Mutual Influence of Two Drops in Water: Complex Behavior of Vortex Rings of Drops Fragmenting due to Hydrodynamic Instabilities

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The phenomenon in which a single drop breaks up into smaller drops after deforming into a ring was first observed about 100 years ago. However, it was just recently that the breakup mechanism of the first drop was studied, and there have been no studies of the interactions of multiple drops. To address this, experiments in the present study were conducted using a sodium chloride solution containing red food coloring loaded into a syringe pump and dropped into a water tank in three stages to clarify the behavior and mutual interaction effects of two drops. In total, 1000 drops were observed and recorded by video from two directions. In previous studies involving the breakup of one drop, the experimental results showed that the number of resulting smaller drops expressed as m could be formulated obeying $m \sim G^{\wedge 1/3}$. Here, G is a dimensionless quantity representing the magnitude of buoyant force relative to gravity. In contrast, the present study shows that the value of G is larger than previously reported, and that m approached five with the increase of G. Furthermore, in experiments involving two drops, it was clarified that the second drop went through the first drop's vortex ring, that the behaviors could be classified into three types, and that there were two reasons why the m of the second drop tended to decline. In other words, a new relationship has been between m and G in one drop, and three types of mutual influence in two drops have been discovered. The results of the present study can be expected to contribute to other physics fields dealing with fluid instabilities, including mantle convection and meteorological phenomenon, as well as industries involving mixing processes such as ink-jet printers and automobile engine fuel injection. It might even be applicable to solving fluid-related environmental problems.