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Competitive aggregation dynamics using phase wave signals

Hidetsugu Sakaguchi and Satomi Maeyama

Department of Applied Science for Electronics and Materials, Interdisciplinary Graduate School of Engineering Sciences, Kyushu University, Kasuga, Fukuoka 816-8580, Japan

Abstract

Coupled equations of the phase equation and the equation of cell concentration n are proposed for competitive aggregation dynamics of slime mold in two dimensions. Phase waves are used as tactic signals of aggregation in this model. Several aggregation clusters are formed initially, and target patterns appear around the localized aggregation clusters. Owing to the competition among target patterns, the number of the localized aggregation clusters decreases, and finally one dominant localized pattern survives. If the phase equation is replaced with the complex Ginzburg-Landau equation, several spiral patterns appear, and n is localized near the center of the spiral patterns. After the competition among spiral patterns, one dominant spiral survives.

Key words: Mathematical model,Slime mold, Aggregation dynamics, Phase waves

1 Introduction

Nonlinear nonequilibrium systems can generate various interesting patterns [1]. Target patterns and spiral patterns are typical patterns found in excitable or oscillatory media such as the BZ reaction [2,3]. Similar type of spiral pattern is observed in the early stage of the aggregation of the slime mold Dictyostelium discoideum [4]. The amoebae cells of Dictyostelium discoideum secrete cAMP and the concentration of cAMP exhibits the limit-cycle oscillation. Martiel and Goldbeter proposed a mathematical model for the limit-cycle oscillation of cAMP [5]. Tyson et al. proposed a mathematical model for spiral waves

Email address: sakaguchi@asem.kyushu-u.ac.jp (Hidetsugu Sakaguchi and Satomi Maeyama).