

References

- Abraham, R. and Marsden, J. 1978: *Foundations of Mechanics*, Benjamin-Cummings, London.
- Alfriend, J.
1970: The stability of the triangular Lagrangian points for commensurability of order 2, *Celest. Mech.* 1, 351–59.
1971: Stability of and motion about L_4 at three-to-one commensurability, *Celest. Mech.*, 4, 60–77.
- Arenstorf, R. F. 1968: New periodic solutions of the plane three-body problem corresponding to elliptic motion in the lunar theory, *J. Diff. Eqs.*, 4, 202–256.
- Arnold, V. I.
1963a: Proof of A. N. Kolmogorov’s theorem on the preservation of quasiperiodic motions under small perturbations of the Hamiltonian, *Russian Math. Surveys*, 18(5), 9–36.
1963b: Small divisor problems in classical and celestial mechanics, *Russian Mathematical Surveys*, 18(6), 85–192.
1978: *Mathematical Methods of Classical Mechanics*, Springer-Verlag, New York.
1985: The Sturm theorems and symplectic geometry, *Functional Anal. Appl.*, 19(4), 251–259
1990: *Dynamical Systems IV*, Encyclopedia of Mathematics, 4, Springer-Verlag, New York.
- Barrar, R. B. 1965: Existence of periodic orbits of the second kind in the restricted problem of three-bodies, *Astron. J.*, 70(1), 3–4.
- Bialy, M. 1991: On the number of caustics for invariant tori of Hamiltonian systems with two degrees of freedom, *Ergodic Theory Dyn. Sys.*, 11(2), 273–278.
- Birkhoff, G. D.
1927: *Dynamical Systems*, Coloq. 9, Amer. Math. Soc., Providence.
- Bondarchuk, V. S. 1984: Morse index and deformations of Hamiltonian systems, *Ukrain. Math. Zhur.*, 36, 338–343.

- Bruno, A. D. 1987: Stability of Hamiltonian systems, *Mathematical Notes*, 40(3), 726–730.
- Buchanan, D. 1941: Trojan satellites—limiting case, *Trans. of the Royal Soc. of Canada*, 35, 9–25.
- Buono, L. and Offin D. C. 2008: Instability of periodic solutions with spatio-temporal symmetries in Hamiltonian systems, preprint.
- Cabral, H. and Meyer, K. R. 1999: Stability of equilibria and fixed points of conservative systems, *Nonlinearity*, 12, 1999, 1351–1362.
- Cabral, H. and Offin D. C. 2008: Hyperbolicity for symmetric periodic solutions of the isosceles three body problem, preprint.
- Chen, Kuo-Chang 2001: On Chenciner–Montgomery’s orbit in the three-body problem, *Discrete Contin. Dyn. Sys.*, 7(1), 85–90.
- Chenciner, A. and Montgomery, R. 2000: On a remarkable periodic orbit of the three body problem in the case of equal masses, *Ann. Math.*, 152, 881–901.
- Chenciner, A. and Venturelli, A. 2000: Minima de l’intégrale d’action du problème Newtonien de 4 corps de masses égales dans \mathbb{R}^3 : orbites ‘Hip–Hop’, *Celest. Mech. Dyn. Astr.*, 77, 139–152.
- Cherry, T. M. 1928: On periodic solutions of Hamiltonian systems of differential equations, *Phil. Trans. Roy. Soc. A*, 227, 137–221.
- Chetaev, N. G. 1934: Un théorème sur l’instabilité, *Dokl. Akad. Nauk SSSR*, 2, 529–534.
- Chevally, C. 1946: *Theory of Lie Groups*, Princeton University Press, Princeton, NJ.
- Chicone, C. 1999: *Ordinary Differential Equations with Applications*, Texts in Applied Mathematics 34, Springer, New York.
- Conley, C. and Zehnder, E. 1984: Morse–type index theory for flows and periodic solutions for Hamiltonian systems, *Comm. Pure Appl. Math.*, 37, 207–253.
- Contreras, G., Gaumbado, J.-M., Itturaga, R., and Paternain, G. 2003: The asymptotic Maslov index and its applications, *Erg. Th. Dyn. Sys.*, 23, 1415–1443.
- Crowell, R. and Fox, R. 1963: *Introduction to Knot Theory*, Ginn, Boston.
- Cushman, R., Deprit, A., and Mosak, R. 1983: Normal forms and representation theory, *J. Math. Phys.*, 24(8), 2102–2116.
- Dell’Antonio, G. F. 1994: Variational calculus and stability of periodic solutions of a class of Hamiltonian systems, *Rev. Math. Phys.*, 6, 1187–1232
- Deprit, A. 1969: Canonical transformation depending on a small parameter, *Celest. Mech.* 72, 173–79.
- Deprit, A. and Deprit–Bartholomê, A. 1967: Stability of the Lagrange points, *Astron. J.* 72, 173–79.
- Deprit, A. and Henrard, J.
1968: A manifold of periodic solutions, *Adv. Astron. Astrophy.* 6, 6–124.

