

## **Richard Montgomery**

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(831) 459-3260 (fax)  
Birthdate: July 22, 1956

### **EMPLOYMENT**

7/2006- 9/2009: chair, Mathematics Department, University of California, Santa Cruz [UCSC]  
9/1999-present: Full Professor, [UCSC].  
7/1993-9/1999: Associate Professor, UCSC  
7/ 1990- 6/1993: Assistant Professor, UCSC  
1988-1990 : NSF Postdoctoral Fellow taken at MSRI and University of California, Berkeley.  
1986-1988 : Moore Instructor, M.I.T.

### **Some Visiting Positions**

9/2015-12/2015, Professor Invité, Insitut Henri Poincaré, (trimester in subRiemannian Geometry) Paris  
France  
2/2003. Astronome Invité, Bureau des Longitudes, Paris, France.  
3/2001. Professeur Invité, Univerite de Boulogne, Dijon, France.  
8/1997-7/1998. Visiting Professor, CIMAT, Guanajuato, Mexico.  
6/1996. Professeur Invité, Universite de Geneve, Geneva, Switzerland  
6/1992. Professeur Invité, Universite de Tours, France.

### **EDUCATION**

1986-1988 Moore Instructor, Massachussets Institute of Technology [MIT] Cambridge, MA  
1986. Ph.D.: Mathematics, University of California, Berkeley [UCB].  
1981. B.A. in Mathematics, B.A. in Physics, Sonoma State University. Sonoma, CA

### **GRADUATE AND POSTDOCTORAL ADVISERS**

J. Marsden (U. C. Berkeley, now at CalTech), V. Guillemin (MIT).

### **GRANTS**

7/2013- 2016. NSF grant in the Mathematical Sciences [DMS-1305844]  
7/2000- 2005. NSF grant in the Mathematical Sciences  
1995-1997. (with M. Zhitomirskii of Technion, Haifa, Israel) Binational Science Foundation grant (joint  
US-Israel)  
6/1997-5/2000. (with V. Ginzburg, UCSC) NSF grant in the Mathematical Sciences.  
7/1994-6/1997. NSF grant in the Mathematical Sciences  
6/1992-5/1994. (with T. Ratiu and D. Lewis, UCSC) NSF grant in the Mathematical Sciences.

### **AWARDS**

2012: Fellow of American Mathematical Society.  
2001-2003: Sigma-Xi distinguished lecturer.  
8/1994-12/1994: Fulbright Fellowship to the United Kingdom.  
1988-1991. Postdoctoral Fellowship, NSF.

