# Workshop “Dynamics, Ergodic Theory and Fractals”

科学研究費基盤研究（C)「正則写像半群・ランダム複素力学系ならびにフラクタル幾何学の研究」
（研究代表者:角大輝、研究課題番号: 15K04899）の補助により下記の研究集会を開催いたします。

世話人: 角大輝　(大阪大学）

記

日時：２０１６年　５月　２１日（土曜日）１０：００～
５月　２２日（日曜日）１７：０５

場所： 大阪大学豊中キャンパス理学部棟Ｄ棟４階Ｄ４０７
（大阪モノレール柴原駅下車徒歩５分、または阪急宝塚線石橋駅下車徒歩 20 分）
https://www.sci.osaka-u.ac.jp/ja/access/campusmap/
（当日は理学部棟 A 棟の正面玄関からお入りください。なお、A 棟正面玄関から D407 への行き方は、まずエレベーターで４階にあがり、エレベータを出てすぐ前に見える廊下を右方向にまっすぐ、A405, A407 等の前を通りすぎてつきあたりまで進み、つきあたりの A427 前を右にまがり、まっすぐ 100m ほど進みます。右手に見える部屋が、D407 です。）

Program

５月２１日（土曜日）

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|---|---|
| １０：００～１１：００ | Rich Stankewitz (Ball State University, USA)<br>Introduction to rational semigroups and recent results on algorithms for drawing their Julia sets |
| １１：１５～１２：１５ | 角大輝 （大阪大学） (Hiroki Sumi, Osaka University)<br>Hausdorff dimension of the Julia sets of postcritically bounded polynomial semigroups and the transversality condition |
| １３：４５～１４：４５ | Johannes Jaerisch (島根大学) (Shimane University)<br>Average behavior of the random iteration of rational maps on the Riemann sphere |
| １５：００～１６：００ | 諸澤俊介（高知大学） (Shunsuke Morosawa, Kochi University)<br>Observations on the parameter space of $G_c = \langle z \mapsto z^2, z \mapsto (z-c)^2+c \rangle$ |
| １６：２０～１７：２０ | Mariusz Urbański (University of North Texas, USA)<br>Random Dynamics of Transcendental Meromorphic Functions |
| １７：３５～１８：２５ | 下村健吾（大阪大学・情報） (Kengo Shimomura, Osaka University)<br>Hausdorff dimension of the limit set of the overlapping iterated function systems |
| １９：００～ | 懇親会 (Dinner) |

5月２２日（日）

１０：００～１１：００　片方江　（一関高専）　( Koh Katagata, National Institute of Technology, Ichinoseki College)
Julia sets of quartic polynomials and polynomial semigroups

１１：１５～１２：１５　田中 晴喜 (和歌山県立医大）(Haruyoshi Tanaka, Wakayama Medical University)
Asymptotic perturbation of graph iterated function systems

１３：４５～１４：４５　盛田健彦（大阪大学）　(Takehiko Morita, Osaka University)
Makeshift Banach algebras associated with dynamical partitions for expanding fibred systems

１５：００～１５：５０　鈴木新太郎（大阪大学）(Shintaro Suzuki, Osaka University
The invariant density function of the random beta-transformation

１６：０５～１７：０５　梶野直孝（神戸大学）　(Naotaka Kajino, Kobe University)
The Laplacian on the Apollonian gasket and its Weyl type eigenvalue asymptotics

# Abstracts

May 21, 2016 (Saturday)

(1) 10:00-11:00
**Speaker**: Rich Stankewitz (Ball State University, USA)
**Title**: Introduction to rational semigroups and recent results on algorithms for drawing their Julia sets
**Abstract**: We introduce the dynamics of Rational Semigroups, an extension of the iteration theory developed by Fatou and Julia, providing key background results that drive the theory. Then we discuss the similarities and differences between this new setting and the classical setting, with a focus on new results in methods for drawing the Julia sets (chaotic sets) via random backward iteration. We also focus on the distinct differences when semigroups are Mobius or not.

(2) 11:15-12:15
**Speaker**: Hiroki Sumi (Osaka University)
**Title**: Hausdorff dimension of the Julia sets of postcritically bounded polynomial semigroups and the transversality condition
**Abstract**: We consider the Hausdorff dimension of the Julia sets of 2-generator postcritically bounded hyperbolic polynomial semigroups. We show that for any paramenter $(f_1, f_2)$ in an open and dense subset of the boundary of the connectedness locus, there exist an open neighborhood $U$ of $(f_1, f_2)$ and a subset $A$ of $U$ with $\dim_H(U \setminus A) < \dim_H U$, where $\dim_H$ denotes the Hausdorff dimension with respect to the Euclidian distance on the parameter space, such that for any parameter $(g_1, g_2) \in A$, the Hausdorff dimension of the Julia set generated by $\{g_1, g_2\}$ is equal to the Bowen parameter (critical exponent of the Poincare series) of $(g_1, g_2)$. The idea of the proof is to show that an open neighborhood $U$ of $(f_1, f_2)$ satisfies the transversality condition.

(3) 13:45-14:45
**Speaker**: Johannes Jaerisch (Shimane University)
**Title**: Average behavior of the random iteration of rational maps on the Riemann sphere
**Abstract**: We consider hyperbolic random complex dynamical systems on the Riemann sphere with separating condition and multiple minimal sets. We investigate the action of the associated transition operator on Hölder spaces by employing the thermodynamic formalism in ergodic theory. This is a joint work with Hiroki Sumi.

