BOOK OF ABSTRACTS

1ST CAMEROONIAN-SPANISH WORKSHOP ON NONLINEAR PHYSICS

Web site: https://grupo.us.es/gfnl/1CSW2025/

Time and premises: Thursdays 22-05-2025 and 29-05-2025.
Departamento de Física Aplicada I. ETSII, Universidad de Sevilla,
Avenida Reina Mercedes s/n; 41012-Sevilla, Spain

Organizers

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Funding
Project MICIU PID2022-138321NB-C22 and Universidad de Sevilla VIIPPITUS-2025

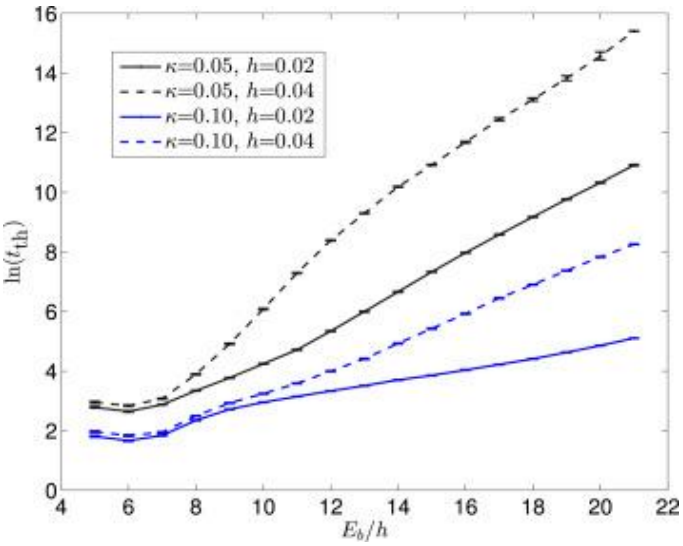
Speakers and titles (alphabetical order)

Session chairs

Session 1. Julia Cantisán Gómez.   **Session 2. Niurka Rodríguez Quintero.**
Session 3. Faustino Palmero Ramos.   **Session 4. Faustino Palmero Acebedo.**

Juan FR Archilla, Universidad de Sevilla
Jānis Bajārs, University of Latvia
Sergej Flach, IBS, Daejeon, Republic of Korea
Quasi-exponential thermal decay of breathers in nonlinear lattices.

Abstract: We demonstrate that a single scalar parameter, the participation number *P*, is close to *N*/2 when the system is thermalized [1] Then we study four different systems and study their path to equilibrium when a given energy is delivered to a single site in a previously thermalized system. We obtain numerically the average thermalization time for 10 or more thousand simulations for each given system, thermal energy and delivered energy. We found that the thermalization time increases in quasi-exponential form for the four different systems. The latter, composed of Josephson junctions shows localization in frequency instead of position. The long lifetime of some breathers may hinder the evacuation of heat in tokamak fusion reactors [2], because it has been demonstrated that alpha particles produce very many energetic breathers which can seriously hinder heat evacuation. Moreover, breathers can bind to an electric charge compromising the isolation needed to keep the intense magnetic field confining the ions within the plasma chamber.



Funding: JFRA thanks grant PID2022-138321NB-C22 funded by MICIU/AEI/ 10.13039/501100011033 and ERDF/EU, and travel help both from Universidad de Sevilla VIIPPITUS-2024, and PCS at the Institute of Basic Science. JB acknowledges financial support from the Faculty of Science and Technology of the University of Latvia. SF acknowledges the financial support from the Institute for Basic Science (IBS) in the Republic of Korea through the Project No. IBS-R024-D1.

Computational resources The computational resources have been provided by a dedicated computer Intel Core i7-12700KF with 12 processors of 12th generation at 3.60 GHz with 64 GB RAM, managed by JB at the University of Latvia, and by the use of Hércules, the supercomputer of the Scientific Computing Center of Andalucía (CICA), where up to a thousand processors have been used for parallel processing.

