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STOCHASTIC MODELING OF CHEMOTACTIC BACTERIAL COLONY FORMATIONS UNDER RANDOM DISTURBANCES

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Abstract. *Many kinds of spatio-temporal patterns appear in various fields of engineering including chemical and biological engineering. Analyses of patterns created by what is called a self-organization play a very important role in engineering. For example, the analysis of the spatio-temporal patterns in phase transitions of polymeric materials is essential to developing new materials. In this paper, focusing on the chemotactic bacterial colony patterns as the spatio-temporal patterns created by the self-organization, we study the influence of the random disturbance on the colony formations.*
Keywords: Chemotaxis, Stochastic reaction diffusion systems, *E. coli*, *S. typhimurium*, Semi-solid media, Colony formations, Numerical simulations

1. **Introduction.** Spatio-temporal patterns created by the self-organization [1-3] are often observed in various fields of engineering. Analyses of the spatio-temporal patterns are crucial as the basic problems in engineering. For instance, analyses of formation processes of the spiral and target patterns in the Belousov-Zhabotinsky (BZ) reaction and the hexagonal pattern in Rayleigh-Bénard systems are important to understand complicate phenomena in chemical and fluid engineering [2]. In addition, since analyses of epidermal patterns of animals and seashell patterns shed light on mystery in biology [1,4], the analyses of spatio-temporal patterns generated by the self-organization have recently drawn many researchers' attraction. In this paper, we study the bacterial colony patterns as the spatio-temporal patterns created by the self-organization. It is well known that some bacteria form complicate geometric spatio-temporal colonies [5,6]. Bacterial species Bacillus subtilis create five kinds of colony patterns depending on two environmental conditions, concentrations of nutrient and hardness of agar in experiments [4,5]. In particular, we consider bacteria such as Escherichia coli (*E. coli*) and Salmonella typhimurium (*S. typhimurium*) which move in the direction of increasing concentration of chemoattractant, asparate. This property of bacteria is called chemotaxis [7]. Because of chemotaxis, they form high-density aggregates, i.e, bacterial colonies [8-12]. Taking into account the fact that there exist fluctuations more or less in the natural world, we propose the stochastic two components reaction diffusion equations as the model of the chemotactic bacterial colony formation. There are two types of culture of bacteria. One is culture in liquid media and the other is one in semi-solid media. In this paper, focusing on chemotactic bacterial colony formations in semi-liquid media under a random fluctuation, we consider