CHAOS2020

Turned into Virtual

13th Chaotic Modeling and Simulation International Conference

9 - 12 June, 2020, Florence, Italy

Book of Abstracts.

Special Session on

Nonlinear Localization in Lattices, .

Special Session Chair: JFR Archilla

Special Session on Nonlinear Localization in Lattices in Chaos 2020 (turned virtual) . Florence, Italy, June 9-12, 2020.

Wednesday, June 10, 2020:

Chair: Juan F.R. Archilla,
Talks (alphabetical order):

Localized waves in silicates.
What we know from experiments?

Juan F.R. Archilla[1,*], F. Michael Russell[2], Santiago Medina-Carrasco[3]

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Abstract: Since the latest review about solitary localized waves in muscovite, called quodons, [FM Russell, Springer Ser. Mater Sci. 221 (2015) 3] there have been many developments, specially from the point of view of experiments, published in several journals. The breakthrough hypothesis that was advanced in that review that dark tracks were produced by positive electrical charge moving in a localized wave, either transported by swift particles or by nonlinear localized waves, has been confirmed by experiments in muscovite and other silicates. In this paper we review the experimental results, some already published and some new, specially the phenomenon of charge transport without an electric field, called hyperconductivity. We also consider alternative explanations as phase transitions for other tracks. We also describe numerical simulations that have confirmed the order of magnitude of quodons energy and calculations underway to determine more properties of electron and hole transport by quodons.

JFR Acknowledges grant 2019/FQM-280 from Junta de Andalucia, Spain and SM-C acknowledges grant from PPITUS-2018.

Keywords: Layered silicates, nonlinear waves, quodons, kinks, breathers, charge transport, hyperconductivity.

References:

FM Russell, Springer Ser. Mater. Sci. 221 (2015) 3-33..
FM Russell, Springer Ser. Mater. Sci. 221 (2015) 475-559.
JFR Archilla, FM Russell, Letters on Materials 6 (2016) 3-8.
FM Russell, JFR Archilla, F Frutos, S Medina-Carrasco, EPL 120 (2017) 46001.
FM Russell, MW Russell, JFR Archilla, EPL 127 (2019) 16001

Dynamics of Discrete Breathers in Normal Modes in a Symmetric Lattice

YusukeDoi, Reiichiro Wada, and Akihiro Nakatani

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Abstract:A nonlinear lattice which has a particular symmetry supports smooth mobility of discrete breathers (DBs) or intrinsic localized modes (ILMs). This lattice, that is called the pairwise interaction symmetric lattice (PISL), is an extension of Fermi-Pasta-Ulam (FPU) β lattice and is invariant with respects to a certain map in the complex normal mode coordinate. In this study, we numerically investigate interaction between DB and normal modes in both FPU-β lattice and PISL. Difference of dynamics of DB is discussed from the viewpoint of the symmetry of lattices.

Keywords: Discrete breather, Intrinsic localized mode, Fermi-Pasta-Ulam β lattice, Pairwise interaction symmetric lattice.

The Wonderful World of Flatbands:

From Basics of Compact Localized States to Caging of Classical and Quantum Interactions

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Abstract: Certain lattice wave systems in translationally invariant settings have one or more spectral bands that are strictly flat or independent of momentum in the tight binding approximation, arising from either internal symmetries or fine-tuned coupling [1]. These flat bands support compact localized eigenstates (CLS) and display remarkable strongly interacting phases of matter. Originally considered as a theoretical convenience useful for obtaining exact analytical solutions of ferromagnetism, flat bands have now been observed in a variety of settings, ranging from electronic systems to ultracold atomic gases and photonic devices [1],[2]. A finetuning of additional nonlinear interactions allows to continue CLS into compact discrete breathers [3]. Combining finetuning for lattices with All Bands Flat and classical and quantum interactions results caging of interactions [4], and ultimately in the explicit derivation of Many-Body-Flat-Band Hamiltonians [5].

[1] *Artificial flat band systems: from lattice models to experiments*. Daniel Leykam, Alexei Andreanov, Sergej Flach. Adv. Phys.: X 3, 1473052 (2018)

[2] *Photonic Flat Bands.* Daniel Leykam, Sergej Flach. APL PHOTONICS 3, 070901 (2018)

[3] *Compact Discrete Breathers on FlatBand Networks*. C. Danieli, A. Maluckov, S. Flach. Low Temperature Physics / FizikaNizkikhTemperatur44, 865 (2018)

[4] *Caging of Short-Range Interaction in All Band Flat Lattices*. Carlo Danieli, Alexei Andreanov, ThudiyangalMithun, Sergej Flach. arXiv:2004.11871 & arXiv:2004.11880

[5] *Many-Body Flatband Localization*. Carlo Danieli, Alexei Andreanov, Sergej Flach. arXiv:2004.11928

Keywords: Flatbands, compact localized states, caging, fine tuning, classical and quantum many body interactions, compact discrete breathers.