(4) 15:00-16:00
**Speaker**: Shunsuke Morosawa (Kochi University)
**Title**: Observations on the parameter space of $G_c = \langle z \mapsto z^2, z \mapsto (z-c)^2 + c \rangle$
**Abstract**: We make observation on the parameter space of $G_c = \langle z \mapsto z^2, z \mapsto (z-c)^2 + c \rangle$ by using fundamental and elementary argument.

(5) 16:20-17:20
**Speaker**: Mariusz Urbański (University of North Texas, USA)
**Title**: Random Dynamics of Transcendental Meromorphic Functions
**Abstract**: This is a joint work with M. Volker Mayer. It concerns random dynamics of tr anscendental functions from the complex plane to the complex sphere. I will establish the existence

of random conformal measures and their invariant versions. An appropriately defined spectral gap property will be shown. In classical (hyperbolic rational functions for ex.) there is a natural and powerful proof of this property which stems from Birkhoff's Contraction Principle with respect to the Hilbert metric or operators preserving positive cones. This method however fails in our non-compact situation. We will nevertheless define appropriate invariant cones of positive functions and will revive an old approach of Bowen to random conformal and invariant measures. Finally, as a corollary the spectral gap we will derive exponential decay of correlations.

(6) 17:35–18:25
**Speaker**: Kengo Shimomura (Osaka University)
**Title**: Hausdorff dimension of the limit set of the overlapping iterated function systems

19:00-21:00 **Banquet**

May 22, 2016 (Sunday)

(7) 10:00-11:00
**Speaker**: Koh Katagata (National Institute of Technology, Ichinoseki College)
**Title**: Julia sets of quartic polynomials and polynomial semigroups
**Abstract**: If the Julia set of a quartic polynomial with certain conditions is neither connected nor totally disconnected, there exists a homeomorphism between the set of all components of the filled Julia set and some subset of the corresponding symbol space. The question is to determine the quartic polynomials exhibiting such a dynamics and describe the topology of the connected components of their filled Julia sets. In this talk, we answer the question, namely we show that for any two quadratic Julia sets, there exists a quartic polynomial whose Julia set includes copies of the two quadratic Julia sets. Moreover, we show that there exists a homeomorphism between the Julia set of the quartic polynomial and that of a certain polynomial semigroup.

(8) 11:15-12:15
**Speaker**: Haruyoshi Tanaka (Wakayama Medical University)
**Title**: Asymptotic perturbation of graph iterated function systems
**Abstract :** We study an asymptotic perturbation of the Hausdorff dimension of the limit set of conformal graph directed iterated function systems with an open set condition. We show that if the contraction maps related to this system have asymptotic expansions under weak conditions, then the Hausdorff dimension of the limit set behaves asymptotically by the same order. We also prove that the Gibbs measure associated with the Hausdorff dimension and the measure theoretic entropy of this measure have asymptotic expansions under an additional condition. We also give a degenerate example of this perturbation.

(9) 13:45–14:45
**Speaker**: Takehiko Morita (Osaka University)
**Title**: Makeshift Banach algebras associated with dynamical partitions for expanding fibred systems
**Abstract**: For a expanding fibred system, we define a family of 'handy' Banach algebras by using the dynamical partitions for the system. We show that under appropriate conditions, the Perron-Frobenius operator for the system turns out to be quasi-compact on these Banach algebras.

(10) 15:00–15:50
**Speaker**: Shintaro Suzuki (Osaka University)
**Title**: The invariant density function of the random beta-transformation
**Abstract**: In this talk, we consider the random beta-transformation introduced by Dajani and Kraaikamp. We give an explicit formula of the density of its absolutely continuous probability measure via the Perron-Frobenius operator of a skew product system related to it.

(11) 16:05-17:05
**Speaker**: Naotaka Kajino (Kobe University)
**Title**: The Laplacian on the Apollonian gasket and its Weyl type eigenvalue asymptotics
**Abstract**: Since Apollonius of Perga (262–190 BC) in ancient Greece it is well-known that an ideal triangle, i.e., the closed subset of the plane enclosed by three circles each of which is tangent to the other two, has a unique inner tangent circle. The Apollonian gasket associated with an ideal triangle is the compact fractal subset of the plane obtained from the given ideal triangle by repeating indefinitely the process of removing the interior of the inner tangent circles of the ideal triangles, and it is homeomorphic to the (usual) Sierpiński gasket as can be easily seen from its construction. This set is also known to appear naturally as (part of) the limit set of a certain classical Kleinian group, and has been extensively studied in relation to various fields of mathematics such as fractal geometry, dynamical systems and theory of Kleinian groups.
The purpose of this talk is to present the author's recent results on construction and analysis of a "canonical" Laplacian ON the Apollonian gasket including its Weyl type eigenvalue asymptotics. The argument in the proof of the eigenvalue asymptotics in fact works also as an alternative proof of the asymptotic distribution of circles in the construction of the Apollonian gasket, a (very) special case of a recent result by Oh and Shah [Invent. Math., 2012] for a large class of circle packings invariant under action of Kleinian groups.
Date: April 13, 2016.