1. **Author**: Alhowaity Sawsan

   Title: The curved 2 and 3-Center Problem on constant negative surfaces.

   Abstract: The dynamics of the negative curved two and three center problems on the the Poincaré upper semi plane model of constant negative curvature κ are considered. We next investigate the equilibrium point of the two center problem. More precisely, for the restricted motion ($x \equiv 0$), the equilibrium point is a center; and for the general 2-center problem, the equilibrium point is unstable. For the three center problem, we have two particular cases. The vertical case when the motion of the free mass is restricted to the vertical line (y-axis) in which it forms a binary collision. The geodesic case when the three masses are fixed on a geodesic and the free mass is moving along the same geodesic in which it forms a double collision. Finally, classifications of the binary collisions of the geodesic 3-center problem are remarked.

   This is a joint work with Ernesto Pérez-Chavela and Juan Manuel Sánchez-Cerritos.

   Participation: Talk.

2. **Author**: Arredondo John Alexander

   Title: On the $2n+1$–body problem

   Abstract: In this talk we introduce a generalization of the Sitnikov problem for a Hip-Hop model with a cero mass body. We will discuss the principal characteristics of the problem and some advances in your treatment.

   Participation: Talk.

3. **Author**: Barrera Anzaldo Carlos Rodolfo

   Title: Comet and moon solutions in the time-dependent restricted $(N+1)$–body problem.

   Abstract: In this work we will prove the existence of periodic solutions to the restricted $(N+1)$–body problem starting with a periodic solution of the N-body and an additional body. The cases in which the additional body is placed as a comet (away from the N bodies) and as a moon (very close to one of the N bodies) are studied. In both cases the analysis can be separated into the Kepler problem and a coupling. The study of the existence of such solutions will be carried out through a variational formalism. The functional action will be taken and a reduction of Lyapunov-Schmidt will be applied to transform the problem into a problem of finite dimension.

   Participation: Talk.

4. **Author**: Belbruno Edward

   Title: Equivalence of the Gravitational Three-Body Problem with Schrodinger's Equation:: Solving the Three-Body Problem Using Methods of Quantum Mechanics.

   Abstract: We show the equivalence of an interesting class of orbits in the three-body problem with Schrodinger's equation that model energy transitions. Some applications are discussed.

   Participation: Invited Talk.

5. **Author**: Burgos-García Jaime

Title: Orbital motion in gravitational perturbed environments

Abstract: Among the vast number of small bodies in the solar system there exist large enough asteroids capable to host artificial and even natural satellites orbiting them. The asteroid 624-Hektor and its moonlet called Skamandrios are a good example of such a system. It is known that in recent years some spacecraft have been put into orbit around small bodies such as asteroids and comets, however, several questions about long-term stability remain unsatisfactory answered due to multiple gravitational disturbances on the system. In this talk, we will show some recent progress that deal with this difficult but interesting problem.

Participation: Invited Talk.

6. **Author**: Calleja Renato

   Title: Torus knot choreographies in the N–body problem

   Abstract: N–body choreographies are periodic solutions to the N–body equations in which N equal masses chase each other around a fixed closed curve. In this talk I will present a systematic approach for proving the existence of spatial choreographies in the gravitational N body problem with the help of the digital computer. These arise from the polygonal system of N bodies in a rotating frame of reference. In rotating coordinates, after exploiting the symmetries, the equation of a choreographic configuration is reduced to a delay differential equation (DDE) describing the position and velocity of a single body. We prove that a dense set of Lyapunov orbits, with frequencies satisfying a Diophantine equation, correspond to choreographies. This is joint work with Eusebius Doedel, Carlos García Azpeitia, Jason Mireles-James and Jean-Philippe Lessard.

   Participation: Invited Talk.

7. **Author**: Cano Caro Ricardo Juniors

   Title: Co-Circular Central Configurations

   Abstract:

   Participation: Talk.

8. **Author**: Chávez Pech Carlos Esteban

   Title: The secular effect of a third body on the volume of the Roche Lobe of a close inner binary. Application to the change of brightness on Cataclysmic Variables.