Singular amplification of low-frequency fluctuations in optical spectra of ^{4}He quantum liquid

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Abstract: The optical spectra of impurity atoms (molecules) in ^{4}He quantum liquid are considered. It is shown that the main distinguishing property of the liquid phase to maintain local pressure in all its macro- and meso-regions leads to a huge increase in the contribution of low-frequency density fluctuations to the electronic transitions of impurity atoms, diverging as ω^{-1} with a decrease of the frequency ω of fluctuations. As a result of this divergence, the zero phonon line (ZPL) in the optical spectrum of an impurity atom acquires finite broadening and asymmetric shape already in the limit of zero temperature. Another consequence of this divergence is an abnormally strong dependence on the width and shape of ZPL on the strength of the vibronic interaction of the electronic transition. The optical spectra observed in [1, 2] for impurity atoms of Au, Cu, Cs, and Dy in liquid ^{4}He at low temperatures are explained.

1. P. Moroshkin, V. Lebedev and A. Weis, EPL, 96, 26002 (2011).

2. P. Moroshkin, A. Borel, and K. Kono, PRB 97, 094504 (2018).

Keywords: Quantum liquids, density fluctuations, zero-phonon lines.

Localized modes induced by distributed impurities in resonant circuit arrays

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Abstract:A localized mode is generated by a distributed impurity induced by en external coil placed on a resonant circuit array. The localized mode is possibly applicable to wireless power transfer since the magnetic flux is spontaneously localized around the external coil. However, the frequency of the localized mode fluctuates for the position of the external coil. We investigated how to reduce the frequency fluctuation by adjusting the interval of resonant circuits and the diameter of the external coil. A specific design that makes the frequency fluctuation almost zero has found numerically. The circular coils in the resonant circuit array are overlapped of almost 40% of its diameter, and the diameter of the external coil is almost double that of the coil in the resonant circuit array. Also, the design is confirmed by analytical solutions which are derived for approximated models.

Keywords: Localized mode, Resonant ciruict array, Distributed impurity, Wireless power transfer.

Supersonic crowdions and voidions

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Abstract: Rapid development of new technologies is often associated with realization of non equilibrium states of materials where new mechanisms of structure evolution different from conventional ones can emerge. One of examples of this phenomenon is formation of crowdions - a particular type of an interstitial defect embedded in a close packed atomic row. It was demonstrated that crowdions can vary by configuration and velocity being able to promote in supersonic and subsonic mode. Compression in part of the crystal naturally initiates the rarefaction in the neighboring zone arousing formation of vacancies and their delocalized variations – voidions able to travel along closely packed crystallographic directions.

The paper presents a state of the art overview on recent advances in the field of crowdion and voidion dynamics in crystals as investigated by means of atomistic simulations.

Presented results can be useful for providing new insight in the analysis of defect rearrangement and accumulation in severely impacted materials.

KEA thank for the financial support the Council of the President of the Russian Federation for state support of young Russian scientists, grant No MD-3639.2019.2 IASh acknowledges the financial support of Russian science foundation, grant No 19-72-00109

Keywords:atomistic simulations, nonlinear dynamics, crystal lattice, crowdion, voidion, extreme impacts.

Localization of negative-effective-mass electron by supersonic kink in 1D lattice

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Abstract: Supersonic kink in nonlinear atomic chains with realistic interatomic potential produces local compression of the lattice. Lattice compression enhances electron Fermi energy and produces for an electron a local potential hill through the deformation potential of the proper sign. Such potential hill can localize (trap) negative-effective-mass (NEM) electron and such unconventional trapping can be observed in the simplest tight-binding model of electron band [1]. Here we confirm numerically the possibility of the trapping of NEM electron with the energy above the top of its tight-binding band by supersonic kink in the nonlinear lattices with two different interatomic potentials, the α-β FPU and Morse, and with the proper electron-phonon interaction. We reveal that the localization length of the electron wave function is much larger than lattice period in the case of adiabatic electron dynamics, electron localization length saturates for small-amplitude kink and continuously decreases with the increase of the velocity of the ultradiscrete supersonic kink. The ultradiscrete supersonic kinks, which were revealed in the nonlinear lattices with different interatomic potentials with hardening anharmonicity, have approximately sinusoidal envelope with the “magic” wave number [2,3]. The compression supersonic kink in the lattice with realistic asymmetric interatomic potential is accompanied by the local lattice expansion [2], which can trap positive-effective-mass electron. The work of Yu.A.K. was funded by the Russian Foundation for Basic Research according to the research project No. 18-29-19135 mk. The work of A.P.Ch. was funded by RFBR and DFG according to the research project No. 20-52-12004.

