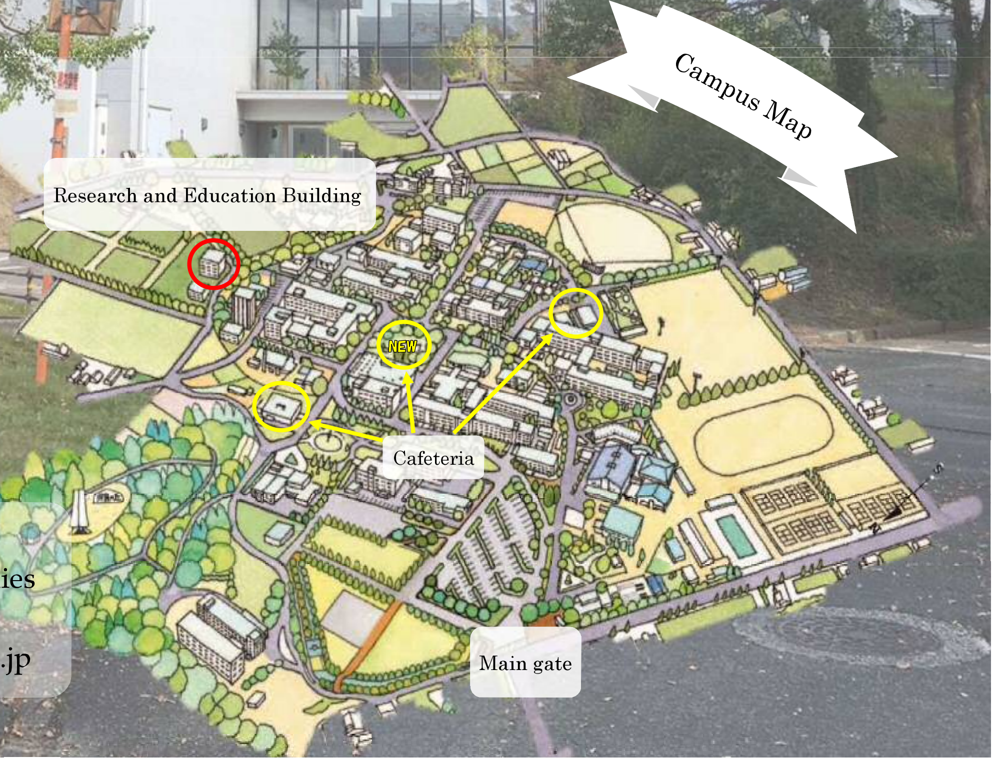
International Mathematical Science Workshop in Yamaguchi 2019

Presented by RITS

November 7 (Thu) 14：00
– 8 (Fri) Afternoon, 2019

Venue：Yamaguchi University Yoshida campus
Research and Education Building 3F,
Forum space (1677-1 Yoshida,Yamaguchi)



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International Mathematical Science Workshop in Yamaguchi 2019

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1. Purpose
   - We will hold a workshop on mathematical science. The research topic is not restricted and may or may not be directly related to Time Studies, but it must be mathematical science. Even not so mathematical study is welcome.
   - The aim is for participants to get inspiration. Conversely, we do not rush to seek practical applications. Emphasis will be on a free atmosphere. Prominent and active researchers will be invited, while students are also encouraged to participate actively.
2. Date / Venue / Language
   - Date 2019 November 7 - 8
   - Venue Yamaguchi University (Yoshida Campus)
     Yoshida Research and Education Building, 3F Forum Space
   - Language English (Japanese maybe ok)
   - Presentation Invited talks
   - Proceeding not produced

Program

<Nov. 7th>		
14:00-14:40	M. I. Tribelsky	Non-Steady Resonant Wave Scattering by an Obstacle
14:40-15:20	H. Matano	Propagation of bistable fronts through a perforated wall
15:20-16:00	S. Kaji	Time evolution of Kaleidocycles
16:00-16:20		Coffee break
16:20-17:00	K. Matsue	Premixed Flame Dynamics: Modeling, Numerical and Mathematical Studies
17:00-17:40	Y. Kuramoto	Dynamical Reduction of Coupled Oscillators
		Banquet
<Nov. 8th>		
09:30-10:10	H. Ueno	Perception of time-dependent environmental change: A toy model with photo-coupled electronic oscillators composing frustrated network
10:10-10:50	T. Narumi	Tagged-particle dynamics in Nikolaevskii turbulence
10:50-11:30	A. Miroshnichenko	On redundant poles of the S-matrix
11:30-13:30		Lunch break
13:30-14:10	T. Makino	On Mathematical Models of Gaseous Stars
14:10-14:50	S. A. Tishchenko	N-separator and its application in the degree-diameter problem

Non-Steady Resonant Wave Scattering by an Obstacle

Michael I. Tribelsky[1,2,3]

