CURRICULUM VITA

HASAN GÜMRAL

- February 11, 1963, Mersin, TURKEY. Married to Devrim, with a child Ateş Bora.
- Address: Department of Mathematics, Yeditepe University, 34755 Kayışdağı, İstanbul
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1 Education and academic degrees

1. Professor of Mathematics, Yeditepe University, 2003
2. Associate Professor of Mathematical Physics, Nov 11, 1998.
3. Ph.D, Dec 2, 1992, Department of Mathematics, Bilkent University, Ankara, Turkey

   Dissertation: Poisson structures of dynamical systems and equations of hydrodynamic type, supervisor: Prof. Dr. Yavuz Nutku.
4. M.S, Sep 22, 1988, Department of Physics, Middle East Technical University, Ankara, Turkey,

   Dissertation: Symmetries, conservation laws and multi-Hamiltonian structure of equations of hydrodynamic type, supervisor: Assoc. Prof. Dr. Ahmet Eriş.
5. B.S, July 17, 1986, Department of Physics, Middle East Technical University, Ankara, Turkey,

2 Work Experiences

- Dec 2001- Department of Mathematics, Yeditepe University
- Sep 2008-Feb 2009, Visiting Researcher, Dipartimento di Matematica e Informatica, Universita degli Studi di Trieste, Italia.
- Jun 1997-Nov 2001, Senior Researcher, Feza Gürsey Institute, İstanbul, Turkey.
- Jul-Oct 2001, Visiting Senior Researcher, Department of Physics and Institute for Fusion Studies, University of Texas at Austin, Texas, USA.
- Sep 2000-Feb 2001, Part-time Lecturer, Department of Mathematics, Boğaziçi University, İstanbul.
- Jul 1993-Feb 1994, Visiting Researcher, Department of Mathematics, University of California at Berkeley, California, USA.
- Apr-Jul 1993, Visiting postdoctoral fellow, Fields Institute For Research in Mathematical Sciences, Waterloo, Canada.
- Feb 1993-Jun 1997, Researcher, Department of Physics, Tübitak, Marmara Research Center, Gebze, Kocaeli, Turkey.
- Oct 1990-Jan 1993, Research Assistant, Department of Mathematics, Bilkent University, Ankara, Turkey.
- Sep 1989-Sep 1990, Research Assistant, Department of Physics, Istanbul Technical University, Istanbul, Turkey.
- Feb 1989-Aug 1989, Visiting researcher, Department of Physics, Research Institute for Basic Sciences, Tübitak, Gebze, Kocaeli, Turkey
- Sep 1988-Feb 1989, Science Teacher, Tarsus Private Lyceè, Tarsus, Mersin, Turkey.
- Dec 1986-Sep 1988, Research Assistant, Department of Physics, Middle East Technical University, Ankara, Turkey.

3 Publication List

3.1 Articles in International Refereed Journals

1. H. Gümral, Y. Nutku, Multi-Hamiltonian structure of equations of hydrodynamic type, J. Math. Phys. 31(11) 1990, 2606-2611.

2. H. Gümral, Bi-Hamiltonian structure of N-component Kodama equations, J. Phys. A: Math. Gen. 25 (1992) 5141-5149.

3. H.Gümral, Y. Nutku, Poisson structure of dynamical systems with three degrees of freedom, J. Math. Phys. 34 (1993) 5691-5723.

4. H.Gümral, Y. Nutku, Bi-Hamiltonian structures of dispersionless-Boussinesq and Benney equations, J. Phys. A: Math. Gen. 27 (1994) 193-200.

5. H.Gümral, Contravariant geometry of time-dependent dynamical systems, Phys. Lett. A 218 (1996) 235-239.

6. H.Gümral, Lagrangian description, symplectic structure, and invariants of 3D fluid flow, Phys. Lett. A 232 (1997) 417-424.

