INTERNATIONAL CONFERENCE ON SINGULARITY THEORY
AND DYNAMICAL SYSTEMS-IN MEMORY OF JOHN MATHER
TSIMFDECEMBER 11-15, 2017

Speaker: Sen Hu University of Science and Technology of China
The title: On Mather's work
Abstract: John Mather is a great scholar who was dedicated on mathematics in his whole life. His works in mathematics can be characterized as original and foundational. He laid out the foundation of singularity theory while he was a graduate student. He also laid out the foundation of modern Hamiltonian dynamical systems. Those fields became mainstream in mathematics and it attracts many talents to pursue. His other works on foliations, celestial mechanics, prime ends of conformal mappings are of the same quality with great influence in mathematics.

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TITLES AND ABSTRACTS

Spearker:A.G.Aleksandrov (Russian Academy of Sciences)
Title: Analytic invariants of multiple points
Abstract: The aim of the talk is to discuss a simple approach in computing some useful invariants of zero-dimensional singularities, which is mainly based on properties of the tangent cohomology of multiple points. In particular, we show how to describe the corresponding objects in the case of complete intersections, quasihomogeneous multiple points, gradient singularities, and others

Spearker: Chong-Qing Chen (Nan Jing University)
Title: On Mather's cohomological equivalence
Abstract: To construct local connecting orbits, Mather introduced the method of cohomological equivalence. However, to make it applicable to autonomous systems we need a new version. In this talk, I shall show the application of the new version in some interesting problems.

Spearker: Wei Cheng, (Nanjing University, China)
Title: Generalized characteristics and singularities of solutions to Hamilton-Jacobi equations
Abstract: This talk is based on the joint work with PiermarcoCannarsa and Albert Fathi.We will talk on the propagation of singularities along the generalized characteristics differential inclusions. In particular, we will discuss the asymptotic behavior of the singularities along the generalized characteristics and its connection to the regular dynamics. We will also discuss the topological structure of the cut loci such as the homotopy equivalence between the complement of the Aubry sets in Mathers theory and the cut loci, and the local path-connectedness of the cut loci.

Spearker: Alexey Davydov, (National University of Science and Technology Lomonosov Moscow State University)
Title: Singularities of Parametric Optimization and Optimal Control of Cyclic Processes
Abstract: Models of many natural processes include parameters. The parameters usually have influence on the models dynamics. As the consequence the optimization of such a dynamic with respect to some objective functional leads to the result, which is minimum (or maximum) of the functional and depends on the parameters (see, for example, Ar1984, Tr1992). We discuss the classification of generic singularities of smooth extremal problems with both implicit and explicit constraints, the

coincidence of them for low dimensions DaZa2001 and applications to the analysis of singularities of cyclic processes optimization Da2005, DaMa2007, DaMaMo2015. The classifications have clear connection with generic singularities of projections Ma1973, Go1983. We also show that the generic singularities of optimal control of cyclic processes with low dimensional parameter are stable.The work is done by partial financial support by Ministry of Education and Science of the Russian Federation under the project 1.638.2016/FPM and by Russian Foundation for Basic Research under the grant 15-01-08075a.

Spearker: Wojciech Domitrz,(Warsaw University of Technology)
Title: The Gauss-Bonet Theorem for Coherent tangent bundles over surfaces with boundary and its applications
Abstract: This is the joint work with Michal Zwierzynski. We prove the Gauss-Bonnet theorem for coherent tangent bundles over surfaces with boundary. We find various applications of this theorem. In particular we study the properties of the affine extended wave front for planar closed non singular hedgehogs (rosettes). Thanks to it we find a link between the total geodesic curvature on the boundary and the total singular curvature of the affine extended wave front, which leads to the relation of integrals of functions of the width.