   Abstract: In this research, we estimate how the secular perturbation of a third body affects the volume of the Roche Lobe of a close inner binary. Since calculating the volume of the Roche Lobe is difficult, we make use of the equivalent radius of the Roche Lobe, this is the radius RL(2) of a sphere with the same volume as the Roche Lobe. We use the equation of Eggleton 1983 for RL(2) and we also use of the generalization of the formula for eccentric binaries made by Sepinsky et al. 2007, since the orbit of the inner binary is not circular due to the third body perturbations. We perform numerical integrations for different mass ratios binaries, we fixed the secular period, then the third body mass and orbital period are varied across and ensemble of numerical experiments. From here we find what we call the most efficient solution, that is the solution with the highest perturbation on the binary for a given secular period. We calculate the effect of the secular perturbations of the third body on the RL(2) of the inner binary. We apply our results for explaining the very long photometric periods observed in five cataclysmic variables by estimating how the secular perturbations of the third body affects the mass transfer rate and brightness of the system.

   Co-authors: Andres Aviles[1], Nikolaos Georgakarakos[2], Cesar Ramos[3,4], Hector Aceves[4], Gagik Tovmassian[4], Sergey Zharikov[4] 1 FIME-UANL, San Nicolas de los Garza, México. 2 New York University Abu Dhabi, Abu Dhabi, UAE. 3 FCFM-UANL, San Nicolas de los Garza, México. 4 IA-UNAM,

Ensenada, México. 5 CINVESTAV, Ciudad de México, México
Participation: Talk.

9. **Author**: Delgado Joaquin

   Title: Some relations between Monge-Kantorovich transport and weak KAM theory

   Abstract: Monge's problem is the following: given measures $\mu_1(x)$, $\mu_2(y)$ and a given cost $c(x, y)$ function, find a mapping T: $(X, \mu_1) \to (Y, \mu_2)$, $y = T(x)$ such that T pushes-forward μ_1 into μ_2 with the minimum average cost $\int_X c(x, T(x))d\mu_1(x)$, $T_{\#}\mu_1 = \mu_2$. Kantorovich formulated a relaxed version which permits a dual formulation (infinite linear-programming). Among several applications of this theory, we explore the dual formulation in Weak KAM theory, mainly using as the cost function either the Pierls barrier or Mañé's potential of a Tonelli Lagrangian system. We present some results on admisible Kantorovich pairs and weak solutions of Hamilton-Jacobi in the sense of limit of viscosity solutions. This is a joint work with Giovanni Wences-Nájera.

   Participation: Invited Talk.

10. **Author**: Delshams Amadeu

    Title: Scattering maps for the hydrogen atom in a circularly polarized microwave field

    Abstract: We consider the Rydberg electron in a circularly polarized microwave field, whose dynamics is described by a 2 d.o.f. Hamiltonian depending on one parameter $K > 0$. The associated Hamiltonian system has two equilibria: L_1 (center-saddle for all K) and L_2 (center-center for small K and complex-saddle otherwise) [1, 2, 3]. Associated to L_1 there is a family of Lyapunov periodic orbits forming a normally hyperbolic invariant manifold (NHIM). In this talk, we compute the primary transversal homoclinic orbits to the NHIM (and therefore the associated scattering maps) combining Poincaré-Melnikov methods with numerical methods. It has to be noticed that the transversality of such homoclinic orbits is exponentially small in K (in analogy to the libration point L_3 of the R3BP).

    [1] E. Barrabés, M. Ollé, F. Borondo, D. Farrelly and J. M. Mondelo. Phase space structure of the hydrogen atom in a circularly polarized microwave field. *Phys. D*, 241(4):333–349, 2012.

    [2] M. Ollé. To and fro motion for the hydrogen atom in a circularly polarized microwave field. *Commun. Nonlinear Sci. Numer. Simul.*, 54:286–301, 2018.

    [3] M. Ollé and J. R. Pacha. Hopf bifurcation for the hydrogen atom in a circularly polarized microwave field. *Commun. Nonlinear Sci. Numer. Simul.*, 62:27–60, 2018.

    Participation: Invited Talk.