7. H.Gümral, A time-extended Hamiltonian formalism, Phys. Lett. A 257 (1999) 43-52.

8. H.Gümral, Kinematical symmetries of 3D incompressible flows, Physica D 135 (2000) 117-136.

9. H.Gümral, Helicity invariants in 3D: Kinematical aspects, Physica D 139 (2000) 335-359.

10. E. Abadoğlu, H. Gümral, Bi-Hamiltonian structure in Frenet-Serret frame, Physica D 238 (2009) 526-530.

11. H. Gümral, Existence of Hamiltonian Structure in 3D, Adv. in Dyn. Sys. and Appl., 5 (2010) 159-171.

12. H. Gümral, Geometry of Plasma Dynamics I: Group of Canonical Diffeomorphisms, J. Math. Phys. 51 (2010) 083501 (23pp).

13. O. Esen, H. Gümral, Lifts, Jets and Reduced Dynamics, Int. J. of Geom. Meth. in Mod. Phys. 8 (2011) 331-344.

14. E. Abadoğlu, H. Gümral, Poisson Structures for the Aristotelian Model of Three-Body Motion, J. Phys. A: Math. Theor. 44 (2011) 325204 (15pp).

15. O. Esen, H. Gümral, Geometry of Plasma Dynamics II: Lie Algebra of Hamiltonian Vector Fields, to be published in J. Geom. Mech. (2012).

3.2 Articles in Turkish

1. Kontakt Parçacıkların Kinetik Denklemleri, "XVII. Ulusal Mekanik Kongresi-bildiriler-" (Yayına hazırlayanlar:) () (O. Esen ile)

2. Kanonik Dönüşümler Grubu ve Plazma Dinamiği, "XVI. Ulusal Mekanik Kongresi-bildiriler-" (Yayına hazırlayanlar: A.Y. Aköz, H. Engin, Ü. Gülçat, A. Hacınlıyan) (Nisan 2010) 631-649.

3. Yavuz Nutku, "Anılarla/With Memories Yavuz Nutku", (Yayına hazırlayan: Yılmaz Akyıldız) Uygulamalı Matematik Enstitüsü, ODTÜ (Ankara, 2010) 3-16.

3.3 Works in Progress

- O. Esen, H. Gümral, Geometry of Plasma Dynamics III: Orbits of Canonical Diffeomorphisms,

- E. Abadoğlu, Z. Demireli, H. Gümral, Gradient Systems, Poisson Structures and Surfaces in 3D,

- H. Gümral, Lagrangian Description, Symplectisation and Eulerian Dynamics of Incompressible Fluids,

- H. Gümral, On Poisson bi-vectors in 4D,

- H. Gümral, Reductions of TMG: Degenerate Second Order Lagrangians,

- F. Çağatay, H. Gümral, Contraint Analysis of Clément Reduction of TMG,

- H. Gümral, Kinetic Theories from Local Lie Algebras,
- H.Gümral, Geometry of Plasma Dynamics IV: Space of Displacement Mappings,

4 Research Interests

4.1 General interests

Geometric mechanics: symplectic, multisymplectic, Poisson, contact, Jacobi and multi-Hamiltonian structures with applications to non-linear differential equations of physical importance, in particular, to fluids and plasma. Higher order and degenerate Lagrangian theories and their (covariant) Hamiltonian formalisms.

4.2 Research Summary

The published works may be grouped under four headings: 1) geometry of plasma dynamics and kinetic theories, 2) generalized Hamiltonian formulation for non-autonomous dynamical systemswith applications to (magneto-)hydrodynamic motions in Lagrangian description, 3) local and global aspects of Poisson structures in three dimensions and, 4) multi-Hamiltonian structure of equations of hydrodynamic type in one space dimension.

- In J. Math. Phys. 51 (2010) 083501 (23pp), The dynamics of collisionless plasma described by the Poisson–Vlasov equations is connected to the Hamiltonian motions of particles and their symmetries. The Poisson equation is obtained as a constraint arising from the gauge symmetries of particle dynamics. Lie–Poisson reduction for the group of canonical diffeomorphisms gives the momentum-Vlasov equations. Plasma density is given a momentum map description associated with the action of additive group of functions of particle phase space. Equivalence of Hamiltonian functionals in momentum and density formulations is shown. An alternative formulation in momentum variables is described. A comparison of one-dimensional plasma and two-dimensional incompressible fluid is presented. In the second paper

J. Geom. Mech. (2012) the underlying geometry of the momentum-Vlasov equations is elaborated. These equations are obtained as vertical equivalence of complete cotangent lift of Hamiltonian vector field generating the particle motion. This technique is also applied, in Int. J. of Geom. Meth. in Mod. Phys. 8 (2011) 331-344, to kinetic theories of particles whose congiguration space is the group of contact diffeomorphisms.

