

# MEMORIAL DAY IN HONOR OF JORGE SOTOMAYOR

2022 THE ORGANIZERS

## Talk 1 (10:00–10:30, São Paulo Local Time)

### Diagrams of Fold Mappings and Chains in 3D Filippov systems: a chaotic phenomenon coalition

Marco Antonio Teixeira  
Universidade Estadual de Campinas

The main aim of this talk is to discuss heuristically some global features phenomena that link naturally three theories: divergent diagram of mappings, dynamics of reversible mappings, chains in non-smooth dynamical systems. Roughly speaking, our main result says that a 2D divergent diagram of fold mappings, generates a discrete dynamics, expressed by the composition of two involutions which, in turn, presents a robust chaotic behavior, on which can be translated to Chains in Filippov systems.

## Talk 2 (10:30–11:00, São Paulo Local Time)

### On my seven articles with the Professor Jorge Sotomayor

Jaume Llibre  
Universitat Autònoma de Barcelona

I will talk about the seven articles that I wrote with the Professor Jorge Sotomayor and the consequences of some these articles.

- A. GASULL, J. LLIBRE AND J. SOTOMAYOR, *Limit cycles of vector fields of the form  $X(v) = Av + f(v)Bv$* , J. Differential Equations **67** (1987), 90–110.
- A. GASULL, J. LLIBRE AND J. SOTOMAYOR, *Further considerations on the number of vector fields of the form  $X(v) = Av + f(v)Bv$* , J. Differential Equations **68** (1987), 36–40.
- A. GASULL, J. LLIBRE AND J. SOTOMAYOR, *Global asymptotic stability for differential equations in the plane*, J. Differential Equations **91** (1991), 327–335.
- J. LLIBRE AND J. SOTOMAYOR, *Phase portraits of planar control systems*, Nonlinear Analysis, Theory, Methods and Applications **27** (1996), 1177–1197.

- J. CHAVARRIGA, J. LLIBRE AND J. SOTOMAYOR, *Algebraic solutions for polynomial systems with emphasis in the quadratic case*, *Expositiones Mathematicae* **15** (1997), 161–173.
- J. LLIBRE AND J. SOTOMAYOR, *Structural stability of constrained polynomial systems*, *Bulletin of the London Math. Soc.* **30** (1998), 589–595.
- J. LLIBRE, J. SOTOMAYOR AND M. ZHITOMIRSKII, *Impasse bifurcations of constrained systems*, in *Differential Equations and Dynamical Systems*, Fields Institute Communications, Amer. Mat. Soc. **31** (2002), 235–255.

### Talk 3 (11:00–11:30, São Paulo Local Time)

#### Methods of singularity theory in local differential geometry

Michail Zhitomirski

Technion – Israel Institute of Technology

I will explain that even though many problems in local differential geometry concern cases of infinite codimension (people are interested in big symmetry groups), the methods of singularity theory can be fruitfully applied.

### Talk 4 (11:30–12:00, São Paulo Local Time)

#### Sotomayor and the bifurcations

Robert Roussarie

Université de Bourgogne

The theory bifurcations in families of vector fields was one of the domain of interest of Jorge Sotomayor. Early in his career, in the sixties, he gave the classification of generic one parameter families of vector fields on a surface  $M$ . To this end he considered the Banach space of vector fields on  $M$  and defined an appropriate open dense part of a codimension one stratum in the complement of set of structurally stable vector fields. This result can be seen as the first step for a general theory of bifurcation of families of vector fields on  $M$ .

In order to continue this theory, one has to look at families with an arbitrary number  $k$  of parameters. It seems that this preoccupation was present in the mind of Sotomayor for decades after the sixties: when Freddy Dumortier and myself spoke to him, in the nineties, of our intention to finish the study of generic 3-parameters unfoldings of planar vector fields, he want to be associated to this project. This leads finally to a monography published in a Lecture Note volume. Later, in the same decade of the nineties, the three of us return to a problem, more in the spirit of the global problems studied earlier by Sotomayor: the study of generic 3-parameter unfoldings of a cuspidal loop.

I want to give a brief account of these different researches, recalling some conjectures about (generalised) Abelian integrals which are still to be solved in order to

obtain a complete result. I hope that this talk will rebew interest for bifurcation theory which remains almost blank until now, but seems to me very promising for future researches.

