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STRUCTURE OF FLOW IN ROTATING SPHERICAL SHELL WITH INNER CORE EXCITED BY OSCILLATING FORCE FIELD

Abstract

Motion of a fluid excited by an oscillating force field in a rotating spherical cavity with a free inner core is experimentally studied. The field direction is perpendicular to the cavity rotation axis. Oscillating force causes the circular oscillations of the solid core relative to the cavity, which result in steady streaming generation in fluid; the solid core comes into differential rotation. Depending on the oscillation frequency, the differential rotation of the core can be lagging or outstripping [1]. The azimuthal velocity of fluid in the rotating cavity is studied by PIV method. It is shown that the velocity profile is characterized by a non-monotonic distribution of angular velocity, which has a series of inflection points. The structure of the flow has the form of multiple nested liquid columns oriented along the rotation axis. In the subcritical region the columns boundaries have the shape of circular cylinders.

It is shown that the flow structure is determined by the dimensionless frequency of core oscillation. The increase of the oscillations intensity leads to the intensification of the differential rotation of fluid and, as consequence, to the emergence of the wave instability of the shear boundaries. Depending on the frequency the various wave modes are excited and the stability thresholds are changed. In this work the threshold of axially symmetric flow stability, subcritical and supercritical regimes of fluid flow are investigated. It is shown that under the simultaneous action of several oscillating force fields the azimuthal velocity of the fluid is determined by linear superposition of excited flows.

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References

1. Kozlov V., Kozlov N., Subbotin S. Vibrational dynamics of a light sphere in a rotating spherical cavity filled with liquid // Proceedings of the International Astronautical Congress, IAC. V. 1. 2013. P. 470–477.