

DE GRUYTER

Oleg N. Kirillov

NONCONSERVATIVE STABILITY PROBLEMS OF MODERN PHYSICS

STUDIES IN MATHEMATICAL PHYSICS 14

DE
GRUYTER



Oleg N. Kirillov

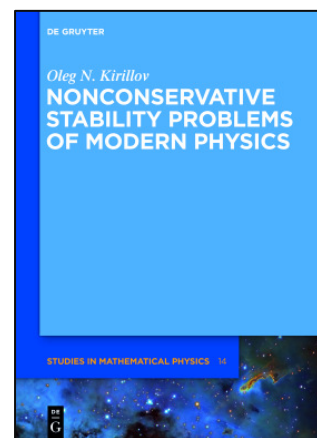
NONCONSERVATIVE STABILITY PROBLEMS OF MODERN PHYSICS

This work gives a complete overview on the subject of nonconservative stability from the modern point of view. Relevant mathematical concepts are presented, as well as rigorous stability results and numerous classical and contemporary examples from mechanics and physics.

It deals with both finite- and infinite-dimensional nonconservative systems and covers the fundamentals of the theory, including such topics as Lyapunov stability and linear stability analysis, Hamiltonian and gyroscopic systems, reversible and circulatory systems, influence of structure of forces on stability, and dissipation-induced instabilities, as well as concrete physical problems, including perturbative techniques for nonself-adjoint boundary eigenvalue problems, theory of the destabilization paradox due to small damping in continuous circulatory systems, Krein-space related perturbation theory for the MHD kinematic mean field α^2 -dynamo, analysis of Campbell diagrams and friction-induced flutter in gyroscopic continua, non-Hermitian perturbation of Hermitian matrices with applications to optics, and magnetorotational instability and the Velikhov-Chandrasekhar paradox.

The book serves present and prospective specialists providing the current state of knowledge in the actively developing field of nonconservative stability theory. Its understanding is vital for many areas of technology, ranging from such traditional ones as rotor dynamics, aeroelasticity and structural mechanics to modern problems of hydro- and magnetohydrodynamics and celestial mechanics.

Oleg N. Kirillov, Helmholtz-Zentrum Dresden-Rossendorf, Germany.



2013. xvii, 429 pages. 109 fig.

Hardcover RRP € 129.95 / *US\$ 182.00

ISBN 978-3-11-027034-1

eBook RRP € 129.95 / *US\$ 182.00

ISBN 978-3-11-027043-3

(De Gruyter Studies in Mathematical Physics)

LANGUAGE English

SUBJECT Physics > Mathematical Physics

READERSHIP Physicists, Engineers and Applied Mathematicians from advanced Graduate Students to actively working Researchers

Contents

Preface	vii
1 Introduction	1
1.1 Gyroscopic stabilization on a rotating surface	1
1.1.1 Brouwer's mechanical model	2
1.1.2 Eigenvalue problems and the characteristic equation	2
1.1.3 Eigencurves and bifurcation of multiple eigenvalues	4
1.1.4 Singular stability boundary of the rotating saddle trap	8
1.2 Manifestations of Brouwer's model in physics	10
1.2.1 Stability of deformable rotors	10
1.2.2 Foucault's pendulum, Bryan's effect, Coriolis vibratory gyroscopes, and the Hannay–Berry phase	15
1.2.3 Polarized light within a cholesteric liquid crystal	16
1.2.4 Helical magnetic quadrupole focussing systems	17
1.2.5 Modulational instability	19
1.3 Brouwer's problem with damping and circulatory forces	24
1.3.1 Circulatory forces	25
1.3.2 Dissipation-induced instability of negative energy modes	25
1.3.3 Circulatory systems and the destabilization paradox	27
1.3.4 Merkin's theorem, Nicolai's paradox, and subcritical flutter	28
1.3.5 Indefinite damping and parity-time (\mathcal{PT}) symmetry	30
1.4 Scope of the book	33
2 Lyapunov stability and linear stability analysis	36
2.1 Main facts and definitions	37
2.1.1 Stability, instability, and uniform stability	38
2.1.2 Attractivity and asymptotic stability	38
2.1.3 Autonomous, nonautonomous, and periodic systems	39
2.2 The direct (second) method of Lyapunov	40
2.2.1 Lyapunov functions	40
2.2.2 Lyapunov and Persidskii theorems on stability	40
2.2.3 Chetaev and Lyapunov theorems on instability	41
2.3 The indirect (first) method of Lyapunov	42
2.3.1 Linearization	43

2.3.2	The characteristic exponent of a solution	43
2.3.3	Lyapunov regularity of linearization	44
2.3.4	Stability and instability in the first approximation	46
2.4	Linear stability analysis	47
2.4.1	Autonomous systems	47
2.4.2	Lyapunov transformation and reducibility	48
2.4.3	Periodic systems	49
2.4.4	Example. Coupled parametric oscillators	51
2.5	Algebraic criteria for asymptotic stability	54
2.5.1	Lyapunov's matrix equation and stability criterion	54
2.5.2	The Leverrier–Faddeev algorithm and Lewin's formula	55
2.5.3	Müller's solution to the matrix Lyapunov equation	56
2.5.4	Inertia theorems and observability index	57
2.5.5	Hermite's criterion via the matrix Lyapunov equation	58
2.5.6	Routh–Hurwitz, Liénard–Chipart, and Bilharz criteria	60
2.6	Robust Hurwitz stability vs. structural instability	61
2.6.1	Multiple eigenvalues: singularities and structural instabilities	62
2.6.2	Multiple eigenvalues: spectral abscissa minimization and robust stability	64
3	Hamiltonian and gyroscopic systems	67
3.1	Sobolev's top and an indefinite metric	68
3.2	Elements of Pontryagin and Krein space theory	72
3.3	Canonical and Hamiltonian equations	74
3.3.1	Krein signature of eigenvalues	76
3.3.2	Krein collision or linear Hamiltonian–Hopf bifurcation	77
3.3.3	MacKay's cones, veering, and instability bubbles	78
3.3.4	Instability degree and count of eigenvalues	80
3.3.5	Graphical interpretation of the Krein signature	82
3.3.6	Strong stability: robustness to Hamiltonian's variation	86
3.3.7	Inertia theorems and stability of gyroscopic systems	87
3.3.8	Positive and negative energy modes and Krein signature	88
3.3.9	Dispersive wave propagation in conservative systems	90
3.3.10	Absolute and convective instability	92
4	Reversible and circulatory systems	95
4.1	Reversible systems	95
4.2	Nonconservative positional forces	96
4.3	Circulatory systems	97
4.3.1	Divergence and flutter instabilities	98

4.3.2	Multiple parameter families of circulatory systems	98
4.3.3	Generic singularities on the stability boundary	99
4.4	Perturbation of eigenvalues	101
4.4.1	Simple eigenvalue	102
4.4.2	Double eigenvalue of geometric multiplicity 1	103
4.4.3	Double eigenvalue of geometric multiplicity 2	105
4.4.4	Triple eigenvalue of geometric multiplicity 1	106
4.5	Geometry of the stability boundary	108
4.5.1	Linear and quadratic approximations at smooth points	108
4.5.2	Singularities in two-parameter circulatory systems	110
4.5.3	Example. Stabilization of comfortable walking	114
4.5.4	Singularities in three-parameter circulatory systems	117
4.5.5	The cone $\alpha\alpha$ and Merkin's instability theorem	124
4.5.6	Example: a brake disk in distributed frictional contact	126
4.5.7	Example: stability of an airfoil in an inviscid flow	129
4.6	Eigencurves, their crossing and veering	133
4.6.1	Convex flutter domain: conical point $\alpha\alpha$	133
4.6.2	Convex/concave flutter domain: smooth points α^2	134
4.7	Parametric optimization of circulatory systems	138
4.7.1	Example: optimization of Ziegler's pendulum	139
4.7.2	A nonsmooth and nonconvex optimization problem	141
4.7.3	The gradient of the critical load	142
4.7.4	An infinite gradient at the crossing of the eigencurves	143
4.7.5	Improving variations and necessary conditions for optimality in the case where the eigencurves cross	143
5	Influence of structure of forces on stability	146
5.1	Undamped potential systems	147
5.1.1	Lagrange's theorem and Poincaré instability degree	148
5.1.2	Rayleigh's theorem on movement of eigenvalues	148
5.1.3	Steady-state bifurcation	148
5.2	Damped potential systems	149
5.2.1	Overdamped and heavily damped systems	150
5.2.2	Indefinitely damped systems	154
5.3	Undamped gyroscopic systems	160
5.3.1	Extension of Rayleigh's theorem	161
5.3.2	Criteria of gyroscopic stabilization	161
5.4	Damped gyroscopic systems	162
5.4.1	Kelvin–Tait–Chetaev theorem	163

5.5	Circulatory systems with and without velocity-dependent forces	164
5.5.1	Merkin's theorem and Bulatovic's flutter condition	165
5.5.2	Bottema–Lakhadanov–Karapetyan theorem	166
5.5.3	Stabilizing and destabilizing damping configurations	167
6	Dissipation-induced instabilities	171
6.1	Crandall's gyropendulum	171
6.1.1	Conservative gyroscopic stabilization and its destruction by stationary damping	172
6.1.2	Singular threshold of the nonconservative gyroscopic stabilization	173
6.1.3	Imperfect Krein collision and exchange of instability between negative and positive energy modes	174
6.2	Gyroscopic stabilization of nonconservative systems	176
6.2.1	The case of $m = 2$ degrees of freedom	177
6.2.2	The case of arbitrary even m	184
6.3	Near-Hamiltonian systems	188
6.4	Gyroscopic and circulatory systems as limits of dissipative systems . .	190
7	Nonself-adjoint boundary eigenvalue problems	200
7.1	Adjoint boundary eigenvalue problems	202
7.2	Perturbation of eigenvalues	204
7.2.1	Semisimple eigenvalues	205
7.2.2	Multiple eigenvalues with the Keldysh chain	207
7.2.3	Higher order perturbation terms for double nonderogatory eigenvalues	209
7.2.4	Degenerate splitting of double nonderogatory eigenvalues . . .	211
7.3	Example: a rotating circular string with an elastic restraint	213
7.4	Example: the Herrmann–Smith paradox	217
7.4.1	Formulation of the problem	217
7.4.2	Stationary flutter domain and mobile divergence region	220
7.4.3	Sensitivity of the critical flutter load to the redistribution of the elasticity modulus	222
7.5	Example: Beck's column loaded by a partially follower force	223
7.5.1	The stability-divergence boundary (point A)	225
7.5.2	The flutter threshold of Beck's column (point C)	226
7.5.3	The singularity 0^2 on the stability boundary (point B)	230

8	Destabilization paradox in continuous circulatory systems	233
8.1	Movement of eigenvalues under a velocity-dependent perturbation . . .	236
8.1.1	Generalized boundary eigenvalue problem	237
8.1.2	Variation of parameters that is transversal to the stability boundary	239
8.1.3	Variation of parameters that is tangential to the stability boundary	240
8.1.4	Transfer of instability between modes	242
8.1.5	Drop in the critical frequency	243
8.2	Singular threshold of the flutter instability	244
8.2.1	Drop in the critical flutter load	245
8.2.2	The “no drop” condition and the tangent cone to the domain of asymptotic stability	246
8.3	Example: dissipation-induced instability of Beck’s column	249
8.3.1	Beck’s column without damping	250
8.3.2	Beck’s column with Kelvin–Voigt and viscous damping	251
8.3.3	Viscoelastic Beck’s column with a dash-pot	255
8.3.4	Ziegler’s pendulum with a dash-pot	259
8.4	Application to finite-dimensional systems	260
8.4.1	The destabilization paradox in Ziegler’s pendulum	261
9	MHD kinematic mean field α^2-dynamo	266
9.1	Eigenvalue problem for α^2 -dynamo	266
9.2	Uniform α -profiles generate only nonoscillatory dynamos	270
9.2.1	Conducting exterior: self-adjointness in a Krein space	271
9.2.2	Basis properties of eigenfunctions	272
9.2.3	Spectral mesh of eigencurves	273
9.2.4	Deformation of the spectral mesh via transition from conducting to insulating surrounding	274
9.3	Nonhomogeneous α -profiles and the conducting exterior	275
9.3.1	$l \geq 0$: definite Krein signature prohibits formation of complex eigenvalues	276
9.3.2	$l = 0$: oscillating solutions from the repeated decaying modes with mixed Krein signature	280
9.3.3	$l = 0$: Fourier components of $\alpha(x)$ determine the unfolding pattern of the spectral mesh.	284
9.4	Insulating boundary conditions induce unstable oscillations	287
9.4.1	$l = 0$: complex unfolding of double eigenvalues with definite Krein signature	289

10 Campbell diagrams and subcritical friction-induced flutter	294
10.1 Friction-induced vibrations and sound generation	294
10.2 Example. Subcritical flutter of a rotating circular string	297
10.3 Axially symmetric rotor with anisotropic stator	304
10.3.1 Sensitivity analysis of the Campbell diagram	307
10.3.2 MacKay's eigenvalue cones and instability bubbles	309
10.3.3 Double-coffee-filter singularity near the crossings with definite Krein signature	312
10.3.4 Unfolding MacKay's cones with mixed Krein signature	316
10.3.5 Indefinite damping as a reason for subcritical flutter	317
10.3.6 Destabilizing role of circulatory forces	320
10.4 Example: eigenvalue surfaces of the rotating circular string	323
10.5 How to play a disk brake?	327
11 Non-Hermitian perturbation of Hermitian matrices	329
11.1 Eigenvalue movement through a 1:1 resonance in complex matrices	332
11.1.1 Diabolical point (DP): passing of eigenvalues	333
11.1.2 Exceptional point (EP): splitting of eigenvalues	334
11.2 Eigensurfaces associated with DPs	335
11.2.1 Complex perturbation of a Hermitian matrix family	336
11.2.2 DP in the spectrum of real symmetric matrices	337
11.2.3 How a DP unfolds into the conical wedge of Wallis	337
11.2.4 Inflating the diabolical point into an exceptional ring	341
11.2.5 Example: flutter instability in granular flow	342
11.3 Unfolding conical singularities in crystal optics	344
11.3.1 DPs in Hamilton's conical refraction	345
11.3.2 Approximation of the dispersion surface near a DP	347
11.3.3 Eigensurfaces of absorption- and chirality-dominated crystals	347
11.4 Eigensurfaces associated with EPs	350
11.5 Perturbation of eigenvectors and Berry phase	355
11.5.1 Hermitian case: geometric phase around a DP	355
11.5.2 Non-Hermitian case: geometric phase around an EP	357
11.5.3 Geometric phase around an EP in a microwave cavity	360
12 Magnetorotational instability	364
12.1 Magnetorotational instability in axial and helical magnetic fields	364
12.1.1 Cylindrical Couette–Taylor flow	364
12.1.2 Paradox of Velikhov and Chandrasekhar	367

12.1.3	Magnetorotational instability in astrophysics and its analogues in celestial mechanics	368
12.1.4	Laboratory experiments with CT-flow in axial and helical magnetic fields	370
12.2	Mathematical setting	371
12.2.1	Nonlinear equations and a steady state	371
12.2.2	Linearization with respect to nonaxisymmetric perturbations	372
12.3	Geometrical optics approximation	373
12.4	Stability analysis	377
12.4.1	The threshold of the standard MRI	377
12.4.2	Singularities and the Velikhov–Chandrasekhar paradox	378
12.4.3	The singular threshold of the HMRI and connection of HMRI and SMRI through a spectral exceptional point	381
	Bibliography	387
	Index	423