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[1] JFR Archilla; J Bajārs, S Flach. Thermal lifetime of breathers. Physica D 473 (2025) 134551
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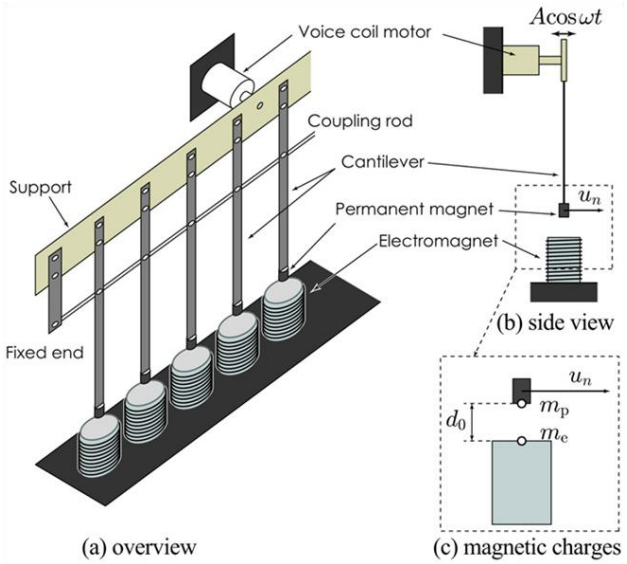
Juan FR Archilla, Universidad de Sevilla
Masayuki Kimura, Setsunan University
Yusuke Doi, University of Osaka.
Víctor J Sánchez-Morcillo, Universitat Politècnica de València
Time Crystals. A space-time modulated system

Abstract: Crystals are periodic structures which appear as the symmetry breaking of the continuous invariance of space translations, which becomes only invariant for a discrete set of transformations. Equally time crystal appear as the symmetry breaking of a forced system with period T, the symmetry being reduced for example to a multiple of T. True time-crystals, however, need more properties, such as cryptoequilibrium and lack of entropy production. Modulation in space and time by a wave will produce space-time crystals [1,2,3]. We propose a model initially built by [4], where the modulation of a cantilever array is obtained via electromagnets. We obtain the change in the linear spectrum when the system is modulated in time, space and space-time.



Through numerical simulations we study the full nonlinear system, showing the existence of breathers, either bond-centered or particle-centered. The emergence of breathers with certain frequencies corresponds to a time-crystal.

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Julia Cantisán[1], Alexandre Rodríguez-Nieto[2], Jesús M Seoane[2], Miguel AF Sanjuán[2].

Transient dynamics for a searcher trapped in a potential well

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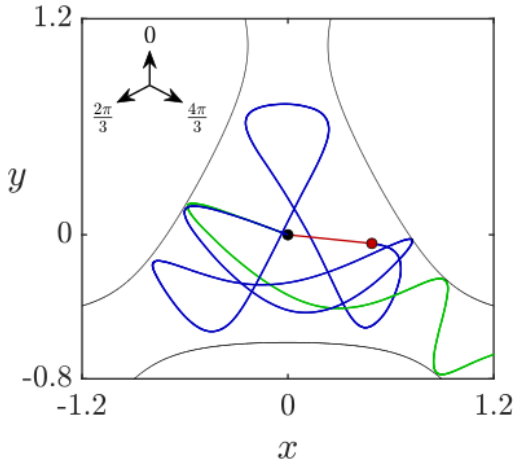
[2]*Nonlinear Dynamics, Chaos and Complex Systems Group, Departamento de Biología y Geología, Física y Química Inorgánica, Universidad Rey Juan Carlos, Tulipán s/n, 28933 Móstoles, Madrid, Spain*

Abstract: In this talk I will focus on studying the transient dynamics of a searcher confined in a potential well. I present a strategy, called Resetting, that minimizes the escape time of the searcher. Restarting a stochastic escape process may accelerate its completion as an opportunity to take a more favorable path is given each time reset is applied. I present the results for both a stochastic searcher and a deterministic chaotic searcher. In the case of a stochastic particle, the phenomenon is commonly referred to as Stochastic Resetting, whereas in the case of a deterministic particle whose motion is chaotic, we denote it as Chaotic Resetting. For Stochastic Resetting I show that resetting is an optimal strategy even when the particle is trapped in a potential well. I present different resetting protocols and the requirements for the strategy to work. Secondly, for Chaotic Resetting, I introduce this technique that can be applied in real systems where uncertainty is unavoidable. I focus on the need of a chaotic system with mixed phase space.