- 1969: Canonical transformations depending on a small parameter. *Celest. Mech.*, 1, 12–30.
- Dieckerhoff, R. and Zehnder, E. 1987: Boundedness of solutions via the twist-theorem, *Annali Della Scu. Norm. Super. di Piza*, 14, 79–95.
- Dirichlet, G. L. 1846: Über die stabilität des gleichgewichts, *J. Reine Angew. Math.*, 32, 85–88.
- Duistermaat, J. J. 1976: On the Morse index in variational calculus, *Adv. Math.*, 21, 173–195.
- Elphick, C., Tirapegui, E., Brachet, M., Couillet, P., and Iooss, G. 1987: A simple global characterization for normal forms of singular vector fields, *Physica D*, 29, 96–127.
- Ferrario D. and Terracini S. 2004: On the existence of collisionless equivariant minimizers for the classical n–body problem, *Inv. Math.* 155, 305–362.
- Flanders, H. 1963: *Differential Forms with Applications to Physical Sciences*, Academic Press, New York.
- Gordon, W. B. 1970: A minimizing property of Keplerian orbits, *Amer. J. Math.*, 99, 961–971.
- Goździewski, K. and Maciejewski, A. 1998: Nonlinear stability of the Lagrange libration points in the Chermnykh problem, *Celest. Mech.*, 70(1), 41–58.
- Hadjidemetriou, J. D. 1975: The continuation of periodic orbits from the restricted to the general three–body problem, *Celest. Mech.*, 12, 155–174.
- Hagel, J. 1996: Analytical investigation of non–linear stability of the Lagrangian point L_4 around the commensurability 1:2, *Celest. Mech. Dynam. Astr.*, 63(2), 205–225.
- Hale, J. K. 1972: *Ordinary Differential Equations*, John Wiley, New York.
- Hartman, P. 1964: *Ordinary Differential Equations*, John Wiley, New York.
- Henrard, J. 1970: On a perturbation theory using Lie transforms, *Celest. Mech.*, 3, 107–120.
- Hénon, M. 1997: *Generating families in the restricted three-body problem*, Springer Verlag, LNP 52.
- Hestenes, M. R. 1966: *Calculus of Variations and Optimal Control*, John Wiley, New York.
- Hubbard, J. and West, B. 1990: *Differential Equations: A Dynamical Systems Approach*, Springer-Verlag, New York.
- Kamel, A. 1970: Perturbation method in the theory of nonlinear oscillations, *Celest. Mech.*, 3, 90–99.
- Kummer, M.
 1976: On resonant non linearly coupled oscillators with two equal frequencies, *Comm. Math. Phy.* 48, 53–79.
 1978: On resonant classical Hamiltonians with two equal frequencies, *Comm. Math. Phy.* 58, 85–112.
- Laloy, M. 1976: On equilibrium instability for conservative and partially dissipative mechanical systems, *Int. J. Non-Linear Mech.*, 2, 295–301.