References

- [1] D.J. Acheson and R. Hide, Hydromagnetics of rotating fluids, *Rep. Prog. Phys.* **36** (1973), 159–221.
- [2] L. Y. Adrianova, *Introduction to Linear Systems of Differential Equations*, Translations of Mathematical Monographs 146, American Mathematical Society, Providence, RI, 1998.
- [3] D. Afolabi, Sylvester’s eliminant and stability criteria for gyroscopic systems, *J. Sound Vibr.* **182** (1995), 229–244.
- [4] S. A. Agafonov, Stability and motion stabilization of nonconservative mechanical systems, *J. Math. Sci.* **112** (2002), 4419–4497.
- [5] S. A. Agafonov, Stability of nonconservative systems and applications, *J. Math. Sci.* **125** (2005), 556–578.
- [6] A. Akay, Acoustics of friction, *J. Acoust. Soc. Amer.* **111** (2002), 1525–1548.
- [7] R. Alam, S. Bora, R. Byers and M. L. Overton, Characterization and construction of the nearest defective matrix via coalescence of pseudospectral components, *Linear Algebra and its Applications* **435** (2011), 494–513.
- [8] S. Altmeyer, C. Hoffmann and M. Lücke, Islands of instability for growth of spiral vortices in the Taylor-Couette system with and without axial through flow, *Phys. Rev. E* **84** (2011), 046308.
- [9] L. J. An and D. G. Schaeffer, The flutter instability in granular flow, *Journal of the Mechanics and Physics of Solids* **40** (1992), 683–698.
- [10] D.R. Andersen, S. Datta and R. L. Gunshor, A coupled mode approach to modulation instability and envelope solitons, *J. App. Phys.* **54** (1983), 5608–5612.
- [11] B. D. O. Anderson, The reduced Hermite criterion with application to the proof of the Lienard–Chipart criterion, *IEEE Trans. AC* **17** (1972), 669–672.
- [12] S. B. Andersson, *Geometric Phases in Sensing and Control*, Ph.D. thesis, University of Maryland, College Park, 2003.
- [13] S. B. Andersson and P. S. Krishaprasad, *The Hannay–Berry Phase of the Vibrating Ring Gyroscope*, Center for Dynamics and Control of Smart Structures, Technical Research Report no. CDCSS TR 2004-2, University of Maryland, College Park, 2004.
- [14] I. P. Andreichikov and V. I. Yudovich, The stability of visco-elastic rods, *Izv. Acad. Nauk SSSR, MTT* **1** (1975), 150–154.
- [15] V. Antropov, E. Boltushkin, A. Ivanov, Y. Korotaev, V. Lohmatov, I. Meshkov, V. Pavlov, R. Pivin, I. Seleznev, A. Sidorin, A. Smirnov, E. Syresin, G. Trubnikov

- and S. Yakovenko, Positron storage ring LEPTA, *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* **532** (2004), 172–176.
- [16] V. Apostolyuk and F. E. H. Tay, Dynamics of micromechanical Coriolis vibratory gyroscopes, *Sensor Letters* **2** (2004), 252–259.
- [17] V. I. Arnold, On matrices depending on parameters, *Russian Mathematical Surveys* **26** (1971), 29–43.
- [18] V. I. Arnold, *Mathematical Methods of Classical Mechanics*, 2nd edn., Graduate Texts in Mathematics 60, Springer, Berlin, 1989.
- [19] V. I. Arnold, Spaces of functions with moderate singularities, *Funct. Anal. Appl.* **23** (1989), 169–177.
- [20] V. I. Arnold, Remarks on eigenvalues and eigenvectors of Hermitian matrices, Berry phase, adiabatic connections and quantum Hall effect, *Selecta Mathematica, New Series* **1** (1995), 1–19.
- [21] V. I. Arnold and B. A. Khesin, *Topological Methods in Hydrodynamics*, Applied Mathematical Sciences 125, Springer, New York, 1998.
- [22] V. I. Arnold, V. V. Kozlov and A. I. Neishtadt, *Mathematical Aspects of Classical and Celestial Mechanics*, Encyclopaedia of Mathematical Sciences 3, Springer, New York, 2006.
- [23] V. Arnold, A. Varchenko and S. Gusein-Zade, *Singularities of Differentiable Maps*, 1st edn., Monographs in Mathematics 1, Birkhäuser, Boston, 1985.
- [24] F. V. Atkinson and A. B. Mingarelli, *Multiparameter Eigenvalue Problems: Sturm–Liouville Theory*, CRC Press, Boca Raton, Florida, 2010.
- [25] D. Avitabile and T. J. Bridges, Numerical implementation of complex orthogonalization, parallel transport on Stiefel bundles, and analyticity, *Physica D* **239** (2010), 1038–1047.
- [26] A. E. Baikov and P. S. Krasil’nikov, The Ziegler effect in a non-conservative mechanical system, *PMM J. Appl. Math. Mech.* **74** (2010), 51–60.
- [27] J. Baillieul and M. Levi, Constrained relative motions in rotational mechanics, *Archive for Rational Mechanics and Analysis* **115** (1991), 101–135.
- [28] S. A. Balbus, Enhanced angular momentum transport in accretion disks, *Ann. Rev. Astron. Astroph.* **41** (2003), 555–597.
- [29] S. A. Balbus, A turbulent matter, *Nature* **470** (2011), 475–476.
- [30] S. A. Balbus and J. F. Hawley, A powerful local shear instability in weakly magnetized disks: I. Linear analysis, *The Astrophysical Journal* **376** (1991), 214–233.
- [31] S. A. Balbus and J. F. Hawley, Instability, turbulence, and enhanced transport in accretion disks, *Rev. Mod. Phys.* **70** (1998), 1–53.
- [32] N. V. Banichuk, A. S. Bratus and A. D. Myshkis, On the destabilizing action of small dissipative forces on non-conservative systems, *Doklady Akademii Nauk SSSR* **309** (1989), 1325–1327.

- [33] N. V. Banichuk, A. S. Bratus and A. D. Myshkis, Stabilizing and destabilizing effects in nonconservative systems, *PMM J. Appl. Math. Mech.* **53** (1989), 158–164.
- [34] L. Barkwell and P. Lancaster, Overdamped and gyroscopic vibrating systems, *Trans. ASME J. Appl. Mech.* **59** (1992), 176–181.
- [35] S. Barnett, A new formulation of the theorems of Hurwitz, Routh and Sturm, *J. Inst. Maths. Appl.* **8** (1971), 240–250.
- [36] S. Barnett, Leverrier’s algorithm – a new proof and extensions, *SIAM J. Matrix Anal. Appl.* **10** (1989), 551–556.
- [37] H. Baumgärtel, *Analytic Perturbation Theory for Matrices and Operators*, Operator Theory: Advances and Applications 15, Birkhäuser Verlag, Basel, 1985.
- [38] B. J. Bayly, Three-dimensional instability of elliptical flow, *Phys. Rev. Lett.* **57** (1986), 2160–2163.
- [39] M. Beck, Die Knicklast des einseitig eingespannten, tangential gedruckten Stabes, *ZAMP Z. angew. Math. Phys.* **3** (1952), 225–228.
- [40] M. Becker, W. Hauger and W. Winzen, Influence of internal and external damping on the stability of Beck’s column on an elastic foundation, *J. Sound Vibr.* **54** (1977), 468–472.
- [41] V. V. Beletsky, Some stability problems in applied mechanics, *Applied Mathematics and Computation* **70** (1995), 117–141.
- [42] V. V. Beletsky, *Essays on the Motion of Celestial Bodies*, Springer, Basel, 2001.
- [43] V. V. Beletsky and E. M. Levin, Stability of a ring of connected satellites, *Acta Astron.* **12** (1985), 765–769.
- [44] V. V. Beletsky and E. M. Levin, *Dynamics of Space Tether Systems*, Advances in the Astronautical Sciences 83, American Astronautical Society, San Diego, 1993.
- [45] V. V. Belov, S. Y. Dobrokhotov and T. Y. Tudorovskiy, Operator separation of variables for adiabatic problems in quantum and wave mechanics, *Journal of Engineering Mathematics* **55** (2006), 183–237.
- [46] C. M. Bender and H. F. Jones, WKB Analysis of PT -Symmetric Sturm–Liouville problems, *J. Phys. A: Math. Theor.* **45** (2012), 444004.
- [47] C. M. Bender and P. D. Mannheim, PT symmetry and necessary and sufficient conditions for the reality of energy eigenvalues, *Phys. Lett. A* **374** (2010), 1616–1620.
- [48] T. B. Benjamin and J. E. Feir, Disintegration of wave trains on deep water. 1. Theory, *J. Fluid Mech.* **27** (1967), 417–430.
- [49] M. V. Berry, Quantal phase factors accompanying adiabatic changes, *Proc. R. Soc. Lond. Ser. A. Math. Phys. Sci.* **392** (1984), 45–57.
- [50] M. V. Berry, Physics of nonhermitian degeneracies, *Czech. J. Phys.* **54** (2004), 1039–1047.
- [51] M. V. Berry, Optical polarization evolution near a non-Hermitian degeneracy, *J. Opt.* **13** (2011), 115701.

- [52] M. V. Berry and M. R. Dennis, The optical singularities of birefringent dichroic chiral crystals, *Proc. R. Soc. Lond. Ser. A. Math. Phys. Sci.* **459** (2003), 1261–92.
- [53] M. V. Berry and M. R. Jeffrey, *Conical diffraction: Hamilton's diabolical point at the heart of crystal optics*, in: *Progress in Optics* 50, pp. 13–50, Elsevier, New York, 2007.
- [54] M. V. Berry and P. Shukla, Slow manifold and Hannay angle in the spinning top, *European Journal of Physics* **32** (2011), 115–127.
- [55] M. V. Berry and P. Shukla, Classical dynamics with curl forces, and motion driven by time-dependent flux, *Journal of Physics A: Mathematical and Theoretical* **45** (2012), 305201.
- [56] M. V. Berry and M. Wilkinson, Diabolical points in the spectra of triangles, *Proc. R. Soc. Lond. A* **392** (1984), 15–43.
- [57] V. Bespalov and V. Talanov, Filamentary structure of light beams in nonlinear liquids, *JETP Letters-USSR* **3** (1966), 307–310.
- [58] S. P. Bhattacharyya, H. Chapellat and L. H. Keel, *Robust Control. The Parametric Approach*, Information & System Science, Prentice Hall, NJ, 1995.
- [59] D. Bigoni, On flutter instability in elastoplastic constitutive models, *International Journal of Solids and Structures* **32** (1995), 3167–3189.
- [60] D. Bigoni, *Nonlinear Solid Mechanics: Bifurcation Theory and Material Instability*, Cambridge, Cambridge University Press, 2012.
- [61] D. Bigoni and G. Noselli, Experimental evidence of flutter and divergence instabilities induced by dry friction, *Journal of the Mechanics and Physics of Solids* **59** (2011), 2208–2226.
- [62] H. Bilharz, Bemerkung zu einem Satze von Hurwitz, *ZAMM Z. angew. Math. Mech.* **24** (1944), 77–82.
- [63] P. Binding and P. J. Browne, Two parameter eigenvalue problems for matrices, *Linear Algebra and its Applications* **113** (1989), 139–157.
- [64] P. Binding and H. Volkmer, Eigencurves for two-parameter Sturm–Liouville equations, *SIAM Rev.* **38** (1996), 27–48.
- [65] P. Birtea, I. Casu and D. Comanescu, Instability conditions for circulatory and gyroscopic conservative systems, *Physica D* **241** (2012), 1655–1659.
- [66] C. C. Bissell, Stodola, Hurwitz and the genesis of the stability criterion, *Int. J. Contr.* **50** (1989), 2313–2332.
- [67] K. Y. Bliokh, The appearance of a geometric-type instability in dynamic systems with adiabatically varying parameters, *Journal of Physics A-Mathematical and General* **32** (1999), 2551–2565.
- [68] K. Y. Bliokh, Geometric amplitude, adiabatic invariants, quantization, and strong stability of Hamiltonian systems, *J. Math. Phys.* **43** (2002), 25–42.
- [69] K. Y. Bliokh, Geometrodynamics of polarized light: Berry phase and spin Hall effect in a gradient-index medium, *Journal of Optics A: Pure and Applied Optics* **11** (2009), 094009.

- [70] K. Y. Bliokh, Y. P. Bliokh, V. Freilikher, S. Savel'ev and F. Nori, Colloquium: Unusual resonators: Plasmonics, metamaterials, and random media, *Reviews of Modern Physics* **80** (2008), 1201–1213.
- [71] K. Y. Bliokh, Y. Gorodetski, V. Kleiner and E. Hasman, Coriolis effect in optics: Unified geometric phase and spin-Hall effect, *Phys. Rev. Lett.* **101** (2008) 030404.
- [72] K. Y. Bliokh, A. Niv, V. Kleiner and E. Hasman, Geometrodynamics of spinning light, *Nature Photonics* **2** (2008), 748–753.
- [73] A. M. Bloch, P. Hagerty, A. G. Rojo and M. I. Weinstein, Gyroscopically stabilized oscillators and heat baths, *Journal of Statistical Physics* **115** (2004), 1073–1100.
- [74] A. M. Bloch, P. S. Krishnaprasad, J. E. Marsden and T. S. Ratiu, Dissipation induced instabilities, *Annales de L'Institut Henri Poincaré – Analyse Non Lineaire* **11** (1994), 37–90.
- [75] V. V. Bolotin, *Nonconservative Problems of the Theory of Elastic Stability*, Pergamon Press, Oxford, London, New York, Paris, 1963.
- [76] V. V. Bolotin, A. A. Grishko and M. Y. Panov, Effect of damping on the postcritical behaviour of autonomous non-conservative systems, *International Journal of Non-Linear Mechanics* **37** (2002), 1163–1179.
- [77] V. V. Bolotin and N. I. Zhinzher, Effects of damping on stability of elastic systems subjected to nonconservative forces, *International Journal of Solids and Structures* **5** (1969), 965–989.
- [78] M. Born and E. Wolf, *Principles of Optics*, 6th edn., Pergamon, London, 1989.
- [79] O. Bottema, On the small vibrations of non-holonomic systems, *Indagationes Mathematicae* **11** (1949), 296–298.
- [80] O. Bottema, On the stability of the equilibrium of a linear mechanical system, *ZAMP Z. angew. Math. Phys.* **6** (1955), 97–104.
- [81] O. Bottema, The Routh-Hurwitz condition for the biquadratic equation, *Indagationes Mathematicae* **18** (1956), 403–406.
- [82] O. Bottema, Stability of equilibrium of a heavy particle on a rotating surface, *ZAMP Z. angew. Math. Phys.* **27** (1976), 663–669.
- [83] N. M. Bou-Rabee, J. E. Marsden and L. A. Romero, A geometric treatment of Jellet's egg, *ZAMM Z. angew. Math. Mech.* **85** (2005), 618–642.
- [84] N. M. Bou-Rabee, J. E. Marsden and L. A. Romero, Dissipation-induced heteroclinic orbits in tippe tops, *SIAM Rev.* **50** (2008), 325–344.
- [85] N. M. Bou-Rabee, L. A. Romero and A. G. Salinger, A multiparameter, numerical stability analysis of a standing cantilever conveying fluid, *SIAM J. Appl. Dyn. Syst.* **1** (2002), 190–214.
- [86] R. N. Bracewell and O. K. Garriott, Rotation of artificial Earth satellites, *Nature* **182** (1958), 760–762.
- [87] J. V. Breakwell, Stability of an orbiting ring, *J. Guid. and Contr.* **4** (1981), 197–200.