## PUBLICATIONS IN JOURNALS

1. “Canonical Formulations of a Particle in a Yang-Mills Field and Wong’s Equations”, *Lett. Math Phys.*, vol. 8, 59-67, 1984.
2. “Analytic Proof of Chaos in the Leggett Equations for Superfluid He<sup>3</sup>”, *J. Low Temp. Phys.*, vol. 58, no. 5/6, 417-423, 1985.
3. “Scattering Off of an Instanton”, *Comm. Math. Phys.*, vol. 107, 515-533, 1986.
4. (with D. Lewis, J. Marsden, and T. Ratiu) “The Hamiltonian Structure for Dynamic Free Boundary Problems”, *Physica D*, vol. 18, 391-404, 1986.
5. (with J. Marsden, P. Morrison, and W.B. Thompson) “Covariant Poisson Brackets for Classical Field Theories”, *Annals of Physics*, vol. 169, 29-48, 1986.
6. “Corrections to the Low-Energy Scattering of Monopoles”, *Physics Letters A*, vol. 125, no. 4, 159-161, (1987).
7. (with N. Ercolani, G. Forest, and D. McLaughlin) “Hamiltonian Structure of Modulation Equations for Sine-Gordon”, *Duke Math Journal*, vol. 55 no. 4, 949-983, 1987.
8. (with L. Bates) “Closed Geodesics on the Space of Stable Two-Monopoles”, *Comm. Math. Phys.* vol. 118, no. 4, 635-640, (1988).
9. “The Connection for a Family of Completely Integrable Systems whose Holonomy is the Classical Adiabatic Angle (Berry’s phase)”, *Comm. Math. Phys.*, vol. 120, 269-294, 1988.
10. (with J. Marsden and T. Ratiu) “Cartan-Hannay-Berry Phases and Symmetry”, *Cont. Math.*, vol. 97, 279-296, 1989.
11. “Isoholonomic Problems and Some Applications”, *Comm. Math. Phys.*, vol. 128, 565-592, 1990.
12. “How Much Does the Rigid Body Rotate? A Berry’s Phase from the 18th Century”, *Am. J. Physics*, vol. 59, no. 5, 394-398, 1991.
13. “Generic Distributions and Lie Algebras of Vector Fields”, *Journal of Differential Equations*, vol. 103, no. 2, 387-393, 1993.
14. (with Nicholas Ercolani) “On the Fluid Approximation to a Nonlinear Schrodinger Equation”, *Physics Letters A*, vol. 180, no. 6, 402-408, 1993.
15. “Abnormal Minimizers”, *SIAM J. Control and Optimization*, vol. 32, no. 6, pp. 1605-1620, 1994.
16. “Singular Extremals on Lie Groups”, *Math. Control Signals Systems*, vol. 7, no. 3, 217-234, 1994.
17. “Hearing the Zero Locus of a Magnetic Field”, *Communications in Mathematical Physics*, vol. 168, no. 3, 651-675, 1995.
18. “A Survey of Singular Curves in Subriemannian Geometry”, vol. 1, *Journal of Dynamical and Control Systems*, 1995.
19. (with K. Ehlers, A. Samuel, and H. Berg) “Do Cyanobacteria swim using travelling surface waves?”, *Proceedings of the National Academy, Biophysics section*, vol. 93, no. 16, 8340-8343, Aug. 6, 1996.
20. (with B. Shapiro and M. Kazarain), “Characteristic Classes for the Degenerations of Two-Plane Fields in Four Dimensions”, *Pac. J. Math.*, vol. 179, no. 2, 355-370, 1997.
21. (with K. Ehlers and J. Koiller) “Problems and Progress in Microswimming”, *J. Nonlinear Science*, vol. 6, 507-541, 1996.
22. “The Geometric Phase of the Three-Body Problem”, *Nonlinearity*, vol. 9, no. 5, 1341-1360, 1996.
23. “The N-body problem, the braid group, and action-minimizing periodic orbits”, *Nonlinearity*, vol. 11, no. 2, 363-376, 1998.
24. Book review of “Global Aspects of Classical Integrable Systems”, by L. Bates and R. Cushman, *SIAM Review*, March, 164- 167. 1998.
25. (with J. Koiller, M.A. Raupp, J. Delgado, and K.M. Ehlers) “Spectral Methods for Stokes Flows: the Lorentz Operator”, *Comp. Appl. Math.*, vol. 17, no. 3, 343-371, 1998.
26. (with V. Ginzburg) “Geometric quantization and no-go theorems”, *Banach Center Publ.* vol. 51, (Poisson Geometry), *Polish Acad. Sci, Warsaw*, 2000.
27. Featured Math Review (solicited; on the AMS web page) of M. Gromov’s “Carnot-Caratheodary Spaces seen from within”, May 2000.
28. “A remarkable periodic solution of the three-body problem in the case of equal masses”, with Alain Chenciner, *Annals of Mathematics*, **152**, 881-901 2000.

29. “A new solution to the three-body problem”, Notices of the American Mathematical Society, vol. 48, no. 5, 471-481, 2001.
30. “Geometric approach to Goursat flags” (with M. Zhitomirskii), Ann. Inst H. Poincare Anal. Non Linéaire, vol. 12, no. 4, 459-493, 2001.
31. “Infinitely many syzygies”, Archives for Rational Mechanics and Analysis, v. 164, no. 4, 311-340, 2002.
32. (solicited book review) “Symmetry in Mechanics: A Gentle, Modern Introduction, by Stephanie Singer,” American Math. Monthly, April, 2003.
- 33 (with M. Shapiro and A. Stolin) “A nonintegrable sub-Riemannian geodesic flow on a Carnot group”, J. Dyn. Control Systems, v. 3, no. 4, 519–530, 1997.
34. “Fitting hyperbolic pants to a three-body problem”. Ergodic Theory Dynam. Systems v. 25 no. 3, 921–947, 2005,
35. (with Alain Chenciner and Jacquez Féjóz ) “Rotating eights. I. The three  $\Gamma_i$  families”, Nonlinearity v. 18 , no. 3, 1407–1424, 2005 .
36. (with Toshiaki Fujiwara) Convexity of the figure eight solution to the three-body problem”, Pac. J. Math., no. 2, v. 219, 271 –285, April 2005.
37. (with Alex Castro, Roberto Manduchi, and X. Shi) Rotational Invariant Operators Based on Steerable Filter Banks IEEE Signal Processing Letters, v. 13, no 11, Nov. 2006
38. (with Persi Diaconis and Susan Holmes) Dynamical Bias in the Coin Toss , (featured article), SIAM Review, Vol. 49, no. 2, 211-235 , May 2007.
39. The zero angular momentum, three-body problem: all but one solution has syzygies. Ergodic Theory Dynam. Systems 27, no. 6, 1933–1946, 2007.
40. ( with Duncan Ralph, and Onuttom Narayan) Exact identity for nonlinear wave propagation , Physical Review E, v. 77, 056219, May 2008.
41. (with Alex Castro) The Chains of Left-invariant CR-structures on  $SU(2)$ , Pac. J. Math. , vol. 238, no. 1, 41-71 2008.
42. (with Vidya Swaminathan and Michail Zhitomirskii) Resolving Singularities Using Cartan’s Prolongation, Journal of Fixed Point Theory and Applications (Arnol’d volume), vol. 3., no. 2, August 8, 2008 (online).
43. (with Sam Kaplan and Mark Levi) “Making the moon reverse its orbit: stuttering in the planar three body problem”, in Discrete and Continuous Dynamical Systems series B, ( Simofest issue), vol. 10, no. 2/3, 2008.
44. (with Gil Bor)  $G_2$  and the Rolling Distribution, L’Enseignement Mathématique, vol. 55, 157-196 (2009).
45. Sub-Riemannian geometry: general theory and examples, invited book review. Bull. Amer. Math. Soc. 47 , 713-722, (2010).
46. (with AL Castro) “Spatial curve singularities and the Monster/Semple tower”, Israel Journal of Mathematics 192 (1), 381-427, (2012).
47. (with R. Moeckel and A. Venturelli), From Brake to Syzygy, Archive for Rational Mechanics and Analysis; 204(3):1009-1060, (2012).
48. (edited by T. Ratiu and A. Weinstein) in ‘ Remember Jerry’, Notices of the AMS, vol. 59, No. 6, p. 767, (2012)
49. (with R. Moeckel), Symmetric Regularization, Reduction, and Blow-Up of the Planar Three-Body Problem, Pac. J. Math. , Vol. 262, No. 1, (2013)
50. (with Gil Bor) Poincare y el problem de N-cuerpos . Miscelánea matemática de la Sociedad Matemática Mexicana, May issue, n. 57 ‘extraordinario’ ( 2013).
- 50A. (with Corey Shanbrom) Keplerian Motion on the Heisenberg Group and Elsewhere (in Geometric Mechanics: The Legacy of Jerry Marsden, Fields Institute Communications Series, 2015)
51. MICZ-Kepler= Dynamics on the Cone over the Rotation Group, Regular and Chaotic Dynamics November 2013, Volume 18, Issue 6, pp 600-607 (2013).
52. The Three-body problem and the shape sphere (Expository), Amer. Math. Monthly, v 122, no. 4, pp 299-321 , April 2015.

