Winners of 2022 Edward Norton Lorenz Early Career Awards

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Originally published as
Kiss, I.Z., Kurths, J., Parlitz, U., Sun, J. (2023): Winners of 2022 Edward Norton Lorenz Early Career Awards. - Chaos, 33, 11, 110402.
https://doi.org/10.1063/5.0182501

Chaos
An Interdisciplinary Journal of Nonlinear Science

EDITORIAL | NOVEMBER 01 2023

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Chaos EDITORIAL pubs.aip.org/aip/cha

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Cite as: Chaos **33**, 110402 (2023); doi: 10.1063/5.0182501
Submitted: 19 October 2023 · Accepted: 19 October 2023 ·
Published Online: 1 November 2023

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This year the Edward N. Lorenz Early Career Award was given for the first time to three young researchers for their outstanding papers published in Chaos in 2022. We, the selection committee, considered the large number of excellent early career papers and were able to select 20 outstanding papers for the Early Career Award Collection that were highlighted as Editor's Picks and Featured articles. From this pool, we chose three winners to receive the Edward N. Lorenz Early Career Award: Tiemo Pedergnana (ETH Zurich), Thomas Lilienkamp (Nuremberg Institute of Technology), and Yuzuru Kato (University of Tokyo). The winners will split a $2000 honorarium and are each invited to contribute a perspective article to the journal.

I. TIEMO PEDERGNANA

Winning paper: "Exact potentials in multivariate Langevin equations" [Chaos **32**, 123 146 (2022)].[1]

Langevin equations govern a broad class of dynamical systems describing biological, chemical, physical, and financial processes. The differential-geometric approach taken by Pedergnana *et al.* to seek hidden exact potentials could be expanded to a broader class of dynamical systems. This should lead to fruitful research and exciting new results in the field of nonlinear and stochastic dynamics.

Pedergnana is a student at ETH Zürich where he conducts theoretical, experimental, and numerical research in acoustics for combustion and metamaterial applications. His core interest is the development of new methods for the analysis of dynamical systems with a strong focus on applying them to real-world experiments. Quoted in an AIPP press release from earlier this year,[2] Pedergnana states, "I work on acoustics for power generation and metamaterial applications. Fundamentally, we are trying to understand the phenomenon of whistling in various configurations and how it can be controlled and manipulated.… Concurrently, we are studying dynamical systems theory to enhance our methods of analysis.… I am happy and honored to receive this award. It shows me that people care about our work, which is, in the end, all that matters. Chaos is an outstanding journal and I have been a reader for many years, which makes this all the better."

II. THOMAS LILIENKAMP

Winning paper: "Taming cardiac arrhythmias: Terminating spiral wave chaos by adaptive deceleration pacing" [Chaos **32**, 121 105 (2022)].[3]

This work explores the fundamental mechanisms underlying cardiac arrhythmias using numerical simulations, with a goal to create efficient control strategies and improve medical treatments for patients. Part of this includes developing low-energy defibrillation strategies to reduce the severe side effects associated with their high-energy counterparts. The suggested pacing protocol starts with fast pulses and ends with slower ones, all of which cover the frequencies and time scales of the heart's underlying dynamics. Numerical simulations showed the method can synchronize and control the chaotic dynamics in an efficient way. Current treatments of ventricular fibrillation induce substantial electrical currents in the myocardium and are associated with significant side effects, including additional tissue damage and post-traumatic stress. This new pulse protocol, called deceleration pacing, represents major progress toward new, gentle low-energy defibrillation methods.