Funding: This work has been financially supported by MCIN/AEI/10.13039/501100011033 and by "ERDF A way of making Europe" (Grant No. PID2023-148160NB-I00).

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Jesús Cuevas Maraver. Universidad de Sevilla.
Julia Cantisán Gómez. Universidad de Huelva.
Fractional kinks and breathers

Abstract: Dispersive differential equations with fractional derivatives is a topic of increasing interest in the last year. Despite this, there is a lack of physical applicability in most of such studies. In this talk we show some recent results on the sine-Gordon equation using Caputo derivatives for temporal ones and Riesz derivatives for spatial ones. The first type of derivatives has been shown to model materials with memory effect as viscoelastic ones; the second of such derivatives emerge as a long-range effect in domains with many branches (as e.g. blood vessels) or by applying *ad hoc* phase masks in optical cavities. Our study covers the effect of introducing such fractional derivatives both in topological (kinks) and non-topological (breather) solitons.

Funding: JC-M acknowledges funding from the Spanish Research Agency (AEI) and UE/ERDF program (project PID2022-143120OB-I00).

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Jesús Cuevas-Maraver, Universidad de Sevilla
2D breathers in sine-Gordon equation: there's life beyond integrability

Abstract: The 1D sine-Gordon equation is one of the very few models that supports the existence of breathers. This is caused by the total integrability of the sine-Gordon equation. However, when working in two-dimensional domains, it is possible to find such solutions as long as the domain is finite, although one has to pay the price of losing the exponential decay and the emergence of wings, giving rise to nanoptera (a.k.a. pterobreathers). In this talk, I will show how 2D breather stripes are modulationally unstable and this stability brings about the emergence of radial breathers. Afterwards, it will be shown the possibility of finding 2D breathers that can even be stable.

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Eduardo Ariel Menéndez Proupin. Universidad de Sevilla

Molecular dynamics of hydrogen bonds. Application to materials used in optoelectronics.

Abstract: Hydrogen bonds appear in many different molecules as, for example, DNA. However, our interest is in perovskite, a material used in solar cells. The tandem perovskite/Si in particular having a very good combination of efficiency and durability. We present our work on molecular dynamics of perovskite and the behaviour of the hydrogen bonds and its consequences for solar technology.

Faustino Palmero, Universidad de Sevilla
Ricardo Chacón, Universidad de Extremadura

Autoresonance in linear and nonlinear damped-driven oscillators

Abstract: Expanding on a recent energy-based theory of autoresonance in chains of coupled oscillators, this study investigates the phenomenon in systems of linearly coupled nonlinear oscillators. Analytical equations governing autoresonance forces are derived for the linear scenario, with further generalization to nonlinear chains using both perturbative methods and numerical simulations.

Niurka Rodríguez Quintero, Bernardo Sánchez-Rey, David Mellado-Alcedo.
Universidad de Sevilla.

Stability of solitons in the parametrically driven and damped nonlinear Dirac equation

Abstract: Certain optical waveguide arrays can be modeled by the nonlinear Dirac (NLD) equation, which admits gap soliton solutions. A key open problem in this context is the stability of stationary solitons, particularly under parametric driving and damping. In the current investigation, we analyze the *linear stability of two exact stationary solutions* of a *parametrically driven, damped NLD equation* [1]. This work was motivated by the study of the parametrically damped nonlinear Schrodinger equation [2,3]. By solving the associated eigenvalue problem obtained through linearization around stationary solutions, we confirm that one solution is always unstable, consistent with previous variational predictions, while the other can be stabilized by sufficient damping. Moreover, we observe an *oscillatory instability,* where the solution initially stable may become unstable due to a collision of two internal modes. This phenomenon was previously reported in the nonlinear Schrödinger equation [1]. The stability curve that delineates the boundary between the stable and unstable regions is obtained for different values of the frequency of stationary solution.

