ORKAN MEHMET UMURHAN

SETI Institute at NASA Ames Research Center
NASA Ames Research Center, Space Sciences Division
Moffett Field, CA 94035 U.S.A.
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Citizenship: United States of America
Date of Birth: 23 July 1969

EDUCATION:

1993 - 1999	Columbia University,	Ph.D., Astronomy Ph.D. Advisor, E.A. Spiegel Thesis Title, "Conducting Sound"
1991 - 1993	Columbia University,	M. Phil., Astronomy
1987 - 1991	University of California, Los Angeles,	B.S., Astrophysics

PROFESSIONAL HISTORY:

2013 - Present	NASA New Horizons, Participating Mission Scientist and Co-I: Geology and Geophysics Imaging Theme Team, Composition Theme Team
2013 - Present	SETI Institute, Senior Research Scientist
2014 - 2017	NASA Ames Research Center, Senior NPP
2011 - 2013	University of California, Merced, Visiting Assistant Professor (Applied Mathematics)
2002 - Present	City College of San Francisco, Adjunct Professor
2008 - 2011	Queen Mary University of London, Dept. of Mathematics, Research Fellow
2003 - 2007	The Technion, Research Fellow, Dept. of Physics
2005 - 2007	Tel-Aviv University, Research Fellow, Dept. of Geophysics and Planetary Sciences
1999 - 2002	San Jose State University, Instructor
1998 - 2002	NASA - Ames Research Center, Research Associate
1998 - 2001	Stanford University, Center for Turbulence Research, Research Fellow
1991 - 1998	Columbia University, Research Assistant
1995 - 1997	Lawrence Livermore National Laboratory (IGPP), Visiting Student Fellow
1995 (Fall Semester)	Columbia Science Honors Program, Instructor
1991 - 1993, 1997	Columbia University, Teaching Fellow
1988 - 1991,	University of California, Los Angeles, Research Assistant
1990 (Summer)	National Optical Astronomy Observatories, Summer Research Student
1989 (Summer)	National Radio Astronomy Observatory, Summer Research Student

CURRENT ACADEMIC RESEARCH:

I employ linear and non-linear analysis, including asymptotic methods and numerical computations, to the following areas of research:

• *Geophysics of the Pluto-Charon MU69System:* Ongoing research on the modeling of glacial flow on Pluto, including theoretical and computational modeling of solid state convection in Pluto's Sputnik Planitia, as well as classical N_2 ice flow from hills and mountains surrounding this plain. Examination of other surface properties including the formation of N_2 ice penitents and ice-cups. Participating in image analysis of New Horizons data to determine oblateness of Pluto and Charon. Ongoing work investigating the possibility of interior water oceans beneath Pluto's surface, surface cryovolcanic flows and its imprint upon the surfaces of Pluto and Charon. Thermalphysical modeling of Pluto's small satellites and MU69.

• *Astrophysical Disks and Turbulence, Planet Formation:* Interest in understanding the structure and turbulent dynamics of protoplanetary and accretion disk environments. Development of understanding of hydrodynamic instabilities of magnetically inactive zones of disks including vertical shear instabilities and

zombie vortex generation. Development of Streaming Instability in the face of disk turbulence. Development of turbulent opacities in the early solar nebula. Simulations of disks both of small and large scale dynamics: studies of vortex development from both purely hydrodynamic and magnetohydrodynamic shear flows and their interaction with particle fields. Explorations of fundamental issues including barotropic and baroclinic instabilities as well as acoustic processes. Establishing origin scenarios for the first planetesimals.

• *Geomorphology and Landform Evolution Modeling:* I employ and further develop landform evolution modeling techniques to assess the origins of various geomorphological features of the icy moons of the outer solar system. Currently examining: the sublimation driven landform features of comet CG-67, chemical erosive shaping of Titan's surface near its various lakes, the development of Bladed Terrain on Pluto, the formation of pinnacles on Callisto, the appearance of flow patterns generated by quasi-glacial flow mechanisms on Saturn's Trojan moon Helene. Investigations also including the stream incision on martian alluvial fans and their earthly analogs. Development of efficient algorithms for sediment transport in landform evolution modeling.