- LaSalle, J. P. and Lefschetz, S. 1961: *Stability by Liapunov's Direct Method with Applications*, Academic Press, New York.
- Laub, A. and Meyer, K. R. 1974: Canonical forms for symplectic and Hamiltonian matrices, *Celest. Mech.* 9, 213–238.
- Lerman, L. and Markova, A. 2009: On stability at the Hamiltonian Hopf bifurcation, *Regul. Chaotic Dyn.*, 14, 148–162.
- Liu, J. C. 1985: The uniqueness of normal forms via Lie transforms and its applications to Hamiltonian systems, *Celest. Mech.*, 36(1), 89–104.
- Long, Y. 2002: *Index Theory for Symplectic Paths with Applications*, Birkhäuser Verlag, Basel.
- Lyapunov, A. 1892: Probleme général de la stabilité du mouvement, *Ann. of Math. Studies 17*, Princeton University Press, Princeton, NJ. (Reproduction in 1947 of the French translation.)
- Marchal, C. 2002: How the method of minimization of action avoids singularities, *Celest. Mech. Dyn. Astron.*, 83, 325–353
- Markeev, A. P.
 1966: On the stability of the triangular libration points in the circular bounded three body problem, *Appl. Math. Mech.* 33, 105–110.
 1978: *Libration Points in Celest. Mech. and Space Dynamics* (in Russian), Nauka, Moscow.
- Markus, L. and Meyer, K. 1974: Generic Hamiltonian systems are neither integrable nor ergodic, *Mem. Am. Math. Soc.*, 144.
- Marsden, J. 1992: *Lectures on Mechanics*, LMS Lecture Note Series 174, Cambridge University Press, Cambridge, UK.
- Marsden, J. and Weinstein, A. 1974: Reduction of symplectic manifolds with symmetry, *Rep. Mathematical Phys.*, 5(1), 121–130.
- Mathieu, E. 1874: Mémoire sur les equations différentielles canoniques de la mécanique, *J. de Math. Pures et Appl.*, 39, 265–306.
- Mawhin, J. and Willem, M. 1984: Multiple solutions of the periodic boundary value problem for some forced pendulum-type equations, *J. Diff. Eqs.*, 52, 264–287.
- McCord, C., Meyer, K. R. and Wang, Q. 1998: Integral manifolds of the spatial three body problem, *Mem. Amer. Math. Soc.*, 628, 1–91.
- McGehee, R. and Meyer, K. R. 1974: Homoclinic points of area preserving diffeomorphisms, *Amer. J. Math.*, 96(3), 409–21.
- Meyer, K. R.
 1970: Generic bifurcation of periodic points, *Trans. Amer. Math. Soc.*, 149, 95–107.
 1971: Generic stability properties of periodic points, *Trans. Amer. Math. Soc.*, 154, 273–77.
 1973: Symmetries and integrals in mechanics., *Dynamical Systems* (Ed. M. Peixoto), Academic Press, New York, 259–72.
 1981a: Periodic orbits near infinity in the restricted N -body problem, *Celest. Mech.*, 23, 69–81.

