

Publications

Edward Belbruno

Books

1. Title: *Fly Me to the Moon*
Subtitle: *An Insiders Guide to the New Science of Space Travel*
Author: Edward Belbruno
Publisher: Princeton University Press
Publication date: February, 2007
Pages: 150
Type of Book: General mathematics and science
2. Title: *Capture Dynamics and Chaotic Motions in Celestial Mechanics*
Subtitle: *With Applications to the Construction of Low Energy Transfers*
Author: Edward Belbruno
Publisher: Princeton University Press
Publication Date: February 2004
Pages: 211
(see www.pupress.princeton.edu/titles/7687.html)
Type of book: Graduate text in mathematics

Proceedings Volumes

- 1., 2. Special issues of journal *Celestial Mechanics and Dynamical Astronomy*
Guest Editor: Edward Belbruno, Regular Editor: Sylvio Ferraz-Mello
Publisher: Springer Verlag
Volume 114: Entitled *Weak Stability Boundaries, Manifolds and Low Thrust Transfers*; Sept. - Oct 2012
Volume 105: Entitled *New Trends in Astrodynamics*; December 2008
3. Title: *Astrodynamics*
Editors: P. Gurfil, Edward Belbruno
Publisher: Elsevier
COSPAR(ASR), Volume 42
Publication Date: October 2008
Pages: 131
4. Title: *New Trends in Astrodynamics and Applications III*
Editor: Edward Belbruno
Publisher: American Institute of Physics
AIP Conference Proceedings, Volume 886
Publication Date: 2007
Pages: 336
5. Title: *Astrodynamics and Applications*
Editor: Edward Belbruno

Publisher: New York Academy of Sciences (Annals Series)
Volume 1065
Publication Date: January 2006
Pages: 471

6. Title: *Astrodynamics, Space Missions and Chaos*
Editors: Edward Belbruno (chief editor), Pini Gurfil, David Folta
Publisher: New York Academy of Sciences (Annals Series)
Volume 1017
Publication Date: May 2004
Pages: 474

7. Title: *Nonlinear Astrodynamics*
Editor: Edward Belbruno
Publisher: The Geometry Center(Univ. of Minnesota)/National Science Foundation
Volume GCG65
Publication Date: April 1994
Pages: 324

Research Papers

Peer Reviewed Publications - Nonconference

"Stochastic Regularization of the Big Bang Singularity with Random Perturbations" , *Classical and quantum Gravity*, v35, 065012, February 2018 (co-author: BingKan Xue)

"Earth-Mars Transfers With Ballistic Capture", *Celestial Mechanics and Dynamical Astronomy*, **121**, pp329-346, 2015 (co-author: Francesco Topputo) (posted on arXiv, number: 1410:88564v1 [astro-ph], October 27,2014)

"Regularization of the Big Bang Singularity with Time Varying Equation of State $w > 1$ ", *Classical and Quantum Gravity*, v 31, 165002, 2014.(co-author: BingKan Xue) (posted on arXiv, number:1403:2122 [gr-qc], March 10, 2014)

"On the Regularizability of the Big Bang Singularity", *Celestial Mechanics and Dynamical Astronomy*, **115**, pp 21-34, Jan. 2013 (posted on arXiv, number: 1205.1474v1 [math-ph], May 2,2012)

"Chaotic Exchange of Solid Material Between Planetary Systems: Implications for Lithopanspermia", *Astrobiology*,**12**, Number 8, pp 754-774, August 2012. (co-authors: Amaya Moro-Martin, Renu Malhotra, Dmitry Savransky) (posted on arXiv, number: 1205.1059v1 [astro-ph.EP], May 2, 2012)

"Optimization of Low Energy Transfers", in Modeling and Optimization in Space Engineering, G. Fasana; J, Pinter Editors, **73**, Series ISSN 1931-6828, Springer, New York, pp 389-404, 2013(co-author - Francesco Topputo)

