

## Curriculum Vitae

**Mohammad R. Kolahchi**

Date of birth: Feb. 6 1962

Citizenship: Iranian

### Background

My work relates to condensed matter physics and physics of complex systems. Here are some examples. I am interested in the ground state and dynamical properties of frustrated Josephson junction arrays. These systems with no inherent disorder, can exhibit complex behavior which is due to the play of frustration and the special nature of the underlying lattice. The simplicity in these models is providing a better grasp on what it takes to refer to a system as being complex. A distinctive property of complex systems is their propensity to exhibit organized behavior via synchronization. An array of nonlinear oscillators modeled by a collection of coupled Josephson junctions is the perfect setting for the study of such synchronous aspects. A neuron is another example of a nonlinear oscillator. Mathematical models exist that describe the neuronal behavior. However, the way these neurons communicate is still not completely understood. Study of the collective action of the neurons, of which synchronization is an example, could ultimately contribute to the understanding of diseases such as epilepsy and processes in the brain that give rise to what is known as memory. Our recent projects have been on synchronization phenomena in intrinsic Josephson junctions, modeling high- $T_c$  superconductors, and on a recent finding known as the chimera state. We have applied the characteristics of a chimera, within the frustrated Josephson junctions with nonlocal interaction, to develop a Lisman switch, hence an attempt to model memory. When the barrier separating the two superconducting islands of the Josephson junction is a ferromagnet, the ground state phase difference of the superconducting order parameter can be tuned to any phase  $\phi_0$ . We discovered that the superconducting-ferromagnet-superconducting  $\phi_0$  junction shows some anomalous response in the ferromagnetic resonance behavior reflecting the nonlinear nature of the Landau-Lifshitz-Gilbert equation. The chaos developed in this nonlinear model is also interesting, as we have shown, since there is no need for an external ac drive. We are near achieving our goal of building a Josephson junction diode based on the properties of the  $\phi_0$  junction when the superconductor is non-centrosymmetric in structure. Our latest project has to do with social balance and how the so called jammed states develop into them. We have invented a non-stochastic growth dynamics on a complete network that can move the system on a jammed state path in the energy landscape, and shown how it can apply to real world data.

## Qualifications and positions held

- Visitor under the Distinguished Researcher Research Support Programme, University of South Africa (UNISA), 24 June to 22 July 2023, Johannesburg, South Africa
- Visiting Researcher at the College of Science, Engineering and Technology, University of South Africa (UNISA), 1 July to 30 September 2014, Johannesburg, South Africa
- Professor of Physics (2010)
- Sabbatical year at School of Physics and Astronomy, University of Nottingham, United Kingdom (2004-2005)
- Associate Professor of Physics (2002)
- Institute for Advanced Studies in Basic Sciences, Zanjan, Iran (1997- )
- Amir-Kabir University of Technology, Tehran, Iran (1991-1996)
- Ph.D. in Physics, University of Kentucky, Lexington, Kentucky, USA (1990)
- Thesis Advisor: **Professor Joseph P. Straley**
- Instructor at Lexington Community College, Lexington, Kentucky (Fall 1990)
- M.S. in Physics, University of Kentucky (Dec. 1985)
- B.S. in Electrical Engineering with High Distinction, University of Kentucky (1982)
- Bellarmine College (Freshman year), Louisville, Kentucky (1979-1980)
- Thomas Jefferson High School, Louisville, Kentucky (Spring 1979)
- Alborz High School, Tehran, Iran (1973-1979)

## Publications

- A. Gharib, A. Janalizadeh, Z. Jafari, F. Osanloo, and M. R. Kolahchi, Intl. J. Modern Physics C — <https://doi.org/10.1142/S0129183126500178>, Online Ready, to be published in 2026
- J. Tekić, A. E. Botha, M. R. Kolahchi, and Yu. M. Shukrinov, Springer proceedings in complexity published on 01 Jan 2024
- A. E. Botha, V. Eclerová, Yu. M. Shukrinov, and M. R. Kolahchi, 15th Chaotic Modeling and Simulation Int. Conf. (SPCOM), 53-61 (2023)
- A. E. Botha, Yu. M. Shukrinov, J. Tekić, and M. R. Kolahchi, Phys. Rev. E, **107**, 024205 (2023)
- A. E. Botha, M. Ansariara, S. Emadi, and M. R. Kolahchi, Frontiers in Computational Neuroscience **16**, 888019 (2022); As part of the Research Topic: Patterns of synchrony in neuronal ensembles: a broad perspective
- Yu. M. Shukrinov, I. R. Rahmonov, A. Janalizadeh, and M. R. Kolahchi, Phys. Rev. B, **104**, 224511 (2021)
- M. Ansariara, S. Emadi, V. Adami, A. E. Botha, M. R. Kolahchi, Nonlinear Dynamics, **100**, 3685 (2020)

