Meiji University Global COE Program

40th Mathematical Sciences based on Modeling, Analysis and Simulation seminar

Date: May 26, 2011, 16:30～18:00

Location: Meiji Univ. Ikuta Campus, Build 2 Annex A, Room A207

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Title : A theoretical study of morphodynamics of dunes using dune skeleton model

Abstract: Sand dunes, which are the largest granular objects on the Earth, form several distinct patterns. These patterns are determined by two dominant factors; the steadiness of wind direction and the amount of available sand constructs dunes. For example, unidirectional wind generates barchans or transverse dunes. The former, crescent-shaped dunes, are formed in dune fields with small amount of available sand, whereas the latter extending perpendicular to the wind direction, are formed in dune fields with the larger amount of available sand than the barchan-rich field. In recent years, rescaled water tank experiments have successfully been conducted to form distinct dune shapes under control. Computer models also reproduced various shapes of dune formation process. However, the theoretical methodology explaining the basic mechanism for the complex morphodynamics of dunes beyond the mere numerical reproduction of their formation process is yet to be developed.

In our presentation, in order to theoretically analyze the basic mechanism hidden in formation and migration process of dune, we propose a Dune skeleton model that consists of coupled ordinary differential equations each of which represents the dynamics of two-dimensional cross sections (hereafter, 2D-CSs). Present model shows that; I) Three typical shapes of dunes; straight transverse dune, wavy transverse dune, and barchan, are reproduced depending on the amount of available sand and wind strength. Also, the increase in the amount of available sand and inter 2D-CSs flow enhances the stability of the shape of transverse dune, whereas the decrease in the amount of available sand and the increase in intra 2D-CS flow destabilizes its shape to enforce the deformation to a barchan [1]. II) A linear stability analysis of two 2D-CSs system showed the bifurcation structure of fixed point and identified the stability condition of the straight and wavy transverse dune. These theoretical results qualitatively correspond to the observation and the experimental facts.

Reference

[1] H. Niiya, A. Awazu and H. Nishimori. J. Phys. Soc. Jpn. 79 063002 (2010).

Everyone is welcome to attend the MAS seminar.

Meiji institute for Advanced Study of Mathematical Science (http://www.mims.meiji.ac.jp)

(Organizers: M. Mimura, D. Ueyama, Y. Wakano, K. Ikeda and S.Kinoshita)

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Access: 10 minutes on foot from Ikuta St. Odakyu line,
Or 10 minutes by bus No. 13「明治大学正門前」, get off at the last stop.
See http://www.meiji.ac.jp/koho/campus_guide/ for details.