[1] Yu. A. Kosevich, Journal of Physics: Conf. Series 883, 012021 (2017).

[2] Yu. A. Kosevich, Phys. Rev. Lett. 71, 2058 (1993).

[3] Yu. A. Kosevich, R. Khomeriki, S. Ruffo, Europhys. Lett. 66, 21 (2004).

Keywords: Supersonic kink, electron, deformation potential, localization length.

Analysis of discrete breathers in the mass-in-mass chain in the state of acoustic vacuum

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Abstract: Present study concerns the dynamics of special localized solutions emerging in the mass-in-mass anharmonic oscillatory chain in the state of acoustic vacuum. Each outer element of the chain incorporates an additional, purely nonlinear mass attachment. Analytical study of the later, revealed the distinct types of stationary discrete breather solutions. Along with the analytical description of their spatial wave profiles we also establish their zones of existence in the space of system parameters. Stability properties of these solutions are assessed through the linear analysis (Floquet). All analytical models are supported by the numerical simulations of the full model.

Keywords: Acoustic vacuum, Mass-in-mass chain, Breather solutions.

This work was supported by Russian Foundation for Basic Research according to the research project no. 18-03-00716.

Management of intrinsic localized modes in a driven nonlinear cyclic electrical transmission line

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Abstract: Nonlinear electric transmission lines continue to play an important role in the understanding of the dynamics of intrinsic localized modes (ILMs). The development of a saturable nonlinearity with MOS capacitors in a cyclic transmission line has enabled the test to determine if transition points existed where the ILM could move freely. The evolution between large amplitude spatial modes (LSMs) and ILMs in a nonlinear cyclic electrical line with saturable capacitors also has been studied in some detail. The most dramatic feature is that by simply changing the driver frequency the spectrum can evolve continuously from an LSM pattern distributed around the ring to multiple ILMs localized on a few sites and visa versa. Through this novel nonlinear excitation and switching channel either energy balanced or unbalanced LSMs and ILMs may occur around the ring.

Keywords: Intrinsic Localized Mode, Spatial modes, electric cyclic lattice, saturable nonlinearity

Increased mobility of discrete breather in lattices with odd inter-site and on-site anharmonic potentials

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The mobility of high-frequency discrete breathers in monatomic chains with on-site and inter-site potentials taking into account the nearest neighbors interactions is numerically investigated.It was found that the odd (cubic and fifth-order) interatomic anharmonic interaction strongly affects the mobility of breathers, sharply increasing the distance that it propagates without being trapped.The enlargement of propagating distance can exceed many thousands times. It was also found that the correctly chosen fifth anharmonicity leads to an inversion of stability between the bond-centered and site-centered breathers and to the low-radiative propagation of discrete breathers along the chain. According to our preliminary study, these conclusions hold also for discrete breathers in iron, copper, niobium and other simple metals.We also found a strong increase of mobility of discrete breathers byeven on-siteanharmonic potential; this increase may also exceed many thousands.

Keywords: Nonlinear dynamics, discrete breathers, intrinsic localized modes

Observation of propagation of nonlinear localized oscillations in a mass-spring chain with excitation and attenuation ends

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Abstract: Mobile type of nonlinear localized oscillations have been excited by making mechanical experiments using a mass-spring chain which emulates the Fermi-Pasta-Ulam (FPU) one of β type [Phys. Lett. A 382 (2018) 1957-1961]. Letting the weight at one end of the chain driven sinusoidally with high frequency and large amplitude, localized oscillations have been excited intermittently near the end and propagated down the chain one after another at a constant speed. Because of the finite length of the chain, the localized oscillations traveling and reflected at the other end immediately interact and make the oscillation mode of the chain complicated. To pick up and observe one-direction propagation of the localized oscillations, we set an apparatus near the driving end to control the approach of excited oscillations into the chain and provide attenuation effects at the other end to suppress the reflection. In this paper we consider the relation of the speed of the propagation tothe driving frequency and amplitude.

