organisms, we focused on the phototactic behavior in *Volvox*. *Volvox* (*V. carteri*.) is a spherical colonial green alga, with about 2,000 biflagellated somatic cells and daughter colonies inside the spheroid. *Volvox* can rotate and helically swim in water, showing positive or negative phototaxis; *Volvox* moves toward or away from the light. In our experiments, we observed *Volvox* colonies cultured in a flask from the top, where the flask was illuminated from both the right and the left using two sheet lights. To realize a sinusoidal photo stimulus the intensity difference between the two lights was sinusoidally varied. From the trajectories of colonies we obtained average velocities among colonies at each time, which characterize the phototactic behavior in *Volvox*. The responses to the photo stimuli were measured at various frequencies, and the frequency response function, i.e. generalized mobility of *Volvox*, was obtained. The response function shows similarity to the one for a charged particle in applied electric field. The relaxation time, however, is much longer than the one expected by the mass and the friction coefficient for *Volvox* in water. The fluctuation of the average velocity was also measured under a uniform illumination, and the relation between the fluctuation and the response will be discussed.

3P321 クラミドモナスの生物対流にみられるパターン遷移現象の特質解析 Characterization of bioconvection pattern transition observed in suspensions of *Chlamydomonas reinhardtii*

Azusa Kage, Chiharu Hosoya, Shoji Baba, Yoshihiro Mogami, (*Graduate School of Humanities & Sciences, Ochanomizu University*)

Motile aquatic protists are known to self-organize into bioconvection. The protists' upward migration due to negative gravitaxis and their subsequent settling due to gravity cause characteristic three-dimensional patterns to emerge. After such a pattern appears to become fully developed and stable, it can spontaneously break down into a new stable phase: a phenomenon termed *pattern transition*, which has been observed uniquely in bioconvection of the unicellular green alga *Chlamydomonas*. We attempted to characterize this bioconvection pattern transition through long-termed quantitative analysis of bioconvection occurring in suspensions of *C. reinhardtii* with the suspension depth and the cell density systematically varying, as these parameters constitute the Rayleigh number which may characterize bioconvection pattern formation. It was found that, at the onset of bioconvection, suspension depth determines pattern wave number, while its influence becomes unclear in the second steady state pattern. The steady state patterns showed instead a striking dependence on cell density both in wave number and in morphology. The cell density also strongly influenced the behavior of pattern transition itself. Our findings expand the studies of Bees & Hill (1997, *J. Exp. Biol.*) and of Akiyama et al. (2005, *JASMA*), unveiling a notable characteristic of pattern transition from the effects of suspension depth and cell density on the long-termed development of bioconvection of *Chlamydomonas*.

3P322 Scale-free proportion in new flock and/or swarm model

Hisashi Murakami¹, Takayuki Niizato¹, Masashi Toda², Koichiro Enomoto², Toru Moriyama³, Kojiro Iizuka³, Yukio-Pegio Gunji¹, (¹*Kobe University*; ²*Future University Hakodate*; ³*Shinshu University*)

Recent image analysis on starlings shows that a bird flock has scale-free proportion (SFP). The SFP means that the bird flock forms a large sub-domain that scales with the linear size of the flock. Some of the same research group also show that the interaction between individual birds in a flock does not rely on metric distance, but rather on topological distance, where the metric distance means that a bird interacts with neighbors within a fixed distance, and on the other hand, the topological distance means that a bird interacts with a fixed number of neighbors (six or seven). The notion of topological distance, however, is inconsistent with the SFP because of fixed number of neighbors. We construct a new flock and/or swarm model motivated by soldier crab in Iriomote Island, where the neighborhood of an individual is used as the extended body or the local space other individuals are located. The ambiguity of the neighborhood contributes to the internal dynamic flow in a coherent motion of a flock. Here we show that this model can reveal SFP over a wide range of the flock size.

3P323 真性粘菌のネットワーク相同性に関する数理モデル Numerical model of morphological order in *Physarum* network

Iori Tani¹, Masaki Yamachiyo¹, Tomohiro Shirakawa², Yukio-Pegio Gunji¹, (¹*Department of Earth and Planetary Sciences, Graduate School of Sciences, Kobe University*; ²*Department of Computer Science, School of Electrical and Computer Engineering, National Defense Academy of Japan*)

True slime mold *Physarum polycephalum* plasmodium is a unicellular ameboid organism. It can move on agar plate by using protoplasmic flow and can form

various adaptive network.