• *Geophysical flows:* Application and extension of the notion of counterpropagating Rossby waves to sheared stratified geophysical flows and and their environments. Applications to atmospheres, disks, magnetized-atmospheres and sea-channel flows, as well as their nonlinear and weakly nonlinear development. Understanding the development of two-dimensional inertial cascades to astrophysical disk systems, with and without surface self-gravity.

• *Sheared MHD Flows:* Linear and nonlinear analysis of magnetorotational processes in experiments and accretion disk systems. Generation of Rossby Waves in the tachoclines of the Sun and other F and G stars, predicting their oscillation amplitudes and observational signatures.

• *Fundamentals of Transient Growth:* Studying the fundamental matters surrounding the role of transient growth phenomena in a variety of fluid flows. Linear and nonlinear characterizations and transitory states to chaos and turbulence.

OTHER RECENT AND ONGOING RESEARCH:

• *Coherent Structures in 2D Sheared Flows:*
• *Computational Methods - Spectral:*
• *Exoplanet Atmospheres:*
• *Atmospheric Convection*
• *Combustion Acoustics*
• *Atmospheric Acoustics*
• *Chaos*

STUDENTS SUPERVISED:

(current)		
• Mr. Ron Yellin-Bergovoy	Tel Aviv University, Israel.	Doctorate of Philosophy
(former)		
• Ms. Talia Tamarin	Tel Aviv University, Israel.	Masters of Science
• Dr. Yotam Gil	The Technion	Doctorate of Philosophy (Physics)
• Dr. Assaf Sternberg	The Technion	Masters of Science (Physics)

PROFESSIONAL CONTACTS:

(research evaluations)		
• Dr. Jeffrey Cuzzi	NASA Ames Research Center, United States.	jeffrey.cuzzi@nasa.gov
• Dr. Jeffrey Moore	NASA Ames Research Center, United States.	jeff.moore@nasa.gov
• Professor William McKinnon	Washington University, United States.	mckinnon@wustl.edu
• Dr. S. Alan Stern	Southwest Research Institute, United States.	astern@boulder.swri.edu
• Dr. Dale Cruikshank	NASA Ames Research Center, United States.	dale.p.cruikshank@nasa.gov
• Dr. William Grundy	Lowell Observatory, United States.	W.Grundy@lowell.edu
• Professor Alan D. Howard	Pacific Science Institute,	ahoward@psi.edu
• Professor Eyal Heifetz	Dept. of Geophysics and Planetary Sciences, Tel Aviv University, Israel.	eyalh@tau.ac.il
• Professor Richard P. Nelson	School of Physics and Astronomy, Queen Mary, University of London, UK	r.p.nelson@qmul.ac.uk
• Professor Oded Regev	Dept. of Physics, The Technion, Israel.	odedregev@gmail.com
(teaching & research evaluations)		
• Professor Lancelot Kao	Dept. of Astronomy, City College of San Francisco, USA.	lancelot.kao@mail.ccsf.edu
• Professor Arnold Kim	School of Natural Sciences, University of California, Merced, USA.	adkim@ucmerced.edu

FUNDED GRANTS (*either as principal investigator or co-investigator*):

"Dynamical instabilities in the aid of planet formation in circumstellar disks"
- NASA: Theoretical and Computational Astrophysics Networks (2020)
- PI: Wladimir Lyra (NMSU), Program Manager: Melissa A. Morris (melissa.a.morris@nasa.gov)
- 01/2021–12/2023
- Commitment: 2.5 months for each year

"Comparing Ice-Atmosphere Interaction on Mars, Pluto, and Triton - PSI"
- NASA: Solar System Workings Program (2019)
- PI: Peter Buhler (PSI), Program Manager: Melissa A. Morris (melissa.a.morris@nasa.gov)
- 01/2021–01/2024
- Commitment: 1 month for each year

"Understanding Transient Changes within Smooth Terrains on 67P"
- NASA: Rosetta Data Analysis Program (2018)
- PI: Alex Hayes (Cornell), Program Manager: Melissa A. Morris (melissa.a.morris@nasa.gov)
- 06/2019–06/22
- Commitment: 1 month for each year

"Interface development and documentation for a planetary landform evolution simulation platform"
- NASA: Planetary Data Archiving, Restoration and Tools (2017)
- PI: Orkan Umurhan (SETI), Program Manager: Sara Noble (sarah.noble-1@nasa.gov), (202) 358-2492
- 03/2018–02/20
- Commitment: 3.5 month for each year

