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DROP DYNAMICS IN SPACE AND INTERFERENCE WITH ACOUSTIC FIELD
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The objective of the experiment is to study contactless positioning of liquid drops, excitation of capillary waves on the surface of acoustically levitated liquid drops, and deformation of liquid drops by means of acoustic radiation pressure.

Contactless positioning technologies are very important in space materials processing because the melt is processed without contacting the wall of a crucible which can easily contaminate the melt specifically for high melting temperatures and chemically reactive materials. Among the contactless positioning technologies, an acoustic technology is especially important for materials unsusceptible to electromagnetic fields such as glasses and ceramics.

The shape of a levitated liquid drop in the weightless condition is determined by its surface tension and the internal and external pressure distribution. If the surface temperature is constant and there exist neither internal nor external pressure peturbations, the levitated liquid drop forms a shape of perfect sphere. If temperature gradients on the surface and internal or external pressure perturbations exist, the liquid drop forms various modes of shapes with proper vibrations. A rotating liquid drop has been specifically studied not only as a classical problem of theoretical mechanics to describe the shapes of the planets of the solar system, as well as their arrangement, but it is also more a contemporary problem of modern non-linear mechanics.

In the experiment, we are expecting to observe various shapes of a liquid drop such as cocoon, tri-lobed, tetropod, multi-lobed, and doughnut.

Wave-wave coupling is also one of the major problems of non-linear mechanics. Various electromagnetic phenomena accompanied by an aurora, the microwave heating in the nuclear fusion, an implosion by means of laser excitation, the rf discharge of an ion thruster, etc., are the relevant subjects. To study the interference of the capillary waves with acoustic fields is one of the objectives of this experiment.

If a large liquid drop is levitated by an acoustic resonance chamber in a weightless condition of an in-orbit space shuttle, the above-mentioned various non-linear phenomena are actually observed. Further, if an acoustic radiation pressure is actively applied to a liquid drop, the drop forms a flattened shape such as liquid disk, a liquid flat tape, and a liquid thread by means of much more sophisticated acoustic manipulation. By various modes of vibrating, rotating, and flattening liquid drops are largely deformed from the original sphere. The theoretical prediction of such kinds of greatly deformed shapes is also another important subject of modern mechanics. The experiment will provide plentiful data for modern theoretical mechanics.

If cocoon, tri-lobed, tetrapod, multi-lobed, and ring-shaped glasses are manufactured in space exactly as the theory predicts, it will not only serve to inspire young scientists but will also contribute much to advancement of science and technology.

The applications aspect of the experimental results may prove productive. Contactless positioning technology promises glassification processing of high melting temperature materials such as tungsten, tantalum, molybdenum, rhenium, and their alloys. For such processes, a contactless mixing technology will be necessary. An acoustic excitation technology of the capillary waves will perform the function of a contactless mixer.

An acoustic contactless technology for forming liquid thread and flat tape also has promise for the manufacturing of amorphous metal tapes and fluoride glass fibers, because the melt is rapidly solidified soon after forming a fine thread or tape. Earth-based fluoride glass fibers are difficult to manufacture because, due to the high reactiveness of fluroine with other materials, their chemical reactions are violent which prevents formation of glasses.

If the fluoride glass fibers are manufactured in the future by means of an acoustic technology, the space-based manufactured optical fibers will drastically impact the state-of-the-art optical communications networks because of their very low attenuation characteristics of transmission.