- 1981b: Hamiltonian systems with a discrete symmetry, *J. Diff. Eqs.*, 41(2), 228–38.
- 1984b: Normal forms for the general equilibrium, *Funkcialaj Ekvacioj*, 27(2), 261–71.
- 1999: *Periodic Solutions of the N-Body Problem*, Lecture Notes in Mathematics 1719, Springer, New York.
- Meyer, K. R. and Hall, G. R. 1991: *Introduction to Hamiltonian Dynamical Systems and the N-Body Problem*, Springer-Verlag, New York.
- Meyer, K. R., Palacián, J. and Yanguas, P. 2012: Stability of a Hamiltonian System in a Limiting Case, *Regular and Chaotic Dynamics*, 17(1), 24–35.
- Meyer, K., Palacian J. and Yanguas, P. 2015: The elusive Liapunov periodic solutions, *Qual. Th. Dyn. Sys.*, 14, 381–401.
- Meyer, K. R. and Schmidt, D. S.
- 1971: Periodic orbits near L_4 for mass ratios near the critical mass ratio of Routh, *Celest. Mech.*, 4, 99–109.
- 1982: The determination of derivatives in Brown's lunar theory, *Celest. Mech.* 28, 201–07.
- 1986: The stability of the Lagrange triangular point and a theorem of Arnold, *J. Diff. Eqs.*, 62(2), 222–36.
- 2016: Bounding solutions of a forced oscillator, submitted.
- MoECKel, R.
- 1988: Some qualitative features of the three body problem, *Hamiltonian Dynamical Systems*, Contemp. Math. 181, Amer. Math. Soc., 1–22.
- 2007: Shooting for the eight – a topological existence proof for a figure-eight orbit of the three-body problem, preprint.
- Moore, C. 1993: Braids in classical gravity, *Phys. Rev. Lett.*, 70, 3675–3679.
- Morris, G. R. 1976: A class of boundedness in Littlewood's problem on oscillatory differential equations, *Bull. Austral. Math. Soc.*, 14, 71–93.
- Morse, M. 1973: *Variational Analysis, Critical Extremals and Sturmian Extensions*, Wiley-Interscience, New York.
- Moser, J. K.
- 1956: The analytic invariants of an area-preserving mapping near a hyperbolic fixed point, *Comm. Pure Appl. Math.*, 9, 673–692.
- 1962: On invariant curves of area-preserving mappings of an annulus, *Nachr. Akad. Wiss. Gottingen Math. Phys.*, Kl. 2, 1–20.
- 1970: Regularization of Kepler's problem and the averaging method on a manifold, *Comm. Pure Appl. Math.*, 23(4), 609–636.
- Moser, J. K. and Zehnder, E. J. 2005: *Notes on Dynamical Systems*, American Mathematical Society, Providence, RI.
- Moulton, F. R. 1920: *Periodic Orbits*, Carnegie Institute of Washington, Washington DC.
- Niedzielska, Z. 1994: Nonlinear stability of the libration points in the photogravitational restricted three-body problem, *Celest. Mech.*, 58, 203–213.

- Noether, E. 1918: Invariante Variationsprobleme, *Nachr. D. König. Gesellsch. D. Wiss. Zu Göttingen*, Math-phys. Klasse, 235–257.
- Offin, D. C.
 1990: Subharmonic oscillations for forced pendulum type equations, *Diff. Int. Eqs.*, 3, 615–629.
 2000: Hyperbolic minimizing geodesics, *Trans. Amer Math. Soc.*, 352(7), 3323–3338.
 2001: Variational structure of the zones of stability, *Diff. and Int. Eqns.*, 14, 1111–1127.
- Palis, J. and de Melo, W. 1980: *Geometric Theory of Dynamical Systems*, Springer–Verlag, New York.
- Palmore, J. I. 1969: *Bridges and Natural Centers in the Restricted Three Body Problem*, University of Minnesota Report.
- Poincaré, H.
 1885: Sur les courbes définies par les equations differentielles, *J. Math. Pures Appl.*, 4, 167–244.
 1899: *Les methods nouvelles de la mecanique celeste*, Gauthier–Villar, Paris.
- Pollard, H. 1966: *Mathematical Introduction to Celestial Mechanics*. Prentice–Hall, New Jersey.
- Pugh, C. and Robinson, C. 1983: The C^1 closing lemma, including Hamiltonians, *Erg. Th. and Dyn. Sys.*, 3, 261–313.
- Roberts, G. E. 2007: Linear Stability analysis of the figure eight orbit in the three body problem, *Erg. Theory Dyn. Sys.*, 27, 6, 1947–1963.
- Robinson, C. 1999: *Dynamical Systems, Stability, Symbolic Dynamics and Chaos* (2nd ed.), CRC Press, Boca Raton, FL.
- Rolfen, D. 1976: *Knots and Links*, Publish or Perish Press, Berkeley, CA.
- Rüssman, H. 1959: Über die Existenz einer Normalform inhaltstreuer elliptischer Transformationen, *Math. Ann.*, 167, 55–72.
- Saari, D.
 1971: Expanding gravatitational systems, *Trans. Amer. Math. Soc.*, 156, 219–240.
 1988: Symmetry in n–particle systems, *Contemporary Math.*, 81, 23–42.
 2005: *Collisions, Rings and Other Newtonian N–Body Problems*, American Mathematical Society, Providence, RI.
- Schmidt, D. S.
 1972: Families of periodic orbits in the restricted problem of three bodies connecting families of direct and retrograde orbits, *SIAM J. Appl. Math.*, 22(1), 27–37.
 1990: Transformation to versal normal form, *Computer Aided Proofs in Analysis* (Ed. K. R. Meyer and D. S. Schmidt), IMA Series 28, Springer–Verlag, New York.
- Sibuya, Y. 1960: Note on real matrices and linear dynamical systems with periodic coefficients, *J. Math. Anal. Appl.* 1, 363–72.