Spearker: Michael Giersig, (Freie Universitat Berlin, Germany)
Title: Sophisticated Nanoparticles and their application in electronics and biomedicine
Abstract: Advances in the controlled growth and characterization of highquality nanomaterials have been the key enablers in establishing the basis of modern applications of such materials in electronics and live science. The development of a new generation of smart nanosized materials requires the corresponding knowledge. One of the most prominent applications of nanotechnology is the design of matter on an atomic, molecular, and supramolecular scale. The most well-known description of nanotechnology was established by the National Nanotechnology Initiative, which defines nanotechnology as the manipulation of matter with at least one dimension sized from 1 to 100 nanometers. The impact of nanotechnology extends from its medical, ethical, mental, legal and environmental applications, to fields such as engineering, medicine, chemistry, computing and materials-science. During this lecture we will focus on various nanoparticles prepared by physical and wet chemistry methods and their applications depending on their unusual properties such size, morphology electronic structures and compositions.

Spearker: Victor Goryunov,(University of Liverpool, UK)
Title: On planar caustics
Abstract: We consider local invariants of planar caustics, that is, invariants of Lagrangian maps from surfaces to $\mathbb{R}^2$ whose increments in generic homotopies are determined entirely by diffeomorphism types of local bifurcations of the caustics. Such invariants are dual to trivial codimension 1 cycles supported on the discriminant in the space $\mathcal{L}$ of the Lagrangian maps. We obtain a description of the spaces of the discriminantal cycles (possibly non-trivial) for the Lagrangian maps of an

arbitrary surface, both for the integer and mod2 coefficients. We show that all integer local invariants of caustics of Lagrangian maps without corank 2 points are essentially exhausted by the numbers of various singular points of the caustics and the Ohmoto-Aicardi linking invariant of ordinary maps. As an application, we use the discriminantal cycles to establish non-contractibility of certain loops in $\mathcal{L}$.

Spearker: Huhe Han, (Yokohama National University, Japan)
Title: Stability of C^∞ convex integrands
Abstract: In this talk, it is shown that the set consisting of stable convex integrands is open and dense in the set consisting of C^∞ convex integrands with respect to Whitney $C\infty$ topology. Moreover, some examples are given. This is a joint work with E. B. Batista and T. Nishimura.

Spearker: Shunsuke Ichiki, (Yokohama National University, Japan)
Title: Generic linear perturbations
Abstract: In his celebrated paper "Generic projections", John Mather has shown thatalmost all linear projections from a submanifold of a vector space into a subspace are transverse with respect to any "modular submanifold". By the result, many important applications are obtained. On the other hand, in my talk, we drastically improve the Mather result. Namely, almost all linear perturbations of a smooth mapping from a submanifold of a vector space into another vector space yield a transverse mapping with respect to any modular submanifold.

Spearker: Shihoko Ishii, (Tokyo Woman's Chiristian University, Japan)
Title: Singularities with respect Mather-Jacobian discrepancies
Abstract: In the talk I will introduce Mather-Jacobian discrepancy which is a variant of usual discrepancy. The Usual discrepancy plays important roles in Minimal Model Program. While Mather-Jacobian discrepancy appears recently and well described by jet-schemes. In the talk I will also show the usefulness of Mather-Jacobian discrepancies in the study of positive characteristic by making use of jet-schemes.

Spearker: Goo Ishikawa, (Hokkaido University, Japan)
Title: Stability of parametric Lagrangian and Legendrian varieties
Abstract: Several results on stability, determinacy and classification of parametric of Lagrangian and Legendrian varieties are surveyed. In particular certain Mather type theorems on them are provided with related topics.