- A Hamiltonian formulation for non-autonomous dynamical systems in the framework of contravariant geometry is given in Phys. Lett. A 218 (1996) 235-239 (MR 97e: 58080). This is further elaborated to show that any Poisson bi-vector in time-extended space possesses two infinitesimal automorphism and applied to the investigations of the phase space geometry and of the invariants of hydrodynamical motions in Phys. Lett. A 257 (1999) 43-52 (MR 00e: 37078). The time-extended Hamiltonian formalism is used to investigate the invariants of hydrodynamical equations in three dimensions. In a series of articles (Phys. Lett. A 232 (1997) 417-424 (MR 98i: 76003), Physica D 135 (2000) 117-136, Physica D 139 (2000) 335-359 (MR 01i: 76027)) the symplectic geometry of Lagrangian motions are given. The implication of this structure to kinematical symmetries and invariants of motion are discussed. The equivalence of Lagrangian and Eulerian types of helicity conservation laws are shown and, this equivalence is characterized in the framework of symplectic and conformally symplectic, or more generally, in the language of Jacobi structures. Time-extended formalism is also applied for Aristotelian model of three-body motion in J. Phys. A: Math. Theor. 44 (2011) 325204 (15pp) where it is also shown to be an autonomous bi-Hamiltonian system.

- A survey of Poisson structures in three dimensions and a discussion of integrability in this framework is given in J. Math. Phys. 34 (1993) 5691-5723 (MR 94i: 58066). The problem in Lichnerowicz complex is converted into the one on de Rham complex. Frobenius theorem is used to characterize integrable bi-Hamiltonian systems. Godbillon-Vey invariants are obtained as obstruction to global integrability in three dimensions. Applications to dynamical systems from general relativity, biology, epidemiology, atomic physics, etc. are given. In Physica D 238

(2009) 526-530, it is shown that in three dimensions, the construction of bi-Hamiltonian structure can be reduced to the solutions of a Riccati equation with the arclength coordinate of a Frenet-Serret frame being the independent variable. All explicitly constructed examples in the literature are exhausted by constant solutions. It is proved that vector fields which are not eigenvectors of the curl operator are locally bi-Hamiltonian. Based on this, the work Adv. in Dyn. Sys. and Appl., 5 (2010) 159-171 shows that explicit integration of conserved quantities are connected with the coefficients of Riccati equation which are elements of the third cohomology class. The Darboux-Halphen system, as the only non-trivial example of locally bi-Hamiltonian system in the literature, is revisited and it is concluded that the Godbillon-Vey invariant arises as obstruction to integrability of integrating factor for Hamiltoian functions. In J. Phys. A: Math. Theor. 44 (2011) 325204 (15pp) Aristotelian model of three-body motion on the line is shown to be bi-Hamiltonian for all physical parameters involved.

- Integrability of equations of hydrodynamic type in one space dimension is studied in the framework of multi-Hamiltonian structure. Gas dynamics hierarchy is completed with the inclusion of new conserved quantities and a continuum limit of Toda lattice J. Math. Phys. 31(11) 1990, 2606-2611 (MR 91j: 35229). In J. Phys. A: Math. Gen. 25 (1992) 5141-5149 (MR 93h: 35164) a combinatorial method is developed for the construction of bi-Hamiltonian structures and is applied to N-component Kodama equations. Some transformations are used in J. Phys. A: Math. Gen. 27 (1994) 193-200 (MR 95e: 58085) for the same purpose and the integrability of dispersionless-Boussinesq, Benney-Lax equations are proved.

4.3 References to Mathematical Reviews

1. 91j: 35229, 35Q35, 58F05, 76B15, 76N15.
2. 93h: 35164, 35Q35, 58F07.
3. 94i: 58066, 58F05, 34A26, 58F07, 70H05.

4. 95e: 58085, 58F07, 35Q58.

5. 97e: 58080, 58F05, 70H05, by Charles-Michel Marle.