- [88] L. Brevdo and T.J. Bridges, Absolute and convective instabilities of spatially periodic flows, *Phil. Trans. R. Soc. Lond. Ser. A Math. Phys. Eng. Sci.* **354** (1996), 1027–1064.
- [89] T.J. Bridges, A geometric formulation of the conservation of wave action and its implications for signature and the classification of instabilities, *Proc. R. Soc. Lond. Ser. A Math. Phys. Eng. Sci.* **453** (1997), 1365–1395.
- [90] T.J. Bridges and F. Dias, Enhancement of the Benjamin-Feir instability with dissipation, *Physics of Fluids* **19** (2007), 104104.
- [91] R.W. Brockett, *Finite Dimensional Linear Systems*, Wiley, New York, 1970.
- [92] E. Brommundt, High-frequency self-excitation in paper calendars, *Technische Mechanik* **29** (2009), 60–85.
- [93] L.E.J. Brouwer, Beweging van een materieel punt op den bodem eener draaiende vaas onder den invloed der zwaartekracht, *N. Arch. v. Wisk.* **2** (1918), 407–419.
- [94] L.E.J. Brouwer, The motion of a particle on the bottom of a rotating vessel under the influence of the gravitational force, in: H. Freudenthal (ed.), *Collected Works*, II, pp. 665–686, North-Holland, Amsterdam, 1975.
- [95] J.W. Bruce and P.G. Giblin, *Curves and Singularities*, Cambridge University Press, Cambridge, UK, 1984.
- [96] G. Bryan, On the beats in the vibrations of a revolving cylinder or bell, *Proc. Cambridge Philos. Soc.* **7** (1890), 101–111.
- [97] A.D. Bryuno, The normal form of a Hamiltonian system, *Russian Mathematical Surveys* **43** (1988), 25–66.
- [98] R.M. Bulatovic, A stability theorem for gyroscopic systems, *Acta Mechanica* **136** (1999), 119–124.
- [99] R.M. Bulatovic, On the heavily damped response in viscously damped dynamic systems, *Trans. ASME J. Appl. Mech.* **71** (2004), 131–134.
- [100] R.M. Bulatovic, A sufficient condition for instability of equilibrium of non-conservative undamped systems, *Phys. Lett. A* **375** (2011), 3826–3828.
- [101] J.V. Burke, A.S. Lewis and M.L. Overton, Optimal stability and eigenvalue multiplicity, *Foundations of Computational Mathematics* **1** (2001), 205–225.
- [102] J.V. Burke, A.S. Lewis and M.L. Overton, Optimizing matrix stability, *Proc. Amer. Math. Soc.* **129** (2001), 1635–1642.
- [103] J.V. Burke, A.S. Lewis and M.L. Overton, Optimization and pseudospectra, with applications to robust stability, *SIAM J. Matrix Anal. Appl.* **25** (2003), 80–104.
- [104] R. Burrige and J. Qian, The fundamental solution of the time-dependent system of crystal optics, *Euro. Jnl of Applied Mathematics* **17** (2006), 63–94.
- [105] F.H. Busse, Convective flows in rapidly rotating spheres and their dynamo action, *Physics of Fluids* **14** (2002), 1301–1314.
- [106] F.H. Busse and A.C. Or, Convection in a rotating cylindrical annulus – thermal Rossby waves, *J. Fluid Mech.* **166** (1986), 173–187.

- [107] T. Butlin and J. Woodhouse, Friction-induced vibration: Should low-order models be believed?, *J. Sound Vibr.* **328** (2009), 92–108.
- [108] R. A. Cairns, Role of negative energy waves in some instabilities of parallel flows, *J. Fluid Mech.* **92** (1979), 1–14.
- [109] W. Campbell, The protection of steam-turbine disk wheels from axial vibration, *Trans. ASME* **46** (1924), 31–160.
- [110] S. V. Canchi and R. G. Parker, Parametric instability of a circular ring subjected to moving springs, *J. Sound Vibr.* **293** (2006), 360–379.
- [111] P. W. Carpenter, Current status of the use of wall compliance for laminar-flow control, *Experimental Thermal and Fluid Science* **16** (1998), 133–140.
- [112] P. W. Carpenter, C. Davies and A. D. Lucey, Hydrodynamics and compliant walls: Does the dolphin have a secret? *Current Science* **79** (2000), 758–765.
- [113] J. Carr and M. Z. M. Malhardeen, Beck’s problem, *SIAM J. Appl. Math.* **37** (1979), 261–262.
- [114] H. Casimir, On Onsager’s principle of microscopic reversibility, *Reviews of Modern Physics* **17** (1945), 343–350.
- [115] A. R. R. Casti, P. J. Morrison and E. A. Spiegel, Negative energy modes and gravitational instability of interpenetrating fluids, in: J. R. Buchler, S. T. Gottesman, and H. E. Kandrup (eds.), *Nonlinear Dynamics and Chaos in Astrophysics: Festschrift in Honor of George Contopoulos*, Annals of the New York Academy of Sciences 867, pp. 93–108, New York Academy of Science, New York, 1998.
- [116] N. Challamel, C. Casandjian and J. Lerbet, On the occurrence of flutter in the lateral-torsional instabilities of circular arches under follower loads, *J. Sound Vibr.* **320** (2009), 617–631.
- [117] N. Challamel, F. Nicot, J. Lerbet and F. Darve, Stability of non-conservative elastic structures under additional kinematics constraints, *Engineering Structures* **32** (2010), 3086–3092.
- [118] S. Chan, J. Mottershead and M. Cartmell, Parametric resonances at subcritical speeds in discs with rotating frictional loads, *Proc. Inst. Mech. Eng. C* **208** (1994), 417–425.
- [119] S. Chandrasekhar, The stability of viscous flow between rotating cylinders in the presence of a magnetic field, *Proc. R. Soc. Lond. A* **216** (1953), 293–309.
- [120] S. Chandrasekhar, The stability of non-dissipative Couette flow in hydromagnetics, *Proc. Natl. Acad. Sci. USA* **46** (1960), 253–257.
- [121] S. Chandrasekhar, *Hydrodynamic and Hydromagnetic Stability*, International Series of Monographs on Physics, Oxford University Press, Oxford, 1961.
- [122] G. Chen, S. A. Fulling, F. J. Narkowich and S. Sun, Exponential decay of energy of evolution equations with locally distributed damping, *SIAM J. Appl. Math.* **51** (1991), 266–301.
- [123] J.-S. Chen and D. B. Bogy, Mathematical structure of modal interactions in a spinning disk-stationary load system, *J. Appl. Mech.* **59** (1992), 390–397.

- [124] J. Chen, P. Fu, S.-I. Niculescu and Z. Guan, An eigenvalue perturbation approach to stability analysis, part I: Eigenvalue series of matrix operators, *SIAM J. Control Optim.* **48** (2010), 5564–5582.
- [125] S.-J. Chern, Stability theory for linear dissipative Hamiltonian systems, *Linear Algebra and its Applications* **357** (2002), 143–162.
- [126] F. L. Chernous'ko, Motion of a solid containing a spherical damper, *Zhurnal prikladnoi Mekhaniki i Teckhnicheskoi Fiziki* **9** (1968), 73–79.
- [127] N. G. Chetaev, *The Stability of Motion*, Pergamon Press, New York, 1961.
- [128] D. M. Christodoulou, J. Contopoulos and D. Kazanas, Interchange method in incompressible magnetized Couette flow: Structural and magnetorotational instabilities, *The Astrophysical Journal* **462** (1996), 865–873.
- [129] M. Chugunova and D. Pelinovsky, Count of eigenvalues in the generalized eigenvalue problem, *J. Math. Phys.* **51** (2010), 052901.
- [130] L. Chumakova and E. G. Tabak, Simple waves do not avoid eigenvalue crossings, *Comm. Pure Appl. Math.* **63** (2010), 119–132.
- [131] F. S. Chute, F. E. Vermeulen and E. A. Youssef, A twisted electrostatic quadrupole for guiding heavy charged particles, *Nuclear Instruments and Methods* **82** (1970), 86–92.
- [132] W. Clohessy and R. Wiltshire, Terminal guidance system for satellite rendezvous, *J. of the Aerospace Sciences* **27** (1960), 653–658, 674.
- [133] R. Cordeiro and R. Viera Martins, Effect of Krein signatures on the stability of relative equilibria, *Celestial Mechanics and Dynamical Astronomy* **61** (1995), 217–238.
- [134] E. Cotton and M. M. Yuan, Sur les criteres de stabilite de Routh et de Hurwitz, *Bull. Sci. Math.* **72** (1948), 115–128.
- [135] M. Couette, Sur un nouvel appareil pour l'etude du frottement des fluids, *Comptes Rend.* **107** (1888), 388–390.
- [136] M. Couette, Etudes sur le frottement des liquides, *Ann. Chim. Phys.* **6** (1890), 433–510.
- [137] S. H. Crandall, The role of damping in vibration theory, *J. Sound Vibr.* **11** (1970), 3–18, IN1.
- [138] S. H. Crandall, Rotordynamics, in: *Nonlinear Dynamics and Stochastic Mechanics*, pp. 1–44, CRC Press, Boca Raton, 1995.
- [139] S. H. Crandall, The effect of damping on the stability of gyroscopic pendulums, *ZAMP Z. angew. Math. Phys.* **46** (1995), S761–S780.
- [140] B. Cushman-Roisin, Motion of a free particle on a beta-plane, *Geophys. Astrophys. Fluid. Dynamics* **22** (1982), 85–102.
- [141] J. L. Daleckii and M. G. Krein, *Stability of Solutions of Differential Equations in Banach Space*, Translations of Mathematical Monographs 43, American Mathematical Society, Providence, RI, 1974.
- [142] B. N. Datta, Stability and inertia, *Linear Algebra and its Applications* **302-303** (1999), 563–600.

- [143] S. Datta, C. T. Chan, K. M. Ho and C. M. Soukoulis, Effective dielectric constant of periodic composite structures, *Phys. Rev. B* **48** (1993), 14936–14943.
- [144] A. David and S. C. Sinha, Versal deformation and local bifurcation analysis of time-periodic nonlinear systems, *Nonlinear Dynamics* **21** (2000), 317–336.
- [145] S. H. Davis, On the principle of exchange of stabilities, *Proc. R. Soc. Lond. Ser. A, Math. Phys. Sci.* **310** (1969), 341–358.
- [146] M. Dellnitz, I. Melbourne and J. E. Marsden, Generic bifurcation of Hamiltonian vector-fields with symmetry, *Nonlinearity* **5** (1992), 979–996.
- [147] M. Dellnitz and I. Melbourne, Generic movement of eigenvalues for equivariant self-adjoint matrices, *Journal of Computational and Applied Mathematics* **55** (1994), 249–259.
- [148] G. Demange and E.-M. Graefe, Signatures of three coalescing eigenfunctions, *Journal of Physics A: Mathematical and Theoretical* **45** (2012), 025303.
- [149] C. Dembowski, H.-D. Gräf, H. L. Harney, A. Heine, W. D. Heiss, H. Rehfeld and A. Richter, Experimental observation of the topological structure of exceptional points, *Phys. Rev. Lett.* **86** (2001), 787–790.
- [150] B. P. Demidovich, *Lectures on the Mathematical Theory of Stability*, Nauka, Moscow, 1967 (in Russian).
- [151] G. G. Denisov, V. V. Novikov and A. E. Fedorov, To the problem of a passive levitation of bodies in physical fields, *Trans. ASME J. Appl. Mech.* **77** (2010), 031017.
- [152] G. Derks and T. Ratiu, Unstable manifolds of relative equilibria in Hamiltonian systems with dissipation, *Nonlinearity* **15** (2002), 531.
- [153] L. Dieci and A. Pugliese, Hermitian matrices depending on three parameters: Coalescing eigenvalues, *Linear Algebra and its Applications* **436** (2012), 4120–4142.
- [154] B. Dietz, H. L. Harney, O. N. Kirillov, M. Miski-Oglu, A. Richter and F. Schaefer, Exceptional points in a microwave billiard with time-reversal invariance violation, *Phys. Rev. Lett.* **106** (2011), 150403.
- [155] R. C. DiPrima and P. Hall, Complex eigenvalues for the stability of Couette flow, *Proc. R. Soc. Lond. Ser. A, Math. Phys. Sci.* **396** (1984), 75–94.
- [156] S. Dobrokhotov and A. Shafarevich, Parametrix and the asymptotics of localized solutions of the Navier–Stokes equations in R^3 , linearized on a smooth flow, *Math. Notes* **51** (1992), 47–54.
- [157] I. Dobson, J. Zhang, S. Greene, H. Engdahl and P. W. Sauer, Is strong modal resonance a precursor to power system oscillations? *IEEE Trans. Circ. Syst. I* **48** (2001), 340–349.
- [158] J. M. Domingos, Time reversal in classical and quantum mechanics, *International Journal of Theoretical Physics* **18** (1979), 213–230.
- [159] G. T. S. Done, Damping configurations that have a stabilizing influence on nonconservative systems, *International Journal of Solids and Structures* **9** (1973), 203–215.
- [160] R. J. Donnelly, Taylor-Couette flow: The early days, *Phys. Today* **44** (1991), 32–39.

- [161] E. H. Dowell, Can solar sails flutter?, *AIAA Journal* **49** (2011), 1305–1307.
- [162] P. G. Drazin and W. H. Reid, *Hydrodynamic Stability*, Cambridge Monographs on Mechanics and Applied Mathematics, Cambridge University Press, Cambridge, UK, 1981.
- [163] G. Y. Dzhanelidze, On the stability of rods due to the action of follower forces, *Trudy Leningradskogo Politekhnikeskogo Instituta* **192** (1958), 21–27.
- [164] B. Eckhardt and D. Yao, Local stability analysis along Lagrangian paths, *Chaos Solitons & Fractals* **5** (1995), 2073–2088.
- [165] W. S. Edwards, S. R. Beane and S. Varma, Onset of wavy vortices in the finite-length Couette–Taylor problem, *Physics of Fluids A-Fluid Dynamics* **3** (1991), 1510–1518.
- [166] H. Eleuch and I. Rotter, Avoided level crossings in open quantum systems, *Fortschritte der Physik* **61(2-3)** (2013), 194–204.
- [167] I. Elishakoff, Controversy associated with the so-called “follower force”: critical overview, *Appl. Mech. Revs.* **58** (2005), 117–142.
- [168] A. L. Fabrikant and Y. A. Stepaniants, *Propagation of Waves in Shear Flows*, World Scientific Series on Nonlinear Science, Series A 18, World Scientific, Singapore, 1998.
- [169] J. D. Fieldhouse, W. P. Steel, C. J. Talbot and M. A. Siddiqui, Rotor asymmetry used to reduce disc brake noise, in: *Brake Colloquium and Exhibition, Oct. 2004, Anaheim, CA, USA*, SAE Paper 2004-01-2797, SAE, Warrendale, 2004.
- [170] A. Figotin and I. Vitebsky, Spectra of periodic nonreciprocal electric circuits, *SIAM J. Appl. Math.* **61** (2001), 2008–2035.
- [171] F. Fish and G. Lauder, Passive and active flow control by swimming fishes and mammals, *Ann. Rev. Fluid Mech.* **38** (2006), 193–224.
- [172] A. Föppl, Das Problem der Lavalschen Turbinenwelle, *Der Civilingenieur* **41** (1895), 333–342.
- [173] E. Frank, On the zeros of polynomials with complex coefficients, *Bull. Amer. Math. Soc.* **52** (1946), 144–157.
- [174] P. Freitas, Quadratic matrix polynomials with Hamiltonian spectrum and oscillatory damped systems, *ZAMP Z. angew. Math. Phys.* **50** (1999), 64–81.
- [175] P. Freitas, M. Grinfeld and P. A. Knight, Stability of finite-dimensional systems with indefinite damping, *Adv. Math. Sci. Appl.* **17** (1997), 435–446.
- [176] P. Freitas and P. Lancaster, On the optimal value of the spectral abscissa for a system of linear oscillators, *SIAM J. Matrix Anal. Appl.* **21** (1999), 195–208.
- [177] P. Freitas and E. Zuazua, Stability results for the wave equation with indefinite damping, *Journal of Differential Equations* **132** (1996), 338–353.
- [178] S. Friedlander and M. M. Vishik, On stability and instability criteria for magnetohydrodynamics, *Chaos* **5** (1995), 416–423.
- [179] S. J. Friedlander and A. Lipton-Lifschitz, Localized instabilities in fluids in: *Handbook of Mathematical Fluid Dynamics*, vol. 2, pp. 289–353, Elsevier, Amsterdam, 2003.