Spearker: Shyuichi Izumiya, (Hokkaido University, Japan)
Title: Tougeron's G-equivalence revisited: 50 years after Mathers K-equivalence. -Open a new door for applications of Singularity theory
Abstract: We consider a slight generalization of G-equivalence introduced by Tougeron (1972), where G is a linear Lie group. G-equivalence is a natural generalization of K-equivalence and R-equivalence in the sense of Mather (1966–1967). Gervais published three papers on G-equivalence (1977,1982,1984). Tougeron and Gervais mentioned that there might be several examples depending on G. However,

there are no proper examples in their papers except K and R. Although main tools for our equivalence are almost the same as those for G-equivalence, we emphasize that there are several interesting applications including quantum chemistry and spintronics, which are expected to have an application to the theory of photo-chemical reaction control and the theory of topological insulators. Even Thom and Arnol'd had never mentioned such applications to quantum physics.

Spearker: Stanislaw Janeczko, (Banach International Center, Poland)
Title: J. Mather linear equations and solvability of implicit Hamiltonian systems
Abstract: We report on the paper by John Mather "Solutions of Generic Linear Equations" (Dynamical Systems 1973) and show its use in constructions of solvable implicit differential systems. As a strightforward consequence we get the new Lie-Poisson algebra connected singularities of implicit and constrained Hamiltonian systems.

Spearker: Solomon Jekel,(Mathematics Department, Northeastern University, Boston)
Title: $\Gamma-$ structures on surface
Abstract: The 1970s was a time of intense activity and great advances in foliation theory, initiated by their homotopy classification. To classify foliations Haefliger broadened the definition of foliation on a manifold to Γ-structure on a topological space. One of the most powerful results concerning the classifying spaces associated to these structures was obtained by John Mather: The loops on the classifying space for codi- mension one, smooth $\Gamma-$ structures is homology equivalent to the discrete group of smooth homeomorphisms of the real line with compact support. Using this equiva- lence Mather proved that the first two homotopy groups vanish for the codimension one, C^∞ classifying space, $\mathrm{B}\Gamma^\infty$. In contrast to the smooth case the classifying space for codimension one, real an- alytic Γ-structures, $\mathrm{B}\Gamma^\omega$, is a $K(\pi, 1)$. Thurston discovered uncountably many non- cobordant, real analytic, codimension one foliations on 3-manifolds showing that H_3 of both $\mathrm{B}\Gamma^\infty$ and $\mathrm{B}\Gamma^\omega$ have homomorphisms onto the reals in integer homology. Be- cause no homology was known to be different it was speculated that the two spaces were homology equivalent. We show, contrary to what was generally expected, that $H_2(B\Gamma^\omega, \mathbb{Z})$ is uncountable. In the talk I will trace the development of modern foliation theory from Haefligers proof of the non-existence of real analytic foliations on the 3-sphere, to its current state. The main focus will be the relationship between smooth and real Γ-structures and foliations -a relationship that remains largely a mystery.

Spearker: Juan J. Nuno-Ballesteros, (Universitat de Valencia, Campus de Burjassot, Spain)
Title: A Lê-Greuel type formula for the image Milnor number
Abstract: The classical Lê-Greuel formula provides a recursive method to compute the Milnor number of an isolated complete intersection singularity (ICIS): Let $(X, 0)$ be a d-dimensional ICIS in $(\mathbb{C}^n, 0)$ and H a generic hyperplane such that the section

$(X \cap H, 0)$ is also an ICIS (of dimension $d-1$). Then,

$$\mu(X,0) + \mu(X \cap H, 0) = \dim \frac{\mathcal{O}_n}{(g)+J(g,p)},$$

where $g : (\mathbb{C}^n, 0) \to (\mathbb{C}^{n-d}, 0)$ is a holomorphic map germ such that $g^{-1}(0) = X$, $p : \mathbb{C}^n \to \mathbb{C}$ is a linear form such that $H = p^{-1}(0)$ and $J(g,p)$ is the ideal generated by the maximal minors of the Jacobian matrix of (g,p). If we denote by $X_s = g^{-1}(s)$ the Milnor fiber of the ICIS and p is generic enough, then X_s is smooth and the restriction $p|_{X_s}$ is a Morse function. The right hand side of theformula can be interpreted geometrically as the number of critical points of $p|_{X_s}$. In this talk, we will discuss about a Lê-Greuel type formula in the case that $(X,0)$ is the image of a finitely determined map germ $f : (\mathbb{C}^n, 0) \to (\mathbb{C}^{n+1}, 0)$ and instead of the classical Milnor number, we consider the image Milnor number in the sense of David Mond (that is, the number of spheres in the image of a stabilisation of f).

