Research Report（April, 2022- March, 2023）

Enrollment from April 2020 | Department of Applied Mechanics and Aerospace Engineering | Takahiro USHIOKU

I. List of Papers

Nothing

II. List of Talks

[1] T. Ushioku and H. Yoshimura, "Experiments and numerical analysis of rebounding behaviors of a laser-induced cloud cavitation", JSME Annual Meeting 2022, J023-01, Toyama University, September 2022. (In Japanese)

[2] T. Ushioku and H. Yoshimura, "Numerical investigation of shock wave phenomena associated with collapse of cloud cavitation by two-dimensional SPH method", JSIAM Annual Meeting 2021, G-2-1-4, Hokkaido University (Online), September 2022. (In Japanese)

III. Research Results in AY2022

An aggregate of cavitation bubbles is called a cloud cavitation and shows collective unsteady behavior of repeating a process of growth and collapse. In particular, it is considered that a high-pressure shock wave is emitted associated with the collapse of the cloud, which cause serious problems such as noises and erosions in fluid machinery. Thus, it is important to understand how the cloud shows the unsteady motion and how the shock wave is generated when the cloud collapses. In this study, we investigated the unsteady behavior of the laser-induced cloud cavitation and its induced shock wave experimentally and numerically. In the experiment, the unsteady behavior of the cloud, namely, from its inception, growth, shrink, collapse to rebound was observed by using a high-speed video camera with a maximum shooting speed of 1.5 million fps. Then, the experimental results and numerical results of two-dimensional multiphase analysis by the SPH method were compared and we found that the numerical analysis qualitatively reproduces the unsteady behavior and shape of the cloud, and the impact pressure associated with the collapse of the cloud matched the experimental results at the order level. Furthermore, we made a PIV measurement of two-dimensional velocity field of the laser-induced cloud cavitation and found a set of twin vortices, which may be related to the unsteady behavior of the cloud as shown in our previous numerical tests.

IV. Research Plan for AY2023

In AY2023, we will plan to observe the unsteady behavior of the cloud and its induced shock wave simultaneously and compare with numerical results. In particular, we will investigate multiple shock wave phenomena associated with the collapse of the cloud, which were found in our numerical results. Furthermore, we will further investigate the two-dimensional velocity field of the cloud by the PIV measurement to clarify the relationship between the motion of the twin vortices and the unsteady behavior of the cloud. In addition, we will make a multiphase flow analysis considering the surface tension and investigate the effects of surface tension on the unsteady behavior of the cloud and the shock wave phenomenon, aiming for further fitting with the experimental results.