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VIBRATIONAL DYNAMICS OF A LIGHT SPHERE IN A ROTATING SPHERICAL CAVITY FILLED WITH LIQUID

Abstract

The behavior of light spherical body in a spherical cavity rotating about a horizontal axis in the presence of transversal vibrations is experimental studied. Experiments are carried out at high rotation speed, when the sphere is shifted to the axis of rotation by the centrifugal force. In the absence of vibration the sphere rotation speed in the laboratory frame is less than the cavity one. This is due to the gravity force: in a non-inertial frame the gravity vector rotates causing the circular oscillations of the sphere near the axis. Such oscillations lead to the generation of the average mass force and cause its lagging differential rotation with respect to the cavity [1]. Under vibration the resonant excitation of sphere oscillations and its intensive differential rotation is found when the frequency of vibration coincides with the natural frequency of the sphere inertial oscillations. Outside the resonance areas the sphere rotates in the same way as in the absence of vibration. The differential rotation speed depends on the intensity of the vibrations and can reach the values comparable to the speed of the cavity rotation. In the area of intensive outrunning rotation the position of the sphere in the center of the cavity is unstable. The sphere moves from the center to one of the poles of the cell and holds a stationary position at a distance from the center of the cavity. The sphere differential rotation is accompanied with the formation of two-dimensional flows in the form of the Taylor – Proudman column extended along the axis of rotation. The stability of the Stewartson shear layer at its border is investigated. With increasing the speed of the differential rotation the boundary of the liquid column experiences the instability accompanied with a change of its form. Earlier this instability was observed in the cylindrical cavity [2].

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References

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