- [180] Y. Fukumoto and Y. Hattori, Curvature instability of a vortex ring, *J. Fluid Mech.* **526** (2005), 77–115.
- [181] T. Gabrielson, Frequency constants for transverse vibration of annular disks, *J. Acoust. Soc. Am.* **105** (1999), 3311–3317.
- [182] A. Gajewski and M. Zyczkowski, *Optimal Structural Design under Stability Constraints*, Kluwer, Dordrecht, 1988.
- [183] G. P. Galdi and B. Straughan, Exchange of stabilities, symmetry, and nonlinear stability, *Archive for Rational Mechanics and Analysis* **89** (1985), 211–228.
- [184] G. Galilei, *Dialogues Concerning Two New Sciences*, William Andrew Publishing, Norwich, NY, 2001.
- [185] D. M. Galin, Real matrices depending on parameters, *Uspekhi Mat. Nauk* **27** (1972), 241–242.
- [186] D. M. Galin, Versal deformations of linear Hamiltonian systems, *AMS Transl.* **118** (1982), 1–12.
- [187] P. Gallina, About the stability of non-conservative undamped systems, *J. Sound Vibr.* **262** (2003), 977–988.
- [188] D. Galloway, ABC flows then and now, *Geophysical & Astrophysical Fluid Dynamics* **106** (2012), 450–467.
- [189] L. Garding, History of the mathematics of double refraction, *Archive for History of Exact Sciences* **40** (1989), 355–385.
- [190] J. C. Garrison and E. M. Wright, Complex geometrical phases for dissipative systems, *Phys. Lett. A* **128** (1988), 177–181.
- [191] A. M. Gasparini, A. V. Sietta and R. V. Vitaliani, On the stability and instability regions of non-conservative continuous system under partially follower forces, *Computer Methods in Applied Mechanics and Engineering* **124** (1995), 63–78.
- [192] T. Gebhardt and S. Grossmann, The Taylor–Couette eigenvalue problem with independently rotating cylinders, *Zeitschrift für Physik B Condensed Matter* **90** (1993), 475–490.
- [193] I. M. Gelfand and V. B. Lidskii, On the structure of the regions of stability of linear canonical differential equations with periodic coefficients, *Uspekhi Matem. Nauk* **10** (1955), 3–40.
- [194] G. Genta, *Dynamics of Rotating Systems*, Mechanical Engineering Series, Springer, New York, 2007.
- [195] A. Giesecke, F. Stefani and G. Gerbeth, Spectral properties of oscillatory and non-oscillatory α^2 -dynamos, *Geophysical & Astrophysical Fluid Dynamics* **107(1-2)** (2012), 45–57.
- [196] G. Gladwell, Follower forces – Leipholz early researches in elastic stability, *Canadian Journal of Civil Engineering* **17** (1990), 277–286.
- [197] G. A. Glatzmaier, Geodynamo simulations – How realistic are they? *Ann. Rev. Earth Planet. Sci.* **30** (2002), 237–257.

- [198] G. A. Glatzmaier and P. H. Roberts, A three dimensional self-consistent computer simulation of a geomagnetic field reversal, *Nature* **377** (1995), 203–209.
- [199] H. Goedbloed, R. Keppens and S. Poedts, *Advanced Magnetohydrodynamics*, Cambridge University Press, Cambridge, UK, 2010.
- [200] I. Gohberg, P. Lancaster and L. Rodman, *Matrix Polynomials*, Academic Press, San Diego, CA, 1982.
- [201] I. Gohberg, P. Lancaster and L. Rodman, Perturbation of analytic Hermitian matrix functions, *Appl. Anal.* **20** (1985), 23–48.
- [202] I. Gohberg, P. Lancaster and L. Rodman, *Indefinite Linear Algebra with Applications*, Birkhauser, Basel, 2005.
- [203] I. C. Gohberg and M. G. Krein, *Introduction to the Theory of Linear Nonselfadjoint Operators*, Translations of Mathematical Monographs, AMS, Providence, RI, 1969.
- [204] J. Goodman and H. Ji, Magnetorotational instability of dissipative Couette flow, *J. Fluid Mech.* **462** (2002), 365–382.
- [205] A. G. Greenhill, On the general motion of a liquid ellipsoid under the gravitation of its own parts, *Proc. Cambridge Philos. Soc.* **4** (1880), 4–14.
- [206] A. G. Greenhill, On the strength of shafting when exposed both to torsion and to end thrust, *Proc. Inst. Mech. Eng.* **34** (1883), 182–225.
- [207] U. Günther and F. Stefani, Isospectrality of spherical MHD dynamo operators: Pseudohermiticity and a non-go theorem, *J. Math. Phys.* **44** (2003), 3097–3111.
- [208] U. Günther and O. N. Kirillov, A Krein space related perturbation theory for MHD α^2 -dynamos and resonant unfolding of diabolical points, *Journal of Physics A: Mathematical and General* **39** (2006), 10057–10076.
- [209] U. Günther and O. N. Kirillov, Asymptotic methods for spherically symmetric MHD α^2 -dynamos, *PAMM* **7** (2007), 4140023–4140024.
- [210] U. Günther and O. N. Kirillov, Homotopic Arnold tongues deformation of the MHD α^2 -dynamo, *PAMM* **8** (2008), 10719–10720.
- [211] U. Günther, F. Stefani and M. Znojil, MHD α^2 -dynamo, Squire equation and PT-symmetric interpolation between square well and harmonic oscillator, *J. Math. Phys.* **46** (2005), 063504.
- [212] F. Haake, *Quantum Signatures of Chaos*, 3rd edn., Springer Series in Synergetics 54, Springer, Berlin, 2010.
- [213] W. Hahn, *Stability of Motion*, Die Grundlehren der mathematischen Wissenschaften, Band 138, Springer, Berlin, 1967.
- [214] J. H. Hannay, Angle variable holonomy in adiabatic excursion of an integrable Hamiltonian, *J. Phys. A: Math. Gen.* **18** (1985) 221–230.
- [215] Y. Hattori and Y. Fukumoto, Short-wavelength stability analysis of thin vortex rings, *Phys. Fluids* **15** (2003), 3151–3163.

- [216] M. Heil and A. L. Hazel, Fluid-structure interaction in internal physiological flows, *Ann. Rev. Fluid Mech.* **43** (2011), 141–162.
- [217] J. Heilig and J. Wauer, Stability of a nonlinear brake system at high operating speeds, *Nonlinear Dynamics* **34** (2003), 235–247.
- [218] W. D. Heiss, The physics of exceptional points, *Journal of Physics A: Mathematical and Theoretical* **45** (2012), 444016.
- [219] D. Henrion and J.-B. Laseerre, Inner approximations for polynomial matrix inequalities and robust stability regions, *IEEE Transactions on Automatic Control* **57** (2012), 1456–1467.
- [220] D. Henrion, D. Peaucelle, D. Arzelier and M. Sebek, Ellipsoidal approximation of the stability domain of a polynomial, *IEEE Transactions on Automatic Control* **48** (2003), 2255–2259.
- [221] C. Hermite, On the number of roots of an algebraic equation contained between given limits (English translation by P. C. Parks), *Int. J. Control* **26** (1977), 183–195.
- [222] G. Herrmann and I. C. Jong, On the destabilizing effect of damping in nonconservative elastic systems, *Trans. ASME J. Appl. Mech.* **32** (1965), 592–597.
- [223] I. H. Herron and H. N. Ali, The principle of exchange of stabilities for Couette flow, *Quarterly of Applied Mathematics* **61** (2003) 279–293.
- [224] K. Higuchi and E. H. Dowell, Effect of structural damping on flutter of plates with a follower force, *AIAA Journal* **30** (1992), 820–825.
- [225] G. W. Hill, Researches in the lunar theory, *Am. J. Math.* **1** (1878), 5–26.
- [226] N. Hoffmann and L. Gaul, Effects of damping on mode-coupling instability in friction induced oscillations, *ZAMM Z. angew. Math. Mech.* **83** (2003), 524–534.
- [227] R. Hollerbach and G. Rüdiger, New type of magnetorotational instability in cylindrical Taylor–Couette flow, *Phys. Rev. Lett.* **95** (2005), 124501.
- [228] E. O. Holopainen, On the effect of friction in baroclinic waves, *Tellus* **13** (1961), 363–367.
- [229] W. Hoover, Time reversibility in nonequilibrium thermomechanics, *Physica D* **112** (1998), 225–240.
- [230] I. Hoveijn, Versal deformations and normal forms for reversible and Hamiltonian linear systems, *Journal of Differential Equations* **126** (1996), 408–442.
- [231] I. Hoveijn and O. N. Kirillov, Singularities on the boundary of the stability domain near 1:1-resonance, *Journal of Differential Equations* **248** (2010), 2585–2607.
- [232] I. Hoveijn and M. Ruijgrok, The stability of parametrically forced coupled oscillators in sum resonance, *ZAMP Z. angew. Math. Phys.* **46** (1995), 384–392.
- [233] R. Hryniv and P. Lancaster, On the perturbation of analytic matrix functions, *Int. Equ. Oper. Theor.* **34** (1999), 325–338.
- [234] R. Hryniv and P. Lancaster, Stabilization of gyroscopic systems, *ZAMM Z. angew. Math. Mech.* **81** (2001), 675–681.

- [235] P. Huerre and P. A. Monkewitz, Local and global instabilities in spatially developing flows, *Ann. Rev. Fluid Mech.* **22** (1990), 473–537.
- [236] A. Hurwitz, Über die Bedingungen unter welchen eine Gleichung nur Wurzeln mit negativen reellen Teilen besitzt, *Math. Ann.* **46** (1895), 273–284.
- [237] K. Huseyin, P. Hagedorn and W. Teschner, On the stability of linear conservative gyroscopic systems, *ZAMP Z. angew. Math. Phys.* **34** (1983), 807–815.
- [238] K. Huseyin, Standard forms of the eigenvalue problems associated with gyroscopic systems, *J. Sound Vibr.* **45** (1976), 29–37.
- [239] K. Huseyin, *Vibrations and Stability of Multiple Parameter Systems*, Kluwer Academic Publishers, The Netherlands, 1978.
- [240] R. A. Ibrahim, Overview of mechanics of pipes conveying fluids. Part I: Fundamental Studies, *Trans. ASME Journal of Pressure Vessel Technology* **132** (2010) 034001.
- [241] D. J. Inman, A sufficient condition for the stability of conservative gyroscopic systems, *Trans. ASME J. Appl. Mech.* **55** (1988), 895–898.
- [242] W. D. Iwan and K. J. Stahl, The response of an elastic disc with a moving mass system, *Trans. ASME J. Appl. Mech.* **40** (1973), 445–451.
- [243] E. Jarlebring, S. Kvaal and W. Michiels, Computing all pairs (λ, μ) such that λ is a double eigenvalue of $A + \mu B$, *SIAM J. Matrix Anal. Appl.* **32** (2011), 902–927.
- [244] H. H. Jeffcott, The lateral vibration of the loaded shaft in the neighbourhood of a whirling speed, *Phil. Mag. Ser.* **6(37)** (1919), 304–314.
- [245] J. Jeronen, *On the mechanical stability and out-of-plane dynamics of a travelling panel submerged in axially flowing ideal fluid: a study into paper production in mathematical terms*, University of Juvaskyla, Finland, 2011.
- [246] C. A. Jones, Multiple eigenvalues and mode classification in plane Poiseuille flow, *Quart. J. Mech. Appl. Math.* **41** (1988), 363–382.
- [247] C. A. Jones, Dynamo theory, in: *Lecture Notes, Les Houches “Dynamos” Summer School, July 30–August 24, 2007*, pp. 44–136, Elsevier, Amsterdam, 2008.
- [248] S. V. Joubert, M. Y. Shatalov and T. H. Fay, Rotating structures and Bryan’s effect, *American Journal of Physics* **77** (2009), 520–525.
- [249] C. M. Jung and B. F. Feeny, On the discretization of an elastic rod with distributed sliding friction, *J. Sound Vibr.* **252** (2002), 409–428.
- [250] W. Kahan, Spectra of nearly Hermitian matrices, *Proc. Amer. Math. Soc.* **48** (1975), 11–17.
- [251] R. Kalaba, K. Spingarn and L. Tesfatsion, Individual tracking of an eigenvalue and eigenvector of a parameterized matrix, *Nonlinear Analysis, Theory, Methods and Applications* **5** (1981), 337–340.
- [252] R. Kalaba, K. Spingarn and L. Tesfatsion, Variational equations for the eigenvalues and eigenvectors of nonsymmetric matrices, *Journal of Optimization Theory and Applications* **33** (1981), 1–8.

- [253] R. E. Kalman and J. E. Bertram, Control system analysis and design via the second method of Lyapunov, *ASME Trans. D* **82** (1960), 371–400.
- [254] J. Kang, C. Krousgrill and F. Sadeghi, Dynamic instability of a thin circular plate with friction interface and its application to disc brake squeal, *J. Sound Vibr.* **316** (2008), 164–179.
- [255] J. Kang, Theoretical model of ball joint squeak, *J. Sound Vibr.* **330** (2011), 5490–5499.
- [256] P. L. Kapitsa, Stability and passage through the critical speed of the fast spinning rotors in the presence of damping, *Z. Tech. Phys.* **9** (1939), 124–147.
- [257] A. V. Karapetjan, The stability of nonconservative systems, *Vestn. Mosk. Univ., Ser. I: Mat. Mekh.* **30** (1975), 109–113.
- [258] T. Kato, *Perturbation Theory for Linear Operators*, 2nd edn., Grundlehren der mathematischen Wissenschaften 132, Springer, Berlin–Heidelberg–New York, 1980.
- [259] J. T. Katsikadelis and G. C. Tsiatas, Optimum design of structures subjected to follower forces, *International Journal of Mechanical Sciences* **49** (2007), 1204–1212.
- [260] F. Keck, H.-J. Korsch and S. Mossmann, Unfolding a diabolic point: a generalized crossing scenario, *Journal of Physics A: Mathematical and General* **36** (2003), 2125–2137.
- [261] M. V. Keldysh, On eigenvalues and eigenfunctions of some classes of nonselfadjoint equations, *Dokl. AN SSSR* **77** (1951), 11–14.
- [262] W. Kerr, On the whirling speeds of loaded shafts, *Engineering* (1916), 150.
- [263] P. Kessler, O. M. O’Reilly, A.-L. Raphael and M. Zworski, On dissipation-induced destabilization and brake squeal: A perspective using structured pseudospectra, *J. Sound Vibr.* **308** (2007), 1–11.
- [264] I. V. Khalzov, A. I. Smolyakov and V. I. Ilgisonis, Energy of eigenmodes in magneto-hydrodynamic flows of ideal fluids, *Physics of Plasmas* **15** (2008), 054501.
- [265] V. L. Kharitonov, Asymptotic stability of an equilibrium position of a family of systems of differential equations, *Differentsialnye Uravnenija* **14** (1978), 2086–2088.
- [266] A. L. Kimball, Internal friction as a cause of shaft whirling, *Phil. Mag.* **49** (1925), 724–727.
- [267] A. L. Kimball and D. E. Lovell, Internal friction in solids, *Phys. Rev.* **30** (1927), 948–959.
- [268] N. M. Kinkaid, O. M. O’Reilly and P. Papadopoulos, Automotive disc brake squeal, *J. Sound Vibr.* **267** (2003), 105–166.
- [269] O. N. Kirillov, A. A. Mailybaev and A. P. Seyranian, Singularities of energy surfaces under non-Hermitian perturbations, *Doklady Physics* **50** (2005), 577–582.
- [270] O. N. Kirillov, A. A. Mailybaev and A. P. Seyranian, Unfolding of eigenvalue surfaces near a diabolic point due to a complex perturbation, *Journal of Physics A: Mathematical and General* **38** (2005), 5531–5546.