53. Who's afraid of the Hill boundary? -conjugate loci clustering at the boundary. SIGMA 10 (2014), 101, 11 pages.
54. (with R. Moeckel), Realizing All Reduced Syzygy Sequences in the Planar Three-Body Problem, Nonlinearity 28 (2015) 1919-1935
55. (with Enrico Le Donne, Alessandro Otazzi, Pierre Pansu, and Davide Vittone) Sard Property for the Endpoint Map on some Carnot Groups , Annales de l'Institut Henri Poincare / Analyse non lineaire; available on-line August, 2015 <http://www.sciencedirect.com/science/journal/aip/02941449>
56. (with Holger Dullin) Syzygies in the two center problem, Nonlinearity, (2016), Vol. 29, No. 4
57. (with Connor Jackman) No Hyperbolic Pants for the Planar Four-Body Problem , Pacific Journal of Mathematics 280-2 (2016), 401–410.

#### IN BOOKS OR CONFERENCE PROCEEDINGS.

1. (with J. Marsden and T. Ratiu) “Gauged Lie-Poisson Structures”, Contemp. Math., vol. 28, 101-114, 1985.
2. (with J. Marsden and T. Ratiu) “Reduction, Symmetry, and Phases in Mechanics”, Memoirs of the AMS, vol. 88, 1990.
3. (with G. Bor) “SO(3) Invariant Yang-Mills Fields which are Not Self-dual”, in Hamiltonian systems, Transformation Groups and Spectral Transform Methods (J. Harnad and J. Marsden, editors), 191-198, Les Presses de l'Université de Montreal, 1990.
4. “Optimal Control of Deformable Bodies and Its Relation to Gauge Theory”, in The Geometry of Hamiltonian Systems MSRI publications, vol. 22, 403-438, Springer-Verlag, 1991.
5. “Heisenberg and Isoholonomic Inequalities”, in Symplectic Geometry and Mathematical Physics, proceedings in honor of Jean-Marie Souriau, ed. by P. Donato, Progress in Mathematics, vol. 99, 303-325, Birkhauser, Boston, 1991.
6. “Nonholonomic Control and Gauge Theory”, in Nonholonomic Motion Planning, (J. Canny and Z. Li, editors), Kluwer Acad Press, 343-378, 1993.
7. “Gauge Theory of the Falling Cat”, in Dynamics and Control of Mechanical Systems, M. Enos, ed., Fields Institute Commun., 1, 193-218, AMS, 1993.
8. (with Eugene Lerman and Reyer Sjamaar) “Examples of Singular Reduction”, in Symplectic Geometry, ed. by D. Salomon, London Math. Society Lecture Note Ser., 192, 127-155, Cambridge University Press, 1993.
9. (with S. Sastry) “The structure of optimal control for a steering problem”, Nonlinear Control Systems Design 1992. Selected Papers from the 2nd IFAC Symposium. (Nonlinear Control Systems Design 1992). Edited by M. Fliess, Pergamon Press, UK, 135-140, 1993.
10. “Abnormal Optimal Controls and Open Problems”, Nonlinear Control Systems Design 1992. Selected Papers from the 2nd IFAC Symposium. (Nonlinear Control Systems Design 1992). Edited by M. Fliess, Pergamon Press, UK, 1993.
11. “Survey of Singular Geodesics”, in Subriemannian Geometry, in Progr. Math. vol. 144, 325-339, Birkhauser, 1996.
12. “Introduction to a paper of M.Z. Shapiro: Homotopy theory in Control”, in Nonsmooth analysis and geometric methods in deterministic control, The IMA Vol. Math. Appl. vol. 78, Springer-Verlag, 1996.
13. “Engel Deformations and Contact Structures”, Amer. Math. Soc. Transl., (2) vol 196, 103-117, 1999.
14. (with A. Cherman, Joaquin Delgado,; F. Duda, K. Ehlers, J. Koiller) “Low Reynolds number swimming in two dimensions” in Hamiltonian systems and celestial mechanics (Patzcuaro, 1998) , 32–62, World Sci. Monogr. Ser. Math., 6, World Sci. Publishing, River Edge, NJ, 2000.
15. “A tour of subriemannian geometries , their geodesics, and applications”. [monograph], Mathematical Surveys and Monographs, vol. 91, American Math. Society, Providence, Rhode Island, 2002.
16. “Action spectrum and collisions in the planar three-body problem”, in Contemporary Math. vol. 292 (Celestial Mechanics), American Math. Society, Providence, Rhode Island, 2002.
17. (with A. Chenciner, J. Gerver, C. Simó) “Simple Choreographic Motions of  $N$  bodies: A preliminary study”, in Geometry, Mechanics, and Dynamics, volume in honor of the 60th birthday of J.E. Marsden, P. Newton, P. Holmes, A. Weinstein, ed. , Springer-Verlag, 2002.