The accuracy of the stability curve depends on the frequency. Although the use of Chebyshev discretization reduces the occurrence of spurious eigenvalues in the numerical spectrum, we emphasize the need for a more robust algorithm that can *fully suppress discretization-induced artifacts*.

It is also observed that in the stable region, the stable solution behaves as an attractor of the dynamics such that the unstable solution evolves towards the stable stationary solution.

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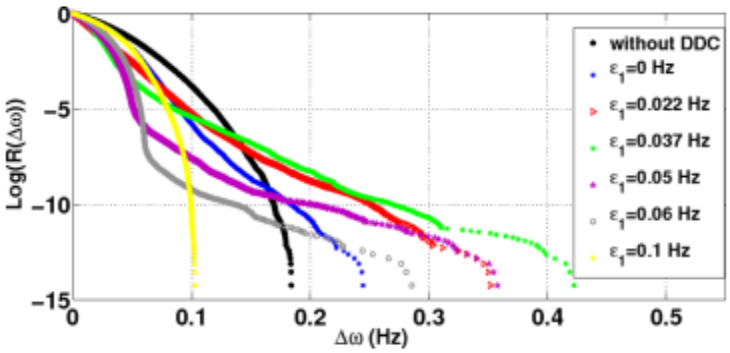
Eder Batista Tchawou Tchuisseu. Institute of Thermomechanics of the Czech Academy of Science, Prague, Czech Republic (current).
Institute for Cross-Disciplinary Physics and Complex Systems (CSIC-UIB), Palma de Mallorca, Spain (former).

Control of the electric grid via dynamic demand control

Abstract:
This work outlines a method to control the electric grid frequency using Dynamic Demand Control (DDC). A stochastic model of power demand, where consumer devices switch on or off based on probabilistic rates, is coupled with a standard power plant model. This combined model is validated against real-world frequency measurements from the grid. The DDC strategy allows individual devices to help stabilize the grid by switching off when the frequency is low and on when it is high. It is shown that if 30% of devices participate in DDC, frequency fluctuations are significantly reduced. An improved method, Communication-enhanced DDC (CeDDC), where devices coordinate their actions, is also presented. This enhanced approach proves more effective, suppressing large frequency deviations while reducing the number of delayed user tasks by a factor of 10.



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Agencia Estatal de Investigación (AEI, Spain) and Fondo Europeo de Desarrollo Regional under Project No. ESoTECoS Grants No. FIS2015- 63628-C2-1-R (AEI/FEDER,UE) and No. FIS2015-63628- C2-2-R (AEI/FEDER,UE). EBTT. also acknowledges the fellowship FIS2015-63628-CZ-Z-R under the FPI program of MINECO, Spain

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Alain B Togueu Motcheyo[1], Masayuki Kimura[2], Yusuke Doi [3], Juan FR Archilla[4],
Discrete rogue waves generated by supratransmission
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[2]*Department of Electrical and Electronic Engineering, Faculty of Science and Engineering, Setsunan University, Japan*
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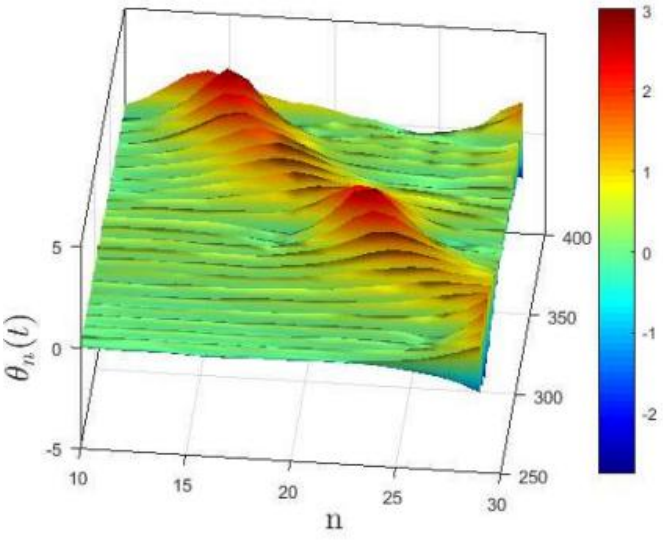
[4]*Group of Nonlinear Physics, Universidad de Sevilla, ETSI Informática, Avda Reina Mercedes s/n, 41012-Sevilla, Spain*