Keywords: Intrinsic localized mode (ILM), Discrete breather (DB), discrete nonlinear system, Fermi-Pasta-Ulam (FPU) chain, piecewise linear spring, mobile ILM

Program - CHAOS 2020

13th Chaotic Modeling and Simulation International Conference

9 - 12 June 2020, Florence, Italy

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Wednesday, 10.6.2020

TIME ZONE: CEST — Central European Summer

11:30- 12:00 Preparation, interconnections

12:00-13:30
SCS4
Special and Contributed Sessions

Room 1	Room 2	Room 3
Special Session **Nonlinear Localization in Lattices I** **Chair: Juan F.R. Archilla**	**Special Session** **Liutex and Third Generation of Vortex Identification IV** **Chair:** Yisheng Gao	**Maps**
Sergej Flach The Wonderful World of Flatbands: From Basics of Compact Localized States to Caging of Classical and Quantum Interactions	**Xiaoshu Cai, Xiangrui Dong and Wu Zhou** Experimental Study on vortex structures in turbulent boundary layer by Liutex identification	**Shunji Kawamoto** Limit Cycle Analysis for 2-D Time-Dependent Logistic Maps
Yosuke Watanabe Observation of propagation of nonlinear localized oscillations in a mass-spring chain with excitation and attenuation ends	**Pengxin Cheng, Nan Gui, Xingtuan Yang, Jiyuan Tu, Shengyao Jiang** A comparison of Liutex with other vortex identification methods on the multiphase flow past a cylinder using LBM on GPU	**Domenico Lippolis, Kensuke Yoshida** Eigenfunctions of the Perron-Frobenius operator for uniformly hyperbolic area-preserving maps
Yusuke Doi, Reiichiro Wada, Akihiro Nakatani Dynamics of Discrete Breathers in Normal Modes in a Symmetric Lattice	**Xuan Trieu, Chaoqun Liu** Liutex and Proper Orthogonal Decomposition for Vortex Structure in the Wake of Micro Vortex Generator	**André M. McDonald, Michaël A. van Wyk** Estimation of Ergodic Maps with Unified Power Spectra from Causal Sequences of State Density Functions
Masayuki Kimura, Yamato Mogi, Shinji Doi Localized modes induced by distributed impurities in resonant circuit arrays	**Pushpa Shrestha, Chaoqun Liu** Comparison between Q, Δ, λ2, λci and Liutex Criteria	**Belqassim Bouteghrine, Camel Tanougast, Said Sadoudi** Application of New 4-D Chaotic Map for Secure IP-Communication
Masayuki Sato, Masato Sakai, A. J. Sievers		**María Muñoz-Guillermo** On the complexity of the q-deformed logistic map

Management of intrinsic localized modes in a driven nonlinear cyclic electrical transmission line		
Yuriy A. Kosevich, Alexander P. Chetverikov, Yusuke Doi Localization of negative-effective-mass electron by supersonic kink in 1D lattice		

13:30- 13:45 Preparation, interconnections

13:45-14:30
Room 1 (PS4)
Plenary Session
Chair: Christos H Skiadas
Speaker: Nikolay V. Kuznetsov
Title: Theory of hidden oscillations (Dedicated to Gennady Alekseevich Leonov (1947-2018))

14:30- 15:00 Break

15:00- 15:15 Preparation, interconnections

15:15-16:00
SCS5
Special and Contributed Sessions

Room 1	Room 2	Room 3
Theory	**Special Session** **Liutex and Third Generation of Vortex Identification V** **Chair: Hongyi Xu**	**Generator**
Vyacheslav M. Somsikov The evolution and breaking symmetry in the physics	**Kan Xie, Jiahui Song** Numerical Study on influence of vortex structure of jet in crossflow in axisymmetric transonic nozzle	**Volodymyr Rusyn** Pulse chaotic Chua's generator
Vyacheslav Somsikov, Svetlana Azarenko Problems of creating an evolutionary picture of the world	**Xiangyang Xu, Wennan Zou** No vortex in flows with straight streamlines—Some comments on real Schur forms of velocity gradient ∇v	**S. Varbanets, Ya. Vorobyov** Inversive generators of second order
Alexander V. Sosnitsky, Anatoly I. Shevchenko The Universe multiphase meta-reduction: The Harmon (Mandala), continuum (Prana), discretization, formalization, knowledge, cognition, condensation and Absolute Nothing	**Yang Huang, Decheng Wan** Application of Liutex for Analysis of Complex Wake Flow Characteristics of Wind Turbine	**Zongchao Qiao, Ina Taralova, Mazen Saad, Safwan El Assad** Chaotic generator design for encryption purposes
	Zhen Ren, Weiwen Zhao, Decheng Wan Visualization of Complex Flow Field of Ship Self-Propulsion and Zigzag Manoeuvrability	**Margarida Facao, M. Inês Carvalho** Extreme solutions of the cubic complex Ginzburg-Landau equation with nonlinear gradient terms