"New High Resolution Topographic Maps of Pluto and Charon"
- NASA: Planetary Data Archiving, Restoration and Tools (2017)
- PI: Ross Beyer (SETI). Program Manager: Sara Noble (sarah.noble-1@nasa.gov), (202) 358-2492
- Co-I: Orkan Umurhan (SETI)
- 03/2018–02/21
- Commitment: 3 weeks for each year

"Hydrodynamic Processes in Planet-Forming Accretion Disks"
- NASA: Astrophysics Theory Program (2016)
- PI: Min-Kai Lin (University of Arizona). Program Manager: Christina Richey (christina.r.richey@nasa.gov), (202) 358-2206
- Co-I: Orkan Umurhan (SETI)
- 03/2017–02/19
- Commitment: 1 month for each year

PUBLICATIONS:

Books:

1. *Modern fluid dynamics for physics and astrophysics*, by O. Regev, **O.M. Umurhan** and P.A. Yecko, Springer-Verlag (2016).

2. *Asymptotic approximation methods in astrophysical fluid dynamics. Techniques and example applications*, by O. Regev and **O.M. Umurhan**, VDM Publishers (2010).

Peer Reviewed Journal Articles: (prints of any of these works are available upon request)

1. **Accepted:** "A minimal model for vertical shear instability in protoplanetary accretion disks", R. Yellin-Bergovoy, **O.M. Umurhan** E. Heifetz, *Geophysical and Astrophysical Fluid Dyanmics* (2021).

2. **Accepted:** "Modeling global-scale mass flows on the Lagrangian satellites of Dione and Tethys", **O.M. Umurhan** A. D. Howard, J.M. Moore *et al.*, *Icarus* (2021).

3. **In Press:** "Rheological and thermophysical properties and some processes involving common volatile materials found on Plutos surface.", **O.M. Umurhan**, Ahrens C. J., and Chevrier V. F. In *Pluto System After New Horizons (S. A. Stern, R. P. Binzel, W. M. Grundy, J. M. Moore, and L. A. Young, eds.)*, pp. 195-258. (2021).

4. "Rossby Waves in Astrophysics." Zaqarashvili, T. V. and 16 colleagues *Space Science Reviews* **217** article id.15. doi:10.1007/s11214-021-00790-2 (2021).

5. "Streaming Instability in Turbulent Protoplanetary Disks." **O.M. Umurhan** P. E. Estrada, J.N. Cuzzi, *The Astrophysical Journal* **895**. (2020)

6. "Color, composition, and thermal environment of Kuiper Belt object (486958) Arrokoth." Grundy, W. M. and 48 colleagues *Science* **367**, 367. doi:10.1126/science.aay3705 (2020).

7. "The geology and geophysics of Kuiper Belt object (486958) Arrokoth." Spencer, J. R. and 77 colleagues *Science* **367**, 367. doi:10.1126/science.aay3999 (2020).

8. "Migrating Scarps on Comet 67P Reveal Large Volumes of Water Ice in Near Surface Regolith", S. Birch, A. Hayes, **O.M. Umurhan** *et al.*, GRL. **46**, 12,794 (2019)

9. "Recent Cryovolcanism in Virgil Fossae on Pluto". D. P. Cruikshank, **O.M. Umurhan** et al., Icarus **330**, 155 (2019)

10. "Linear and nonlinear stability of a quasigeostrophic mixing layer subject to a uniform background shear", L. Biancofiore & **O.M. Umurhan**, *Physical Review Fluids* **131**, 072001 (2019).

11. "The initial conditions for planet formation: Turbulence driven by hydrodynamical instabilities in disks around young stars", W. Lyra & **O.M. Umurhan**, *Publications of Astronomical Society of the Pacific* **131**, 072001 (2019).

12. "Formation of metre-scale bladed roughness on Europa's surface by ablation of ice", D.E.J. Hobley, J.M. Moore, A. D. Howard, **O.M. Umurhan**, *Nature Geosciences* **11**, 901-904 (2019).