Abstract: Supratransmission [1] is a fascinating nonlinear wave phenomenon that enables plane wave transmission through frequency band gaps. This phenomenon reveals the type of waves that can exist in discrete systems [2-3] apart from its numerous applications in physics and engineering. In this work, we generate the discrete rogue waves [4] by the supratransmission way with a chain of pendula submitted to a harmonic-driving source with constant amplitude and parametric excitation. This approach opens the door for the application of discrete rogue waves within a basic device.



Funding: ABTM is supported by grant VII PPITUS-2025 from the University of Seville., MK acknowledges support from JSPS Kakenhi (C) No. 24K07393, YD acknowledges JSPS Kakenhi No. (C) No. 24K14978. JFRA thanks project MICIU PID2022-138321NB-C22.

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Alain B Togueu Motcheyo[1], Juan FR Archilla[2]

Microbubbles and prenatal scans in Africa

[1]*Laboratory of Mechanics, Department of Physics, Faculty of Science, University of Yaounde I, P.O. Box 812, Yaounde, Cameroon*
[2]*Group of Nonlinear Physics, Universidad de Sevilla, ETSI Informática, Avda Reina Mercedes s/n, 41012-Sevilla, Spain*

Abstract: Africa is one of the continents with the highest birth rate. Neonatal ultrasound is vital for monitoring the pregnancy process. Although ultrasound is widely used for diagnosis and medical imaging in developed countries, due to its relatively low cost, Africa is still lagging behind. This is due to the small size of the microbubbles used as contrast agents, which makes their handling complex. It is therefore important to find a shortcut to enable us to study certain aspects of microbubbles. An analogy based on coupled pendula has been proposed as an alternative way to investigate microbubble dynamics by [1,2]. As a periodic structure, microbubbles present a gap that was considered prohibited for the propagation of plane waves until the works on nonlinear supratransmission [3,4]. We embrace interactions with the real world through a strong emphasis on fundamental and numerical experimental research. Through the present work, we complement our current expertise in wave propagation [4] by extensive simulations on band gap transmission in the acousto-mechanical analogy of a microbubble.

Funding: ABTM is supported by grant VII PPITUS-2025 from the University of Seville. JFRA thanks grant PID2022-138321NB-C22 funded by MICIU/AEI/ 10.13039/501100011033 and ERDF/EU.

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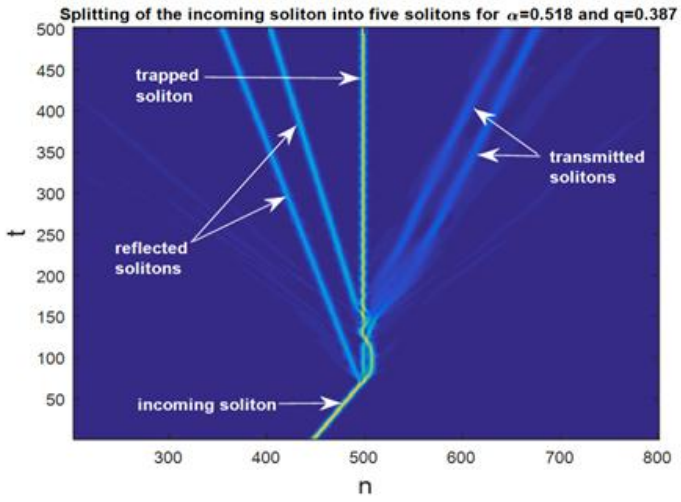
Joël François Tsoplefack, Faustino Palmero, Jesús Cuevas-Maraver,
Universidad de Sevilla