11. **Author**: Easton Bob

    Title: Celestial Travel; From My Ellipse to Your Ellipse

    Abstract: A fundamental problem in spacecraft mission design is to find a free flight path from one place to another in a chosen travel time. Lambert studied this problem for free flight in an inverse square central force field, and Lagrange produced a solution in 1778. Although this is an old problem, a new approach may be of some value. There are two steps to the proposed solution. First, find every ellipse with focus at the origin that intersects two circles both centered at the origin. Then select only those ellipses that have a specified angle between the intersection points of the ellipse with the inner and outer circles. Second, find the travel times between intersections for each ellipse. These are all the possible travel times from which one may choose.

    Participation: Invited Talk.

12. **Author**: Escobar Adrian

    Title: On a symmetric reduction for the n-body system

    Abstract: In this talk we discuss aspects of the classical dynamics of an n-body system in a d-dimensional space, $d \geq n-1$, with interaction depending only on mutual relative distances r_{ij} between the particles. Using the *squares* of the relative distances $\rho_{ij} = r_{ij}^2$ as coordinates of the dynamical system, a reduction of the original $d\,n$-dimensional problem to a $\frac{n(n-1)}{2}$-dimensional one is presented. We construct the Hamiltonian of this reduced problem explicitly. The facets of the polytope whose vertices correspond to the positions of the particles also provides $(n-1)$ variables, *geometrical* variables, to study the degeneration of the system from $d \geq n-1$ to lower dimensions. For the lowest cases $n = 3$ and $n = 4$ we illustrate the results in detail.

    Participation: Talk.

13. **Author**: Fujiwara Toshiaki

    Title: Bifurcations from the Figure-eight – Bifurcation and Symmetry

    Abstract: The figure-eight solution is a choreographic solution to the planar equal mass three-body problem under homogeneous potential $1/(ar^a)$ for $a > -2$ ($a = 0$ should be understood $-\log r$) or inhomogeneous Lennard-Jones potential $1/r^6 - 1/r^{12}$ for period $T > T_{\min}$. The following six bifurcation patterns are observed: four of them yielding choreographic bifurcated solutions and two of them yielding non-choreographic bifurcated solutions.

    We will show that, in general, the symmetry group that keeps original solution invariant determines bifurcation patterns. To show this, we use the variational principle and group theory.

    For the figure-eight, the symmetry group is $D_6 =< x, s : x^6 = s^2 = 1, xs = sx^{-1} >$. It is known that D_6 has six irreducible representations: four 1-dimensional representations and two 2-dimensional representations. This explains the observed six bifurcation patterns.

    This is a joint work with Hiroshi Fukuda and Hiroshi Ozaki.

    Participation: Invited Talk.

14. **Author**: Galán Vioque Jorge

    Title: Continuation of periodic orbits in the N–body problem

    Abstract: We present analytical and continuation results for periodic solutions in two paradigmatic examples of N–body problem: the symmetric solutions of the classical Sitnikov problem as the eccentricity of the elliptical solutions of the primaries is changed and the exchange orbits in the general planar $2k+1$–body problem. We concentrate on stabilities and global connections as the parameters are varied.

    Participation: Invited Talk.

15. **Author**: Gallego Maria

    Title: Modelling the influence of campaign contributions and advertising on Presidential elections

    Abstract: We provide a stochastic electoral model of a Presidential election where candidates use the contributions they receive from special interest groups (SIGs) to run their campaign. Prior to the election, candidates announce their policy platforms and advertising (ad) campaigns and use the contributions of SIGs to generate a SIG policy and ad campaign valence that enhance their electoral prospects. Voters' preferences depend on candidates' policies relative to their ideal policy and on candidates' ad campaign messages relative to their ideal message frequency, their campaign tolerance level and are also influenced by endogenous the SIG policy and ad campaign valences. Voters' non-campaign evaluation of candidates, voters' mean valence, and their private idiosyncratic valence also influence

their choices. In equilibrium, candidates' critical campaigns depends on candidates' weighted electoral mean (the electoral pull) and on the marginal effect that the SIG valences (the SIG pull) have on voters' choices. In local Nash equilibrium (LNE), candidates' campaign balance the electoral and SIG pulls. Candidates campaign constitute a strong (weak) LNE of the election if the expected vote shares of all candidates are greater than the sufficient (necessary) pivotal vote shares which happens only when there are enough voters voting for each candidate with high enough probability. If the expected vote share of at least one candidate is lower than its necessary pivotal vote share, then the critical campaigns are not a LNE of the election.

Participation: Invited Talk.