18. (with J. Koiller, W. Earnest, Joaquin Delgado, K. Ehlers, T. Stuchi, Maria de Fatima Almeida) “Momentum maps and geometric phases”, in Classical and celestial mechanics, (Recife, 1993/1999), 281–349, Princeton Univ. Press, Princeton, NJ, 2002.
19. (with K. Ehlers, J. Jair, and P. Rios) “Nonholonomic systems via moving frames: Cartan equivalence and Chaplygin Hamiltonization” in The breadth of symplectic and Poisson geometry, 75–120, Progr. Math., 232, Birkhuser Boston, Boston, MA, 2005.
20. “The Three Body Problem, A Cambridge Mystery”, Notices of the AMS, invited book review, 1031-1033, Oct. 2006; <http://www.ams.org/notices/200609/rev-montgomery.pdf>
21. (with Michail Zhitomirskii) Points and Curves in the Monster Tower, Memoirs of the A.M.S. , vol. 205 (2010)
22. (with Corey Shanbrom) Keplerian Dynamics on the Heisenberg Group and Elsewhere. to appear: Geometry, Mechanics and Dynamics: The Legacy of Jerry Marsden, Fields Institute Communications series. (2013).

### **STUDENTS.**

#### **UNDERGRADUATE.**

Matt Chisholm. Mentored for Steck award and undergraduate thesis. 1999-2000.  
 Kevin Vajk. Undergraduate thesis. 1995.

#### **PhD STUDENTS.**

Gil Bor, (1991) co-advised with J. Marsden, UCB  
 Pat Tantalo, (1993) co-advised with T. Ratiu, UCSC.  
 Grijia Mittagunta, (1994) co-advised with T. Ratiu, UCSC.  
 Kurt Ehlers, (1996), UCSC.  
 Andrew Klinger, (1999), UCSC.  
 Alexander Golubev, (1999), co-advised with Viktor Ginzburg, UCSC.  
 Cesar Castilho , (1999), co-advised with Viktor Ginzburg, UCSC.  
 William C. McCain (2007), UCSC  
 Vidya Swaminathan (2008), UCSC  
 Alex Castro (2010), UCSC.  
 Corey Shanbrom (2013)  
 Wyatt Howard (2013)

### **COLLABORATORS.**

- a partial list of collaborators, in a rough reverse chronological order. I have written papers with all of them.