13. " Recent Advancements and Motivations of Simulated Pluto Experiments." Ahrens, C. J., Grundy, W. M., Mandt, K. E., Cooper, P. D., Umurhan, O. M., Chevrier, V. F. *Space Science Reviews* **214**. doi:10.1007/s11214-018-0558-6 (2018)

14. "On the physical mechanism of centrifugal-gravity wave resonant instability in swirling free surface rotating Polygons", R. Y-Bergovoy, E. Heifetz and **O.M. Umurhan**, *Physics of Fluids* (2017).

15. "Bladed Terrain on Pluto: Possible origins and evolution", J.M. Moore, A. D. Howard, **O.M. Umurhan** *et al.*,*Icarus* **300**, 129 (2017).

16. "Modeling glacial flow on and onto Pluto's Sputnik Planitia", **O.M. Umurhan**, A. D. Howard, J. M. Moore *et al.*, *Icarus* **287**, 301 (2017)

17. "Sublimation as a landform-shaping process on Pluto", J.M. Moore, A. D. Howard, **O.M. Umurhan** *et al.*, *Icarus* **287**, 320 (2017).

18. "Present and Past Glaciation on Pluto", A. D. Howard, J. M. Moore, **O.M. Umurhan**, O.L. White, *et al.*, *Icarus* **287**, 287 (2017)

19. "Critical layers and turbulence in protoplanetary disks", **O.M. Umurhan**, K. Shariff and J. Cuzzi, *Astrophysical Journal*, 830, 95 (2016)

20. "Convection in a massive volatile ice layer maintains Plutos geological and atmospheric vigor", W. B. McKinnon, ... **O.M. Umurhan** ..., *Nature* (2016)

21. "Mean radius and shape of Pluto and Charon from New Horizons images", F. Nimmo, **O.M. Umurhan**, *et al.*, *Icarus* **287**, 12 (2017)

22. "Linear analysis of the vertical shear instability: outstanding issues and improved solutions", **O.M. Umurhan**, R. P. Nelson and O. Gressel, *Astronomy and Astrophysics* **586**, 33 (2016)

23. "On the mechanism of self gravitating Rossby interfacial waves in proto-stellar accretion discs", R. Y-Bergovoy, E. Heifetz and **O.M. Umurhan**, *Geophysical and Astrophysical Fluid Dynamics* **110**, 274 (2016)

24. "Vortex formation in protoplanetary discs induced by the vertical shear instability", R. Richard, R. P. Nelson and **O.M. Umurhan**, *MNRAS*, **456**, 357 (2016)

25. "Modeling of ice pinnacle formation on Callisto", O. L. White, **O.M. Umurhan**, J.M. Moore and A.D. Howard, *Journal of Geophysical Research: Planets* **121**, 21 (2016)

26. "On the nonnormal-nonlinear interaction mechanism between counter-propagating Rossby waves", T. Tamarin, E. Heifetz, **O.M. Umurhan** and R Yellin-Bergovoy *Theoretical and Computational Fluid Dynamics* (2015).

27. "Interacting vorticity waves as an instability mechanism for MHD shear instabilities", E. Heifetz, J. Mak, J. Nycander, **O.M. Umurhan**, *Journal of Fluid Mechanics* **767**, 199-225 (2015).

28. "Intercomparison of General Circulation Models for Hot Extrasolar Planets", I. Politchtchouk, J. Y-K. Cho, C. Watkins, H. Thrastarson, **O.M. Umurhan** and M. de la Torre-Juarez , *Icarus* **229**, 355-377 (2013).

29. "Linear and nonlinear evolution of the vertical shear instability in accretion discs", R. P. Nelson, O. Gressel and **O.M. Umurhan**, *Mon. Not. Royal A. S.* **435**, 2610-2632 (2013).

30. "Non-Dissipative Saturation of the Magnetorotational Instability", E. Liverts, Y. Shtemler, M. Mond, **O. M. Umurhan** and D. V. Bisikalo, *Phys. Rev. Let.* **109**, 224501 (2012).

31. "Potential vorticity dynamics in the framework of disk shallow-water theory: II. Mixed barotropic-baroclinic instability", *Astron. and Astrophys.*, **543**, 543-554 (2012). **O.M. Umurhan**,

32. "Vorticity inversion and action-at-a-distance instability in stably stratified shear flow", A. Rabinovich **O.M. Umurhan**, E. Heifetz, N. Harnik and F. Lott, *J. of Fluid Mech.*, **670**, 301-325 (2011).

