Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

A rigorous proof of the scallop theorem and finite mass effects of a microswimmer KENTA ISHIMOTO, MICHIO YAMADA, Research Institute for Mathematical Sciences, Kyoto University — We reconsider fluid dynamics of a self-propulsive swimmer in Stokes flow. With an exact definition of deformation of a swimmer, a proof is given to the scallop theorem including the body rotation of the swimmer. Introducing a virtual swimmer, which has the same shape as the real swimmer but has no ambient fluid, we give an exact definition of the surface deformation of the generally translating and rotating swimmer, and then prove the scallop theorem rigorously for the massless swimmer. We also discuss the breakdown of the scallop theorem due to a finite mass (finite Stokes number) of the swimmer by using a perturbation expansion method and it is found that the breakdown generally occurs at the first order of Stokes number. In addition, employing the Purcell's "scallop" model, we show that the theorem holds up to a higher order of the Stokes number, if the swimmer's stroke has some symmetry.

[1] K. Ishimoto and M. Yamada, "A rigorous proof of the scallop theorem and a finite mass effect of a microswimmer," arXiv:1107.5938v1 [physics.flu-dyn].

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Date submitted: 10 Aug 2011 Electronic form version 1.4