### **Talk 5 (13:45–14:15, São Paulo Local Time)**

#### **Limit cycles for fewnomial differential equations**

Armengol Gasull

Universitat Autònoma de Barcelona, Centre de Recerca Matemàtica

The first part of the talk will be devoted to explain the Influence of Jorge Sotomayor in all my carrier. In the second part. I will present several results about the maximum number of limit cycles for planar ordinary differential equations, that in complex variables write as the sum of very few monomials. For instance, for the family with two monomials  $z' = az^k\bar{z}^l + bz^m\bar{z}^n$ , with  $a$  and  $b$  complex numbers and  $k, l, m$  and  $n$  non-negative integers, we prove that although the differential equation can have arbitrarily many critical points of index 1, the maximum number of limit cycles is 1.

### **Talk 6 (14:15–14:45, São Paulo Local Time)**

#### **A few of the ideas I learned from Soto and some applications**

Carmen Chicone

University of Missouri

The first part of this talk will be a brief description of a few of the ideas I learned from Soto and their impact on my professional life. In the second part of the talk, I will briefly describe my involvement in some projects in applied mathematics after my retirement. One of these projects is about binder burnout, a problem from the ceramics industry; It involves the mathematics of optimal control. Another is an ongoing project on oscillating heat pipes (which are sometimes highly efficient heat transfer devises with no mechanical moving parts). A simple model for the so-called startup problem is a system of ODEs where the existence of Hopf and Hopf-Hopf bifurcations provide an explanation of the onset of desired oscillations. More sophisticated physically realistic models seem to require a numerical approach to make predictions. A possibly viable approach is via smoothed particle hydrodynamics (SPH), a numerical method that will be briefly described. A few observations about working with engineers will also be included.

**Talk 7 (14:45–15:15, São Paulo Local Time)****Classical differential geometry: a singular point of view**

Débora Lopes da Silva  
Universidade Federal de Sergipe

In his classic work “Mémoire sur la Théorie des Déblais et des remblais” (1784), Monge begins to study two parametric families of lines in space, line congruence, seeking to solve a problem of minimization costs of transporting an amount of land from one place to another while preserving the volume.

In an attempt to understand this problem, many techniques of differential equations, analysis and geometry were developed. Monge’s work can be considered one of the founding texts of differential geometry. In this lecture, we seek to show how the Theory of Singularities, Differential Geometry and Differential Equations interlace, from the emergence of a problem, still open, proposed more than two centuries ago.

**Talk 8 (15:30–16:00, São Paulo Local Time)****Jorge Sotomayor and Mathematics in Peru**

César Camacho  
IMPA and Fundação Getúlio Vargas

**Talk 9 (16:00–16:30, São Paulo Local Time)****Memórias sobre as contribuições de Jorge Sotomayor na teoria geométrica das bifurcações de edo’s e na teoria qualitativa das edo’s da geometria diferencial**

Ronaldo A. Garcia  
Universidade Federal de Goiás

Nessa palestra iremos abordar os trabalhos clássicos de Jorge Sotomayor na teoria geométrica de bifurcações de edo’s (iniciado na sua tese de doutorado em 1964) e na fundação da teoria qualitativa das linhas de curvatura (iniciado em colaboração com Carlos Gutierrez em 1982).

**Contributions (16:30–17:30, São Paulo Local Time)**

Representing the Institute of Mathematics and Statistics of the University of São Paulo - IME - USP

- Waldyr M. Oliva (Full Professor at IME-USP and Instituto Superior Técnico)

Representing the Institute of Pure and Applied Mathematics IMPA-RJ

- Marcelo Viana (IMPA)

Contributions from collaborators:

- Enrique Ponce (Universidad de Sevilla)
- Freddy Dumortier (Hasselt University)
- Howie Weiss (The Pennsylvania State University)
- Jean-Pierre Francoise (Sorbonne Université)
- Marcelo Messias (Universidade Estadual Paulista)
- Ricardo M. Martins (Universidade Estadual de Campinas)
- Roberto R. Paterlini (Universidade Federal de São Carlos)
- Xavier Jarque (Universitat de Barcelona)