16. **Author**: García Azpeitia Carlos

Title: Braids in the N–body problem

Abstract: We prove the existence of periodic solutions of the $N = (n + 1)$–body problem starting with n bodies whose reduced motion is close to a non-degenerate central configuration and replacing one of them by the center of mass of a pair of bodies rotating uniformly. When the motion takes place in the standard Euclidean plane, these solutions are a special type of braid solutions obtained numerically by C. Moore. The proof uses blow-up techniques to separate the problem into the n–body problem, the Kepler problem, and a coupling which is small if the distance of the pair is small. The formulation is variational and the result is obtained by applying a Lyapunov-Schmidt reduction and by using the equivariant Lyusternik-Schnirelmann category.

Participation: Invited Talk.

17. **Author**: García-Naranjo Luis C.

Title: Relative equilibria of the gravitational 2-body problem in spaces of constant curvature

Abstract: We consider the gravitational 2-body problem on 2-dimensional surfaces of constant curvature. For non-zero curvature the problem is no longer integrable and numerical experiments indicate that its dynamics is chaotic. We perform the Poisson reduction of the equations and classify all relative equilibria (RE) with respect to the action of the group of isometries of the corresponding constant curvature space. These RE are the simplest solutions of the problem and have the property that the distance between the bodies remains constant throughout the motion. We also establish the stability of these RE and consider their behaviour as a function of the curvature of the space.

Participation: Invited Talk.

18. **Author**: Gerver Joseph

Title: A simpler model for a non-collision singularity with four bodies in the plane.

Abstract: This is joint work with Jinxin Xue. It arose from an offhand remark by Donald Saari to Gerver in 2012. There are two large bodies, which move away from each other, and two small bodies which orbit around each other, and move back and forth between the large bodies. The orbits of the small bodies are very eccentric, and their major axes are nearly perpendicular to the line between the large bodies. Our result makes use of Robert Devaney's 1980 analysis of the planar isosceles triple collision manifold, although in this case the isosceles symmetry is slightly broken.

Participation: Invited Talk.

19. **Author**: Gidea Marian

Title: Energy Drift and Diffusion Process in the Three-Body Problem.

Abstract: We regard the elliptic restricted three-body problem as a perturbation of the circular

problem, with the perturbation parameter being the eccentricity of the orbits of the primaries. We consider a concrete model, on the motion of a small body (e.g., asteroid or spaceship) relative to the Neptune-Triton system.

We show that for every suitably small, non-zero perturbation parameter, there exists a set of initial conditions whose corresponding orbits drift in energy by order $\mathcal{O}(1)$ with respect to the perturbation parameter. Also, there are orbits which make chaotic jumps in energy. We show that the distributions of energies along these orbits converge to a Brownian motion with drift as the perturbation parameter tends to zero. We can obtain any desired values of the drift and of the variance for the limiting Brownian motion, by choosing appropriate sets of initial conditions. Our results address conjectures made by Arnold and Chirikov. This is joint work with Maciej Capinski.

Participation: Invited Talk.

20. **Author**: Golebiewska Anna

Title: Continuation of closed orbits from equilibria of Hamiltonian systems with Coriolis forces

Abstract: We consider the Hamiltonian system:

$$\dot{u} = J_N H'(u), \tag{HS}$$

with the Hamiltonian H having the term due to the Coriolis force. We assume that (p_0, q_0) is an equilibrium of this system and consider the following question: under what conditions on the behavior of potential one can assure the existence of a connected branch of closed orbits of (HS) emanating from (p_0, q_0)? Using the equivariant global bifurcation theory we formulate such conditions, both in non-degenerate and in degenerate case, obtaining the generalisation of Lyapunov center theorem. Moreover, we study the properties of emanating sets.

This is a joint work with Ernesto Pérez-Chavela, Sławomir Rybicki and Antonio J. Ureña.

Participation: Talk.

