# Sustaining mechanism of turbulence in a rotating container partially filled with liquid

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Since a steady rotation of a container always leads to solid-body rotational flow irrespective of the container shape, we cannot sustain non-trivial flow of the filled liquid in a constantly rotating container. However, we recently discovered that turbulence was sustained in a constantly rotating container, if it has a gas-liquid interface[1].

We conduct experiments to visualize the flow in a spherical container of radius 0.09 m, which is partially filled (filling rate is 0.5) with water and rotating about a horizontal axis at the constant angular velocity of $0.2\pi$ rad/s. To visualize the flow, we seed reflective flakes and irradiate a laser sheet on the equatorial plane. Interestingly, we can observe, in Fig. 1(a1), a complex pattern (i.e. turbulence) in the bulk of the liquid phase.

To investigate the sustaining mechanism of turbulence, we also conduct direct numerical simulations (DNS) of the gas-liquid flow in the rotating spherical container. First, we visualize, in Fig. 1(a2), the isosurfaces of the second invariant of the velocity gradient tensor. The flow obtained by DNS is turbulence, where the small-scale tubular vortices exist in the liquid phase. The observation is similar to the experiment shown in Fig. 1(a1). To clarify the generation mechanism of turbulence, we show, in Fig. 1(b), the temporal averaged velocity field on the vertical plane parallel to the container's rotation axis. Note that we could not observe any flow on this plane, if the container were filled with liquid. Surprisingly, we observe a counter-rotating pair of container-size vortices in the liquid phase. This observation implies that the mean shear flow around these counter-rotating vortices generates the turbulence. In the conference, we will also show, in addition to the above results, (i) the details of the sustaining mechanism of the turbulence and (ii) results in the case with cylindrical containers.

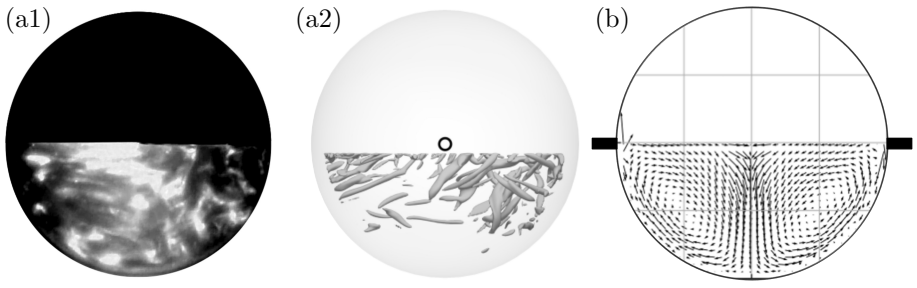


Figure 1: (a) Turbulent structure in a constantly rotating spherical container. Results of (1) experiments and (2) DNS. (b) The velocity field on the vertical plane parallel to the spin axis of the container. The filling rate of liquid is 0.5.

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[1]D. Watanabe and S. Goto, *Flow* **2**, E28 (2022).