Rick Moeckel (U. Minn.)  
 Roberto Manduchi, UCSC, EE Dept.  
 Alex Castro, UCSC, Math Dept (Graduate Student)  
 Persi Diaconis, Stanford U. Mathematics Dept and Statistics Dept  
 Susan Holmes, Stanford U. Statistics Dept.  
 Alain Chenciner, Bureau des Longitudes and Paris 7, Paris, France.  
 Carles Simo, Mathematics Dept., U. of Barcelona, Barcelona, Spain  
 Mikhail Zhitomirskii, Mathematics Dept., Technion, Haifa, Israel.  
 Joseph Gerber, Mathematics Dept., Rutgers U., Camden Campus, N.J.  
 Jair Koiller, Mathematics Dept., Federal University, and Laboratorio Nacional de Computacao, Rio de Janeiro, Brazil.  
 K. Ehlers, Mathematics Dept., Reno Community College, Reno, Nevada.  
 Boris Shapiro, Mathematics Dept., U. of Stockholm, Stockholm, Sweden.  
 Howard Berg, Biology Dept., Harvard, and the Rowland Institute, Cambridge, MA.  
 Viktor Ginzburg, Mathematics Dept., UCSC.  
 Tudor Ratiu, Applied Mathematics Dept. U. of Lausanne, Switzerland.  
 J.E. Marsden, Control and Dynamical Systems, Cal Tech, Pasadena, CA  
 Nick Ercolani, Mathematics Dept., U. of Arizona, Tucson, AZ.

Greg Forest, Mathematics Dept., U. of N. Carolina, Chapel Hill, N.C.  
Dave McGlaughlin, Mathematics Dept., NYU  
D. Lewis, Mathematics Dept , UCSC  
Larry Bates, Mathematics Dept. , U. of Calgary  
Eugene Lerman, Mathematics Dept., U. of Illinois, Champagne-Urbana,  
Reyer Sjamaar, Matematics Dept. , Cornell U.

#### **UNIVERSITY SERVICE.**

##### **Department of Mathematics.**

Fall 1990. Organized and administered the Putnam Exam (national undergraduate mathematics competition).

1990-91. Undergraduate Vice-Chair for department advising and signing forms (Winter/Spring) for mathematics majors; matriculation agreements

Spring 1991. graduate geometry seminar

1991. Member of Department Library Committee

1991-1992. graduate geometry seminar

1991-1992. Member, Department Recruitment Committee.

1991-1992. Undergraduate Vice-Chair for department advising and signing forms for mathematics majors; matriculation agreements

1993-1994. Graduate Vice-Chair for department advising and signing forms for mathematics graduate students

1993-1994. Recruited two foreign graduate students with full support: Cesar Castilho; funded by CNPq, Brazil Juan-Pablo Ortega; funded by Fulbright/Rotary Scholarship, Spain

1995-1998: Graduate Vice-Chair for department

2002-3: chair of committee for restructuring graduate program.

##### **Division of Natural Sciences.**

1991, 1992, 1999. Science Day.

1997-1998, 1999-2000. Applied Mathematics committee.

2000-2002: member of Divisional CAP

2002-2003: chair of Divisional CAP

2004-2005 cochair, Mathematics Dept. , UCSC

2006-2009 : chair Mathematics Dept. , UCSC.

2015-2016: Divisional CAP member

##### **Campuswide**

1999,2001,2002. Member of Ad-hoc committees.

#### **OUTSIDE PROFESSIONAL ACTIVITIES.**

##### **Invited Lectures.**

4/1990 Symplectic Geometry Seminar, Stanford University

5/1990 Mathematical Physics Seminar, Utrecht, The Netherlands

5/1990 Mathematics Colloquium, University of California at Berkeley

6/1990 Mathematical Physics Seminar, Heidelberg, Germany

6/11-15, 1990 Colloque International en l'honneur de Jean-Marie Souriau 'Geometrie Symplectique et Physique Mathematique' Aix-en-Provence, France.

6/25-30, 1990 Conference in Nonlinear Elasticity, Oberwolfach, Germany

7/29-8/3 1990 Conference on Topological Phases in Nuclear and Molecular Systems, organized by Alden Meade (physical chemist, Telluride, Colorado)

11/1990 Mathematics Colloquium, University of Arizona at Tucson

12/1990 Differential Geometry Seminar, University of California at Berkeley

3/1992 Conference on Falling Cats and Other Nonholonomic Systems Fields Institute, Canada

7/1992 Conference on Subriemannian Geometry, Paris 6, Paris, France

4/1992 AMS conference on Symplectic Topology, Fayetteville, Arkansas

5/1992 UC Davis Mathematics Colloquium, University of California, Davis

6/1992 Conference on Variational Principles and Nonholomic Control Fields Institute, Canada.

6/1992 Conference on Nonlinear Control, Bordeaux, France

7/1992 Conference on Subriemannian Geometry, Paris, France

3/1994 MSRI workshop on Differential Systems, Submanifolds, and Control, talk entitled "Hearing Singular Extremals", Berkeley, California

3/1994 "Gauge Theory and Swimming Micro-organisms", Caltech, California

9/1994 "Is there time-periodic monopole motion?" Spitalfields Day Conference, sponsored by the London Mathematical Society, held at the Isaac Newton Institute of Mathematical Sciences, Cambridge, England

3/1995 "Subriemannian Volumes", Pacific Northwest Geometry Seminar 1995 Winter Meeting, held at the Mathematical Sciences Research Institute, Berkeley, California

4/1995 "Isoperimetric Problems and Falling Cats" Colloquium, Sonoma State University

4/1995 "Geometric Phase in the 3 Body Problem", University of Arkansas Spring Lecture Series

6/1995 "Geometric Phase in the 3 Body Problem", IMPA, Rio de Janeiro, Brazil

6/1995 Workshop on Biological Motion, CNPq, LNCC, Rio de Janeiro, Brazil

7/1995 ARO-NASA Montana State University Workshop on Intelligent Control Conference on Nonlinear Control and Robotics

4/1996 "Geometric Phase in the three-body problem", U.C. Berkeley Differential Geometry Seminar

9/14/1996: Washington DC. workshop in "Biology and Control" for the NSF, "Mystery swimmers: How Cyanobacteria swim". Workshop in "Biology and Control" for the NSF in Washington DC.