- [271] O. N. Kirillov and A. P. Seyranian, Optimization of Stability of a Flexible Missile under Follower Thrust, in: *7th AIAA/USAF/NASA/ISSMO Symposium on Multidisciplinary Analysis and Optimization. St. Louis, Missouri (USA). September 2-4, 1998.*, AIAA Paper 98-4969, pp. 2063–2073, AIAA, Reston, VA, 1998.
- [272] O. N. Kirillov and A. P. Seyranian, Optimality conditions in nonconservative stability problems, in: G. I. N. Rozvany and N. Olhof (eds.), *Topology Optimization of Structures and Composite Continua*, NATO Science Series, Series II: Mathematics, Physics and Chemistry 7, pp. 363–365, Springer, Dordrecht, Netherlands, 2000.
- [273] O. N. Kirillov and A. P. Seyranian, Collapse of Keldysh chains and the stability of non-conservative systems, *Doklady Mathematics* **66** (2002), 127–131.
- [274] O. N. Kirillov and A. P. Seyranian, Metamorphoses of characteristic curves in circulatory systems, *J. Appl. Math. Mech.* **66** (2002), 371–385.
- [275] O. N. Kirillov and A. P. Seyranian, A nonsmooth optimization problem, *Moscow University Mechanics Bulletin* **57** (2002), 1–6.
- [276] O. N. Kirillov and A. P. Seyranian, Solution to the Herrmann–Smith problem, *Doklady Physics* **47** (2002), 767–771.
- [277] O. N. Kirillov and A. P. Seyranian, Collapse of the Keldysh chains and stability of continuous nonconservative systems, *SIAM J. Appl. Math.* **64** (2004), 1383–1407.
- [278] O. N. Kirillov and A. P. Seyranian, Dissipation induced instabilities in continuous non-conservative systems, *Proc. Appl. Math. Mech.* **5(1)** (2005), 97–98.
- [279] O. N. Kirillov and A. P. Seyranian, Effect of small internal and external damping on the stability of continuous non-conservative systems, in: *Proceedings CDRom of the ENOC-2005, Eindhoven, The Netherlands, 7-12 August 2005*, pp. 2428–2436, 2005.
- [280] O. N. Kirillov and A. P. Seyranian, Instability of distributed nonconservative systems caused by weak dissipation, *Doklady Mathematics* **71** (2005), 470–475.
- [281] O. N. Kirillov and A. P. Seyranian, Stabilization and destabilization of a circulatory system by small velocity-dependent forces, *J. Sound Vibr.* **283** (2005), 781–800.
- [282] O. N. Kirillov and A. P. Seyranian, The effect of small internal and external damping on the stability of distributed non-conservative systems, *PMM J. Appl. Math. Mech.* **69** (2005), 529–552.
- [283] O. N. Kirillov, Optimization of stability of the flying bar, *Young Scientists Bulletin. Appl. Maths Mechs.* **1** (1999), 64–78.
- [284] O. N. Kirillov, *Analysis of Stability Boundaries and Optimization of Circulatory Systems*, Ph.D. thesis, M. V. Lomonosov State University, Moscow, 2000.
- [285] O. N. Kirillov, *How do Small Velocity-dependent Forces (De)stabilize a Non-conservative System?* DCAMM Report. 681, Technical University of Denmark, Lyngby, Denmark, 2003.
- [286] O. N. Kirillov, How do small velocity-dependent forces (de)stabilize a non-conservative system? in: *2003 International Conference Physics and Control, vols. 1–4, Proceedings*, pp. 1090–1095, IEEE, 2003.

- [287] O. N. Kirillov, Destabilization paradox, *Doklady Physics* **49** (2004), 239–245.
- [288] O. N. Kirillov, A theory of the destabilization paradox in non-conservative systems, *Acta Mechanica* **174** (2005), 145–166.
- [289] O. N. Kirillov, Gyroscopic stabilization of non-conservative systems, *Phys. Lett. A* **359** (2006), 204–210.
- [290] O. N. Kirillov, Destabilization paradox due to breaking the Hamiltonian and reversible symmetry, *International Journal of Non-Linear Mechanics* **42** (2007), 71–87.
- [291] O. N. Kirillov, Gyroscopic stabilization in the presence of nonconservative forces, *Doklady Mathematics* **76** (2007), 780–785.
- [292] O. N. Kirillov, On the stability of nonconservative systems with small dissipation, *J. Math. Sci.* **145** (2007), 5260–5270.
- [293] O. N. Kirillov, Subcritical flutter in the acoustics of friction, *Proc. R. Soc. Lond. Ser. A Math. Phys. Eng. Sci.* **464** (2008), 2321–2339.
- [294] O. N. Kirillov, Campbell diagrams of weakly anisotropic flexible rotors, *Proc. R. Soc. Lond. Ser. A Math. Phys. Eng. Sci.* **465** (2009), 2703–2723.
- [295] O. N. Kirillov, Perspectives and obstacles for optimization of brake pads with respect to stability criteria, *Int. J. Vehicle Design* **51** (2009), 143–167.
- [296] O. N. Kirillov, Sensitivity analysis of Hamiltonian and reversible systems prone to dissipation-induced instabilities, in: E. E. Tyrtshnikov and V. Olshevsky, (eds.), *Matrix Methods: Theory, Algorithms, Applications. Proceedings of the 2nd International Conference on Matrix Methods and Operator Equations, July 23-27, 2007, Moscow, Russia*, pp. 31–68, World Scientific, Singapore, 2009.
- [297] O. N. Kirillov, Unfolding the conical zones of the dissipation-induced subcritical flutter for the rotationally symmetrical gyroscopic systems, *Phys. Lett. A* **373** (2009), 940–945.
- [298] O. N. Kirillov, Eigenvalue bifurcation in multiparameter families of non-self-adjoint operator matrices, *ZAMP Z. angew. Math. Phys.* **61** (2010), 221–234.
- [299] O. N. Kirillov, Brouwer’s problem on a heavy particle in a rotating vessel: Wave propagation, ion traps, and rotor dynamics, *Phys. Lett. A* **375** (2011), 1653–1660.
- [300] O. N. Kirillov, Re-visiting structural optimization of the Ziegler pendulum: singularities and exact optimal solutions, *PAMM* **11** (2011), 717–718.
- [301] O. N. Kirillov, Sensitivity of sub-critical mode-coupling instabilities in non-conservative rotating continua to stiffness and damping modifications, *Int. J. Vehicle Struct. Syst.* **3** (2011), 1–14.
- [302] O. N. Kirillov, Singularities in structural optimization of the Ziegler pendulum, *Acta Polytechnica* **51** (2011), 32–43.
- [303] O. N. Kirillov, \mathcal{PT} -symmetry, indefinite damping and dissipation-induced instabilities, *Phys. Lett. A* **376** (2012), 1244–1249.
- [304] O. N. Kirillov, Exceptional and diabolical points in stability questions, *Fortschritte der Physik* **61** (2013), 205–224.

- [305] O. N. Kirillov, Stabilizing and destabilizing perturbations of \mathcal{PT} -symmetric indefinitely damped systems, *Phil. Trans. R. Soc. A* **371** (2013), 20120051.
- [306] O. N. Kirillov and U. Günther, On Krein space related perturbation theory for MHD α^2 -dynamoes, *PAMM* **6** (2006), 637–638.
- [307] O. N. Kirillov, U. Günther and F. Stefani, Determining role of Krein signature for three-dimensional Arnold tongues of oscillatory dynamoes, *Phys. Rev. E* **79** (2009), 016205.
- [308] O. N. Kirillov, D. E. Pelinovsky and G. Schneider, Paradoxical transitions to instabilities in hydromagnetic Couette–Taylor flows, *Phys. Rev. E* **84** (2011), 065301(R).
- [309] O. N. Kirillov and F. Stefani, On the relation of standard and helical magnetorotational instability, *Astrophysical Journal* **712** (2010), 52–68.
- [310] O. N. Kirillov and F. Stefani, Paradoxes of magnetorotational instability and their geometrical resolution, *Phys. Rev. E* **84** (2011), 036304.
- [311] O. N. Kirillov and F. Stefani, Standard and helical magnetorotational instability: How singularities create paradoxical phenomena in MHD, *Acta Applicanda Mathematica* **120** (2012), 177–198.
- [312] O. N. Kirillov and F. Verhulst, Paradoxes of dissipation-induced destabilization or who opened Whitney’s umbrella? *ZAMM Z. angew. Math. Mech.* **90** (2010), 462–488.
- [313] Y. S. Kivshar and M. Peyrard, Modulational instabilities in discrete lattices, *Phys. Rev. A* **46** (1992), 3198–3207.
- [314] W. Kliem and C. Pommer, Indefinite damping in mechanical systems and gyroscopic stabilization, *ZAMP Z. angew. Math. Phys.* **60** (2009), 785–795.
- [315] C. Klingshirn, *Semiconductor Optics*, 3rd edn., Springer, Berlin, 2007.
- [316] E. Knobloch, On the stability of magnetized accretion discs, *Mon. Not. R. Astron. Soc.* **255** (1992), 25–28.
- [317] V. Kobelev, Sensitivity analysis of the linear nonconservative systems with fractional damping, *Structural and Multidisciplinary Optimization* **33** (2007), 179–188.
- [318] R. Kollar, Homotopy method for nonlinear eigenvalue pencils with applications, *SIAM J. Math. Anal.* **43** (2011), 612–633.
- [319] R. Kollar and P. D. Miller, Graphical Krein signature theory and Evans–Krein functions, *SIAM Rev.*, arXiv:1209.3185 (2013), to appear.
- [320] N. D. Kopachevskii and S. G. Krein, *Operator Approach in Linear Problems of Hydrodynamics. Self-adjoint Problems for an Ideal Fluid*, Operator Theory: Advances and Applications 1, Birkhäuser, Basel, 2001.
- [321] Z. Kordas and M. Zyczkowsky, On the loss of stability of a rod under a super-tangential force, *Archiwum Mechaniki Stosowanej* **15** (1963), 7–31.
- [322] V. N. Koshlyakov and V. L. Makarov, Mechanical systems, equivalent in Lyapunov’s sense to systems not containing non-conservative positional forces, *J. Appl. Math. Mech.* **71** (2007), 10–19.

- [323] A. Kounadis and J. Katsikadelis, On the discontinuity of the flutter load for various types of cantilevers, *International Journal of Solids and Structures* **16** (1980), 375–383.
- [324] V. V. Kozlov, Linear systems with a quadratic integral, *J. Appl. Math. Mech.* **56** (1992), 803–809.
- [325] V. V. Kozlov, Gyroscopic stabilization and parametric resonance, *PMM J. Appl. Math. Mech.* **65** (2001), 715–721.
- [326] V. V. Kozlov, Restrictions of quadratic forms to Lagrangian planes, quadratic matrix equations, and gyroscopic stabilization, *Functional Analysis and its Applications* **39** (2005), 271–283.
- [327] V. V. Kozlov, Kelvin’s instability theorem: Topological meaning and generalizations, *Doklady Mathematics* **79** (2009), 25–28.
- [328] V. V. Kozlov, On the mechanism of stability loss, *Differential Equations* **45** (2009), 510–519.
- [329] Kimball, noted G. E. physicist, dies suddenly, *Schenectady Gazette* (March 22, 1943), 1,8.
- [330] V. V. Kozlov and A. A. Karapetyan, On the stability degree, *Differential Equations* **41** (2005), 195–201.
- [331] F. Krause and K.-H. Rädler, *Mean-field Magnetohydrodynamics and Dynamo Theory*, Pergamon Press, Oxford, 1980.
- [332] R. Krechetnikov and J. E. Marsden, On destabilizing effects of two fundamental non-conservative forces, *Physica D: Nonlinear Phenomena* **214** (2006), 25–32.
- [333] R. Krechetnikov and J. E. Marsden, Dissipation-induced instabilities in finite dimensions, *Rev. Mod. Phys.* **79** (2007), 519–553.
- [334] R. Krechetnikov and J. E. Marsden, Dissipation-induced instability phenomena in infinite-dimensional systems, *Archive for Rational Mechanics and Analysis* **194** (2009), 611–668.
- [335] M. A. Krein, M. G. Naimark, The method of symmetric and Hermitian forms in the theory of the separation of the roots of algebraic equations (Translated from Russian by O. Boshko and J. L. Howland), *Linear and Multilinear Algebra* **10** (1981), 265–308.
- [336] M. G. Krein, A generalization of several investigations of A. M. Liapunov on linear differential equations with periodic coefficients, *Dokl. Acad. Nauk SSSR.* **73** (1950), 445–448.
- [337] M. G. Krein, *Topics in Differential and Integral Equations and Operator Theory*, Operator Theory 7, Birkhauser, Basel, Switzerland, 1983.
- [338] M. G. Krein and G. I. Liubarskii, On the theory of transmission bands of periodic waveguides, *PMM J. Appl. Math. Mech.* **25** (1961), 24–37.
- [339] M. I. Krivoruchenko, Rotation of the swing plane of Foucault’s pendulum and Thomas spin precession: Two sides of one coin, *Physics-Uspeski* **52** (2009), 821–829.