Spearker: Laurentiu Paunescu(University of Sydney)
Title: Arc-wise analytic stratifications
Abstract:I will describe the notion of arc-wise analytic stratification and sketch the proof of Whitney fibering conjecture
Spearker: Markus J. Pflaum(University of Colorado at Boulder)
Title: Equivariant control data and neighborhood deformation retractions
Abstract: In his famous article "Notes on topological stability", John Mather created the notion of control data which became a powerful tool in singularity theory. In particular Mather's new concept of control data enabled him to provide a detailed proof of local triviality of Whitney stratified spaces. Even though an equivariant version of Mather's control data has been conjectured to exist for a long time, it was not worked out in detail. In this talk an equivariant version of Mather's control data will be explained. It will be shown that for every Whitney stratified space with a compatible G-action equivariant control data exist. To prove this an equivariant submersion theorem needs to be proved first. Moreover, we show that if $A \subset X$ is a closed G-stratified subspace which is a union of strata of X, then the inclusion $i : A \hookrightarrow X$ is a G-equivariant cofibration. The theorem applies in particular whenever X is a G-invariant analytic subspace of an analytic G-manifold M and $A \subset X$ is a closed G-invariant analytic subspace of X.
The talk is on joint work with Grame Wilkin from Singapore.

Spearker: Maria Carmen Romero Fuster,(Universitat de Valencia)
Title: Generic Geometry from a global viewpoint
Abstract: The aim of this talk is to describe the usefulness of Singularity Theory techniques in the global study of the Geometry of submanifolds in convenient ambient spaces. Some of the basic principles underneath this fact are the following:
a) The local geometry of a submanifold can be specified in terms of the geometrical properties of adequate models which are invariant under the action of the transformation group associated to the considered geometry. Such models are chosen as those that better approach the submanifold at each point In order to determine them we can analyze the singularities of appropriate families of functions and mappings

on the submanifold.
b) The parameter spaces of such families can be stratified according to the singularity types of the different functions of the family. Such stratifications are the pull-back of convenient stratifications of the space of smooth functions (or mappings) on the submanifold. Provided the incidence relations among the different strata are well known, the multi-transversality conditions imposed by the genericity requirements on the considered families of functions lead to a complete information on the local behaviour of relevant geometrical subsets that are characterized through appropriate singular phenomena.
c) The contact directions associated to the considered families of contact functions determine foliations whose critical points have a relevant interpretation from the geometrical viewpoint. This allows us to apply well known topological techniques, such as the Poincar-Hopf formula, in order to ensure the existence of critical points, or even to obtain lower bounds for their number.
Clearly, all these principles can be applied to different ambient spaces, provided we have convenient families of contact functions attached to the geometrical properties that we want to analyze.

Spearker: Osamu Saeki, (Kyushu University, Japan)
Title: Singular fibers of stable maps and their applications
Abstract: We show that singular fibers of stable maps play important roles in the study of manifolds and mappings between them, through several examples. First, if we consider stable maps on 4-manifolds, by counting a certain type of singular fibers, we get the signature of the 4-manifold. Using this formula, we can define a Vassiliev type invariant of order one for stable maps on 3-manifolds. We give an explicit formula for the invariant in terms of a certain linking matrix for the 3-manifold. We also give some explicit examples, together with an explicit path connecting them in the mapping space. Finally, we show that singular fibers can be applied for the visualization of scientific data obtained by simulations or experiments.