33. "Potential vorticity dynamics in the framework of disk shallow-water theory: I. The Rossby wave instability", **O.M. Umurhan**, *Astron. and Astrophys.*, **521**, A25-33 (2010).

34. "Non-exponential hydrodynamical growth in density-stratified thin Keplerian discs", Y. U. Shtemler, M. Mond, G. Rudiger, O. Regev and **O.M. Umurhan**, *Monthly Notices of the RAS*, **406**, 517-528 (2010).

35. "Low magnetic-Prandtl number flow configurations for cold astrophysical disk models: speculation and analysis", **O.M. Umurhan**, *Astron. and Astrophys.*, **513**, A47-54 (2010).

36. "Global transient dynamics of three-dimensional hydrodynamical disturbances in a thin viscous accretion disk", P. Rebusco, **O.M. Umurhan**, W. Kluzniak and O. Regev, *Phys. Fluids*, **21**, 076601-20 (2009).

37. "Linear dynamics of weakly viscous accretion disks: A disk analog of Tollmien-Schlichting waves", **O.M. Umurhan** and G. Shaviv, *Astron. and Astrophys.*, **497**, 1-15 (2009).

38. "A shallow-water theory for annular sections of Keplerian Disks", **O.M. Umurhan**, *Astron. and Astrophys.*, **489**, 953-962 (2008).

39. "Hydrodynamic response of rotationally supported flows", A. Sternberg, **O.M. Umurhan**, Y. Gil and O. Regev, *Astron. and Astrophys.*, **486**, 341-345 (2008).

40. "Properties of a solid state device with mobile dopants; Analytic analysis for the thin film device," Y. Gil, I Riess, **O.M. Umurhan**, and Y. Tsur, *J. Appl. Physics*, **104**, 084504-084516 (2008).

41. "Recent calculations and measurements of I-V relations in simple devices based on thin nano versus thick layers of semiconductors with mobile acceptors or donors," Y. Gil, **O.M. Umurhan**, Y. Tsur, and I Riess, *Solid State Ionics*, **179**, 21-26 (2008).

42. "I-V Relations in Nano Thin Semi-conductors with Mobile Acceptors or Donors," Y. Gil, **O.M. Umurhan**, I Riess, and Y. Tsur, *Solid State Ionics*, **179**(6), 24-32 (2008).

43. "On the viability of the shearing box approximation for numerical studies of MHD turbulence in accretion disks", O. Regev and **O.M. Umurhan**, *Astron. and Astrophys.*, **481**, 21-32 (2008).

44. "Properties of solid state devices with significant impurity hopping conduction," Y. Gil, and Y. Tsur, **O.M. Umurhan** and I. Riess, *J. of Physics, D*,**41**, 2615-30 (2008).

45. "A buoyancy-vorticity wave interaction approach to stratified shear flow," N. Harnik, E. Heifetz, **O.M. Umurhan** and F. Lott, *J. Atm. Sci.*,**65**, 135106 (2008).

46. "On the nonlinear saturation of the magnetorotational instability near threshold in a thin-gap Taylor-Couette setup", **O.M. Umurhan**, O. Regev and K. Menou, *Phys. Rev. E* **76**, 036310 (2007)

47. "Holmboe modes revisited", **O.M. Umurhan** and E. Heifetz, *Phys. of Fluids*, **19**, 064101 (2007).

48. "A weakly nonlinear analysis of the magnetorotational instability in a model channel flow," **O.M. Umurhan**, K. Menou and O. Regev, *Phys. Rev. Lett.*, **98**, 034501 (2007).

49. "I-V relations in semiconductors with mobile ionic defects with application to nano films, Part I.,$\cdots$" Y. Gil, **O.M. Umurhan** and I. Riess, *Solid State Ionics*, **178**(1-2), 1-12 (2007).

50. "Global axisymmetric dynamics of thin viscous accretion disks", **O.M. Umurhan**, A. Nemirovsky, O. Regev and G. Shaviv *Astronomy and Astrophysics* , **446**, 1-18 (2006).

51. "On the stratorotational instability in the quasi-hydrostatic semi-geostrophic limit", **O.M. Umurhan**, *MNRAS*, **365**, 85-100 (2006).

