Dynamics of Bubble-Ring -A Mechanism Which Realizes High Stability and Efficient Energy Transfer

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The vortex-ring is known as a unique flow keeping ring shape and moving on by itself .We focus on a fascinating exception of this, bubble-ring. Bubble-ring's specialty is so simple: the center of vortex is composed of air bubble and is separated from surrounding water as material. Yet we find it generates interesting characteristics which realize high stability and efficient energy transfer. First, we carry out analysis and modeling of the whole motion of the bubble and surrounding water. Above the center of the ring, pressure is locally increased due to a stagnation of water, and the hemisphere water hill appears. From this model, structural difference between bubble-ring and ordinary vortex-ring is grasped. Also, due to the surface tension acting between the air and water, instability is corrected with the rise of bubble-ring. Next, we discuss the dynamics of bubble-ring in terms of energy. While propulsion power of ordinary vortex-ring depend only on the force by launching and it is reduced by water viscosity, in case of bubble-ring, buoyancy works while ring raises. We find that the potential energy of the ring converts into kinetic energy of the localized laminar flow of surrounding water suppressing turbulence. Vortex-ring can transport nearby water as rotational laminar flow. Some bubble-ring's specialties we discovered in this research greatly improve this carrying capacity: stable transport over long distances is realized. We explore the possibility of development of a new unique, efficient fluid-transport system using bubble-ring.

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