- [340] M. Kroeger, M. Neubauer and K. Popp, Experimental investigation on the avoidance of self-excited vibrations, *Philos. Trans. R. Soc. A, Math. Phys. Eng. Sci.* **366** (2008), 785–810.
- [341] P. Kuchment, *Floquet Theory for Partial Differential Equations*, Operator Theory: Advances and Applications 60, Birkhauser, Basel, 1993.
- [342] V. Lakhadanov, On stabilization of potential systems, *Prikl. Mat. Mekh.* **39** (1975), 53–58.
- [343] H. Lamb, On kinetic stability, *Proc. R. Soc. Lond. A* **80** (1908), 168–177.
- [344] J. S. W. Lamb and J. A. G. Roberts, Time-reversal symmetry in dynamical systems: A survey, *Physica D* **112** (1998), 1–39.
- [345] P. Lancaster, Explicit solutions of linear matrix equations, *SIAM Rev.* **12** (1970), 544–566.
- [346] P. Lancaster, *Lambda-Matrices and Vibrating Systems*, Dover Books on Mathematics, Dover, New York, 2002.
- [347] P. Lancaster, A. Markus and F. Zhou, Perturbation theory for analytic matrix functions: the semisimple case, *SIAM J. Matrix Anal. Appl.* **25** (2003), 606–626.
- [348] P. Lancaster and M. Tismenetsky, Inertia characteristics of self-adjoint matrix polynomials, *Linear Algebra and its Applications* **52-53** (1983), 479–496.
- [349] M. Landahl, On the stability of a laminar incompressible boundary layer over a flexible surface, *J. Fluid Mech.* **13** (1962), 609–632.
- [350] M. J. Landman and P. G. Saffman, The three-dimensional instability of strained vortices in a viscous fluid, *Phys. Fluids* **30** (1987), 2339–2342.
- [351] A. S. Landsberg, Geometrical phases and symmetries in dissipative systems, *Phys. Rev. Lett.* **69** (1992), 865–868.
- [352] H. Langer and B. Naiman, Remarks on the perturbation of analytic matrix functions, II, *Int. Equ. Oper. Theor.* **12** (1989), 392–407.
- [353] H. Langer and C. Tretter, A Krein space approach to PT-symmetry, *Czech. J. Phys.* **54** (2004), 1113–1120.
- [354] W. F. Langford, Hopf meets Hamilton under Whitney’s umbrella, in: S. N. Namachchivaya, (ed.), *IUTAM Symposium on Nonlinear Stochastic Dynamics. Proceedings of the IUTAM Symposium, Monticello, IL, USA, Augsut 26-30, 2002*, Solid Mech. Appl. 110, pp. 157–165, Kluwer, Dordrecht, 2003.
- [355] M. A. Langthjem, On the influence of damping in a problem of dynamic stability optimization, *Structural Optimization* **7** (1994), 227–236.
- [356] M. A. Langthjem and Y. Sugiyama, Dynamic stability of columns subjected to follower loads: A survey, *J. Sound Vibr.* **238** (2000), 809–851.
- [357] M. A. Langthjem and Y. Sugiyama, Optimum design of cantilevered columns under the combined action of conservative and nonconservative loads Part I: The undamped case, *Computers and Structures* **74** (2000), 385–398.

- [358] C. N. Lashmore-Davies, Negative energy waves, *Journal of Plasma Physics* **71** (2005), 101–109.
- [359] D. P. Lathrop and C. B. Forest, Magnetic dynamos in the lab, *Phys. Today* **64** (2011), 40–45.
- [360] H. N. Latter, H. Rein and G. I. Ogilvie, The gravitational instability of a stream of co-orbital particles, *Mon. Not. R. Astron. Soc.* **423** (2012), 1267–1276.
- [361] K. A. Lazopoulos and A. K. Lazopoulos, Stability of a gradient elastic beam compressed by non-conservative forces, *ZAMM Z. angew. Math. Mech.* **90** (2010), 174–184.
- [362] S. Le Dizès and P. Billant, Radiative instability in stratified vortices, *Physics of Fluids* **21** (2009), 096602.
- [363] N. R. Lebovitz and E. Zweibel, Magnetoelliptic instabilities, *The Astrophysical Journal* **609** (2004), 301–312.
- [364] Y. S. Ledyev and Q. J. Zhu, Nonsmooth analysis on smooth manifolds, *Trans. Amer. Math. Soc.* **359** (2007), 3687–3732.
- [365] R. Lefebvre and O. Atabek, Exceptional points in multichannel resonance quantization, *The European Physical Journal D - Atomic, Molecular, Optical and Plasma Physics* **56** (2010), 317–324.
- [366] V. Legostayev, A. Subbotin, S. Timakov and Y. Cheremnykh, Normal modes of oscillations of a rotating membrane with a rigid central insert (an application of Heun functions), *J. Appl. Math. Mech.* **75** (2011), 154–164.
- [367] H. Leipholz and H. Ziegler, *Stability: Fourteen Special Lectures Presented at the University of Waterloo, 1970-71*, SM Studies Series, Solid Mechanics Division, University of Waterloo, 1972.
- [368] H. Leipholz, On conservative elastic systems of the first and second kind, *Archive of Applied Mechanics* **43** (1974), 255–271.
- [369] H. Leipholz, *Stability Theory: An Introduction to the Stability of Dynamic Systems and Rigid Bodies*, 2nd edn., B. G. Teubner/John Wiley and Sons, Stuttgart, Chichester (England) and New York, 1987.
- [370] A. Leissa, On a curve veering aberration, *ZAMP Z. angew. Math. Phys.* **25** (1974), 99–111.
- [371] G. A. Leonov, *Strange Attractors and Classical Stability Theory*, Ex Libris Universitatis Petropolitanae, St. Petersburg University Press, 2008.
- [372] G. A. Leonov and N. V. Kuznetsov, Time-varying linearization and the Perron effects, *International Journal of Bifurcation and Chaos* **17** (2007), 1079–1107.
- [373] J. Lerbet, O. Kirillov, M. Aldowaji, N. Challamel, F. Nicot and F. Darve, Additional constraints may soften a non-conservative structural system: Buckling and vibration analysis, *International Journal of Solids and Structures* **50** (2013), 363–370.
- [374] L. V. Levantovskii, The boundary of a set of stable matrices, *Usp Mat. Nauk* **35** (1980), 212–214.

- [375] L. V. Levantovskii, Singularities of the boundary of a region of stability, *Funktsional. Anal. i Prilozhen.* **16** (1982), 44–48, 96.
- [376] M. Levi, *The Mathematical Mechanic: Using Physical Reasoning to Solve Problems*, Princeton University Press, Princeton, NJ, 2009.
- [377] M. Lewin, On the coefficients of the characteristic polynomial of a matrix, *Discrete Mathematics* **125** (1994), 255–262.
- [378] A. S. Lewis, The mathematics of eigenvalue optimization, *Mathematical Programming, Ser. B* **97** (2003), 155–176.
- [379] V. Lidskii, Perturbation theory of non-conjugate operators, *U.S.S.R. Comput. Math. and Math. Phys.* **6** (1966), 73–85.
- [380] M. Liertzer, L. Ge, A. Cerjan, A. D. Stone, H. E. Türeci and S. Rotter, Pump-induced exceptional points in lasers, *Phys. Rev. Lett.* **108** (2012), 173901.
- [381] A. Lifschitz, Short wavelength instabilities of incompressible three-dimensional flows and generation of vorticity, *Phys. Lett. A* **157** (1991), 481–487.
- [382] S. G. Lipson, Berry’s phase in optical interferometry: a simple derivation, *Optics Letters* **15** (1990), 154–155.
- [383] W. Liu, J. Goodman, I. Herron and H. Ji, Helical magnetorotational instability in magnetized Taylor–Couette flow, *Phys. Rev. E* **74** (2006), 056302.
- [384] A. Loria and E. Panteley, *Stability, Told by its Developers*, Advanced Topics in Control Theory, pp. 199–258, Springer, LNCIS, London, 2006.
- [385] D. Ludwig, Conical refraction in crystal optics and hydromagnetics, *Comm. Pure Appl. Math.* **14** (1961), 113–124.
- [386] K. A. Lurie, *An Introduction to the Mathematical Theory of Dynamic Materials*, Advances in Mechanics and Mathematics, Springer, New York, 2007.
- [387] A. M. Lyapunov, The general problem of the stability of motion (translated into English by A. T. Fuller), *Int. J. Control* **55** (1992), 531–773.
- [388] A. A. Lyashenko and S. J. Friedlander, A sufficient condition for instability in the limit of vanishing dissipation, *J. Math. Anal. Appl.* **221** (1998), 544–558.
- [389] B. R. Mace and E. Manconi, Wave motion and dispersion phenomena: Veering, locking and strong coupling effects, *J. Acoust. Soc. Amer.* **131** (2012), 1015–1028.
- [390] R. S. MacKay, Stability of equilibria of Hamiltonian systems, in: S. Sarkar (ed.), *Nonlinear Phenomena and Chaos*, pp. 254–270, Adam Hilger, Bristol, 1986.
- [391] R. S. MacKay, Movement of eigenvalues of Hamiltonian equilibria under non-Hamiltonian perturbation, *Phys. Lett. A* **155** (1991), 266–268.
- [392] R. S. MacKay and P. G. Saffman, Stability of water-waves, *Proc. R. Soc. Lond. Ser. A Math. Phys. Eng. Sci.* **406** (1986), 115–125.
- [393] R. S. MacKay and J. A. Sepulchre, Stability of discrete breathers, *Physica D-Nonlinear Phenomena* **119** (1998), 148–162.

- [394] J. H. Maddocks, *Stability in Hamiltonian Systems and the Calculus of Variations*, EPFL, Lausanne, 1998.
- [395] J. H. Maddocks and M. L. Overton, Stability theory for dissipatively perturbed Hamiltonian-systems, *Comm. Pure Appl. Math.* **48** (1995), 583–610.
- [396] O. Mahrenholtz and R. Bogacz, On the shape of characteristic curves for optimal structures under non-conservative loads, *Archive of Applied Mechanics* **50** (1981), 141–148.
- [397] A. A. Mailybaev, O. N. Kirillov and A. P. Seyranian, Geometric phase around exceptional points, *Phys. Rev. A* **72** (2005), 014104.
- [398] A. A. Mailybaev, O. N. Kirillov and A. P. Seyranian, Berry phase around degeneracies, *Doklady Mathematics* **73** (2006), 129–133.
- [399] A. A. Mailybaev, Transformation to versal deformations of matrices, *Linear Algebra and its Applications* **337** (2001), 87–108.
- [400] I. G. Malkin, *Theory of Stability of Motion*, Nauka, Moscow, 1966 (in Russian).
- [401] W. V. R. Malkus, Precession of Earth as cause of geomagnetism, *Science* **160** (1968), 259–264.
- [402] C. Mallagh, *Naval Architecture: Mid-period Theory and Ideology*, <http://homepage.ntlworld.com/christopher.mallagh/INCKy/Hist/NavArch/MidPeriodIdeol.html>.
- [403] A. Mallock, Determination of the viscosity of water, *Proc. R. Soc. Lond.* **45** (1888–1889), 126–132.
- [404] A. Mallock, Experiments on fluid viscosity, *Phil. Trans. R. Soc. Lond. A* **187** (1896), 41–56.
- [405] S. Mandre and L. Mahadevan, A generalized theory of viscous and inviscid flutter, *Proc. R. Soc. Lond. Ser. A Math. Phys. Eng. Sci.* **466** (2010), 141–156.
- [406] M. Mansour and B. D. O. Anderson, Kharitonov’s theorem and the second method of Lyapunov, in: *Proceedings of the Workshop on Robust Control and Stability*, pp. 3–11, Ascona, Switzerland, 1992.
- [407] M. Mansour and B. D. O. Anderson, Kharitonov’s theorem and the second method of Lyapunov, *Systems and Control Letters* **20** (1993), 39–47.
- [408] A. S. Marathay, Propagation of polarized light in a cholesteric structure, *Optics Commun.* **3** (1971), 369–373.
- [409] M. Marden, *Geometry of Polynomials*, 2nd edn., Mathematical Surveys and Monographs, Number 3, American Mathematical Society, Providence, RI, 1966.
- [410] J. E. Marsden, R. Montgomery and T. Ratiu, Reduction, symmetry, and phases in mechanics, *Memoirs of the American Mathematical Society* **88** (1990), 1–110.
- [411] J. E. Marsden, O. M. O’Reilly, F. J. Wicklin and B. W. Zombro, Symmetry, stability, geometric phases and mechanical integrators (Part II), *Nonlin. Sci. Today* **1** (1991), 14–21.

- [412] J. E. Marsden and T. S. Ratiu, *Introduction to Mechanics and Symmetry: A Basic Exposition of Classical Mechanical Systems*, Texts in Applied Mathematics 17, Springer, Berlin, 1999.
- [413] L. M. Martyushev, The maximum entropy production principle: two basic questions, *Philos. Trans. R. Soc. Ser. B Biol. Sci.* **365** (2010), 1333–1334.
- [414] L. M. Martyushev and V. D. Seleznev, Maximum entropy production principle in physics, chemistry, and biology, *Physics Reports* **426** (2006), 1–45.
- [415] F. Massi, O. Giannini and L. Baillet, Brake squeal as dynamic instability: an experimental investigation, *J. Acoust. Soc. Am.* **120** (2006), 1388–1398.
- [416] J. C. Maxwell, On governors, *Proc. R. Soc.* **16** (1868), 270–283.
- [417] J. C. Maxwell, *The Scientific Letters and Papers of James Clerk Maxwell*, 3, Cambridge University Press, Cambridge, UK, 2009.
- [418] H. Mehri-Dehnavi and A. Mostafazadeh, Geometric phase for non-Hermitian Hamiltonians and its holonomy interpretation, *Journal of Mathematical Physics* **49** (2008), 082105.
- [419] L. Meirovitch and P. Hagedorn, A new approach to the modeling of distributed non-self-adjoint systems, *J. Sound Vibr.* **178** (1994), 227–241.
- [420] J. D. Meiss, *Differential Dynamical Systems*, Mathematical Modeling and Computation 14, SIAM, Philadelphia, 2007.
- [421] R. Mennicken and M. Moeller, *Non-Self-Adjoint Boundary Eigenvalue Problems*, North-Holland Mathematics Studies 192, Elsevier, 2003.
- [422] D. R. Merkin, *Gyroscopic Systems*, Gostekhizdat, Moscow, 1956 (in Russian).
- [423] D. R. Merkin, *Introduction to the Theory of Stability*, Texts in Applied Mathematics 24, Springer, Berlin, 1997.
- [424] H. K. Moffatt, The fluid dynamics of James Clerk Maxwell, in: R. Flood, M. McCartney, and A. Whitaker, (eds.), *James Clerk Maxwell*, Oxford University Press, 2013 (in press).
- [425] H. K. Moffatt and Y. Shimomura, Spinning eggs – a paradox resolved, *Nature* **416** (2002), 385–386.
- [426] N. Moiseyev, *Non-Hermitian Quantum Mechanics*, Cambridge University Press, Cambridge, UK, 2011.
- [427] M. Montagnier, C. C. Paige and R. J. Spiteri, Real Floquet factors of linear time-periodic systems, *Systems and Control Letters* **50** (2003), 251–262.
- [428] J. Moro, J. V. Burke and M. L. Overton, On the Lidskii–Vishik–Lyusternik perturbation theory for eigenvalues of matrices with arbitrary Jordan structure, *SIAM J. Matrix Anal. Appl.* **18** (1997), 793–817.
- [429] P. J. Morrison, A paradigm for joined Hamiltonian and dissipative systems, *Physica D* **18** (1986), 410–419.