- A. Janalizade and M. R. Kolahchi, 13th Chaotic Modeling and Simulation International Conference, **13**, (2020)
- A. E. Botha and M. R. Kolahchi, Scientific Reports **8**, 1830 (2018)
- M. R. Kolahchi, A. E. Botha, and Yu. M. Shukrinov, J. Supercond. Nov. Magn. **30**, 1659 (2017)
- A. E. Botha, Yu. M. Shukrinov, I. R. Rahmonov, K. V. Kulikov, and M. R. Kolahchi, IEEE Xplore 2017, 1-4
- A. E. Botha, Yu. M. Shukrinov, and M. R. Kolahchi, Nonlinear Dynamics **84**, 1363 (2016)
- A. E. Botha, Yu. M. Shukrinov, and M. R. Kolahchi, Proceedings of the 4th South Africa - JINR Symposium, Few to Many Body Systems: Models, Methods and Applications (Dubna, September 21-25, 2015), edited by F. Šimkovic, pp.135-141 (2016)
- A. E. Botha, Yu. M. Shukrinov, S. Yu. Medvedeva, and M. R. Kolahchi, J. Supercond. Nov. Magn., **28**, 349 (2015)
- Yu. M. Shukrinov, A. E. Botha, S. Yu. Medvedeva, M. R. Kolahchi, and A. Irie, CHAOS **24**, 033115 (2014)
- Yu. M. Shukrinov, S. Yu. Medvedeva, A. E. Botha, M. R. Kolahchi, and A. Irie, Physical Review B, **88**, 214515 (2013)
- M. R. Kolahchi, Yu. M. Shukrinov, M. Hamdipour, A. E. Botha, and M. Suzuki, Physica C, **491**, 63 (2013) (This volume is dedicated to PLASMA 2012: The 8th International Symposium on Intrinsic Josephson Effects and Plasma Oscillations in high- $T_c$  Superconductors, edited by Lutfi Ozyuzer)
- A. E. Botha, Yu. M. Shukrinov, and M. R. Kolahchi, Chaos, Solitons & Fractals, **48**, 32 (2013)
- Yu. M. Shukrinov, M. Hamdipour, M. R. Kolahchi, A. E. Botha, and M. Suzuki, Physics Letters A, **376**, 3609 (2012)
- A. Valizadeh, M. R. Kolahchi, and J. P. Straley, Physical Review B, **82**, 144520 (2010)
- A. Valizadeh, Kh. Jahanbani, and M. R. Kolahchi, Physical Review A, **81**, 023616 (2010)
- Yu. M. Shukrinov, M. Hamdipour, and M. R. Kolahchi, Physical Review B, **80**, 014512 (2009) • also selected and published in the Virtual Journal of Applications of Superconductivity, John R. Clem, Editor
- Y. Azizi, M. R. Kolahchi, J. P. Straley, Proceedings of the 15th Gava Zang Meeting on Condensed Matter Physics, Spring 2009
- M. R. Kolahchi, Journal of Physics: Conference Series **129**, 012039 (2008)
- A. Valizadeh, M. R. Kolahchi, J. P. Straley, Journal of Nonlinear Mathematical Physics **15**, Supplement 3, 397-406 (2008)
- F. Osanloo, M. R. Kolahchi, S. McNamara, and H. J. Herrmann, Phys. Rev. E **78**, 011301 (2008)
- A. Valizadeh, M. R. Kolahchi, and J. P. Straley, Phys. Rev. B **76**, 214511 (2007)
- Nahal, Amjad, Ghods, Khajepour, Reyhani, Kolahchi, J. Appl. Phys. **100** 053503 (2006)

