Flow characterisation in Homogeneous Isotropic Turbulence facility

Description

The group's brand-new Dodecahedron setup has been created to generate strong, turbulent flows. More specifically, its aim is to create Homogeneous Isotropic Turbulence (HIT), which is one of the most interesting forms of turbulent flow. A brief description of the setup is in the caption of Figure 1.

When it comes to experimentally investigating HIT, the first (and possibly most relevant) task is to assess the strength of the turbulence. The flow can be investigated using different experimental techniques, yielding measurements that can reveal how homogeneous and isotropic the flow is.

The Dodecahedron is an exceptional experimental facility, and only few other groups in the world have similar tanks (Göttingen-Lyon [6], Buffalo [1], Stanford [3]), and each has approached the flow investigation in a different way. Yet in one way or another, all are based on the foundational theoretical work of Kolmogorov, 1941 [4] (see also [5] and [2]).

We intend to investigate the flow with the help of micrometric tracer particles and high-speed cameras, and apply either the PIV 1 or PTV 2 technique to obtain flow fields.

Ultimately, this project is an excellent opportunity to hands-on apply the theory of turbulence in a world-class experimental facility.



Figure 1: Graphical rendering of the Dodecahedron. The tank contains about 210 liters of water. Each of the vertices of the tank hosts a 1 kW electric motor (they are visible as "spikes" in the tank). The motors are controlled through a computer, and each can run independently of the others. Two of the windows are used as heat-exchange plates, the other ten are free for lighting and imaging.

¹Particle Image Velocimetry

²Particle Tracking Velocimetry

Assignment

This project touches several aspects of the experimental investigation of turbulence. Hereafter we sketch a possible plan, but we are open to discuss with you and adapt the assignment to your personal preference.

The initial phase of the project is of a literature review, specifically of the references mentioned in appendix to this document. Before approaching a new characterization of an isotropic turbulent flow, you need to have clear in mind how this can be done, and how it has been done before.

Later, the high-speed cameras setup will be prepared, and recordings of the flow will be made. The complexity of the setup can be adjusted (e.g. 3D is more complex than 2D).

Lastly, the data will be analysed and the drawn conclusions will be summarised in the student's thesis report.

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