Spearker: Vyacheslav Sedykh, (Russian State Gubkin University of Oil and Gas)
Title: The topology of singularities of caustics and wave fronts
Abstract: We study the topology of simple multisingularities of stable Lagrangian and Legendrian mappings. In particular, the adjacency indices of singularities of generic wave fronts in spaces of the dimension $n \leq 6$ are calculated. It is proved that each connected component of the manifold of multisingularities of any fixed type $A^{\pm}_{\mu_1} \cdots A^{\pm}_{\mu_p}$ for a germ of the image of a Lagrangian mapping with a monosingularity of type $D^{\pm}_{\mu}$ is either contractible or homotopy equivalent to a circle. We calculate the number of connected components of each kind for all types of multisingularities. We will speak also on the manifolds of singular points of a fixed type in a stable real caustic germ of type E_6. It is proved that every connected component of the manifold of singular points which are not points of the transversal intersection of smooth branches of the caustic is contractible. We calculate the number of these components.

Spearker: Alfonso Sorrentino (Università degli Studi di Roma "Tor Vergata", Italy)
Title: On the integrability of mathematical billiards
Abstract: A mathematical billiard is a system describing the inertial motion of a point mass inside a domain, with elastic reflections at the boundary. This simple model has been first proposed by G.D. Birkhoff as a mathematical playground where "*the formal side, usually so formidable in dynamics, almost completely disappears and only the interesting qualitative questions need to be considered*".
Since then billiards have captured much attention in many different contexts, becoming a very popular subject of investigation. Despite their apparently simple (local) dynamics, their qualitative dynamical properties are extremely non-local. This global influence on the dynamics translates into several intriguing rigidity phenomena, which are at the basis of several unanswered questions and conjectures.
In this talk I shall focus on several of these questions. In particular, I shall describe some recent results related to the classification of integrable billiards (also known as Birkhoff conjecture).
This talk is based on works in collaboration with V. Kaloshin and with G. Huang and V. Kaloshin.

Spearker: Mina Teicher, (NYU and Bar-Ilan university math dep and brain research center)
Title: How does the brain works
Abstract: In this talk we will present the theory of synchronization in brain activity, will present an experiment on behaving monkeys and analysis that gives the first proof ever to synchronization in brain activity , (using geometric search engine and statistics) and will show two application - localizing epileptic focus and analyzing sleep disorders.

Spearker: David Trotman, (Aix-Marseille University, France)
Title: Refinements of two theorems by John Mather
Abstract: We improve upon the first Thom-Mather isotopy theorem for Whitney stratified sets. In particular, for the more general Bekka stratified sets we show that there is a local foliated structure with continuously varying tangent spaces, thus proving the smooth version of the Whitney fibering conjecture. A regular wing structure is also shown to exist locally, for both Whitney and Bekka stratifications. The proofs involve integrating carefully chosen controlled distributions of vector fields. As an application we show the density of the subset of strongly topologically stable mappings in the space of all smooth quasi-proper mappings between two smooth manifolds, an improvement of another theorem of Mather.

Spearker Asahi Tsuchida (Hokkaido University, Japan)
Title: Singularities of bundle homomorphisms from a tangent distribution into a vector bundle of the same rank
Abstract: We consider bundle homomorphisms between tangent distributions and vector bundles of the same rank. We study the conditions for fundamental singularities when the bundle homomorphism is induced from a Morin map. We see some

relation among distributions and singularities.

Spearker: Yuefei Wang (Academy of Mathemtics and Systems Sciences, China)
Title: Holomorphic motions and extremal problems
Abstract: Holomorphic motions were introduced by Mane, Sad and Sullivan in 1980's to solve the density problem of structural stability of rational maps, which are closely related to quasiconformal geometry. Since then Holomorphic motions have many important applications in complex dynamics, quasiconformal geometry, Teichmuller spaces, etc. I will talk about the motions and extremal problems for polynomial maps.