"Geometry of Weak Stability Boundaries", *Qualitative Theory of Dynamical Systems*, DOI 10.1007/s12346-012-0069-x, 2012 (co-authors: Marian Gidea, Francesco Topputo) (posted on arXiv, number: 1204.1502v1 [math.DS], April 6, 2012)

"Dynamical Systems Approach to Schwarzschild Null Geodesics", *Classical and Quantum Gravity*, v 28, 195007, 2011.(co-author: Frans Pretorius) (posted on arXiv, number: 1103.0585v1 [gr-qc])

"Weak Stability Boundary and Invariant Manifolds", *SIAM J. Appl. Dyn. Systems*, Volume 9, No. 3, pp 1061-1089, December 2010.

"A Survey of Recent Results on Weak Stability Boundaries and Applications", in *Space Manifold Dynamics*(subtitle: Novel Spaceways for Science and Exploration), edited by E. Perrozi, S. Ferraz-Mello, Springer-Verlag, 2010.

"Computation of Weak Stability Boundaries: Sun-Jupiter", *Celestial Mechanics and Dynamical Astronomy*, Volume 105, pp 3-17, 2009 (co-author, Francesco Topputo)

"Random Walk in Celestial Mechanics", *Regular and Chaotic Dynamics*, (Jürgen Moser-80), Volume 14, number 1, pp 7-17, February 2009.

"Recollections of Jürgen Moser", *Regular and Chaotic Dynamics*, (Jürgen Moser-80), Volume 14, number 1, pp 3-4, February 2009.

"Random Walk in the Three-Body Problem", *Discrete and Continuous Dynamical Systems-S*, Volume 1, number 4, pp 519-540, Dec. 2008.

"Resonance Transitions Associated to Weak Capture in the Restricted Three-Body Problem", *Advances in Space Research*, Volume 42, number 8, Elsevier, pp 1330-1352, 2008.

"Resonant Motion, Ballistic Escape and their Applications in Astrodynamics", *Advances in Space Research*, Volume 42, number 8, pp 1318-1330, Elsevier, 2008.

"Where Did The Moon Come From?", *Astronomical Journal*, V 129, No 3, pp 1724-1745, March 2005. (co-author: J. R. Gott III)

"Construction of Periodic Orbits in Hill's Problem for $C \gtrsim 3^{\frac{4}{3}}$ ", in *New Advances in Celestial Mechanics and Hamiltonian Systems*, pp 37-63, Kluwer Academic/Plenum Publishers, 2004.

"Analytic Estimation of Weak Stability Boundaries and Low Energy Transfers", *Contemporary Mathematics*, AMS, V 292, Feb. 2002, pp 17-45

"Resonance Hopping in Comets", *The Astronomical Journal*, V113, pp 1433-1444, April 1997. (co-author: Brian Marsden)

"On the Families of Periodic Orbits which Bifurcate from the Circular Sitnikov Motions", *Cel. Mech. and Dyn. Ast.*, V.60, 1994, pp 99-129. (co-authors: J. Llibre, M. Olle)

"Ballistic Lunar Capture Transfers Using the Fuzzy Boundary and Solar Perturbations: A Survey", *Journal of the British Interplanetary Society*, v. 47, Jan. 1994, pp 73-80.

"Sun-Perturbed Earth-to-Moon Transfers with Ballistic Capture", *Journal of Guidance, Control, and Dynamics*, V.16, No.4, July- August 1993. pp 770-775. (co-author: J. Miller)

"Through the Fuzzy Boundary: A New Route to the Moon", *Planetary Report*, V.7, No. 3, May/June 1992, pp 8-10.

"On Simultaneous Double Collision in the Collinear Four-Body Problem", *Journal of Differential Equations*, V.52, 1984, pp 415-431.

"A New Family of Periodic Orbits for the Restricted Problem", *Celestial Mechanics*, V.25, 1981, pp 195-217.