Splitting of discrete solitons after collision with delta-like impurities in nonlinear waveguide arrays

Abstract; We study the interactions of moving solitons with localized impurities in nonlinear waveguide arrays described by the Discrete Nonlinear Schrödinger (DNLS) equation. Each localized impurity (which is a waveguide different from the others) is modeled by the delta function, and we consider the DNLS equation with saturable nonlinearity. The numerical simulations of collisions of discrete solitons with impurities show that, depending on the incoming soliton velocity and the impurity strength, after collision, the soliton can be split into (i) two reflected solitons, (ii) three solitons of which one is trapped by the impurity, and the two others are transmitted or reflected, (iii) four solitons: one trapped, two transmitted and one reflected, or one transmitted and two reflected, (iv) five solitons: one trapped, two reflected and two transmitted. Except for the splitting into two reflected solitons of a Bragg soliton incident on a chirped fiber grating observed experimentally and reproduced numerically in [1], and of a two-soliton molecule by a Gaussian potential barrier in the Gross-Pitaevskii Equation observed numerically in [2], to the best of our knowledge, the other splitting scenarios involving the trapping of one soliton and the transmission and / or the reflection of more than one soliton have never been observed. In the previous similar studies (one or many decades ago, or recently), for instance those of Ref. [3, 4], the splitting into more than three solitons has never been observed. When the incoming soliton is split into three solitons, one is trapped, one is reflected and one is transmitted.



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Francisco Vega Narváez. Universidad de Sevilla.
Women and Science in Africa (in Spanish)

Abstract: The 2014 Social Perception of Science and Technology report published by the FECYT (Federal Council of Science and Technology) indicates that while 20.4% of men declare an interest in science, only 9.9% of women show such interest. In Physics, Engineering, and Information Technology, the presence of women among the student body is very low at many Spanish universities. To try to address this gap, a group of six members from the University of Seville designed a recreational and educational theatre activity aimed at school audiences between the ages of 8 and 14. In it, we seek to highlight the role of women in science and technology, bringing students closer to the lives and achievements of several female scientists from the past, and the professions and real lives of some female scientists from the present. Our hypothesis is that the exposure of these female role models can awaken vocations that might otherwise remain hidden. However, against common misperceptions, there are many female scientists, and many also in Africa. Just in Cameroon, a rapid search allows us to present seven female scientist, working in different fields, from agriculture to mathematics. They could inspire many young women in their objective of a scientific career.

Dr. Rose Gana Fomban Leke, malariologist and professor emeritus of immunology and parasitology, member of the World Health Organization (WHO) Malaria Policy Advisory Committee and the International Health Regulations Emergency Committee for the Eradication of Poliomyelitis. In 2024, she was awarded the L'Oréal-UNESCO Prize for Women in Science.

Dr. Nzweundji Justine Germo is a researcher at the Institute for Medical Research and Medicinal Plant Studies (IMPM) in Cameroon. She is president of the Cameroon Academy of Young Scientists and a member of the Global Youth Academy.

Drs. Sabine Fanta and Daïrou Hadidjatou have received two UNESCO awards for young scientists. Their research seeks to bring the ancestral wisdom of Africa into the laboratory. The two Cameroonian biologists awarded for researching medicinal plants for Alzheimer's and heart health

Dr. Njukeng Jetro Nkengafac, PhD in Chemistry, from the University of Buea. She is Head of Research at the Agricultural Research Institute for Development in Cameroon. Her work seeks to evaluate the properties of natural rubber/organic waste composite materials. The goal is to reduce dependence on petroleum-based fillers such as black coal and also add value to agricultural waste.

Dr. Loeontine Nkamba, director of the École Normale Supérieure de Bertoua. Her research interests include applied mathematics, scientific computing, and mathematical modeling of infectious diseases.

Dr. Sara Irène Eyangoh, the scientific director of the Pasteur Center in Cameroon, a benchmark for biomedical research in Central Africa. She is concerned about the cuts in international aid and urges African countries to seek domestic mitigation solutions. In here opinion is “"When we depend solely on external funding, we also depend on the external agenda.”