- [430] P. J. Morrison, Hamiltonian description of the ideal fluid, *Reviews of Modern Physics* **70** (1998), 467–521.
- [431] J. Moser, New aspects in the theory of stability of Hamiltonian systems, *Comm. Pure Appl. Math.* **11** (1958), 81–114.
- [432] J. E. Mottershead and S. N. Chan, Brake squeal – an analysis of symmetry and flutter instability, in: R. A. Ibrahim and A. Soom (eds.), *Proceedings of the Winter Annual Meeting of the ASME, Anaheim, CA, USA, Nov. 8-13, 1992, DE-vol. 49, Friction-Induced Vibration, Chatter, Squeal and Chaos*, pp. 87–97, ASME Publications, New York, 1992.
- [433] J. Mottershead, Vibration- and friction-induced instabilities in discs, *The Shock and Vibration Digest* **30** (1998), 14–31.
- [434] T. S. Motzkin and O. Taussky, Pairs of matrices with the property L , *Trans. Amer. Math. Soc.* **73** (1952), 108–114.
- [435] T. S. Motzkin and O. Taussky, Pairs of matrices with the property L . II, *Trans. Amer. Math. Soc.* **80** (1955), 387–401.
- [436] D. F. Moyer, Energy, dynamics, hidden machinery: Rankine, Thomson and Tait, Maxwell, *Studies in History and Philosophy of Science Part A* **8** (1977), 251–268.
- [437] P. C. Müller, *Stabilität und Matrizen*, Springer, Berlin, 1977.
- [438] I. Mutabazi and A. Bahloul, Stability analysis of a vertical curved channel flow with a radial temperature gradient, *Theoretical and Computational Fluid Dynamics* **16** (2002), 79–90.
- [439] U. Nackenhorst and M. Brinkmeier, On the dynamics of rotating and rolling structures, *Archive of Applied Mechanics* **78** (2008), 477–488.
- [440] W. Nagata and N. Namachchivaya, Bifurcations in gyroscopic systems with an application to rotating shafts, *Proc. R. Soc. Lond. A* **454** (1998), 543–585.
- [441] B. Naiman, Remarks on the perturbation of analytic matrix functions, *Int. Equ. Oper. Theor.* **9** (1986), 593–599.
- [442] M. Naimark, *Linear differential operators. Part I: Elementary theory of linear differential operators*. With additional material by the author, Frederick Ungar Publishing Co., 1967.
- [443] Y. I. Neimark, On the problem of the distribution of the roots of polynomials, *Doklady Akad. Nauk SSSR (N.S.)* **58** (1947), 357–360.
- [444] F. C. Nelson, A brief history of early rotor dynamics, *Sound and Vibration* **37** (2003), 8–11.
- [445] S. Neukirch, J. Frelat, A. Goriely and C. Maurini, Vibrations of post-buckled rods: The singular inextensible limit, *J. Sound Vibr.* **331** (2012), 704–720.
- [446] M. V. Nezlin, Negative-energy waves and the anomalous Doppler effect, *Soviet Physics Uspekhi* **19** (1976), 946.

- [447] E. L. Nicolai, On the stability of a circular ring and of a circular arch under uniformly distributed normal loading (in Russian), *Izv. Petrogradskogo Polit. Inst.* **27** (1918) 232–378.
- [448] E. L. Nicolai, On the stability of the rectilinear form of equilibrium of a bar in compression and torsion, *Izvestia Leningradskogo Politechnicheskogo Instituta* **31** (1928), 201–231.
- [449] E. L. Nicolai, On the problem of the stability of a bar in torsion, *Vestnik Mekhaniki i Prikladnoi Matematiki* **1** (1929), 41–58.
- [450] E. L. Nicolai, Über den Einfluss der Torsion auf die Stabilität rotierender Wellen, in: *Proc. of the 3rd Congr. Appl. Mech.*, pp. 103–104, Stockholm, 1930.
- [451] S. M. Nikolskii, *Memoirs (in Russian)*, Steklov Mathematical Institute, Moscow, 2003.
- [452] E. Nissim, Effect of linear damping on flutter speed. I. Binary systems, *Aeronautical Quarterly* **16** (1965), 159–178.
- [453] M. D. Nornberg, H. Ji, E. Schartman, A. Roach and J. Goodman, Observation of magnetocoriolis waves in a liquid metal Taylor–Couette experiment, *Phys. Rev. Lett.* **104** (2010), 074501.
- [454] M. North, Disc brake squeal, in: *Braking of Road Vehicles*, Automobile Division of the Institution of Mechanical Engineers, pp. 169–176, Mechanical Engineers Publications Limited, London, England, 1976.
- [455] G. I. Ogilvie, James Clerk Maxwell and the dynamics of astrophysical discs, *Phil. Trans. R. Soc. A* **366** (2008), 1707–1715.
- [456] K. Ono, J.-S. Chen and D. B. Bogy, Stability analysis for the head-disk interface in a flexible disk drive, *Trans. ASME J. Appl. Mech.* **58** (1991), 1005–1014.
- [457] L. Onsager, Reciprocal relations in irreversible processes. I., *Phys. Rev.* **37** (1931), 405–426.
- [458] A. C. Or, On the behaviour of a pair of complex eigenmodes near a crossing, *Quart. J. Mech. Appl. Math.* **44** (1991), 559–569.
- [459] O. M. O’Reilly, N. K. Malhotra and N. S. Namachchivaya, Reversible dynamical systems – dissipation-induced destabilization and follower forces, *Applied Mathematics and Computation* **70** (1995), 273–282.
- [460] O. M. O’Reilly, N. K. Malhotra and N. S. Namachchivaya, Some aspects of destabilization in reversible dynamical systems with application to follower forces, *Nonlinear Dynamics* **10** (1996), 63–87.
- [461] G. Ostermeyer and M. Müller, New insights into the tribology of brake systems, *IMEchE Journal of Automobile Engineering* **222** (2008), 1167–1200.
- [462] L. A. Ostrovskii, S. A. Rybak and L. S. Tsimring, Negative energy waves in hydrodynamics, *Sov. Phys. Uspekhi* **29** (1986), 1040–1052.
- [463] H. Ouyang, W. Nack, Y. Yuan and F. Chen, Numerical analysis of automotive disc brake squeal: A review, *Int. J. Veh. Noise and Vibr.* **1** (2005), 207–231.

- [464] N. Paldor and A. Sigalov, The mechanics of inertial motion on the Earth and on a rotating sphere, *Physica D* **160** (2001), 29–53.
- [465] Y. G. Panovko and I. I. Gubanov, *Stability and Oscillations of Elastic Systems*, Consultants Bureau, New York, 1965.
- [466] Y. G. Panovko and S. V. Sorokin, On quasi-stability of viscoelastic systems with the follower forces, *Izv. Acad. Nauk SSSR. Mekh. Tverd. Tela* **5** (1987), 135–139.
- [467] Y. P. Park and C. D. Mote, The maximum controlled follower force on a free-free beam carrying a concentrated mass, *J. Sound Vibr.* **98** (1985), 247–256.
- [468] P. C. Parks, A new look at the Routh–Hurwitz problem using Lyapunov’s second method, *Bull. de l’Acad. Polon. des Sciences, Ser. des Sciences Techniques* **12** (1964), 19–21.
- [469] P. C. Parks, A. M. Lyapunov’s stability theory – 100 years on, *IMA Journal of Mathematical Control and Information* **9** (1992), 275–303.
- [470] P. C. Parks and V. Hahn, *Stability Theory*, Prentice Hall International Series in Systems and Control Engineering, Prentice Hall, New York, 1993.
- [471] W. Paul, Electromagnetic traps for charged and neutral particles, *Rev. Mod. Phys.* **62** (1990), 531–542.
- [472] R. M. Pearce, Strong focusing in a magnetic helical quadrupole channel, *Nuclear Instruments and Methods* **83** (1970), 101–108.
- [473] P. Pedersen and A. P. Seyranian, Sensitivity analysis for problems of dynamic stability, *International Journal of Solids and Structures* **19** (1983), 315–335.
- [474] P. Pedersen, Influence of boundary conditions on the stability of a column under non-conservative load, *International Journal of Solids and Structures* **13** (1977), 445–455.
- [475] F. M. Penning, Die Glimmentladung bei niedrigem Druck zwischen koaxialen Zylindern in einem axialen Magnetfeld, *Physica* **3** (1936), 873–894.
- [476] N. Perkins and C. Mote, Comments on curve veering in eigenvalue problems, *J. Sound Vibr.* **106** (1986), 451–463.
- [477] M. Philipp, P. von Brentano, G. Pascovici and A. Richter, Frequency and width crossing of two interacting resonances in a microwave cavity, *Phys. Rev. E* **62** (2000), 1922–1926.
- [478] J. M. Piau, M. Bremond, J. M. Couette and M. Piau, Maurice Couette, one of the founders of rheology, *Rheol. Acta* **33** (1994), 357–368.
- [479] R. H. Plaut, Determining the nature of instability in nonconservative problems, *AIAA Journal* **10** (1972), 967–968.
- [480] R. Plaut, New destabilization phenomenon in nonconservative systems, *ZAMM Z. angew. Math. Mech.* **51** (1971), 319–321.
- [481] H. Poincare, Note sur la stabilite de l’anneau de Saturne, *Bulletin Astronomique Serie I*, **2** (1885), 507–508.

- [482] S. Ponti, J. A. Reyes and C. Oldano, Homogeneous models for bianisotropic crystals, *Journal of Physics: Condensed Matter* **14** (2002), 10173.
- [483] L. Pontryagin, Hermitian operators in a space with indefinite metric, *Izv. Akad. Nauk. SSSR Ser. Mat.* **8** (1944), 243–280.
- [484] C. G. Poulton, L. C. Botten, R. C. McPhedran, N. A. Nicorovici and A. B. Movchan, Noncommuting limits in electromagnetic scattering: Asymptotic analysis for an array of highly conducting inclusions, *SIAM J. Appl. Math.* **61** (2001), 1706–1730.
- [485] L. Prandtl, Beiträge zur Frage der kritischen Drehzahlen, *Dinglers Polytechnisches Journal* **20** (1918), 179–182.
- [486] J. Priede, I. Grants and G. Gerbeth, Inductionless magnetorotational instability in a Taylor–Couette flow with a helical magnetic field, *Phys. Rev. E* **75** (2007), 047303.
- [487] M. Proctor, The role of mean circulation in parity selection by planetary magnetic fields, *Geophys. Astrophys. Fluid Dynamics* **8** (1977), 311–324.
- [488] B. I. Rabinovich, *A discussion upon the talk of M. L. Pivovarov “Rotating motion of satellites with a weak self-excitation, a survey”*, http://www.iki.rssi.ru/seminar/200011/piv_ans.htm, 30 November 2000, in Russian.
- [489] K.-H. Rädler, Mean-field dynamo theory: Early ideas and today’s problems, in: S. Molokov, R. Moreau, K. Moffatt, and K.-H. Rädler (eds.), *Magnetohydrodynamics*, Fluid Mechanics and its Applications 80, pp. 55–72, Springer Netherlands, 2007.
- [490] A. Ralston, A symmetric formulation of the Hurwitz–Routh criterion, *Trans. I.R.E. on Automatic Control* **AC-7** (1962), 50–51.
- [491] W. J. M. Rankine, On the centrifugal force of rotating shafts, *The Engineer* **27** (1869), 249.
- [492] J. S. Rao, *History of Rotating Machinery Dynamics*, History of Mechanism and Machine Science 20, Springer, Berlin, 2011.
- [493] J. W. S. Rayleigh, *The Theory of Sound*, 1, Macmillan, London, 1877.
- [494] J. W. S. Rayleigh, On the dynamics of revolving fluids, *Proc. R. Soc. Lond. A* **93** (1917), 148–154.
- [495] F. Rellich, Störungstheorie der Spektralzerlegung, *Mathematische Annalen* **113** (1937), 600–619.
- [496] F. Rellich, *Perturbation Theory of Eigenvalue Problems*, Gordon and Breach, New York, 1968.
- [497] U. Ringertz, On the design of Beck’s column, *Structural Optimization* **8** (1994), 120–124.
- [498] C. W. Roberson, A. Mondelli and D. Chernin, High-current betatron with stellarator fields, *Phys. Rev. Lett.* **50** (1983), 507–510.
- [499] P. Y. Rocard, *Dynamic Instability: Automobiles, Aircraft, Suspension Bridges*, F. Ungar Publication, New York, NY, 1957.

- [500] A. Rohlmann, T. Zander, M. Rao and G. Bergmann, Applying a follower load delivers realistic results for simulating standing, *J. Biomech.* **42** (2009), 1520–1526.
- [501] R. Romea, Effects of friction and beta on finite-amplitude baroclinic waves, *Journal of the Atmospheric Sciences* **34** (1977), 1689–1695.
- [502] T. Rossing, Acoustics of the glass harmonica, *J. Acoust. Soc. Am.* **95** (1994), 1106–1111.
- [503] N. Rouche, P. Habets and M. Laloy, *Stability Theory by Liapunov's Direct Method*, Applied Mathematical Sciences 22, Springer-Verlag, New York Heidelberg Berlin, 1977.
- [504] E. J. Routh, Stability of a dynamical system with two independent motions, *Proc. Lond. Math. Soc.* **5** (1874), 97–99.
- [505] E. J. Routh, *Treatise on the Stability of a Given State of Motion, Particularly, Steady Motion*, MacMillan, London, 1877.
- [506] M. S. Ruderman, L. Brevdo and R. Erdelyi, Kelvin–Helmholtz absolute and convective instabilities of, and signalling in, an inviscid fluid-viscous fluid configuration, *Proc. R. Soc. Lond. A* **460** (2004), 847–874.
- [507] C. E. Ruter, K. G. Makris, R. El-Ganainy, D. N. Christodoulides, M. Segev and D. Kip, Observation of parity-time symmetry in optics, *Nature Physics* **6** (2010), 192–195.
- [508] A. K. Samantaray, R. Bhattacharyya and A. Mukherjee, On the stability of Crandall gyropendulum, *Phys. Lett. A* **372** (2008), 238–243.
- [509] G. R. Sarson and C. A. Jones, A convection driven geodynamo reversal model, *Phys. Earth Planet. Int.* **111** (1999), 3–20.
- [510] G. S. Schajer, The vibration of a rotating circular string subject to a fixed end restraint, *J. Sound Vibr.* **92** (1984), 11–19.
- [511] J. Schindler, A. Li, M. C. Zheng, F. M. Ellis and T. Kottos, Experimental study of active LRC circuits with PT-symmetries, *Phys. Rev. A* **84** (2011), 040101(R).
- [512] R. Sedney, A survey of the fluid dynamic aspects of liquid-filled projectiles, in: *AIAA, Atmospheric Flight Mechanics Conference, 12th, Snowmass, CO, Aug. 18-21, 1985.*, AIAA-85-1822-CP, pp. 1–19, 1985.
- [513] C. Semler, H. Alighanbari and M. Paidoussis, A physical explanation of the destabilizing effect of damping, *Trans. ASME J. Appl. Mech.* **65** (1998), 642–648.
- [514] M. B. Sevryuk, *Reversible Systems*, Lecture Notes in Mathematics 1211, Springer-Verlag, New York, 1986.
- [515] M. B. Sevryuk, Reversible linear systems and their versal deformations, *Journal of Mathematical Sciences* **60** (1992), 1663–1680.
- [516] A. P. Seyranian, Bifurcations in single-parameter circulatory systems, *Izv. RAN Mekhanika Tverdogo Tela* **29** (1994), 142–148.
- [517] A. P. Seyranian, O. N. Kirillov and A. A. Mailybaev, Coupling of eigenvalues of complex matrices at diabolic and exceptional points, *J. Phys. A: Math. Gen.* **38** (2005), 1723–1740.