11/1996 "Singular Curves and a Sard Theorem in Subriemannian Geometry", 1996 Fall Western Sectional Meeting of the AMS, Pasadena, CA

12/29/1996: -Jan. 7 1997: International Conference on Singularities and Control Theory, Technion, Haifa, Israel, "A survey of singular geodesics in subriemannian geometry".

9/14/1996: Washington DC. workshop in "Biology and Control" for the NSF, "Mystery swimmers: How Cyanobacteria swim".

11/1997 "The braid group and periodic orbits for the N-body problem", in the Celestial Mechanics session of the joint SMM-AMS meeting in Oaxaca, Mexico.

1/13/98 "Grupo de trenzas y el problema del N cuerpos", UAM, Ixtapalapa, Mexico City

1/15/98 "Teoria de normas en controle optimo", in UAM, Acapulco, Mexico City

4/9/98 "Orbitos periodicos por el problema del N cuerpos en el plano", CIMAT, Guanajuato, Mexico.

3/18/98 "(4,7) distributions: a case study, I", seminaire de controle, Institut Henri Poincare Universite Pierre et Marie Curie, Paris, France

3/20/98 "(4,7) distributions: a case study, II", seminaire de controle, Institut Henri Poincare Universite Pierre et Marie Curie, Paris, France

3/26/98 "The Braid Group and action minimizing periodic orbits", Bureau de Longitudes, seminaire de mecanique celeste.

4/3/98 "A survey of problems and results in Subriemannian geometry", Institut Henri Poincare Universite Pierre et Marie Curie seminaire en geometrie symplectique de C. Marle

4/26/98 "Quaternionic contact distributions and their symmetry groups", MIT, symplectic geometry seminar, MIT, Cambridge, MA.

5/1/98 "The braid group and periodic orbits in the planar N-body problem", gauge theory seminar, Harvard U. Cambridge, Mass.

8/2-7/98 Mecanica Celestial for the Curso de Verano (summer school for the year between undergraduate and master's level students) CIMAT, Guanajuato, Mexico

12/16/1999: Northwestern U., Evanston, Ill, USA ; International Conference in Celestial Mechanics in honor of Don Saari's 60th birthday: "Figure eights with three bodies".

3/2/00 "Figure eights with three bodies", UC Berkeley, math colloquium.

4/9/00 "A Tour of the zoo of Distribution", AMS conference, Notre Dame.

4/20/00 "Figure eights with three bodies", Stanford University, math colloquium.

5/22/00 "Figure eights with three bodies", UC Davis, math colloquium.

5/24/00 "Figure eights and flowers with n-bodies", CalTech, Control and Dynamical Systems colloquium.

5/20/2001 "New solutions to the three-body problem", , Park City Utah, **plenary talk** for the SIAM Dynamics Days conference.

6/20/2002 “New solutions to the N-body problem”, Portland, OR, **plenary talk** for the AMS meeting.

10/16/2002, ‘New solutions to the N-body problem’, Sonoma State U. Math colloquium, Rohnert Park, CA.

11/17/2002, “Variational Methods in the N-body Problem”. Pacific Northwest Geometry Seminar at Oregon State University,

2/14/2003 “The three body problem” a **general science audience talk**, Contra Costa community college, (Sigma-Xi lecturer).

3/6/2003 “Conformal Structure of the Shape Sphere” Bureau des Longitudes, Paris, France.

3/20/2003 “Scattering in the three-body problem”, Bureau des Longitudes, Paris, France.

6/10/2003 Introductory Talk for the start of the AIM/ARCC international conference on Variational Methods in Celestial Mechanics.

6/12/2003 “Infinitely Many Syzygies and the conformal structure of the shape sphere”, AIM/ARCC international conference on Variational Methods in Celestial Mechanics.

1/7/2005, Phoenix Arizona, AMS/MAA Joint Mathematics Meeting, special session in Celestial Mechanics, “Bifurcations out of the Eight”.

3/15/2004 ‘Falling Cats, planets, and gauge theory’, a **general science audience talk**, Presentation High School, San Jose California, honors society.

4/18/2004, “Fitting hyperbolic pants to a three-body problem”, Banff, Canada, BIRS workshop on celestial mechanics.

4/27/2004, “Why coin flipping is biased”, a **general science audience talk**, Long Beach State University, Sigma-Xi invited lecture.