6. 98i: 76003, 76A02, 58D05, 58F05, by Yuri E. Gliklikh.

7. 00e: 37078, 37J05, 37C60, 53D17, 70H05, by David Martin de Diego.

8. 01(kin sym) 37K65, 37N10, 76M60,

9. 01i: 76027, 76B99, 37K05, 37N10, 76A25, 76W05, by Hans-Peter Kruse.

5 Conferences, Seminars, Meetings

*: *participation with invited talks, lectures or anouncements*

1. *Hamiltonyen Parçacıkların Kinetik Denklemleri I, XVI. Ulusal Mekanik Kongresi, Erciyes Üniversitesi, 22-26 Haziran 2009, Kayseri.

2. *Üç Boyutta iki-Hamiltonlu Yapının Varlığı, 9. Dinamik Sistemler Çalıştayı, İzmir Üniversitesi, 18-19 Haziran 2009, İzmir.

3. *Geometry of Vlasov-Poisson Equations, Seminars at Department of Physics and Institute For Fusion Studies, Sep. 21, 2001, University of Texas at Austin, USA.

4. *Symplectic Geometry of Incompressible Flows, talk at NEEDS 2000, June 29-July 7, Gökova, Turkey.

5. *Geometric Mechanics, seminar at Physics Department of Boğaziçi University, Dec. 15, 1999, Istanbul.

6. International Conference on New Applications of Multisymplectic Geometry, Sep. 20-24, 1999, Universidad de Salamanca, Spain.

7. *Neo-Klasik Mekanik, Geometrik Mekanik başlıklı iki çağrılı konuşma. 12. Ulusal Matematik Kongresi, 6-10 Eylül, 1999, İnönü Üniversitesi, Malatya.

8. *Hydrodynamical Invariants and Jacobi Structures, talk at IX. Regional Conference on Mathematical Physics, Aug. 9-14, 1999, Feza Gürsey Institute, Istanbul.

9. *Fen fakültesi ögrencilerine Feza Gürsey Enstitüsünü tanıtıcı konuşma, 4 Haz. 1999, İstanbul Üniversitesi, Vezneciler.

10. *Lectures on Symplectic Geometry, in: Research semester on Geometry and Integrability, Feb. 15-June 15, 1999, Feza Gürsey Institute, Istanbul, Turkey.

11. *Colloqium on Geometry and Integrability, at Physics Departments of Middle East Technical University (Feb 11, 1999), Bilkent University (Feb 11, 1999) and Boğaziçi University (Feb 18, 1999).

12. *Poisson Geometry and Time-dependent Motions, seminars at Mathematics Department of Boğaziçi University (Nov 3, 1998) and, Physics Department of Istanbul Technical University (Nov. 12, 1998), Istanbul.

13. Research semester on Seiberg-Witten monopoles and M-theory, summer, 1998, Feza Gürsey Institute, Istanbul, Turkey.

14. 6th Gökova Conference on Geometry and Topology, May 25-30, 1998, Akyaka-Gökova, Turkey.

15. *Geometrik Mekaniğin Yapısı, Sicimler, Zarlar ve Dualite Simetrileri Kış Okulunda yapılan konuşma, 19-23 Ocak 1998, İzzet Baysal Üniversitesi, Bolu, Türkiye.

16. *A time-extended Hamiltonian formalism, talk at VIII. Regional Conference on Mathematical Physics, June 27-July 4, 1997, Yerevan, Armenia.

17. *General Helicity conservation, talk at Anatolian Lectures on Dynamical Systems, June 15-19, 1997, Department of Mathematics, Middle East Technical University, Ankara, Turkey.

18. Workshop on Turbulence Modelling and Vortex dynamics, Sep. 2-6, 1996, Istanbul Technical University, Maçka, Istanbul, Turkey.

19. *Poisson geometrisi, Fizikte Geometri ve Topoloji Kış Okulunda yapılan konuşma, 29 Ocak-2 Şubat 1996, İzzet Baysal Üniversitesi, Bolu, Türkiye.

20. Variational and local methods in the study of Hamiltonian systems, 24-28 October, 1994 (with certificate) ICTP, Trieste, Italy.