- M. R. Kolahchi, Proceedings of the 12th Gava Zang Meeting on Condensed Matter Physics, Spring 2006
- H. Fazli, R. Golestanian, P. L. Hansen, M. R. Kolahchi, Eur. Phys. Lett. **73**, 429 (2006)
- H. Fazli, R. Golestanian, M. R. Kolahchi, Phys. Rev. E **72**, 011805 (2005)
- M. R. Kolahchi, Proceedings of the International Conference on Physics, Amirkabir University of Technology, 487 (2004)
- M. R. Kolahchi and J. P. Straley, Physical Review B **66**, 144502 (2002)
- M. R. Kolahchi and H. Fazli, Physical Review B **62**, 9089 (2000)  
Behavior of a Josephson junction array with golden mean frustration
- M. R. Kolahchi, Annual Reviews of Computational Physics VIII, D. Stauffer, ed. World Scientific 2000  
Some aspects of dynamics of Josephson junction array at golden mean frustration
- M. R. Kolahchi, Physical Review B **59**, 9569 (1999) Ground state of uniformly frustrated Josephson junction array at irrational frustration
- M. R. Kolahchi, Physical Review B **56**, 95 (1997)  
Finding local minimum states of Josephson junction arrays in a magnetic field
- M. R. Kolahchi, Proceedings of the Second Gava Zang Meeting on Condensed Matter Physics, Spring 1996  
Lattice with quasiperiodic ground state
- M. R. Kolahchi and J. P. Straley, Physical Review B **43**, 7651 (1991)  
Ground state of the uniformly frustrated two-dimensional XY model near  $f=1/2$

### **Publications in Farsi in Iranian Journals**

#### *University?*

M. R. Kolahchi, Iranian Physical Society Quarterly ('Physics Today') **4**, 26 Spring (2014)

#### *Remembering brief moments with John Archibald Wheeler*

M. R. Kolahchi, Iranian Journal of Physics **27**, 54 Spring-Summer (2009)

#### *LZ complexity in chaotic dynamical systems and the quasiperiodic Fibonacci sequence*

D. Arasteh and M. R. Kolahchi, Iranian Journal of Physics Research **1**, 207 (1998)

#### *Tools for evaluating scientific journals*

M. R. Kolahchi, Rahyaf Science Policy Quarterly **15**, 28 (1997)

### **Books and articles translated**

The 100 selected papers of journal Nature published in the 20th century, published on January 7, 1999 in an special issue. Translated with Firooz Arash, 2022

- Kirsten Franklin, Paul Muir, Terry Scott, Lara Wilcocks, and Paul Yates, Introduction to Biological Physics for the Health and Life Sciences, with M.E. AbuKazemi, 2013

- Jearl Walker, Halliday, Resnick, Fundamentals of Physics third volume, with M.E. AbuKazemi and J. Pashaie-Rad, 2010
  - Amit Goswami, Quantum Mechanics, 2nd ed. with Firooz Arash; Markaz-e-Nashr-e-Daneshgahi, 2009
  - Jearl Walker, Halliday, Resnick, Fundamentals of Physics second volume, with M.E. AbuKazemi and J. Pashaie-Rad, 2009
  - Jearl Walker, Halliday, Resnick, Fundamentals of Physics with M.E. AbuKazemi and J. Pashaie-Rad, 2008
  - thirty one articles translated for the Farsi translation of the MacMillan Encyclopedia of Physics
- M. E. AbuKazemi ed. to the Farsi edition, vol. 1 (2002); vol. 2 (2006); vol. 3 (2008)
- Wave physics: oscillations, solitons, chaos by Stephen Nettel, Springer 1995
  - co-translator of: Berkeley physics course vol 3, Waves by Frank S. Crawford
  - articles in several issues of Iranian Journal of Physics, autumn 1994-

**Member of the Board of Editors** of the Iranian Journal of Physics, 2007-2011

**Assistant Editor** to the Farsi translation of the MacMillan Encyclopedia of Physics vol. 1 (2002); vol. 2 (2006); vol. 3 (2008)

Institute for Advanced Studies in Basic Sciences and Bonyad Daneshnam-e-Bozorg Farsi, M. E. AbuKazemi editor

**A Guest Editor** to the Annual Reviews of Computational Physics VIII, edited by Dietrich Stauffer, World Scientific (2001)

### **Collaborations/International Schools and Conferences**

- College of Science, Engineering and Technology, University of South Africa (UNISA), 12 July to 12 September 2015, Johannesburg, South Africa (as guest)
  - 4th South Africa - JINR Symposium
- Few to Many Body Systems: Models and Methods and Applications  
September 21-25, 2015, BLTP JINR Dubna, Moscow Region, Russia (as guest)
- Department of Physics, University of South Africa, Pretoria, South Africa, Dec. 2 – Dec. 16, 2013 (as guest)
  - BLTP, JINR, Dubna, Russia, April 24 – May 4, 2013 (as guest)
  - The 8th International Symposium on Intrinsic Josephson Effects and Plasma Oscillations in High-Tc Superconductors (PLASMA 2012)
- Izmir Institute of Technology, Izmir, Turkey, June 10-13, 2012  
(contributed a poster)
- The International Conference on Theoretical Physics ‘Dubna-Nano2010’  
Dubna, Russia, July 5-10, 2010
  - The International Conference on Theoretical Physics ‘Dubna-Nano2008’  
Dubna, Russia, July 7-11, 2008  
(contributed a poster)
  - Nonlinear Evolution Equations and Dynamical Systems (NEEDS) 2007

