticity and the subsequent motion develops into a number of characteristic structures. The most simple form of this interaction occurs when a planar shock passes through a density interface between two fluids. Under these circumstances small random perturbations are unstable and grow as a result of the instantaneous baroclinic torque experienced as the shock interacts with the density discontinuity. This instability is known as Richtmyer-Meshkov instability and can be thought of as a variant on the more classical Rayleigh-Taylor instability which occurs when pressure variations are produced by continuous acceleration such as a gravitational field. In the latter case the baroclinic generation of vorticity occurs continuously whenever the higher pressure exists in the less dense fluid, such as when dense fluid overlies less dense fluid.

Despite the differences in detail, particularly of the forcing of the turbulent flow that develops, these instabilities have much in common and consequently considerable attention has been paid in recent years to examining the similarities between the two forms of instability. These two classical flow situations provide a means of analysing the transition to turbulence from the linear instability regime, and also provide a mechanism for studying turbulent mixing in compressible and stratified flows. Considering them as archetypes for the kinds of interactions that take place in compressible turbulence in general then enables the basic instabilities to be used as building blocks for the study of complex compressible turbulent flows. In addition to these effects, compressible turbulence is often affected by gravitational forces and so the effects of density stratification when the gravitational field is stabilising also play an important part in the mixing processes.

This dynamics of Richtmyer-Meshkov and Rayleigh-Taylor instabilities then underlies the basic theme of the meeting which was devoted to an examination of these questions. The papers in the meeting were then divided into 6 sections concerned with:

Rayleigh-Taylor mixing
Richtmyer-Meshkov mixing
Shear and vortex flows
Theoretical and empirical models
Laser-driven instability experiments
Converging flows

One of the main questions of practical interest is how much mixing occurs in these flows between the fluids as a result of the various instabilities that are observed. As a consequence much of the emphasis was on experimental work involving diagnostic techniques for analysing flow within a shock tube and also in other stratified scenarios. Despite considerable efforts over recent years it is still very difficult to make unambiguous measurements of these flows particularly as averaging problems cause difficulties in resolving the details of the flow structures. However, some progress has been made in terms of phenomenological modelling and detailed turbulence modelling. There have been some significant improvements in the ability to predict experimental behaviour for a range of flows using sophisticated numerical codes. The ability of the turbulence models used by codes to predict accurately the mixing processes and to paramaterise them at small scales depends heavily on the ability to tune the models according to appropriate data. Consequently the meeting provided a healthy discussion about the interactions between models and experiments.

The wide participation in this conference is possible largely due to the generous sponsorship of this meeting by Cray Research (UK), the European Research Community on Flow Turbulence and Combustion (ERCOFTAC), The Ministry of Defence and the Royal Society.