While our numerical model (Model 1) based on the prompt gel-sol transformation can show adaptive network (Gunji et al. 2008), the revised model (Model 2) equipped with the short-lived gel can show network with redundant loops (Niizato et al, 2010).

We construct a new model equipped with two parameters, one from the model 1 and the other from model 2. Here we show that the homology of *Physarum* network on dumbbell-shaped agar field with a few food sources (Shirakawa and Gunji, 2007) can be reconstructed by this model in revealing various network patterns.

3P324 分子の離散性の相関時間への影響 Impact of the molecular discreteness on correlation time

Taichi Haruna^{1,2}, (¹*Graduate School of Science, Kobe University*; ²*PRESTO, JST*)

Understanding the molecular discreteness is one of the intriguing problems in biophysics. Togashi and Kaneko [2001, PRL 86:2459] studied a small autocatalytic system consisting of four molecular species by computer simulation. They decrease the volume of the system with fixing the concentrations of molecules and found a transition phenomenon that cannot be observed in the large volume limit. Ohkubo et al. [2008, J. Phys. Soc. Jpn. 77:044002] simplifies the model proposed by Togashi and Kaneko in order to study the transition phenomenon analytically. They proposed an autocatalytic system consisting of just two molecular species and found that the same transition phenomenon as that of Togashi and Kaneko occurs in their model. Based on their model, they proved that the transition phenomenon also occurs in the Fokker-Planck formalism. However, they only considered the steady probability distribution. In this presentation, we consider how the discreteness affects information about time correlation. In particular, we calculate correlation time for the model of Ohkubo et al. by combining the generating function method and the large deviation theory for stationary time series. The discreteness of the system can be varied by the scheme which bridges the chemical master equation and the chemical Fokker-Planck equation proposed by Haruna [in press, J. Comput. Chem. Jpn.] recently. We found that correlation time significantly decreases as the discreteness of the system is lowered in the parameter region in which the transition phenomenon occurs.

3P325 Direct quantification of mitochondria and mitochondrial DNA dynamics in living cells

Yasutomo Nomura¹, Tomomi Nabeya¹, Kyohei Nakayama¹, Kazuki Nishimoto¹, Yui Januma¹, Masataka Kinjo², (¹*Department of Systems Life Engineering, Maebashi Institute of Technology*; ²*Faculty of Advanced Life Science, Hokkaido University*)

Using image correlation spectroscopy, diffusion coefficient of mitochondrial DNA (mtDNA) was measured to determine the diagnostic feasibility of mitochondrial diseases. mtDNA and mitochondria were stained with PicoGreen and MitoTracker Deep Red, respectively. Despite of no spectral cross-talk, diffusion coefficient of mtDNA was comparable to that of mitochondria, which suggested that mtDNA was bound to mitochondria tightly. By the use of present method, it would be able to detect large deletion or abnormal transmission of mtDNA in mitochondrial diseases.

3P326 質量顕微鏡法へのナノ粒子の応用 Application of Nanoparticles for Imaging Mass Spectrometry

Takahiro Hayasaka¹, Naoko Goto-Inoue¹, Nobuhiro Zaima¹, Kamlesh Shrivastava^{1,2}, Yukiyasu Kashiwagi³, Mari Yamamoto³, Masami Nakamoto³, Mitsutoshi Setou¹, (¹*Hamamatsu University School of Medicine*; ²*Japan Society for the Promotion of Science*; ³*Osaka Municipal Technical Research Institute*)

Imaging Mass Spectrometry (IMS) analysis has concentrated on main cell components, such as cell membrane phospholipids and cytoskeletal peptides. Silver nanoparticles (AgNPs) modified with alkylcarboxylate and alkylamine were used for nanoparticle-assisted laser desorption/ionization (nano-PALDI)-IMS to identify fatty acids, such as palmitic, stearic, oleic, linoleic, arachidonic, and eicosapentaenoic acids, in mouse liver sections; these fatty acids are not detected using 2,5-dihydroxybenzoic acid (DHB) as a matrix. The limit of detection for the determination of palmitic acid was 50 pmol using nano-PALDI-IMS. The nano-PALDI-IMS method is successfully applied to the reconstruction of the ion images of fatty acids in mouse liver sections. We verified the detection of fatty acids in liver tissue sections of mice by analyzing standard lipid samples, which showed that fatty acids were from free fatty acids and dissociated fatty acids from lipids when irradiated with a laser. Additionally, we applied the proposed method to the identification of fatty acids in mouse retinal tissue sections, which enabled us to learn the six-zonal distribution of fatty acids in different layers of the retina. We believe that the current approach using AgNPs in nano-PALDI-IMS could lead to a new