L' Ametlla de Mar, Spain, June 15-24, 2007

(contributed a paper with A. Valizadeh and J.P. Straley)

- The Centenary of Einstein's Annus Mirabilis, London, 4-5 March 2005  
organized by The British Society for the history of science
- Summer School on the Theoretical Aspects of Computer Science,  
Institute for Physics and Mathematics (IPM), Tehran 2000
- International Summer School on Statistical Physics and Probabilistic Methods  
in Computer Science  
+ Conference on NP-Hardness and Phase Transitions, ICTP 1999 (as invited  
participant)  
presented poster entitled: Slow dynamics in a Josephson junction array with the  
Golden mean frustration
- STATPHYS20 Paris July 98 (as invited participant) presented poster entitled:  
Ground state of irrationally frustrated Josephson junction arrays (under the  
topic of *Disordered media*)
- ICTP Extended Workshop on Frustrated Systems 1997 (as tutor)
- ICTP Workshop on Josephson-junction arrays 1995 (as invited participant)
- Fundamental Aspects of Quantum Theory, A conference on the Foundations  
of Quantum Mechanics to celebrate 30 years of the Aharonov-Bohm effect, De-  
cember 14-16, 1989, The University of South Carolina, Columbia SC USA (co-  
incident with Andrei Sakharov's death)

### **Theses directed**

#### **Ph.D.**

- Current-Voltage characteristics and parametric resonance features of coupled  
Josephson junctions with Y. Shukrinov (2012)
- Ground state and dynamics of aperiodic Josephson junction arrays: The role  
of the vortex lattice (2011)
- Study of synchronization in a triangular plaquette of Josephson junctions and  
a chain of triangular plaquettes (2008)
- Study of sediment transport in the saltation regime with H. J. Herrmann and  
S. McNamara (2008)
- Study of the collective behavior of rod-like polyelectrolytes using computer  
simulation methods in cooperation with R. Golestanian (2005)

#### **Master's**

- The fractal basin boundary in the dynamical systems (2019)
- Learning through synchronous synaptic activity (2016)
- Moderation and belief propagation in the framework of socio-physics (2015)
- Aspects of scalefree networks in neuronal systems (2014)
- Pyramidal neurons and synaptic plasticity (2013)
- Investigation of the neuron's dynamics within the Morris-Lecar model (2012)

- Investigation of synchronization and bursting in a triangular array of Morris-Lecar neurons with S. Emadi (2011)
- Study of dynamic memory of gradually changing objects (2010)
- The Hodgkin-Huxley model of the neuron with S. Emadi (2010)
- Bose-Einstein condensation and formation of vortex lattices in dilute gases (2009)
- Levitation using the diamagnetic property (2006)
- Study of the homogeneous cooling and inelastic collapse in a one-dimensional granular system using the event driven molecular dynamics method (2004)
- Study of the internet traffic within the Ohira-Sawatari model (2003)
- Dynamics of a globally coupled series array of Josephson junctions (2003)
- Superheating field of a superconducting slab (2003)
- Synchronization of coupled oscillators with nearest neighbor coupling (2001)
- Numerical calculation of entropy from trajectory of motion (2001)
- Ground state of a quasiperiodic Penrose lattice of Josephson junctions in presence of a perpendicular magnetic field (2001)
- Glassy behavior in Josephson junction arrays (1999)
- Ground state of Josephson junction arrays in transverse magnetic field (1999)
- Determination of some characteristic dynamical parameters of chaotic systems (1995)

