Simulations of self-propelled particles with fully resolved hydrodynamics

(Kyoto University)　John Molina and Ryoichi Yamamoto

[Introduction]　The smooth profile method (SPM) method [1,2] developed for the direct numerical simulation (DNS) of colloidal dispersions has been successfully used to study various dynamical problems of particle dispersions, such as diffusion, sedimentation, rheology, and electrophoresis. We present a new extension that allows for the description of self-propelled particles, which move due to the generation of a slip velocity at the particle/fluid interface.　The "squirmer" model used for the self-propelled particles, originally introduced by Blake[3], has been widely adopted to study the collective behavior of microorganisms [4,5], but so far numerical studies have provided only a limited description of the hydrodynamics (two-body interactions, zero Reynolds number, simple solvent, etc.).

[Results & Discussions]　The new method presented here allows one to fully resolve both the hydrodynamic interactions among the self-propelled particles as well as the hydrodynamics of the host fluid [6]. Preliminary results calculated for a single swimmer shown below clearly support the validity of the present method. Dynamical properties of many swimmer dispersions will be presented.

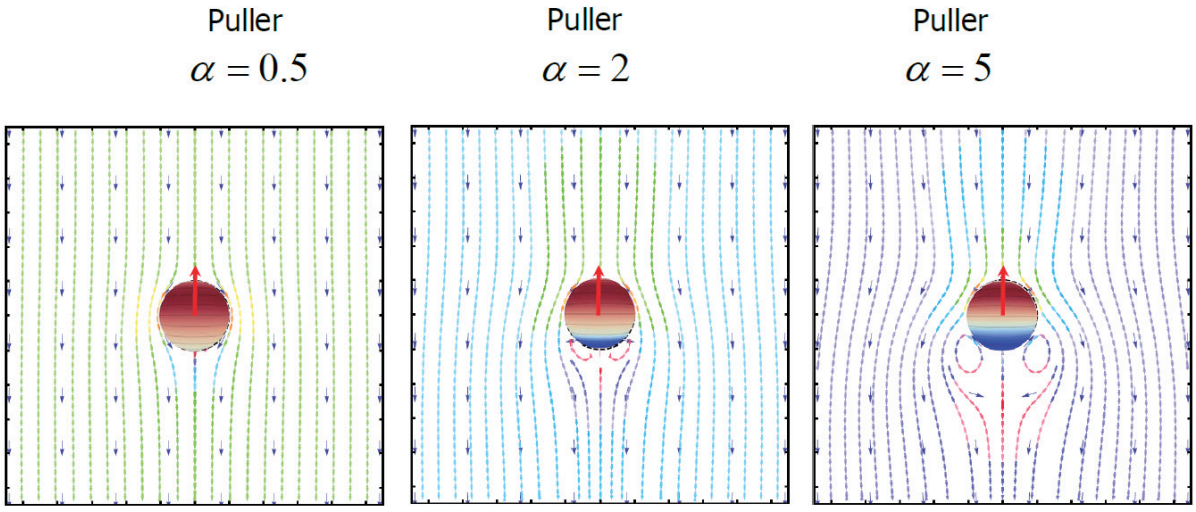

Fig. 1　Computed stream lines around a single puller, neutral, and pusher swimmer.

[References]

[1] Y. Nakayama, K. Kim and RY, EPJE, 26, 361-368 (2008)
[2] KAPSEL website, http://www-tph.cheme.kyoto-u.ac.jp/kapsel/
[3] J.R. Blake, JFM, 46, 199-208 (1971)
[4] T. Ishikawa and T.J. Pedley, JFM, 588, 437-462 (2007)
[5] T. Ishikawa and T.J. Pedley, JFM, 588, 399-435 (2007)
[6] J. Molina, Y. Nakayama, and RY, preprint.