

1. INTRODUCTION.

Experiments show that turbulence is essentially a disorganized motion. At a given scale, each component of the turbulent field appears as an irregularly periodic function of space and time. The recording of this function at different times in identical conditions yields totally different curves, definitely not superposable, and indicates the random character of the function.

Hence only statistical data can provide stable information on turbulence*.

The set of all components of the turbulent field at every point and at every time constitutes a system of coexisting random variables whose physical interactions - characterizing the structure of turbulence - are described mathematically by correlations.

* Turbulence is more exactly a field of chaotic vorticity. Random irrotational flows do exist but the fundamental dynamical processes are not the same as in turbulent flows. For instance, if the fluctuations are irrotational, the Reynolds stresses responsible for the remarkable transport properties of turbulence can be absorbed in the pressure and they have no dynamical action on the mean flow.

In practice, one is mainly interested in the two points velocity correlation tensor*.

$$(I.1) \quad R_{ij} = \langle v_i(x, t) v_j(x + \underline{\xi}, t) \rangle$$

which is related to simple physical aspects of the turbulence such as its specific kinetic energy.**

$$(I.2) \quad R_0 = \frac{1}{2} \left[R_{ii} \right]_{\underline{\xi} = 0} = \langle \frac{1}{2} v^2 \rangle$$

The object of this course is the study of homogeneous turbulence which is a random phenomenon whose average properties are independent of position.(i.e., for instance R_{ij} is a function of $\underline{\xi}$ only). The concept of homogeneous turbulence is an idealization for no observed turbulence is strictly homogeneous.

Homogeneous turbulence is a fair approximation in geophysical and astrophysical problems where the dependence of average properties on position is small and in laboratory experiments with the flow downstream of grids in wind tunnels which provide the major source of experimental data with which the theories are compared.

*Mean values will be denoted by angle brackets.

**Repeated indices indicate a summation.