21. **Author**: Goncalves Schaefer Rodrigo

Title: Scattering maps and global instability in Hamiltonian systems

Abstract: In this work we illustrate the Arnold diffusion in a concrete example: the *a priori* unstable Hamiltonian system of $2 + 1/2$ degrees of freedom

$$H(p, q, I, \varphi, s) = \frac{p^2}{2} + \cos q - 1 + \frac{I^2}{2} + h(q, \varphi, s; \varepsilon),$$

proving that for any small periodic perturbation of the form

$$h(q, \varphi, s; \varepsilon) = \varepsilon \cos q (a_1 \cos(k\varphi + ls) + a_2 \cos(k'\varphi + l's))$$

($a_1 a_2 \neq 0$, $kl' \neq k'l$, and $\varepsilon \neq 0$ small enough) there is global instability for the action I. For this, we apply a geometrical mechanism based in the explicit computation of several scattering maps.
This is a joint work with Amadeu Delshams.

Participation: Talk.

22. **Author**: Guardia Marcel

Title: Diffusive behavior along mean motion resonances in the Restricted 3 Body Problem

Abstract: Consider the Restricted Planar Elliptic Three Body Problem. This problem models the Sun–Jupiter–Asteroid dynamics. For eccentricity of Jupiter e_0 small enough, we show that if the Asteroid is in the $3 : 1$ mean motion resonance, its dynamics may have stochastic diffusive behavior.

More precisely, there exists a family of probability measures ν_{e_0} supported at this resonance such that the pushforward under the associated Hamiltonian flow has the following property. At the time scale te_0^{-2}, the distribution of the energy of the Asteroid (in rotating coordinates) weakly converges to an (Ito stochastic) diffusion process on the line as $e_0 \to 0$. The $3:1$ mean motion resonance corresponds to the biggest of the Kirkwood gaps on the Asteroid belt in the Solar System.

Participation: Invited Talk.

23. **Author**: Hernández-Garduño Antonio

Title: Saari's velocity decomposition for the N–body problem on hyperbolic space

Abstract: We will discuss the analogous to Saari's velocity decomposition for the N–body problem on a 2-dim space with constant negative curvature, using the "mechanical connection" of geometric mechanics. Applications within the context of the hyperbolic Kepler problem and the restricted 3-body problem will be mentioned.

Participation: Talk.

24. **Author**: Levi Mark

Title: Linear Hamiltonian Systems and Rolling Cones in Minkowski space

Abstract: I will describe an apparently new relationship between the objects mentioned in the title. This is joint work with Gil Bor.

Participation: Invited Talk.

25. **Author**: López Vieyra Juan Carlos

Title: Choreography on Lemniscate: polynomial integrals of motion, superintegrability

Abstract: It will be presented that a 3 and 5 body choreography on the algebraic Lemniscate by Bernoulli is superintegrable. All integrals are polynomial in coordinates and momenta.

Participation: Invited Talk.

26. **Author**: Maderna Ezequiel

Title: Viscosity solutions and hyperbolic motions

Abstract: We prove for the N-body problem the existence of hyperbolic motions for any prescribed limit shape and any given initial configuration of the bodies. The energy level $h > 0$ of the motion can also be chosen arbitrarily. Our approach is based on the construction of global viscosity solutions for the Hamilton-Jacobi equation $H(x, d_x u) = h$. We prove that these solutions are fixed points of the associated Lax-Oleinik semigroup. The presented results can also be viewed as a new application of Marchal's theorem, whose main use in recent literature has been to prove the existence of periodic orbits. Joint work with Andrea Venturelli.

Participation: Invited Talk.

27. **Author**: Martinez-Seara Tere

Title: Oscillatory orbits in the planar three body problem

Abstract: The planar three body problem models the motion of three bodies under the Newtonian gravitational force. In the restricted case we assume that one of the bodies has no mass and the other two bodies evolve in Keplerian ellipses.

Since Chazy (1922), it is known that the possible states the body $q(t)$ can approach as time tends to infinity are four:

- Hyperbolic: $\|q(t)\| \to \infty$ and $\|\dot{q}(t)\| \to c > 0$ as $t \to \pm\infty$.
- Parabolic: $\|q(t)\| \to \infty$ and $\|\dot{q}(t)\| \to 0$ as $t \to \pm\infty$.
- Bounded: $\limsup_{t\to\pm\infty} \|q\| < +\infty$.
- Oscillatory: $\limsup_{t\to\pm\infty} \|q\| = +\infty$ and $\liminf_{t\to\pm\infty} \|q\| < +\infty$.

Examples of all these types of motion, except the oscillatory ones, were already known by Chazy.