"A New Regularization of the Restricted Three-Body Problem and an Application", *Celestial Mechanics*, V. 25, 1981, pp398-415.

"Regularizations and Geodesic Flows", *Classical Mechanics and Dynamical Systems*, Lecture Notes in Pure and Applied Mathematics, (R. Devaney; Z. Nitecki, ed.), Volume 80, pp 1-11, 1981.

"Two-Body Motion Under the Inverse Square Central Force and Equivalent Geodesic Flows", *Celestial Mechanics*, V.15, 1977, pp 467-476.

Peer Reviewed Publications - Conference Proceedings

"Ballistic Capture Transfers from the Earth to Mars", In Proceedings AAS/AIAA Spaceflight Mechanics Conference, Paper AAS 15-342, Williamsburg Virginia, January 2015. (co-author Francesco Topputo)

"Mars Mission Design and Maximizing Performance Utilization", In Proceedings IEEE Aerospace Conference, Big Sky, Montana, pages 1-18, March 2014 (co-authors: Kevin Post, Ulhas Kamath) doi 10.1109/AERO.2014.6836181

"Efficient Cis-Lunar Trajectories", in Proceedings of Global Exploration Conference 2012, Paper GLEX-2012.02.3.6x12248, Washington, D.C., May 22-24, 2012. (co-authors: Kevin Post, Francesco Topputo)

"A New Class of Low Energy Orbits and Mission Applications", AIP Conference Proceedings, **886**, *New Trends in Astrodynamics and Applications III*, (Belbruno, ed.), pp 3-20, American Institute of Physics, 2007.

"Weak Capture, Chaos, and Applications", in *Annals of the New York Academy of Sciences, Astrodynamics and Applications*, **1065**, (Belbruno, ed.), pp 1-14, New York Academy of Sciences, Annals, V. 1065, 2006.

"Reduction of Lunar Landing Fuel Requirements by Utilizing Ballistic Lunar Capture", in *Annals of the New York Academy of Sciences, Astrodynamics and Applications*, **1065**, (E. Belbruno, ed.), pp 139-151, New York Academy of Sciences, Annals, V. 1065, 2006.(co-author: M. Johnson (main author))

"A Low Energy Lunar Transportation System Using Chaotic Dynamics", In Proceedings AAS/AIAA Astrodynamics Specialists Conference, Paper AAS 05-382, Lake Tahoe, August 2005.

"Existence of Chaos Associated with Weak Capture and Applications", In *Annals of the New York Academy of Sciences, Astrodynamics, Chaos and Space Missions*, **1017**, (E. Belbruno, P. Gurfil, D. Folta, ed.), pp 1-10, New York Academy of Sciences, May 2004.

"Low Energy Transfers, Weak Capture and Chaos", Paper IAC-02-A.6.03, Proceedings of the 53rd International Astronautical Congress, October 10-19, 2002, Houston, Texas.

"Quasi-Stationary Motion", Paper IAC-02-A.7.01, Proceedings of the 53rd International Astronautical Congress, October 10-19, 2002, Houston, Texas.

"Biological Analogs and Emergent Intelligence for Control of Stratospheric Balloon Constellations", in *Lecture Notes in Computer Science*, V 2564, Springer, (Proceedings of First Inter. Workshop on Radical Agent Concepts WRAC), 2003, pp 393-407. (co-authors: N. Leonard (main author), P. Bhatta, M. Heun, R. Schlaifer, K. Aaron, K. Nock)

"Calculation of Weak Stability Boundary Ballistic Lunar Capture Transfer Trajectories", AIAA paper no. 2000-4142, in Proceedings of AIAA/AAS Astrodynamics Specialist Conference, Denver, Colorado, August, 2000. (co-author: J. Carrico)

"A Note On Reducing Cost of Lunar Base Construction Using the Ballistic Lunar Capture Transfer", in Proceedings of the Annual Lunar Development Conference", July 2000, Las Vegas, Published by SSI/Princeton, October 2000.