4/29/2004, “Dynamical Bias in Coin-Flipping”, UC Santa Cruz Physics Colloquium, U.C. S.C, Santa Cruz, CA.

12/14/2004. “Dynamical Bias in Coin Tossing”, Mathematics colloquium, Nara Woman’s University, Nara, Japan,

12/13/13-15, 2004. Three one hour lectures (mini-course) on subRiemannian Geometry, in the Workshop on subRiemannian geometry, Nara Woman’s University, Nara, Japan,

12/17-18/2004, Two one-hour lectures on new solutions to the N-body problem, in the Workshop on Dynamical Systems. Kyoto University, Kyoto, Japan.

4/1/2005, “Fitting hyperbolic pants to a three-body problem”, Minneapolis MN, Midwest dynamical systems meeting.

4/9/2005, “Around the eight”, International Conference in Honor of Don Saari, CIMAT, Guanajuato, Mexico.

9/7/2005 ‘Prolongations of Lie algebras and Symmetries of Distributions’ Math Colloquium, San Jose State University.

10/4/2005. “A new characterization of an orbit of Lagrange” UCSC Math colloquium.

10/26/2005 “Fitting hyperbolic pants to a three-body problem” Dynamical Systems Seminar, Penn State, State College, PA.

10/27/2005 “The N-body problems” MASS undergraduate colloquium, Penn State, State College, PA.

10/27/2005 “The N-body problem. New solutions. new problems” math colloquium, Penn State, State College, PA.

11/9/05 “Bias in Coin-flipping, ” undergraduate mathematics colloquium. UCSC.

4/29/06 “G2 and rolling” invited talk, AMS special session on Elliptic methods in geometry, SF State.

4/29/06 “Infinitely many syzygies, redux” - invited talk, AMS special session on Geometry dynamics and Ergodic Theory , SF State.

5/18/06 “Stuttering in the three-body problem” - invited talk,colloquium, Bureau des Longitudes Seminar, Paris, France.

5/19/06 “G2 and rolling” geometry colloquium, Paris VII, Paris, France

5/29/06 “Only Lagrange is Syzygy-Free”, conference in honor of Carles Simo’s 60th birthday, S’agaro, Spain.

1/31/06 “G2 and the rolling distribution”, invited speaker at BIRS, in Banff, the workshop on “Non-holonomic Dynamics and Integrability” held Jan. 28- Feb 2, 2007.



5/10/07 “Scattering in the N-body problem”, invited talk at the 38th annual meeting of the American Astronomical Society’s Division of Dynamical Astronomy, Ann Arbor, MI, held May 6-10.

6/8/07 “Scattering in the N-body problem” in the conference ”Symmetry and Perturbation Theory” held June 2-9 June 2007 in Otranto (Puglia, Southern Italy)

5/6/08-5/09/08 “Singularities of 2-plane fields, Legendrian Curves, and the Friendly Monster” an invited mini-course given at the the Centre de Recherches Mathematiques, Universite de Montreal.

12/6/08 ”Resolving Curve Singularities and Higher Contact Manifolds”, invited lecture at the 1st meeting of the Bay Area Differential Geometry Seminar, (held at MSRI).

9/23/2009 “Compactifying Taylor Series” undergraduate math colloquium, U. N.C. , Asheville.

2/6/2009 “From the Falling Cat to Celestial Mechanics”, math colloquium, University of Milano-Bicocca, Milan, Italy.

3/4-3/7/2010 “Variational Methods in Celestial Mechanics’, a series of four lectures in an NSF-sponsored graduate mini-school in Celestial Mechanics, at U. of Maryland, College Park, MD.

3/30/2010 “Goursat distributions, Monster/Semple Towers and Algebraic Geometry” in ‘New Trends in Sub-Riemannian geometry’, a conference held in Nice, France from 3/29-4/2/2010

4/8/2010 “Ubiquity of Stuttering” Bureau des Longitudes, Paris, France.

7/4-7/8/2011: A 5 day summer school in ‘Geometric methods in the N-body problem’; one of the three main teachers for “5th Summer School in Geometry, Mechanics and Control. ; in Spain. (This one held in Miraflores de la Sierra, near Madrid.)

7/ 13/2011. “The Brake-to-Syzygy Map in the planar three-body problem” invited lecture, Universitat Politcnica de Catalunya, Barcelona, Barcelona, Spain.

10/03/2011. “K3 and the planar four body problem”. In the Floer Memorial Lecture, a yearly lecture at UC Berkeley in honor of Andreas Floer.

10/13/2011. “From the planar four-body problem to the K3 surface” invited lecture at the IAS in Princeton.

3/26/2012: ‘From Brake to Syzygy in the three-body problem’ IAM-PIMS-MITAC distinguished colloquium series, UBC, Vancouver, British Columbia, Canada

3/28/2012: ‘Reducing and regularizing everything for the N-body problem’, Applied Math. Colloq., U. Victoria, Victoria, British Columbia, Canada.