In this talk we recall some previous results where we prove the existence of oscillatory motions, near parabolic ones, in the restricted case for any value of the masses of the primaries. We also present some new results for the full body problem, about the existence of parabolic motions and the oscillatory ones nearby. These orbits are a consequence of the transversal intersection of the stable and unstable manifolds of periodic orbits at "infinity".

This is a joint work with M. Guardia and P. Martin.

Participation: Invited Talk.

28. **Author**: Offin Daniel

Title: Searching for stable orbits

Abstract:

Participation: Invited Talk.

29. **Author**: Olvera Arturo

Title: Renormalization phenomena in area preserving map without symmetries

Abstract: Area preserving maps with twist property show renormalization phenomena, numerical studies in these maps showed renormalization properties but these studies were done in area preserving maps with symmetries. We show a numerical study of general area preserving maps where we do not need the existence of symmetries. We development a new numerical method to find periodic orbits of very high period in order to show these renormalization phenomena.

Participation: Talk.

30. **Author**: Panayotaros Panayotis

Title: Spectral localization in graphs with agglomeration regions and nonlinear oscillations in protein vibration models

Abstract: We study localization in inhomogeneous quartic FPUT lattices, i.e. systems of masses interacting through nonlinear springs, in which each mass interacts with a variable number of neighbors. These systems are simplified models of protein vibrations. Recent studies suggest that spatially localized oscillations are very common in enzymes, moreover there is evidence that these motions play a significant role in catalytic reactions. We describe a strategy to understand these phenomena in 3-D models built from crystallographic data by first examining 1-D lattices with some connectivity properties seen in the 3-D models. We also present recent analytical results on spatially localized linear normal modes and spectral gaps in some of the simplest relevant geometries. The basic object there is the Laplacian of the graph encoding the coupling between the masses. The linear results are applied to Birkhoff normal forms of the nonlinear system and to the existence of spatially localized nonlinear oscillations.

Participation: Talk.

31. **Author**: Pérez Bustamante Adrián

Title: Gevrey estimates of Lindstedt series for a family of dissipative standard maps.

Abstract: We compute expansions of quasiperiodic solutions when we add dissipative perturbations (and forcing) to a Hamiltonian system. The expansions are the Lindstedt series used by astronomers. The problem is a singular perturbation since the dissipation makes many quasi-periodic solutions coalesce. We show rigorously that the series expansions satisfy Gevrey estimates, that is, the n term in the expansion is bounded by a power of $n!$. The general scheme of the proof seems to be applicable to obtain Gevrey estimates in other settings. Joint work with R. de la Llave.

Participation: Talk.

32. **Author**: Piña Eduardo

Title: Computing central configurations of few masses

Abstract: The motion of any number of bodies larger than two, obeying the Newton differential equation with the gravitational force is a well-known difficult task, demanding the numerical use of computers. The solutions to those differential equations known with the Euler and Lagrange's names for 3 bodies give us examples of solutions where the dynamics is quite similar with the easy two-body problem. For such cases each of the 3 bodies moves on a conic like in the case of two bodies. Introducing the Central Configurations as the generalization of the three body cases of Euler and Lagrange we recover in this lecture how to compute Central Configurations of 4 bodies of different masses with the similar behavior of the two-body problem in the plane and we find Central Configurations of five particles in 3D, with the Laplace's 3D dynamics on straight lines. These Central Configurations and its generalizations require to find in some cases non trivial initial conditions with computer's help.

Participation: Invited Talk.

33. **Author**: Rastelli Giovanni

Title: Block-separation of variables: a form of partial separation for natural Hamiltonians

Abstract: Block-separation of variables has been introduced in [1]. We study twisted products $H = \alpha^r H_r$ of natural autonomous Hamiltonians H_r, each one depending on a separate set, called here separate r-block, of variables. We show that, when the twist functions α^r are a row of the inverse of a block-Stäckel matrix, the dynamics of H reduces to the dynamics of the H_r, modified by a scalar potential depending only on variables of the corresponding r-block. It is a kind of partial separation of variables. We characterize this block-separation in an invariant way by writing in block-form classical results of Stäckel separation of variables. We classify the block-separable coordinates of $\mathbb{E}^3$. In [2], an equivalent type of block-separation is studied for separation of the Helmholtz equation. We shortly review the main results of this other research.