- Siegel, C. L. and Moser, J. K. 1971: *Lectures on Celestial Mechanics*, Springer-Verlag, Berlin.
- Simó, C. 2002: Dynamical properties of the figure eight solution of the three body problem. *Celestial Mechanics*, Contemp. Math. 292, American Mathematical Society, Providence, RI, 209–228.
- 1978: Proof of the stability of Lagrangian solutions for a critical mass ration, *Sov. Astron. Lett.*, 4(2), 79–81.
- Spivak, M. 1965: *Calculus on Manifolds*, W. A. Benjamin, New York.
- Strömberg, E. 1935: Connaissance actuelle des orbites dans le problème des trois corps, *Bull. Astron.*, 9, 87–130.
- Sundman, K. F. 1913: Mémoire sur le problème des trois corps, *Acta Math.*, 36, 105–179.
- Szebehely, V. 1967: *Theory of Orbits*, Academic Press, New York.
- Taliaferro, S. 1980: Stability of two dimensional analytic potential, *J. Diff. Eqs.* 35, 248–265.
- Weyl, H. 1948: *Classical Groups*, Princeton University Press, Princeton, NJ.
- Whittaker, E. T. 1937: *A Treatise on the Analytical Dynamics of Particles and Rigid Bodies*, Cambridge University Press, Cambridge, UK.
- Whittaker, E. T. and Watson, G. N. 1927: *A Course of Modern Analysis*, (4th ed), Cambridge University Press, Cambridge, UK.
- Williamson, J.
- 1936: On the algebraic problem concerning the normal forms of linear dynamical systems, *Amer. J. Math.*, 58, 141–63.
 - 1937: On the normal forms of linear canonical transformations in dynamics, *Amer. J. Math.*, 59, 599–617.
 - 1939: The exponential representation of canonical matrices, *Amer. J. Math.*, 61, 897–911.
- Wintner, A. 1944: *The Analytic Foundations of Celestial Mechanics*, Princeton University Press, Princeton, NJ.
- Yakubovich, V. A. and Starzhinskii, V. M. 1975: *Linear Differential Equations with Periodic Coefficients, 1 and 2*, John Wiley, New York.

Index

- \mathcal{L}_4 , 92–99, 228, 266–267, 295–301
- 2-body problem, 62–66, 200
- 3-body problem, 200, 233–236, 345–372
 - angular momentum, 346–352
 - linear momentum, 347
- Abraham, Ralph, 169
- action–angle variables, 6, 200–204
- algebra
 - Lie, 26, 186
- amended potential, 25, 85
- anomaly
 - mean, 215, 217
 - true, 66, 207–220
- argument of perigee, 207
- Arnold’s stability theorem, 316–320
- Barrar, Richard, 237
- bifurcation
 - Hamiltonian–Hopf, 301
 - periodic solutions, 279–290
- Cabral, Hildeberto, 339, 344, 346–365
- canonical coordinates, 53
- center of mass, 63, 68, 235
- central configuration(s), 73–78, 348–364
- central force, 3, 190
- characteristic polynomial, 42, 91, 93
- Chenciner, Alain, 345–371
- Cherry’s example, 308–309
- Chetaev’s Theorem, 308, 343
- Chicone, Carmen, 143
- closed form, 181
- collapse, 79–80
- complexification, 43
- conjugate variable, 2
- Conley, Charlie, 137
- conservative, 2
- coordinate(s),
 - action–angle, 6, 200–204
 - canonical, 6
 - complex, 211–214
 - Delaunay, 214–215, 217–219, 236–238
 - ignorable, 25, 154, 199
 - Jacobi, 63, 69, 197–200, 235
 - lemniscate, 205
 - Poincaré, 216, 291
 - polar, 5, 206–208
 - pulsating, 219–223
 - rotating, 78, 229, 78–237
 - spherical, 24, 25, 208–211
 - symplectic, 6, 25, 52, 41–57
- Coriolis forces, 78
- cotangent bundle, 177
- covector, 38, 170, 174–182
- cross section, 10–14, 157
- d’Alembert character, 201
- Darboux’s Theorem, 185
- degrees of freedom, 2
- Delaunay elements, 214–215, 217–219
- Deprit, André, 66, 245–266, 295
- $\det A = +1$, 35, 116, 132, 174
- determinant, 32, 35, 42, 170–174
- differential forms, 177–182, 195–197
- Dirichlet’s theorem, 4, 307
- Duffing’s equation, 17, 201, 238, 344
- eigenvalues, 113, 41–116
- Einstein convention, 175–177
- elliptic
 - equilibrium, 146
 - fixed point, 148

