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Direct Numerical Simulation of Sheared Turbulent Flow

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The summer assignment to study sheared turbulent flow was divided into three phases which were: 1. Literature survey, 2. Computational familiarization and 3. Pilot computational studies.

The governing equations of fluid dymanics or Navier-Stokes Equations describe the velocity, pressure, density as functions of position and time. In principle, when combined with conservation equations for mass, energy and thermodynamic state of the fluid a determinate system could be obtained. In practice the Navier-Stokes equations have not been solved due to the non-linear nature and complexity of these equations.

Consequently, the importance of experiments in gaining insight for understanding the physics of the problem has been an on going process. The homogeneous shear flow problem has been studied experimentally by Champagne, Harris and Corrsin(1969), Harris, Graham and Corrsin (1977) and Tavoularis and Corrsin (1981). In each of the above cases measurements were reported in the simplest conceiveable sheared flows, namely free shear layers, which were statistically homogeneous with a linear or quadratic dependence of mean velocity on position.

Reasonable computer simulations of the problem have occured as the compotational speed and storage of computers has evolved. The importance of the microstructure of the turbulence dictates the need for high resolution grids in extracting solutions which contain the physical mechanisms which are essential to a successful simulation. The recognized breakthrough occurred as a result of the pioneering work of Orzag and Patterson (1972) in which the Navier-Stokes equations were solved numerically utilizing a time saving toggiling technique between physical and wave space, known as a Spectral Method. A wealth of literature has been generated addressing the turbulence problem utilizing these methods. This includes investigations by Shebalin on isotropic turbulence (1992,93) and many others.

An equally analytically insoluable problem, containing the same quasi-chaotic nature as turbulence, is known as the three body problem which was studied computationally as a first step this summer. This study was followed by computations of a two dimensional (2D) free shear layer. These results will be available on departure from N.A.S.A. in August.