[1] C. M. Chanu, G. Rastelli: *Block-separation of variables: a form of partial separation for natural Hamiltonians*. SIGMA 15 (2019), 013, 22 pages

[2] T. Daudé, N. Kamran, F. Nicoleau: *Separability and Symmetry Operators for Painlevé Metrics and their Conformal Deformations* . arXiv:1903.10573 [math-ph]

Participation: Talk.

34. **Author**: Ratiu Tudor

Title: Geodesic dynamics for rigid body type metrics on real forms of complex semisimple Lie algebras

Abstract: Rigid body metrics have been introduced by Mishchenko and Fomenko in 1976. The geodesic flows on complex semisimple Lie algebras as well as their compact and compact normal forms have been showed to be integrable. Since the introduction of these metrics, the analogous dynamics

on the full list of real forms has not been studied. I will present these systems, their integrability, and the full analysis of the nature of generic equilibria by giving their Williamson type for each real form in the classification of these real forms.

Participation: Invited Talk.

35. **Author**: Roldan Pablo

    Title: Stochastic Beasts and Where to Find Them

    Abstract: The "Kirkwood gaps" are visible gaps in the distribution of asteroids on the Asteroid belt of the Solar System. These gaps are associated to the mathematical phenomenon of Arnold instability along resonances [1]. In Marcel Guardia's talk (see his abstract), we show that some asteroids in 3 : 1 mean motion resonance with Jupiter have dynamics that follow a stochastic diffusion process. Our argument requires the existence of four different homoclinic channels (transverse intersections of 3 dimensional invariant manifolds).

    Proving the existence of homoclinic channels in this problem is largely out of reach, both by analytical and computer-assisted methods. Thus we set out to find them numerically. In this talk, I will explain the extraordinary **numerical** difficulties encountered to find 4 different homoclinic channels in this problem, and how to overcome them.

    This is a joint work with Marcel Guardia, Vadim Kaloshin and Pau Martin.

    Reference [1]: Jacques Fejoz et al. "Kirkwood gaps and diffusion along mean motion resonances in the restricted planar three-body problem". In: J. Eur. Math. Soc. (JEMS) 18.10 (2016), pp. 2315– 2403. ISSN: 1435-9855. URL: https://doi.org/10.4171/JEMS/642.

    Participation: Invited Talk.

36. **Author**: Rybicki Slawomir

    Title: Bifurcations of periodic solutions of Hamiltonian systems

    Abstract: Let us consider Hamiltonian system $(*)$ $\dot{x}(t) = JH'(x(t))$ and assume that $0 \in \mathbb{R}^{2N}$ is an isolated critical point of the Hamiltonian $H \in C^2(\mathbb{R}^{2N}, \mathbb{R})$, i.e. 0 is isolated in $(H')^{-1}(0)$.

    The aim of my talk is to formulate sufficient conditions for the existence of connected sets of non-stationary periodic solutions of system $(*)$ in a neighborhood of the origin. We underline that $0 \in \mathbb{R}^{2N}$ can be a degenerate critical point of H, i.e. it can happen that $\det H''(0) = 0$.

    Participation: Invited Talk.

37. **Author**: Saari Donald

    Title: A wonderful N-body journey traveling from collisions to dark matter

38. **Author**: Santoprete Manuele

    Title: Central Configurations of the Four body Problem and Geometry

    Abstract: In his classical 1900 paper Dziobek introduced a set of equations for the central configurations (c.c's) of four bodies in terms of mutual distances. There are six mutual distances between four bodies. Since these distances are not independent, Dziobek used a planarity condition to obtain the c.c. eqations of four bodies. Following this approach to central configurations leads to several curious connections between Euclidean Geometry, Distance Geometry and the four body problem, some of which will be discussed in this talk.

    Participation: Invited Talk.

39. **Author**: Slim Ibrahim

Title: Global dynamics of the Hill's type lunar problem, a PDE approach

Abstract: In a recent work with Y. Deng, we used the concept of ground and excited states in non-linear dispersive equations (e.g. Klein-Gordon and Schrödinger equations) to characterize solutions in the N–body problem with strong force under some energy constraints. In this talk, I will explore this method to a restricted 3-body problem (Hill's type lunar problem). It turns out to have very nice analogies with the nine-set theorem studied by Nakanishi-Schlag.