- elliptic restricted problem, 101–102, 221–223
- equilibrium(a), 4
 - elementary, 226
 - Euler collinear, 91–92, 228–229, 310, 351–357
 - hyperbolic, 93, 162
 - Lagrange equilateral, 92–99, 228–229, 311, 320, 330, 331, 334, 339
 - N-body, 73–80
 - relative, 25, 75, 348–364
 - restricted problem, 87–90
 - stable/instable, 4, 93, 307–311, 316–339
- Euler, L., 78
- Euler–Lagrange’s equation, 18–25, 353–359
- exact form, 181
- exponents, 52, 155, 226–228
- exterior algebra, 169–174
- fixed point(s),
 - elementary, 280
 - elliptic, 243, 272
 - extremal, 281
 - flip, 244, 275–276
 - hyperbolic, 243, 271–272
 - k-bifurcation, 287–290
 - normal form, 267–276
 - period doubling, 283–286
 - shear, 244, 274–275, 282
 - stability, 312–315, 339–340, 343–344
- Floquet–Lyapunov theorem, 50–52, 267
- generating function(s), 196–197
- geodesic, 27
- gravitational constant, 62
- group
 - Lie, 185–187
 - orthogonal, 60
 - special linear, 60
 - special orthogonal, 60
 - symplectic, 31, 60, 129–133
 - unitary, 130
- Hadjidemetriou, John, 234
- Hamiltonian
 - linear, 29
 - matrix, 30–31
 - operator, 40
- Hamiltonian–Hopf, 301
- harmonic oscillator, 4–9, 17
- Henrard, Jacques, 245, 295
- Hill’s
 - lunar problem, 58, 99–102
 - orbits, 230–232
 - regions, 89
- holonomic constraint, 184
- homoclinic, 165
- Hopf fibration, 9
- hyperbolic, 146, 148
- integrable, 190–191
- integral(s), 2, 25, 67, 199, 206, 209, 213, 214, 224, 347–352
- invariant
 - curve theorem, 312–315
 - plane, 65
 - set, 2
- involution, 34, 154
- J, 2, 29, 38
- Jacobi, 73
 - constant, 85
 - coordinates, 63, 69, 197–200, 235
 - field(s), 139–140
 - identity, 3, 26, 178
- KAM theorem, 312–320
- Kepler problem, 3, 80, 206–207, 229–237, 347–349
- Kepler’s law(s), 65, 66, 80
- kinetic energy, 19, 25, 62
- knots, 9
- Kronecker delta, 38
- Lagrange–Jacobi Formula, 79–80
- Lagrangian
 - complement, 40
 - Grassmannian, 133–141
 - manifold, 185
 - set of functions, 34
 - set of solutions, 34
 - splitting, 40
 - subspace, 40
- lambda lemma, 165
- Lang, Serge, 47
- lemniscate functions, 15–16, 205, 336–339
- Levi-Civita Regularization, 212–214
- Lie
 - algebra, 26, 60, 178
 - bracket, 178
 - product, 31
- Lie group, 185
 - action, 187

- free, 187
- proper, 187
- linearize/linearization, 90–119, 228, 137–238, 240–268
- logarithm, 50, 108–113
- long period family, 228
- Lyapunov
 - center theorem, 227–229
 - stability theorems, 307–311, 343–344

