FUNDING PROGRAM FOR NEXT GENERATION WORLD-LEADING RESEARCHERS

Project Title: Innovation of an algal suspension model based on cellular biomechanics of microbes	
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1. Background of research

Algae cells spread all over the world. They play important roles in global warming, global ecosystem, fish industries, and so on. Bio-fuel can also be made from algae cells, which has a potential to solve worldwide energy problems. However, mathematical and physical understandings in this field are quite poor. Thus, it is an important and urgent task of science and engineering to develop a proper mathematical tool to describe physics of suspensions of algae cells.

2. Research objectives

We will develop a mathematical model of a solitary algae cell considering its swimming, geotaxis and phototaxis. Interaction of many algae cells will be modeled by expanding the solitary model, which will be used to calculate particle stress tensor and the diffusion tensor of a suspension. By exploiting the database of the tensor values, we will develop a novel continuum model to predict distribution of algae cells in macroscopic level.

3. Research characteristics (incl. originality and creativity)

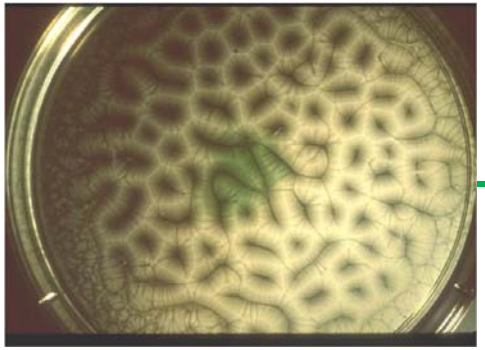
Main feature of the research project is the bottom-up strategy, in which a macroscopic continuum model is constructed from individual cellular level. By using the bottom-up strategy, we can develop a novel continuum model that is applicable to even dense suspensions. This attempt has not been succeeded in none of former studies, and shows strong originality of the project.

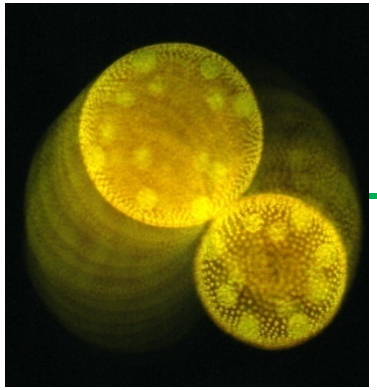
4. Anticipated effects and future applications of research

The developed mathematical model to calculate macroscopic distribution of algae cells can be used to more accurately predict various global phenomena, such as global warming, global ecosystem, and so on. The developed model can also be used to improve various bioreactors, such as the one for bio-fuel. Thus, it is expected to contribute to energy revolution as well.

NOVEL MODEL OF ALGAL SUSPENSION

Bottom-up Strategy





Macro-scale :

- Rheological and diffusion properties
- Database of tensor quantities

Strong Effect

Meso-scale :

- Collective motions
- Stokesian dynamics simulation of multiple cells

Strong Effect

Cellular Scale :

- Interaction of two cells
- Modeling a solitary cell
- Simulation by a boundary element method