Participation: Invited Talk.

40. **Author**: Strzelecki Daniel

Title: Periodic solutions near orbits of equilibria of symmetric Hamiltonian systems

Abstract: The talk is devoted to present a theorem which provides the existence of periodic solutions of Hamiltonian system $\dot{z}(t) = JH'(z(t))$ with symmetries in a nearby of the stationary solutions z_0. When Hamiltonian H is invariant under symplectic symmetries then its critical points form orbits of this symmetry action and, as a consequence, they are not isolated in general. Therefore it is hard to apply classical tools to study the existence of new non-stationary solutions in a neighborhood of the stationary ones.

We prove that under some assumptions expressed in terms of Brouwer degree of $H'(z_0)$ and Morse index of the Hessian $H''(z_0)$ there exists a connected family of non-stationary periodic solutions of the system $\dot{z}(t) = JH'(z(t))$ emanating from the stationary solution z_0. Moreover, we are able to estimate the minimal periods of this new solutions. The result presented in this talk is a generalization of the famous result of Liapunov.

The abstract result will be applied to the study of quasi-periodic motions near the geostationary orbit of an oblate spheroid. We estimate gravitational potential up to J_2 term which is positive for the oblate body. We analyze the Hamiltonian equation in rotating frame, where geostationary orbit can be interpreted as an orbit of critical points and therefore the abstract result is well applicable.

Participation: Talk.

41. **Author**: Turbiner Alexander

Title: Choreography and Integrability (towards theory of dancing curves, superintegrability)

Abstract: By definition the choreography on a closed curve (dancing curve) is when n classical bodies move chasing each other without collisions on the curve. The first choreography (the Remarkable Figure Eight) at zero angular momentum was discovered in physics unexpectedly by C. Moore (Santa Fe Institute) at 1993 for 3 equal masses in R^3 Newtonian gravity numerically and independently in mathematics by Chenciner-Montgomery at 2000 and confirmed in applied math by C. Simo at 2001. At the moment about 6,000 choreographies in R^3 Newtonian gravity are found, all numerically for different number of bodies $n > 2$ of equal masses.

A number of 3-body choreographies on the plane is known under different pairwise potentials: in R^d Newtonian gravity at $d = 2, 3, \ldots$, on algebraic lemniscate with Fujiwara et al. potential, for Lennard-Jones potential (hence, relevant for molecular physics), the general classification of potentials is absent.

In the talk it will be shown that 3-body choreographies in deformed $2D$ gravity with Fujiwara et al. potential and in R^3 Newtonian gravity are characterized by additional constants of motion and the additional Liouville integrals of motion manifesting superintegrability. In the space of relative (inter-particle) distances the trajectory (dancing curve) is (almost) hyper-elliptic curve.

Participation: Invited Talk.

42. **Author**: Ureña Antonio J.

Title: Instability of closed orbits obtained by minimization

Abstract: We study the dynamics around closed orbits of autonomous Lagrangian systems. When the configuration space is two-dimensional and orientable we show that every closed orbit minimizing the free-period action functional is orbitally unstable. This result applies even when the minimizers are degenerate or nonisolated, but a particularly strong form of instability holds in the isolated case. Under some symmetry assumptions, free-period action minimizers are unstable also in the higher-dimensional case. Applications to geodesics and Celestial Mechanics are given.

Participation: Invited Talk.

43. **Author**: Xia Jeff

Title: Astroids, inclinations and Planet Nine

Abstract: We study the distributions of the orbits of hundreds of thousands of known astroids in the solar system, we discover some interesting patterns in these distributions, and hopefully, this will give us some insight on the existence (or non-existence), and possible position of the much sought after Planet Nine.

Participation: Invited Talk.

44. **Author**: Zhu Shuqiang

Title: Stability of regular polygonal relative equilibria on $\mathbb{S}^2$

Abstract: For the n–body problem on $\mathbb{S}^2$, there is a family of polygonal relative equilibria. We first study their nonlinear stability in a 4-dimensional invariant manifold. We then apply the reduced energy-momentum method to study the nonlinear stability in the full phase space. For n odd, we show that the relative equilibria are stable near the equator and unstable near the poles of the sphere.

Participation: Talk.