"Low Energy Trajectories for Space Travel Using Stability Transition Regions", In Proceedings IFAC Workshop on Lagrangian and Hamiltonian Methods for Nonlinear Control, 16-18 March 2000, IFAC Publications, Elsevier Science Ltd., Oxford.

"Significance of the 2:3 Resonance and Hopping in the Kuiper Belt", in *The Dynamics of Small Bodies in the Solar System*; Kluwer Press, Mathematical Sciences Series, (B. Steves; A. Roy, ed.), 1999.

"Ballistic Capture To L4, L5", in Proceedings of Space Studies Institute Princeton Conference: Space Manufacturing 12, SSI, (B. Greber, ed.), May 1999.

"Fast Resonance Shifting as a Mechanism of Dynamic Instability Illustrated by Comets and CHE Trajectories", *Annals of the New York Academy of Sciences*, V822, in *Near Earth Objects*, (J. Remo, ed.), May 1997.

"Ballistic Lunar Capture Transfer Determination for the US Air Force Academy Blue Moon Mission", Paper no. AAS 97-171, Proceedings of the AAS/AIAA Space Flight Mechanics Meeting, Huntsville, Alabama, February 1997. (co-authors: R. Humble; J. Coil)

"Low Energy Comet Rendezvous Using Resonance Transitions", First IAA Symposium on Missions to the Outer Solar System and Beyond, Politecnico di Torino, Torino, Italy, June 1996. (co-author: G. Genta)

"An Investigation Into Critical Aspects of a New Form of Low Energy Transfer, The Belbruno-Miller Transfer", AIAA Paper No. 92-4581, August 1992. (co-authors: V.J. Krish (main author), W.M. Hollister)

"Robotic Lunar Exploration Using the Pegasus Winged Rocket and Ballistic Lunar Capture: An Update,

in Proceedings of AIAA Space Programs and Technologies Conf., March 24-27, 1992, Huntsville, AL.(co-authors: R. Ridenoure, J. Fernandez).

"To the Moon from a B52: Robotic Lunar Exploration Using the Pegasus Winged Rocket and Ballistic Lunar Capture", in Proceedings of 5th Annual AIAA/USU Conf. on Small Satellites, Utah State Univ., Logan, UT, August 24, 1991.(co-author: R. Ridenoure(main author)

"A Method for Construction of Lunar Transfer Trajectories Using Ballistic Capture", AAS/AIAA Paper No. 91-100, Proceedings of the AAS/AIAA Space Flight Mechanics Meeting, Feb. 1991. (co-author: J. Miller)

"Examples of the Nonlinear Dynamics of Ballistic Capture and Escape in the Earth-Moon System", AIAA Paper No. 90-2896, Proceedings of the Annual AIAA Astrodynamics Conference, August 1990.

"Low Launch-Energy Trajectories to the Outer Solar System Via Venus and Earth Gravity-Assist Fly-bys", in Proceedings of AAS/AIAA Astrodynamics Specialists Conference, Kalispell, Montana, August 10-13, 1987. (co-authors: R. Diehl(main author), D. Bender, M. Meyers, D. Stetson).

"Lunar Capture Orbits, A Method of Constructing Earth-Moon Trajectories And The LunarGAS Mission", AIAA Paper no. 87- 1054, in Proceedings of AIAA/DGLR/JSASS Inter. Elec. Propl. Conf., May 1987.

Key Technical Reports, Book Chapters, and Preprints

"Weak Stability boundary and Invariant Manifolds", NASA AISRP Annual Report (Period: May 30 2009 - May 30, 2010), Report No. NASA-1-ARPT-09-10, Science Mission Directorate, March 31, 2010.

"Structure of the Weak Stability Boundary III", NASA AISRP Annual Report (Period: March 10, 2008-April 1, 2009), Report No. NASA-4-ARPT-08-09, Science Mission Directorate, April 5, 2009.

