EXPERIMENTAL STUDY OF TURBULENT BAROCLINIC BOUNDARY LAYERS

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The interaction of a M=1.4 air shock wave with a dense-gas wall layer was studied in the EMI shock tube. A 10mm thick 1000mm long layer was created in the shock tube by injecting Freon through the porous floor of the test section. Shock interactions with the layer were visualized by shadow-schlieren photography; pressure measurements and Laser-Doppler Velocimetry measurements were used to investigate the dynamics of the layer evolution.

The incident shock was retarded in the layer due to its reduced sound speed, and reflected obliquely from the floor of the test section. This sets up a series of alternating compression and expansion waves, leading to large pressure fluctuations (4 bars) and large velocity variations (200 m/s). They strongly perturb the interface shear layer, which rapidly evolves to a turbulent boundary layer flow.

In this case, vorticity is created by an inviscid baroclinic mechanism, namely, the misalignment of pressure gradients and density gradients. In contrast to viscous boundary layers, baroclinic boundary layers evolve according to inviscid mechanism which are eminently amenable to inviscid gasdynamic simulations. This allows us to study the inviscid aspects of turbulent boundary layers at all scales larger than the Kalmogorov scale without the unnecessary complication of viscosity. In addition, baroclinic boundary layers provide an excellent gasdynamic calculation of dusty boundary layers, since they evolve according to the same mechanism.