Name: Tetsuji Tokihiro

Research field: Applied Mathematics

Key words: Integrable systems, Ultradiscrete system, Medical mathematics

Current research:

The main subject of my research activity is the theoretical study of discrete and ultradiscrete dynamical systems and mathematical modeling for medical and biological sciences.

Integrable systems originally mean the differential equations which can be solved by integration. The theory of KP hierarchy (Sato theory) for integrable partial differential equations and quantum algebras founded by Drinfeld-Jimbo are well known in the theory of integrable systems. Recently difference equations and cellular automaton (CA) are actively investigated with respect to their integrability. When a CA is constructed from a continuous equation by a limiting procedure called ultradiscretisation, it enjoys numerical analyses and is called an ultradiscrete system. It has deep connection with various fields (number theory, combinatorics, discrete geometry, representation theory, informatics etc.) and has been investigated actively.

Our recent research object is a system of difference equations which are equipped with both integrable and chaotic features. We call them a quasi-integrable equation. Last year we obtained quasi-integrable two dimensional lattice equations (an extended discrete KdV equation) of which co-primeness we have proved, and showed that its reductions give a hierarchy of quasi-integrable equations. The mathematical structures of the quasi-integrable equations are now being investigated in detail.

I am also studying the dynamics of morphogenesis in medical and biological sciences to establish mathematical frameworks in cellular dynamics. In particular, I focus on the transcription process of DNA and the angeogenic morphogenesis by endothelial cell movement, and synchronization of cardiomyocytes (cardiac cells). There are a lot of unsolved problems in genetics and molecular biology, and I expect that our new mathematical approach may elucidate genetic processes and biological functions for innovative drug development.

Prerequisites:

It is recommended to master elementary calculus and linear algebra, complex analysis, differential equations in undergraduate program. Specific knowledge should be acquired when you encounter your problem. Those who are interested in medical mathematics are expected to collaborate with medical scientists and/or biological scientists. I hope that you always have pioneering spirit in your research activity.