- Markus, Larry, 129
- Marsden, Jerry, 73, 169
- Maslov index, 133–141, 365–371
- mass ratio, 93
- Mathieu transformation, 197
- matrix
 - fundamental, 32
 - Hamiltonian, 30
 - infinitesimally symplectic, 30
 - normal form, 94–99, 117–129
 - skew symmetric, 37
 - symplectic, 31
- McCord, Chris, 69
- Moeckel, Rick, 346–352
- moment map, 188
- momentum
 - angular, 3, 25, 26, 64, 214, 217, 346–372
 - linear, 63, 67, 347
- monodromy, 50, 55, 156, 345
- Montgomery, Richard, 345–371
- Morris, Granger, 315
- Moser, Jurgen, 228
- Moulton, F. R., 78
- multilinear, 169
- multipliers, 50, 156, 189, 226, 229, 233, 293, 294

- N-body problem, 61–81
 - angular momentum, 68
 - central configuration(s), 73–78
 - equilibrium, 73–74
 - Hamiltonian, 62
 - integrals, 67
 - linear momentum, 67
- Newton's
 - headache, 61
 - laws, 61–62, 73
- Newton's laws, 1
- Newtonian system, 18
- Noether's Theorem, 69
- normal form(s)
 - fixed points, 242–244
 - summary, 239–242
- orbifold, 11, 320
- orbit(s)
 - circular, 231–233, 290
 - comet, 232
 - direct, 230, 290
 - figure eight, 345–372
 - Hill's, 230–232
 - Poincaré, 229–230
 - retrograde, 230, 290
 - space, 187
- orbits, 2

- Palacián, Jesús, 229
- Palmore, Julian, 295
- parametric stability, 103–108
- pendulum
 - equation, 17, 26
 - spherical, 24–26
- perihelion, perigee, 207
- period map, 150
- phase space, 2
- Poincaré
 - conjecture, 279
 - continuation method, 225
 - elements, 216
 - lemma, 181
 - map, 150, 157, 160, 279
 - orbits, 229–230
- Poisson bracket, 3–4, 26, 34, 56–57, 118
- Poisson series, 201
- polar decomposition, 35–36, 129
- Pollard, Harry, 66
- potential energy, 1, 18, 19, 24, 25
- Pugh, Charles, 279

- Ratiu, Tudor, 169
- reality conditions, 45, 212
- reduced space, 25, 189, 346–349, 355–370
- reduction, 25
- relative equilibria, 78, 221
- remainder function, 33, 54, 248–251
- resonance
 - 1 : -1, 334–339
 - 2 : -1, 330–331
 - 3 : -1, 332–334
- restricted 3-body problem, 83–86, 233–236, 266–267, 290–301, 310–311, 319–339, 341–342
- reversible, 86
- Robinson, Clark, 143, 279
- rotating coordinates, 78

- Saari, Don, 75, 354
 Schmidt, Dieter, 90, 230, 290
 self-potential, 62
 short period family, 228
 singular reduction, 320
 Sokol'skii normal form, 242, 296,
 334–339
 spectra, 41
 spectral decomposition, 113–116
 stability/instability
 – equilibrium(a), 4, 305–339
 – fixed point(s), 339–340
 – orbit(s), 365, 371
 stable manifold, 161–166
 Sundaman's theorem, 79, 363
 symmetry(ies), 86–87
 symplectic
 – action, 188
 – basis, 37, 174
 – coordinates, 52–57
 – form, 37, 174
 – group, 31, 60, 129–133
 – infinitesimally, 30
 – linear space, 36–41
 – manifold, 169, 183
 – matrix, 31–32
 – operator, 40
 – scaling, 57–58, 101
 – structure, 183
 – subspace, 39
 – symmetry, 69
 – transformations, 52–58
 – with multiplier, 31
 symplectically similar, 41
 symplectomorphic, 38
 symplectomorphism, 148
 syzygy, 85, 168, 352

 tangent bundle, 177
 topological equivalent, 145, 148
 transversal, 165
 transversality conditions, 20
 twist map, 287

 variational equation(s), 55–56
 variational vector field, 20, 368–369

 Wang, Qiudong (Don), 69, 154
 wedge product, 171–174
 Weinstein, Alan, 73

 Yanguas, Patricia, 229