Lilienkamp completed his Ph.D. in physics at the University of Göttingen and his postdoctoral research at the Max Planck Institute for Dynamics and Self-Organization, where he performed the research in this paper. He is now a professor for computational physics in life science at the Nuremberg Institute of Technology where his work explores the fundamental mechanisms underlying cardiac arrhythmias using numerical simulations, with a goal to create efficient control strategies and improve medical treatment for patients. As quoted in an AIPP press release from earlier this year,[2] Lilienkamp states, "In our study, we suggest that the temporal distances between consecutive shocks should be coordinated/adapted to the underlying dynamics of the cardiac muscle during ventricular fibrillation.… This award is a great honor for me and encourages me to continue working on such interesting topics with such wonderful collaborators. Based on our study, we want to investigate how we can further improve the current low energy approaches."

III. YUZURU KATO

Winning paper: "A definition of the asymptotic phase for quantum nonlinear oscillators from the Koopman operator viewpoint" [Chaos **32**, 063133 (2022)].[4]

Spontaneous oscillations and synchronization are observed in a wide variety of classical rhythmic systems. Recent progress in nanotechnology has facilitated a similar analysis of rhythm and synchronization in quantum systems. The proposed phase function is a natural extension of the classical phase function. This original definition of an asymptotic phase function provides appropriate phase values for characterizing quantum nonlinear oscillators. Because the asymptotic phase plays a fundamental role in the analysis of classical limit-cycle oscillations and synchronization, the proposed phase function will have a strong impact on technology.

Kato received his Ph.D. from Tokyo Institute of Technology in 2020 and continued as a postdoctoral researcher at the same institute until 2022. Since 2022, he has been an associate professor in the Department of Complex and Intelligent Systems at Future University Hakodate, where he focuses on the interdisciplinary combination of nonlinear dynamics and quantum physics, including synchronization and pattern formation. Quoted in an AIPP press release from earlier this year,[2] Kato says, "I try to provide mathematical frameworks for analyzing quantum nonlinear dynamics and unveil the qualitative difference between classical and quantum nonlinear dynamics from a mathematical viewpoint…In this work, we introduced a definition of a phase function for quantum rhythmic systems. This is useful for the analysis of quantum synchronization. I feel for the first time that I have made a contribution to the scientific community.… I would be grateful if more researchers became interested in quantum synchronization and other nonlinear phenomena in open quantum systems through this work."

IV. ELIGIBILITY FOR THE EDWARD N. LORENZ AWARD

The authors can self-identify themselves as candidates for this award during the submission of their manuscripts. In order to be eligible, the first author must have received their Ph.D. in the past five years, received their master's degree within the past eight years, or be a current student (times from degree exclude career breaks such as parental leave).[5] There were more than 200 papers in 2022 fulfilling these basic criteria. Submissions are open for consideration for the 2023 award to be announced next year

AUTHOR DECLARATIONS

Conflict of Interest

The authors have no conflicts to disclose. U.P. was not involved in the decision to award the prize to T. Lilienkamp.

Author Contributions

I.Z.K., J.K., U.P., and J.S. contributed equally.

István Z. Kiss: Conceptualization (equal); Writing – review & editing (equal). **Jürgen Kurths:** Conceptualization (equal); Writing – review & editing (equal). **Ulrich Parlitz:** Conceptualization (equal); Writing – review & editing (equal). **Jie Sun:** Conceptualization (equal); Writing – review & editing (equal).

DATA AVAILABILITY

Data sharing is not applicable to this article as no new data were created or analyzed in this contribution.

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2. See https://publishing.aip.org/about/news/chaos-announces-winners-of-2022-edward-n-lorenz-early-career-awards/ for "Chaos Announces Winners of 2022 Edward N. Lorenz Early Career Awards" (2023).
3. T. Lilienkamp, U. Parlitz, and S. Luther, "Taming cardiac arrhythmias: Terminating spiral wave chaos by adaptive deceleration pacing," Chaos **32**, 121105 (2022).
4. Y. Kato and H. Nakao, "A definition of the asymptotic phase for quantum nonlinear oscillators from the Koopman operator viewpoint," Chaos **32**, 063133 (2022).
5. For more information, please visit the journal website: https://pubs.aip.org/aip/cha/pages/award.