21. Research workshops on Mathematical Ecology (May 26-29, 1993) and, Pattern Formation and Lattice Gas Automata (Jun 7-12, 1993) at Fields Institute, Waterloo, Canada.

22. *N-bileşenli Kodama denklemlerinin iki-Hamiltonlu yapısı, VI. Diferansiyel Denklemler Sempozyumu'nda yapılan konuşma, 28-29 Eylül, 1992, Ankara Üniversitesi, Fen Fakültesi, Ankara, Türkiye.

23. International Workshop on Geometry and Arithmetic, July 19-Aug 1, 1992, Akdeniz University, Antalya, Turkey.

24. *Poisson structures and 2-monopole problem, talk at Dynamics Days, June 19-20, 1992, Department of Mathematics, Middle East Technical University, Ankara, Turkey.

25. 1st Gökova Conference on Geometry and Topology: Low Dimensional Topologies, May 25-29, 1992, Akyaka-Gökova, Turkey.

26. *2-monopole problem, talk at V. Regional Conference on Mathematical Physics, Dec 15-22, 1991 Trakya University, Edirne, Turkey.

27. *3-boyutta korunum yasaları için bir yöntem, V. Diferansiyel Denklemler Sempozyumu'nda yapılan konuşma, 25-27 Eylül, 1991, Anadolu Üniversitesi, Eskişehir, Türkiye.

28. I. International Colloquium on Recent Developments in Theoretical Physics, May 27-31, 1991, Trakya University, Edirne, Turkey.

29. *Multi-Hamiltonian structure of hydrodynamic type equations, talk at NATO-Advanced Research Workshop: Singular Limits of Dispersive Waves, July 7-12, 1991, ENS-Lyon, France.

30. *Poisson structure of 3-dimensional dynamical systems, seminar at Physics Department, March 28, 1991, Middle East Technical University, Ankara.

31. Summer School on High Energy Physics and Cosmology, June 18-July 28, 1990 Trieste, ICTP, Italy.

32. Trieste Conference on Topological Methods in Quantum Field Theory, June 11-15, 1990, ICTP, Trieste, Italy.

33. Recent Developments in Quantum Electrodynamics and Quantum Optics, NATO-ASI, Augost 14-26, 1989, Boğaziçi Univ. Istanbul, Turkey.

34. Partially Integrable Nonlinear Evolution Equations and Their Physical Applications, NATO-ASI, March 21-30, 1989 Centre de Physique, Les Houches, Haute-Savoie, France

6 Courses

- Undergraduate level: Calculus for Engineers I,II, Calculus for Math Students I,II, Calculus for Health Sciences, Calculus III, Analytic Geometry, Differential Equations, Ordinary Differential Equations, Advanced Ordinary Differential Equations, Linear Algebra, Linear spaces, Matrix algebra, Elementary Differential Geometry, Calculus on Manifolds, Geometries, Mathematical Foundations of Thermodynamics, Graduate level: Geometry of Diffeomorphism Groups (Yeditepe University)

- Lectures on Symplectic Geometry, in: Research Semester on Geometry and Integrability, Feza Gursey Institute, Spring 1999.

- Organizer of the regular seminars in 1999-2000 academic year (FGI).

- Member of the organizing commitee of Special Program on Geometry and Topology, FGI, Spring 2000.

- Lectures on Plasma Physics Geometry, in Research Semester on Qualitative Theory of Nonlinear Partial Differential Equations, FGI, Spring 2001.

- Calculus for Mathematics Students III (Bogazici University).

- Teaching assistant to the second year course: Linear Algebra (Bilkent University).
- Teaching assistant to mechanics, electric, optic laboratories (ITU).
- Science (physics, astronomy, chemistry, biology) courses to first encounters (Lyceè).
- Teaching assistant to mechanics, electric, optic laboratories and the second year course: Mathematical Methods of Physics (METU).

7 Scholarships, memberships and awards

7.1 Scholarship

- NATO-B2 Postdoctoral Research grant 2001
- NATO-B Postdoctoral scholarship 1993-1994
- TÜBİTAK-Graduate scholarship 1991-1992

7.2 Award

- TÜBİTAK junior science prize, 1998