7/25/2012 Plenary speaker, ‘Regularizing and reducing the whole shebang’, Marsdenfest, Fields Institute, Toronto, Canada.

12/13-14/2012 Invited speaker, ‘Variational and Geometric approaches to N body problems.’, Poincaré Symposium (honoring the 100th anniversary of Poincaré’s death), Brown University, Providence RI.

1/15/2013, Invited speaker “Paradoxes and Opportunities from Global Regularization”, Banff ?International Research Center weeklong program “New Perspective on the N-body problem.”

4/15/2013. Colloquium speaker “ The Three-Body Problem: Open problems, new solutions and the shape sphere of triangles.” Mathematics Dept., Reed College.

4/11/2014. Invited speaker “From the falling cat to the N-body problem’ International conf on Geometry, Control, and Mechanics, IMPA, Rio de Janeiro.

4/14/2014. Colloquium.”Two open problems in the N-body problem”, Departamento de Mathematica, Universidade Federal de Sergipe.

4/16/2014. Special Lecture Series: ”From falling cats to the 3-body problem.”, Departamento de Mathematica, Universidade Federal de Pernambuco.

4/17/2014. Colloquium speaker ”Regularizing and Reducing Everything”, Departamento de Mathematica, Universidade Federal Rural de Pernambuco.

5/03/2014. Invited speaker, ‘Differential geometry arising from the N-body problem.’ Pacific Northwest Geom Seminar, yearly meeting, Eugene, OR

5/07/2014. Colloquium speaker, ‘The Kepler-Heisenberg problem’, U. of Washington Mathematics Colloq., Seattle, WA.

9/29/2014. Invited speaker, “ Searching for Area rules in nonAbelian gait generation” , international workshop on Geometric Analysis on subRiemannian Manifolds, Institut Henri Poincaré, Paris, France.

10/30/2014, Invited speaker, “Sketch of the Syzygy Program”, dynamics seminar, Universidad Autonoma de Barcelona, Barcelona, Spain.

11/6/2014. Colloquium speaker, “Particles in Magnetic Field. Abnormal Minimizers in Geometry”, Bureau des Longitudes (IMCEE), Paris France

11/12/2014. Colloquium speaker, “Solutions for the three-body problem realizing every free homotopy class”, applied dynamical systems colloquium, Imperial College, London, U.K.

11/24/2014, plenary speaker, “Reduction and Singular Curves”, International Conference Honoring the 80th Birthday of Charles Marle, Institut Henri Poincaré, Paris, France.

11/26/2014. Invited speaker, “Open Problems in subRiemannian Geometry”, international workshop on Nonholonomic Mechanics and Optimal Control, Institut Henri Poincaré, Paris, France.

12/ 4/2014. Colloquium speaker, “From Falling Cats to Quantum Mechanics near the zero locus of a Magnetic Field”, Institut Fourier, (mathematics department) Univ of Grenoble, Grenoble, France.

12/10/2014. Invited speaker, “A Tale of Two Towers”, international workshop on Equivalence, invariants, and symmetries of vector distributions and related structures : from Cartan to Tanaka and beyond, Institut Henri Poincaré, Paris, France.

10/26/2015. Undergraduate Colloquium, “Geometry and Billiards”, UCSC.

4/12/2016: invited speaker “The Shape Sphere: A New Vista on the Three-body problem”, 17th conferencia David Alcaraz, IIMAM, UNAM, Mexico City, Mexico. ( a single public lecture given once a year or less often, in honor of David Alcaraz, a mathematician at UNAM who died in the 1985 earthquake there).

5/16/2016: undergraduate mathematics colloquium “Quantum mechanics and projective geometry” , UCSC.

### **Conferences organized**

10/1989.(with Tudor Ratiu) International conference on Geometric Phases, Cornell U., Ithaca, NY.

3/8-12/1989. (with Jair Koiller) of International Workshop on Geometric Mechanics and Control, , IMPA, Rio de Janeiro, Brazil.

5/1997 Minisymposium on microswimming for SIAM Dynamics Days, Park City Utah

7/2000. (with J. Huebschmann) session in Mathematical Physics for the joint American Math.Society-French math Society international congress, Lyon, France.

6/9-6/14/2003: (with A. Chenciner) AIM/ARCC international workshop on Variational Methods in Celestial Mechanics, Palo Alto, CA. (see <http://www.aimath.org/ARCC/workshops/varcelest.html>)

5/9/2009 (with D. Hoffmann) Bay Area Differential Geometry Seminar, Santa Cruz meeting

### **Memberships and Refereeing.**

Member, American Mathematical Society, Society for Industrial and Applied Mathematics

Reviewer for NSF grants

Referee for Mathematical Reviews, Communications in Mathematical Physics, Journal of Mathematical Physics, Nonlinearity, Physics Letters A, Journal of Differential Geomety, Nonlinearity, Physics Review Letters, Pacific Journal of Mathematics, SIGMA and a number of other journals.