[1]*M. V. Lomonosov Moscow State University, Moscow, Russia*
[2]*National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Moscow, Russia*
[3]*RITS Yamaguchi University, Yamaguchi, Japan*

A survey of the recent results of the author in the unsteady high-Q resonant scattering of ultrashort pulses by a particle, whose size is comparable or smaller than the wavelength of the incident radiation at the carrier frequency is presented. It is shown that the unsteadiness of the scattering process may result in qualitative changes in the manifestation of the phenomenon both in the near-field and in far-field wave zones. Most attention is paid to the dynamics of the nonradiating anapole modes and dynamic Fano resonances, which are discussed in detail. Simple, analytically tractable models are proposed to describe the transient processes. Their comparison with the results of the direct numerical integration of the complete set of the Maxwell equations shows that the models exhibit high accuracy in the quantitative description of the phenomenon.

The financial support of the Russian Foundation for Basic Research (Grant No. 17-02-00401) and the Russian Science Foundation (Project No. 19-72-30012) is acknowledged.

Propagation of bistable fronts through a perforated wall

Hiroshi Matano

Meiji University

We consider a bistable reaction-diffusion equation in the presence of an obstacle, which can be regarded as a wall of infinite span with periodically arrayed holes. Our goal is to study what happens when a planar traveling front coming from infinity meets the wall .

We first show that there is clear dichotomy between `propagation' (or invasion) and `blocking', and that there is no intermediate behavior. This dichotomy result is proved by what we call a De Giorgi type lemma.

Next we discuss sufficient conditions for blocking, and those for propagation. Roughly speaking, blocking occurs if the holes are small.
As for propagation, we present three types of walls that allow the front to propagate, namely (a) walls with large holes; (b) small-capacity wall; (c) skeleton walls. This is joint work with Henri Berestycki (EHESS Paris) and Francois Hamel (Univ. Aix-Marseile).

Time evolution of Kaleidocycles

Kaji Shizuo
Institute of Mathematics for Industry Kyusyu University

Kaleidocycle is an origami toy which can be folded from a sheet of paper.
Unlike usual origami, it has some mobility; in fact, it can be seen as an example of linkage mechanisms which consists of hinges.
We model (a generalisation of) Kaleidocycles as discrete space curves with constant torsions.
In particular, we see that the motion of a Kaleidocycle is governed by a semi-discrete (discrete space, continuous time) integrable system.
The origami piece demonstrates visually how different fields of mathematics, topology, algebraic geometry, and analysis meet as well as art.
This is joint work with K. Kajiwara and H. Park.

Premixed Flame Dynamics: Modeling, Numerical and Mathematical Studies

Kaname Matsue

Institute of Mathematics for Industry, Kyushu University
International Institute for Carbon-Neutral Energy Research, Kyushu University
University of Illinois at Urbana-Champaign

Combustion is the oldest technology for energy generation in human history.
Recently, renewable energy and related technology are coming into the mainstream of energy generation or new infrastructure towards creating the carbon-neutral society.
Nevertheless, combustion is still important for balancing energy generation and efficiency to maintain our daily lives.
One of the important issues in combustion research is to understand the mechanism of flame dynamics related to energy generation and realistic combustion processes.
In the present study, we study the dynamics of hydrodynamical unstable, premixed planar flame fronts based on a fully nonlinear, hydrodynamic model obtained by a multi-scale analysis that exploits the distinct length scales associated with such problems.
In particular, we focus on the composite effects of thermal expansion, differential diffusion, and gravity on flame dynamics.
The flame dynamics based on the model with finite thermal expansion is the main issue, while the problem in the weak thermal expansion setting, where numerical bifurcation theory and mathematical methodology for describing rigorous solutions can be applied, is also considered to extract mathematically intrinsic feature in flame dynamics in the presence of gravity.

Perception of time-dependent environmental change: A toy model with photo-coupled electronic oscillators composing frustrated network

H. Ueno, M. Matsushima, Y. Kamiya, H. Kawakami, and K. Yoshikawa.

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We adapted a very simple experimental model on the coupling of excitable/oscillatory element, by using opto-electronic circuit known as multi-vibrator composed of resistor, capacitor, Op-Amp. The circuit exhibits periodic ON/OFF rhythmic oscillation by a LED in a dark environment, whereas this synchronizes its blinking with environmental event, detecting light by photo-transistor.
A simple network of three oscillators composing a triangle connection performs the time-dependent processing of information; each neighbouring pair exhibit anti-phase synchronization; i.e., frustrated network. In this system, multi-stability is embedded, where each mode is generated from specific time-sequential input. Certain history of input evokes corresponding mode of entrainment in these simple oscillators. Such specificity of time-dependent mode selection will be discussed in relation to the potentiality of perception with coupled oscillators.