#### **Conferences organized**

- Chaired the organizing committee of the 27th Annual IASBS Meeting on Condensed Matter Physics, celebrating IASBS 30th Anniversary, Online May 18-19, 2022 (28-29 Ordibehesht 1401)
- served on the organizing committee of the 16th Gava Zang meeting on Condensed Matter Physics, Institute for Advanced Studies in Basic Sciences, Spring 2010
- served on the organizing committee of the 15th Gava Zang meeting on Condensed Matter Physics, Institute for Advanced Studies in Basic Sciences, Spring 2009
- served on the organizing committee of the 14th Gava Zang meeting on Condensed Matter Physics, Institute for Advanced Studies in Basic Sciences, Spring 2008
- served on the organizing committee of the 13th Gava Zang meeting on Condensed Matter Physics, Institute for Advanced Studies in Basic Sciences, Spring 2007
- served on the scientific committee of the Iran's Annual Physics Conference for the year 2003 • organized the 8th Gava Zang meeting on Condensed Matter Physics, Institute for Advanced Studies in Basic Sciences (IASBS), Spring 2002
- organized the 7th Gava Zang meeting on Condensed Matter Physics, IASBS, Spring 2001
- organized the 6th Gava Zang meeting on Condensed Matter Physics, IASBS, Spring 2000

- a member of the organizing committee of the First Regional Summer School on Scaling and Disordered Systems 3-16 July 1999, Gava Zang, Zanjan, Iran
- served on the scientific committee of the Iran's Annual Physics Conference for the year 1999
- organized the 5th Gava Zang meeting on Condensed Matter Physics, IASBS, Spring 1999
- organized the 4th Gava Zang meeting on Condensed Matter Physics, IASBS, Spring 1998

#### **Courses taught**

- Graduate  
Condensed matter physics, Statistical physics, Quantum mechanics, Computational physics, Superconductivity, Neural excitability
- Undergraduate  
practically every course on the physics curriculum

#### **Contribution to Special Academic Programs**

- talk at CHAOS2018 11th Chaotic Modeling and Simulation International Conference 5 - 8 June 2018 Rome, Italy (held at the Faculty of Economics, "Sapienza" University of Rome) : Chimera States as Drive-Response Systems
- talk at the Physics Colloquium, IASBS Feb. 2018 : The first nuclear reactor by man: Chicago Pile-1 (CP-1)
- talk entitled "Cassini's Mission" at the School for gifted undergraduate students, IASBS, Feb. 2018
- talk at ICSM2016 5th International Conference on Superconductivity and Magnetism 24 - 30 April 2016 Fethiye, Turkey : Chimera States in an Intrinsically Coupled Stack of Intrinsic Josephson Junctions
- talk at the 21th Gava Zang meeting on Condensed Matter Physics, IASBS, May 2015 : Coherence coexists with incoherence
- talk at the 9th International Symposium on Intrinsic Josephson Effects and THz Plasma Oscillations in High-Tc Superconductors (THz-PLASMA 2014), Kyoto Univ. Kyoto, Japan, Nov. 30-Dec. 3, 2014 : Structured Chaos in a Devil's Staircase of the Josephson Junction  
<http://sk.kuee.kyoto-u.ac.jp/plasma2014/>  
<http://sk.kuee.kyoto-u.ac.jp/plasma2014/wp-content/uploads/2014/11/ScientificProgram.pdf>  
<http://sk.kuee.kyoto-u.ac.jp/plasma2014/wp-content/uploads/2014/04/GP1.jpg>
- invited talk at the 2nd One Day Conference on Superconductivity and its Applications held at Dept. of Electrical Engineering, Sharif University of Technology, Feb. 28, 2011 : Synchronization Effects in a Strongly Coupled Nano-Mechanical Single-Electron Transistor
- lectures entitled "Memory: A Basic Model" at the School for gifted undergraduate students, IASBS 2011



- presented a talk at the 12th Gava Zang meeting on Condensed Matter Physics, Institute for Advanced Studies in Basic Sciences (IASBS), Spring 2006
- talk entitled “Starting on granular matter” at the School for gifted undergraduate students, IASBS 2003
- three lectures entitled “Life is nonlinear” at the School for gifted undergraduate students, IASBS 2001
- two lectures entitled “The role of simulations in physics” at the School for gifted undergraduate students, IASBS 1998

### **Positions in Administration**

- Member of the University’s Board of Supervisors (2005-2010, 2017-2022)
- Member of the Supervisory Committee (2009-2010)
- Head of the Physics Department (2007-2009)
- Director of the library (2001-2003)
- Member of the research council (2000-2003)

### **Professional Membership**

Associate Member of Sigma Xi (initiation ceremony 1982)  
 Member of Sigma Pi Sigma (Honor Society of Physics Students, init. 1985)  
 Member of the Iranian Physical Society  
 Lifetime member of the American Physical Society

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