"Minimal Energy Transfer of Solid Material Between Planetary Systems", arXiv:0808.3268v2(astro-ph), (co-authors: Amaya Moro-Martin, Renu Malhotra), September 3, 2008.

"Structure of the Weak Stability Boundary II", NASA AISRP Annual Report (Period: January 10, 2007-March 10, 2008), Report No. NASA-3-ARPT-07-08, Science Mission Directorate, March 10, 2008.

"Structure of the Weak Stability Boundary", NASA AISRP Annual Report (Period: April 1, 2006- January 10, 2007), Report No. NASA-2-ARPT-06-07, Science Mission Directorate, January 10, 2007.

"Low Energy Transfers and Applications", Book chapter in *Advances in Astrodynamics* (P. Gurfil, ed.), Elsevier, September 2006.

"Mission Extension Using Sensitive Trajectories and Autonomous Control", NASA AISRP Annual Report (Period: March 2005-March 2006), Report No. NASA-1-ARPT-06, Science Mission Directorate, February 22, 2006.

"Lunar Launch Period Determination: A Primer", Technical Report No. TS-IOD-0812, T/Space, LLC., August 12, 2005.

"Where Did the Moon Come From?", arXiv:astro-ph/0405372v2, (co-author: Richard Gott), January 5, 2005.

"Low Energy Transfer to Mars and the Moon Using Fuzzy Boundary Theory", Alenia Spazio S.p.A., Technical Report no. STAV/GBA/96/0280, August 1, 1996. (co-author: G. Amata).

"The Dynamical Mechanism of Ballistic Lunar Capture Transfers In The Four-Body Problem From The Perspective Of Invariant Manifolds And Hill's Regions", Centre De Recerca Matematica(CRM), (Institute d'Estudis Catalans; Apartat 50; E-08193, Bellaterra(Barcelona) Spain (www.crm.es) Preprint n. 270, December 1994.

"A Ballistic Lunar Capture Trajectory for the Japanese Spacecraft Hiten", JPL IOM 312/90.4-1317, June 1990 (co-author: J. Miller)

General Audience Science Articles

"Aided by Art, A Theory of Life's Extra-Solar Origins, space.com, Op-Ed, Feb. 26, 2015

"Painting Our Way to the Moon", space.com, Op-Ed section, Jan. 14, 2015

"The Angel that Flew to the Moon", New Scientist, Turning Point column, pp51, Feb. 2007

"Through the Fuzzy Boundary: A New Route to the Moon", Planetary Report, May 1992

Noted Articles by Other Authors on my Work

Hadhazy, Adam, "A New way to Reach Mars Safely, Anytime and on the Cheap", Scientific American (cover story on wesbite), December 22, 1014

Kluger, J., "Aliens Among Us", *Time Magazine*, (cover mention) pp44-47, October 22, 2012.

Kelly, M, Princeton University, Office of Communications "Slow Moving Rocks Better Odd that Life Crashed to Earth from Space", Princeton University, Office of Communications, Sept. 24, 2012. (www.princeton.edu/main/news/archive/S34/82/42M30/)

Editorial Staff, "Interstellar 'Slowball' Could Have Carried Seeds of Life", *New Scientist*, Volume 272, page 21, September 4, 2008.

Casselmann, R., "Chaos in the Weak Stability Boundary", Cover of the *Notices*, American Mathematical Society, Volume 55, number 4, April 2008. (see www.ams.org/notices/200804/)

Ross, S., "Review of Fly Me to the Moon", *Notices*, American Mathematical Society, Volume 55, number 4, pp 478-480, April 2008. (see www.ams.org/notices/200804/)

Stockey, J., "Colors of the Universe: Ed Belbruno Talks about Microwaves and Art", *Wild River Review*, November 2007

Elfman, L., "Canvas of Reality: Ed Belbruno's Parallel Lives", *Space Life Style Magazine*, Fall 2007

Editorial Staff, "Top Ten Most Influential Space Thinkers", *New Scientist*, 40th Anniversary Issue, September 2007