Tagged-particle dynamics in Nikolaevskii turbulence

Narumi Takayuki

Yamaguchi University Graduate School of Sciences and Technology for Innovation

We have studied the Nikolaevskii turbulence, which is a mathematical model of weak turbulence. To clarify it from the Lagrangian description, we calculated the velocity field of the turbulence assuming convective structure and carried out tagged-particle simulations in the flow. The particle diffuses in the disturbed flow, and the diffusion was superdiffusive in an intermediate timescale. A simplified model we proposed has revealed a hierarchy in the Nikolaevskii turbulence. The diffusive feature of the slow structure is characterized by the power-law for the control parameter near the transition point of the Nikolaevskii turbulence, implying that the diffusive characteristics of the slow structure hold scale-invariance.

On redundant poles of the S-matrix

Andrey Miroshnichenko
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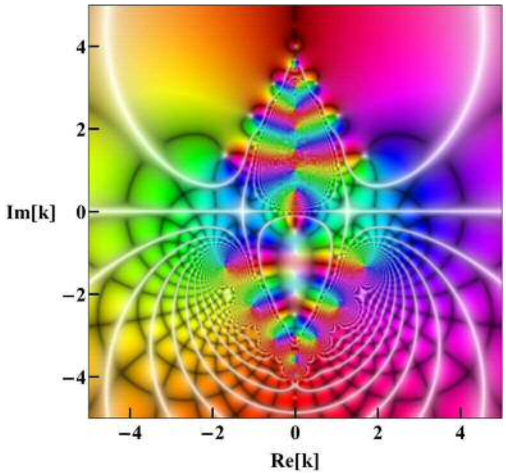

A fundamental property of the S-matrix is that any bound state corresponds to a pole of the S-matrix on the physical sheet of the complex energy plane. For a repulsive exponentially decaying potential, none of infinite number of poles of the s-wave S-matrix on the physical sheet corresponds to any physical state. On the 2nd sheet of the complex energy plane, the S-matrix has infinite number of poles corresponding to virtual states and a finite number of poles corresponding to complementary pairs of resonances and anti-resonances. The origin of redundant poles and zeros is confirmed to be related to peculiarities of analytic continuation of a parameter of two linearly independent analytic functions. The overall contribution of redundant poles to the asymptotic completeness relation, provided that the residuum theorem can be applied, is determined to be an oscillating function.

On Mathematical Models of Gaseous Stars

Tetu Makino (Prof. Emer. at Yamaguchi Univ.)

The internal structure and its time evolution of stars are the major subject of astrophysics. On this subject the study through observations and through numerical simulations have been achieved marvelous progress, as well known, thanks to the efficiency of observational and computational devices. However the progress of mathematically rigorous theoretical study on this subject is very slow, and has not yet caught up with the observational and numerical performance.

The reason is that the underlying hydrodynamical equations are degenerated at the boundary of the gaseous matter and the vacuum. Here the underlying equations are the Euler-Poisson equations in the non-relativistic frame work, and the Einstein-Euler equations in the relativistic frame work, while the former is the limit of the latter as the speed of light tend to infinity. Moreover the effect of self-gravitation is not yet well clarified. In this sense the mathematics of the matter-vacuum boundary and self-gravitation should be more rapidly developed. Maybe some new theoretical paradigm is needed.

In this talk the historical development of the mathematically rigorous theory on the internal structure and time evolution of gaseous star models is reviewed, and the open problems which confront us are introduced.

N-separator and its application in the degree-diameter problem

Serge A. Tishchenko (Moscow State University)

We study N-separators the divide and conquer method in weighted (vertices, edges and faces) planar graph (an N-separator of a connected graph G is a subgraph G whose deletion decomposes G into N connected components). A number of papers were inspired by the original paper by Lipton and Tarjan on 2-separators in weighted (only vertices and edges) planar graphs. Their separator construction is very important issue in many graph applications such as VLSI modelling, communication networks, parallel computing. The most complete and recent survey on graph separators was made by Rosenberg and Heath.

One of the possible applications of the separator method is the degree-diameter problem in planar graphs. In this case, the separator method is used for planar graph characterization. The largest graphs in the degree-diameter problem are very dense. Therefore, the simplest Lipton and Tarjan separator which is a cycle obtained by addition of an edge to some edges of a spanning tree becomes an efficient tool in the degree-diameter problem. Each of two separated subsets is either the interior or the exterior of the cycle. Further progress can be achieved in the degree-diameter problem increasing the number of separated subsets. In general, an N-separator is needed consisting of several cycles.

We optimize the separator construction in plane graphs with weighted vertices, faces and edges. Such generalization is important for practical applications. We consider the problem of existence of an N-separator in a planar graph and give optimal bounds to the minimum weight component.

Titles N-separator and its application in the degree-diameter problem
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