

INTRODUCTION

1.1. The study of homogeneous turbulence

The problem to be studied herein can be stated very briefly, provided we do not worry about details for the moment. We imagine an infinite uniform body of fluid which can be characterized in the usual way by a density ρ and molecular transport coefficients such as the viscosity μ . This body of fluid can be set into different kinds of motion, many of which are described in the textbooks on hydrodynamics. It is a well-known fact that under suitable conditions, which normally amount to a requirement that the kinematic viscosity ν be sufficiently small, some of these motions are such that the velocity at any given time and position in the fluid is not found to be the same when it is measured several times under seemingly identical conditions. In these motions the velocity takes random values which are not determined by the ostensible, or controllable, or 'macroscopic', data of the flow, although we believe that the *average* properties of the motion are determined uniquely by the data. Fluctuating motions of this kind are said to be turbulent. Our concern is with homogeneous turbulence, which is a random motion whose average properties are independent of position in the fluid. The problem is to understand the mechanics, and to determine analytically the average properties, of this kind of motion.

The conception of homogeneous turbulence is idealized, in that there is no known method of realizing such a motion exactly. The various methods of producing turbulent motion in a laboratory or in nature all involve discrimination between different parts of the fluid, so that the average properties of the motion depend on position. However, in certain circumstances this departure from exact independence of position can be made very small, and it is possible to get a close approximation to homogeneous turbulence. It has been found, for instance, that if a uniform stream of fluid passes through a regular array of holes in a rigid sheet, or a regular grid of bars, held at right angles to the stream, the motion down-