52. "On the nature of hydrodynamic stability of accretion disks", **O.M. Umurhan** and G. Shaviv. *Astronomy and Astrophysics*, **432** L31-L34 (2005).

53. "Hydrodynamic stability of rotationally supported flows: Linear and nonlinear 2D shearing box results", **O.M. Umurhan** and O.Regev. *Astronomy and Astrophysics*, **427**, 855-872 (2004).

54. "Dynamics in coalescing critical layers", N.J. Balmforth, C. Piccolo and **O.M. Umurhan**, *J. Fluid Mech.*, **449**, 115-139 (2001).

55. "Stellar oscillons," **O.M. Umurhan**, E.A. Spiegel and L. Tao, *Ann. N.Y. Acad. Sci.*, **867**, 298-305 (1998).

LANL Archiv. and Internal Reports:

56. "In pursuit of structures in protoplanetary disks,"**O. M. Umurhan**, Annual Research Briefs - 2000, Center for Turbulence Research, **2000**, 17-30.

57. "Scalings and asymptotics of coherent vortices in protoplanetary disks," with J. Barranco, P. Marcus and **O. M. Umurhan**, Proceedings of the 2000 Summer Program, Center for Turbulence Research, **2000**, 85-96.

58. "Exploration of fundamental matters of acoustic instabilities in combustion chambers,"**O. M. Umurhan**, Annual Research Briefs - 1999, Center for Turbulence Research, **1999**, 85-98.

59. "WKB approximation for acoustics in combustion chambers with arbitrary steady-state heat release profiles,"**O. M. Umurhan**, Annual Research Briefs - 1999, Center for Turbulence Research, **1999**, 99-108.

CONSULTING WORK:

• *Thermal Transfer in Flow Controllers:* Consultant on the thermal transfer properties and behavior of gases pumped through mass-flow controllers. Made predictions for and verified the veracity of the flow controller's temperature sensors. Work was done in the summer of 2002 at Parker Engineering's Veriflo Division under the direction of Dan Morgan.

TEACHING EXPERIENCE:

Course Instructor:

2013 (Spring)	University of California Merced	Math 232 "Advanced Numerical Methods"
2013 (Spring)	University of California Merced	Math 32 "Probability and Statistics"
2012 (Fall)	University of California Merced	Math 121 "Ordinary Differential Equations"
2012	University of California Merced	Math 132 "Numerical Analysis II."
2011-12	University of California Merced	Math 131 "Numerical Analysis I."
2011 (Fall, Spring)	University of California Merced	Math 23 "Vector Calculus"
2002-2012	City College of San Francisco	Astronomy 1 "Cosmic Evolution"
2008,2012 (Spring)	City College of San Francisco	Astronomy 20 "Astrophysics"
2007 (Fall)	City College of San Francisco	Astronomy 17 "Solar System"
2006-2007	City College of San Francisco	Astronomy 14 "Exploring the Universe"
2003 (Spring)	San Jose State University	Physics 160 "Thermodynamics and Statistical Mecl
2002 (Spring)	San Jose State University	Physics 252 "Advanced Physics: General Relativity
2001-2	San Jose State University	Astronomy 101 "Stars, Galaxies and Cosmology"
2001 (Fall)	San Jose State University	Physics 50 "Mechanics"
1999,2000 (Fall)	San Jose State University	Astronomy 10 "Descriptive Astronomy"
1994 (Fall)	Columbia University	Columbia Science Honors Program "Astronomy"

Course Tutor: (British System)

2010	Queen Mary University of London	MTH4102 "Differential Equations"
2008	Queen Mary University of London	MTH4101 "Calculus II"
2008	Queen Mary University of London	MTH4100 "Calculus I"

Lab Instructor:

2001-2	San Jose State University	Astronomy 102 "Astronomy Laboratory"
1991-3,1997	Columbia University	Astronomy 1304 "Astronomy Laboratory"

Teaching Assistant:

1995,1992 (Fall)	Columbia University	Astronomy 3902 "General Relativity, Cosmology, B
1993	Columbia University	Astronomy 6008 "Geophysical and Astrophysical F
1993	Columbia University	Astronomy 3910 "Order and Disorder in Nature"