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ZONAL FLOW GENERATED BY OSCILLATING CORE IN A ROTATING SPHERICAL CAVITY

Abstract

Zonal flow excited by circular oscillations of inner solid core in a rotating spherical cavity is experimentally studied. The ratio of the radii of the core and the cavity is equal to 0.5. The core oscillates in the equatorial plane around the cavity axis, with the rotation frequency, under the action of an external static field (gravity field), which is directed perpendicularly to the rotation axis. Differential rotation of the core is absent; for this, one of the core poles is fastened to the nearest cavity pole by fishing line.

It is found that the oscillating core excites in the cavity an averaged azimuthal axisymmetric fluid flow. The flow consists of a system of nested coaxial cylindrical surfaces rotating with different angular velocities. Maximums of the lagging differential rotation of the fluid are at the distances of 0.15, 0.50 and $0.90R$ from the axis, where R is the cavity radius. It is shown that the averaged differential rotation is generated in the oscillatory boundary layers near the boundaries of the core and the cavity. The intensity of the flow increases by the square law with the amplitude of the core oscillations. The comparison with [1] shows that in the case of oscillations of a free inner core, the zonal flow is a linear superposition of the flows generated independently by the differential rotation of the core and by its oscillations. It is concluded that two mechanisms of zonal flow generation (in the Ekman layer because of the differential core rotation and in the oscillating boundary layers caused by the oscillations of the core) manifest themselves independently.

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References:

1. V.G. Kozlov, N.V. Kozlov, and S.V. Subbotin. Influence of an external force field on the dynamics of a free core and fluid in a rotating spherical cavity // Phys. Fluids 2015 V. 27 (7). 074106.