16:00- 16:15 Preparation, interconnections

16:15-17:45
SCS6
Special and Contributed Sessions

Room 1	Room 2	Room 3
Special Session Nonlinear Localization in Lattices II Chair: Juan F.R. Archilla	**Special Session Liutex and Third Generation of Vortex Identification VI Chair: Wennan Zou**	**Plasma**
Aleksandr Shelkan, Mihail Klopov, Vladimir Hizhnyakov Increased mobility of discrete breather in lattices with odd inter-site and on-site anharmonic potentials	**Charles Nottage** Visualization of The Batchelor Vortex with Liutex and Liutex Core Line Methods	**Dan G. Dimitriu, Sebastian Popescu, Maricel Agop** Double Layer in Plasma as an Interface Generated through the Interaction of Two Fractal Fluids
Irina Koroleva (Kikot), Nina Breitman (Rayzan), Margarita Kovaleva, Yuli Starosvetsky Analysis of discrete breathers in the mass-in-mass chain in the state of acoustic vacuum	**Vishwa Patel, Yonghua Yan, Xiangrui Dong, Chaoqun Liu** Correlation Analysis between low frequency shock oscillation and Liutex in SBLI	**Dan G. Dimitriu, Sebastian Popescu, Maricel Agop** Chaotic states of Plasma Triggered by the Nonlinear Dynamics of Simple and Multiple Double Layers
Juan F.R. Archilla, F. Michael Russell, Santiago Medina-Carrasco Localized waves in silicates. What we know from experiments?	**Xiaoping Chen, Renfei Kuang, and Shaorong Wang** Application Modified Liutex-Omega method to High-Temperature Supersonic Turbulent Channel Flows	**V J Law, D P Dowling** Application of microwave oven plasma reactors for the formation of carbon-based nanomaterials
Sergey V. Dmitriev, Igor A. Shepelev, Elena A. Korznikova Supersonic crowdions and voidions	**Xiang Li, Qun Zheng, Bin Jiang** A Classification and criterion of Vortex Boundary based on Eigenvector	**Julio J. Martineli, Nikolay Kryukov** Study of turbulent transport in magnetized plasmas with flow using symplectic maps
Vladimir Hizhnyakov, Vadim Boltrushko Singular amplification of low-frequency fluctuations in optical spectra of 4He quantum liquid		

17:45- 18:00 Preparation, interconnections

18:00-18:45
Room 1 (PS5)
Plenary Session
Chair: Christos H Skiadas
Speaker: Elena Babatsouli
Title: Order in disordered speech data

18:45- 19:00 Preparation, interconnections

19:00-20:00 SCS7 Special and Contributed Sessions		
Room 1	**Room 2**	**Room 3**
Astronomy	**Special Session** **Liutex and Third Generation of Vortex Identification VII** **Chair:** Xiangrui Dong	**Nano**
Valeriy S. Abramov Higgs boson and Higgs field in fractal models of the Universe: active femtoobjects, new Hubble constants, solar wind, heliopause	**Weiwen Zhao, Decheng Wan*** Vortex Identification for Study of Flow Past Stationary and Oscillating Cylinder	**Alexandr Valyaev, Sergey Petrov, Alexei Valiaev Gurgen Aleksanyan** Ways to Accelerate Nanotechnologies Implementation in the Health Care System
Paniveni U. Shankar Supergranulation – A Chaotic Phenomenon	**Jie Chen, Guoyu Wang, Biao Huang, Qin Wu** Numerical investigation of the cavitation vortex interaction around a twisted hydrofoil with emphasis on the vortex identification method	**Alexandr Valyaev, Sergey Petrov, Aleksey Valiaev, Oleg Apanasyuk** Application of Special Nanomaterials in Medicine
Nada Jevtic A nonlinear search for delta□Scuti-like pulsations across the whole frequency spectrum	**Xiaoyang Zhao, Jie Chen, Biao Huang, Guoyu Wang** The identification of tip leakage vortex of an axial flow waterjet pump by using Omega method and Liutex	**Philippe Beltrame** Selective transport of airborne microparticles in a microgravity environment
	Yumeng Tang, Yangwei Liu Comparison of Vortex Identification Methods for Corner Separation flow in a Compressor Cascade	
End of the 2nd Day		