Suzuki, J., Review of Fly Me to the Moon, Mathematics Association of America (MAA), MAA Online, in *Read This!*, August 31, 2007 (see www.maa.org/reviews/FlyMeMoon.html)

Faust, J., Review: Fly Me to the Moon, *The Space Review* (online), April 9, 2007

Stockey, J., "Fly Me to the Moon: A Conversation with Mathematician and Artist Ed Belbruno", *Wild River Review*, V. 1, n. 3.3, September 2006

Stewart, I., "Celestial Pioneer", *New Scientist*, April 21, 2006.

Foust, J., "From Chaos, A New Order", *The Space Review*, March 6, 2006. (www.thespacereview.com/article.569/1)

Osserman, J. , "Mathematics of the Heavens", American Mathematical Society *Notices*, V. 52, No. 4, April 2005.

Macau, E., Book Review of 'Capture Dynamics and Chaotic Motions in Celestial Mechanics', *Celes. Mech. and Dyn. Astr.*, V 91, 2005, pp 405-406.

Klarreich, E., "Navigating Celestial Currents", *Science News* (Feature Cover Story), April 16, 2005.

Meyer, K., Book Review of 'Capture Dynamics and Chaotic Motions in Celestial Mechanics', *SIAM Review*, V 46, no. 4, Dec. 2004, pp 754-755.

Chown, Marcus, "The Planet that Stalked the Earth", *New Scientist* (Feature Cover Story), August 14-20, 2004.

Case, J., "Celestial Mechanics Theory Meets the Nitty Gritty of Trajectory Design", *SIAM News*, V 37, No. 6, July/August 2004. (Book Review of Capture Dynamics and Chaotic Motions in Cel.Mech.)

Murray, C., "Interplanetary Rescue", *New Scientist*, no. 2447, May 15, 2004. (Book review of 'Capture Dynamics and Chaotic Motions in Celestial Mechanics')

Adler, Mark, "To the Planets on a Shoestring", *Nature* (Feature Research Article), V. 408, Issue no. 6812, 510-512, November 30, 2000.

Harkin, Senator Thomas, "Reach for the Moon", *Smithsonian Air and Space Magazine*, March 2000, pp54-55.

Naeye, Robert, "Hoppin the Solar System", *Astronomy*, November 1997.

Frank, Adam, "Gravity's Rim: Riding Chaos to the Moon", *Discover*(Featured Article), September 1994, pp 74-79.

Dye, Lee, "With a Boost From JPL, Japanese Lunar Mission May Get Back on Track", *Los Angeles Times*, Science Section, July 16, 1990.

Dye, Lee, "Cluster Probes Look for Lift on Space Guns", *Los Angeles Times*, Front page, January 11, 1988.

Milnor, John, "On the Geometry of the Kepler Problem", *American Mathematical Monthly*, Vol. 90, No. 6, June-July 1983, pp 353 - 365.

by The Electrochemical Society. in ECS Proceedings Volumes. ECS Proceedings Volumes, Volume 2005-07, pp 1210-1217; doi:10.1149/200507.1210pv. Show/hide abstract. The publisher has not yet granted permission to display this abstract. Proceedings volumes contain the expedition summary, methods, site chapters, core descriptions, data reports, and synthesis papers. Proceedings of the International Ocean Discovery Program.Â About IODP Proceedings ISO disc images. The ISO disc images associated with each Proceedings of the Integrated Ocean Drilling Program volume are optical disc archive files that contain expedition reports and other content distributed at the time of initial publication. Proceedings of the 6th ACM SIGCHI New Zealand Chapter annual. international conference on Computer-Human Interaction: Making CHI Natural. 2005, Auckland, New Zealand.Â 1. When paginating the volume, paginate sequentially throughout the volume. 2. If you are using article numbering, number the articles sequentially as you wish them to appear in the ACM Digital Library Table-of-Contents and paginate each article 1-n.