- [518] A. P. Seyranian and A. A. Mailybaev, *Multiparameter Stability Theory with Mechanical Applications*, Series on Stability, Vibration and Control of Systems, Series A 13, World Scientific, Singapore, 2003.
- [519] A. P. Seyranian and A. A. Mailybaev, Paradox of Nicolai and related effects, *ZAMP Z. angew. Math. Phys.* **62** (2011), 539–548.
- [520] A. P. Seyranian and P. Pedersen, On two effects in fluid/structure interaction theory, in: *Flow-induced Vibration*, pp. 565–576, Balkema, Rotterdam, 1995.
- [521] A. P. Seyranian and O. N. Kirillov, Bifurcation diagrams and stability boundaries of circulatory systems, *Theoret. Appl. Mech.* **26** (2001), 135–138.
- [522] V. E. Shapiro, Rotating class of parametric resonance processes in coupled oscillators, *Phys. Lett. A* **290** (2001), 288–296.
- [523] M. Y. Shatalov, A. G. Every and A. S. Yenwong-Fai, Analysis of non-axisymmetric wave propagation in a homogeneous piezoelectric solid circular cylinder of transversely isotropic material, *International Journal of Solids and Structures* **46** (2009), 837–850.
- [524] R. C. Shieh and E. F. Masur, Some general principles of dynamic instability of solid bodies, *ZAMP Z. angew. Math. Phys.* **19** (1968), 927–941.
- [525] A. A. Shkalikov, Operator pencils arising in elasticity and hydrodynamics: The instability index formula, *Oper. Theory Adv. Appl.* **87** (1996), 358–385.
- [526] A. A. Shkalikov, Invariant subspaces of dissipative operators in Krein space and Sobolev problem on a rotating top, *Funct. Anal. Appl.* (2004), 273–286.
- [527] A. Shuvalov and N. Scott, On singular features of acoustic wave propagation in weakly dissipative anisotropic thermoviscoelasticity, *Acta Mechanica* **140** (2000), 1–15.
- [528] G. J. Simitses and D. H. Hodges, *Nonconservative Systems*, Fundamentals of Structural Stability, Butterworth-Heinemann, Burlington, 2006, pp. 297 – 328.
- [529] S. C. Sinha, E. A. Butcher and A. Dávid, Construction of dynamically equivalent time-invariant forms for time-periodic systems, *Nonlinear Dynamics* **16** (1998), 203–221.
- [530] J.-J. Sinou, F. Thouverez and L. Jezequel, Stability analysis and non-linear behaviour of structural systems using the complex non-linear modal analysis, *Comput. Struct.* **84** (2006), 1891–1905.
- [531] J.-J. Sinou and L. Jezequel, Mode coupling instability in friction-induced vibrations and its dependency on system parameters including damping, *European Journal of Mechanics - A/Solids* **26** (2007), 106 – 122.
- [532] D. R. Sisan, N. Mujica, W. A. Tillotson, Y.-M. Huang, W. Dorland, A. B. Hassam, T. M. Antonsen, and D. P. Lathrop, Experimental observation and characterization of the magnetorotational instability, *Phys. Rev. Lett.* **93** (2004), 114502.
- [533] D. Sjöberg, C. Enström, G. Kristensson, D. J. N. Wall and N. Wellander, A Floquet–Bloch decomposition of Maxwell’s equations applied to homogenization, *Multiscale Model. Simul.* **4** (2005), 149–171.

- [534] D. M. Smith, The motion of a rotor carried by a flexible shaft in flexible bearings, *Proc. R. Soc. Lond. A* **142** (1933), 92–118.
- [535] T. E. Smith and G. Herrmann, Stability of a beam on an elastic foundation subjected to a follower force, *Trans. ASME J. Appl. Mech.* **39** (1972), 628–629.
- [536] S. Sobolev, On motion of a symmetric top with a cavity filled with fluid, in: G. V. Demidenko and V. L. Vaskevich (eds.), *Selected Works of S. L. Sobolev*, pp. 333–382, Springer, 2006.
- [537] G. Spelsberg-Korspeter, D. Hochlenert and P. Hagedorn, Self-excitation mechanisms in paper calendars formulated as a stability problem, *Technische Mechanik* **31** (2011), 15–24.
- [538] G. Spelsberg-Korspeter, D. Hochlenert, O. N. Kirillov and P. Hagedorn, In- and out-of-plane vibrations of a rotating plate with frictional contact: Investigations on squeal phenomena, *Trans. ASME J. Appl. Mech.* **76** (2009), 041006.
- [539] G. Spelsberg-Korspeter, O. N. Kirillov and P. Hagedorn, Modeling and stability analysis of an axially moving beam with frictional contact, *Trans. ASME J. Appl. Mech.* **75** (2008), 031001.
- [540] R. J. Spiteri and M. Montagnier, The real story behind Floquet–Lyapunov theory, in: N. Masorakis (ed.), *Problems in Modern Applied Mathematics*, pp. 276–281, World Scientific and Engineering Society Press, 2000.
- [541] R. Spurr, The ringing of wine glasses, *Wear* **4** (1961), 150–153.
- [542] R. Spurr, A theory of brake squeal, *Proc. Inst. Mech. Eng.* **AD** (1961), 33–52.
- [543] M. Steenbeck, F. Krause and K.-H. Rädler, Berechnung der mittleren Lorentz-Feldstärke $\mathbf{v} \times \mathbf{b}$ für ein elektrisch leitendes Medium in turbulenter, durch Coriolis-Kräfte beeinflusster Bewegung, *Z. Naturforsch.* **21a** (1966), 369–376.
- [544] F. Stefani, S. Eckert, G. Gerbeth, A. Giesecke, T. Gundrum, C. Steglich, T. Weier and B. Wustmann, DRESDYN – A new facility for MHD experiments with liquid sodium, *Magnetohydrodynamics* **48** (2012), 103–113.
- [545] F. Stefani, A. Gailitis and G. Gerbeth, Magnetohydrodynamic experiments on cosmic magnetic fields, *ZAMM Z. angew. Math. Mech.* **88** (2008), 930–954.
- [546] F. Stefani, T. Gundrum, G. Gerbeth, G. Rüdiger, M. Schultz, J. Szklarski and R. Hollerbach, Experimental evidence for magnetorotational instability in a Taylor-Couette flow under the influence of a helical magnetic field, *Phys. Rev. Lett.* **97** (2006), 184502.
- [547] F. Stefani and G. Gerbeth, Asymmetric polarity reversals, bimodal field distribution, and coherence resonance in a spherically symmetric mean-field dynamo model, *Phys. Rev. Lett.* **94** (2005), 184506.
- [548] G. W. Stewart and J. G. Sun, *Matrix Perturbation Theory*, Computer Science and Scientific Computing, Academic Press, Boston, 1990.
- [549] K. Stewartson, On the stability of a spinning top containing liquid, *J. Fluid Mech.* **5** (1959), 577–592.

- [550] A. Struthers and G. Jayaraman, Elastic stability of columns on partial elastic foundations under subtangential loading, *J. Sound Vibr.* **329** (2010), 3856–3865.
- [551] P. A. Sturrock, Kinematics of growing waves, *Phys. Rev.* **112** (1958), 1488–1503.
- [552] P. A. Sturrock, In what sense do slow waves carry negative energy, *J. Appl. Phys.* **31** (1960), 2052–2056.
- [553] Y. Sugiyama, *Experimental Approach to Nonconservative Stability Problems*, Modern Problems of Structural Stability, pp. 341–394, Springer, Vienna, 2002.
- [554] Y. Sugiyama, K. Katayama and K. Kiriya, Experimental verification of dynamic stability of vertical cantilevered columns subjected to a sub-tangential force, *J. Sound Vibr.* **236** (2000), 193–207.
- [555] Y. Sugiyama, T. Katayama, T. Yosimura and H. Kawagoe, Stability of Reut’s columns having a damper, *Transactions of the Japan Society of Mechanical Engineers. C* **57(537)** (1991), 1575–1579.
- [556] Y. Sugiyama and M. A. Langthjem, Physical mechanism of the destabilizing effect of damping in continuous non-conservative dissipative systems, *International Journal of Non-Linear Mechanics* **42** (2007), 132–145.
- [557] Y. Sugiyama, M. Langthjem and B.-J. Ryu, Realistic follower forces, *J. Sound Vibr.* **225** (1999), 779–782.
- [558] Y. Sugiyama, M. Langthjem and B.-J. Ryu, Beck’s column as the ugly duckling, *J. Sound Vibr.* **254** (2002), 407–410.
- [559] Y. Sugiyama, M. A. Langthjem, T. Iwama, M. Kobayashi, K. Katayama and H. Yutani, Shape optimization of cantilevered columns subjected to a rocket-based follower force and its experimental verification, *Structural and Multidisciplinary Optimization* **46** (2012), 829–838.
- [560] J. Sun, Eigenvalues and eigenvectors of a matrix dependent on several parameters, *J. Comput. Math.* **3** (1985), 351–364.
- [561] J. Sun, Multiple eigenvalue sensitivity analysis, *Linear Algebra and Applications* **137/138** (1990), 183–211.
- [562] C. Sundararajan, Optimization of a nonconservative elastic system with stability constraint, *Journal of Optimization Theory and Applications* **16** (1975), 355–378.
- [563] G. E. Swaters, Modal interpretation for the Ekman destabilization of inviscidly stable baroclinic flow in the Phillips model, *J. Phys. Oceanogr.* **40** (2010), 830–839.
- [564] E. Tassi and P. J. Morrison, Mode signature and stability for a Hamiltonian model of electron temperature gradient turbulence, *Physics of Plasmas* **18** (2011), 032115.
- [565] H. Tasso, Linear and nonlinear stability in resistive magnetohydrodynamics, *Annals of Physics* **234** (1994), 211–224.
- [566] G. I. Taylor, Stability of a viscous liquid contained between two rotating cylinders, *Phil. Trans. R. Soc. Lond. A* **223** (1923), 289–343.
- [567] B. D. H. Tellegen, The gyrator, a new electric network element, *Philips Res. Rep.* **3** (1948), 81–101.

- [568] E. Teller, The crossing of potential surfaces, *J. Phys. Chem.* **41** (1937), 109–116.
- [569] M. Teytel, How rare are multiple eigenvalues? *Comm. Pure Appl. Math.* **52** (1999), 917–934.
- [570] J. M. T. Thompson, *Instabilities and Catastrophes in Science and Engineering*, Wiley, New York, 1982.
- [571] R. I. Thompson, T. J. Harmon and M. G. Ball, The rotating-saddle trap: A mechanical analogy to RF-electric-quadrupole ion trapping?, *Canadian Journal of Physics* **80** (2002), 1433–1448.
- [572] W. Thomson, On the precessional motion of a liquid, *Nature (London)* **15** (1877), 297–298.
- [573] W. Thomson and P. G. Tait, *Treatise on Natural Philosophy, vol. I, part I, New Edition*, Cambridge University Press, Cambridge, 1879.
- [574] J. Tian and S. Hutton, On the mechanisms of vibrational instability in a constrained rotating string, *J. Sound Vibr.* **225** (1999), 111–126.
- [575] V. N. Tkhai, On stability of mechanical systems under the action of position forces, *PMM J. Appl. Math. Mech.* **44** (1980), 24–29.
- [576] L. N. Trefethen and M. Embree, *Spectra and Pseudospectra: The Behavior of Nonnormal Matrices and Operators*, Princeton University Press, Princeton, NJ, 2005.
- [577] G. S. Triantafillou, Note on the Kelvin-Helmholtz instability of stratified fluids, *Phys. Fluids* **6** (1994), 164–171.
- [578] D. Tsiklauri, On the conical refraction of hydromagnetic waves in plasma with anisotropic thermal pressure, *Physics of Plasmas* **3** (1996), 800–803.
- [579] J. van der Meer, *Hamiltonian Hopf Bifurcation*, Lect. Notes Math. 1160, Springer-Verlag, Berlin, 1985.
- [580] C. F. van Loan, How near is a stable matrix to an unstable matrix? *Contemp. Math.* **47** (1985), 465–477.
- [581] E. P. Velikhov, Stability of an ideally conducting liquid flowing between cylinders rotating in a magnetic field, *Sov. Phys. JETP-USSR* **9** (1959), 995–998.
- [582] K. Veselic, On the stability of rotating systems, *ZAMM Z. angew. Math. Mech.* **75** (1995), 325–328.
- [583] S. Vidoli and F. Vestroni, Veering phenomena in systems with gyroscopic coupling, *Trans. ASME, J. Appl. Mech.* **72** (2005), 641–647.
- [584] M. Vishik and L. Lyusternik, Solution of some perturbation problems in the case of matrices and selfadjoint or non-selfadjoint equations, *Russian Math. Surveys* **15** (1960), 1–74.
- [585] H. Volkmer, *Multiparameter Eigenvalue Problems and Expansion Theorems*, Springer, Berlin, 2009.
- [586] T. von Karman, *Festigkeitsprobleme im Maschinenbau*, in: Encyklopaedie der Mathematischen Wissenschaften, IV:4, pp. 311–385, Teubner, Leipzig, 1910.

- [587] J. von Neumann and E. Wigner, Concerning the behaviour of eigenvalues in adiabatic processes, *Physikalische Zeitschrift* **30** (1929), 467–470.
- [588] U. von Wagner, D. Hochlenert and P. Hagedorn, Minimal models for disk brake squeal, *J. Sound Vibr.* **302** (2007), 527–539.
- [589] J. A. Walker, A note on stabilizing damping configurations for linear nonconservative systems, *International Journal of Solids and Structures* **9** (1973), 1543–1545.
- [590] J. A. Walker, *Dynamical Systems and Evolution Equations: Theory and Applications*, Mathematical Concepts and Methods in Science and Engineering 20, Plenum Press, New York, 1980.
- [591] J. Wallis, *Cono-cuneus, or, The shipwright's circular wedge that is, a body resembling in part a conus, in part a cuneus, geometrically considered*, in a letter to the honourable Sir Robert Moray, printed by John Playford for Richard Davis, London, 1684.
- [592] G. Wang and Y. Lin, A new extension of Leverrier's algorithm, *Linear Algebra and Applications* **180** (1993), 227–238.
- [593] A. Welters, On explicit recursive formulas in the spectral perturbation analysis of a Jordan block, *SIAM J. Matrix Anal. Appl.* **32** (2011), 1–22.
- [594] F. J. W. Whipple, The motion of a particle on the surface of a smooth rotating globe, *Phil. Mag., 6th series* **33** (1917), 457–471.
- [595] E. P. Wigner, Ueber die Operation der Zeitumkehr in der Quantenmechanik, *Nachrichten von der Gesellschaft der Wissenschaften zu Göttingen, Mathematisch-Physikalische Klasse* (1932), 546–559.
- [596] J. C. Willems and P. A. Fuhrmann, Stability theory for high order equations, *Linear Algebra and its Application* **167** (1992), 131–149.
- [597] J. Williamson, On the algebraic problem concerning the normal forms of linear dynamical systems, *American Journal of Mathematics* **58** (1936), 141–163.
- [598] J. Williamson, On the normal forms of linear canonical transformations in dynamics, *American Journal of Mathematics* **59** (1937), 599–617.
- [599] A. P. Willis and C. F. Barenghi, Magnetic instability in a sheared azimuthal flow, *Astronomy and Astrophysics* **388** (2002), 688–691.
- [600] H. Wimmer, Inertia theorems for matrices, controllability and linear vibrations, *Linear Algebra and its Applications* **8** (1974), 337–343.
- [601] Y. Xie, S.-S. Li, Y.-W. Lin, Z. Ren and C. T.-C. Nguyen, UHF micromechanical extensional wine-glass mode ring resonators, in: *Technical Digest, 2003 IEEE International Electron Devices Meeting, Washington, DC, Dec. 8–10*, pp. 953–956, IEEE, 2003.
- [602] Y. Xiong and S. G. Hutton, Vibration and stability analysis of a multi-guided rotating string, *J. Sound Vibr.* **169** (1994), 669–683.
- [603] V. A. Yakubovich and V. M. Starzinskii, *Linear Differential Equations with Periodic Coefficients*, vols. 1 and 2, Wiley, New York, 1975.
- [604] L. Yang and S. Hutton, Interactions between an idealized rotating string and stationary constraints, *J. Sound Vibr.* **185** (1995), 139–154.

- [605] E. A. Youssef, F. S. Chute and F. E. Vermeulen, A note on particle trajectories in a Helical Electrostatic Quadrupole, *Nuclear Instruments and Methods* **93** (1971), 181–186.
- [606] M. Y. Yurkin, The finite dimension property of small oscillations of a top with a cavity filled with an ideal fluid, *Functional Analysis and its Applications* **31** (1997), 40–51.
- [607] M. Y. Yurkin, On the stability of small oscillations of a spinning asymmetrical top with liquid inside, *Doklady Akademii Nauk* **362** (1998), 170–173.
- [608] E. E. Zajac, Kelvin–Tait–Chetaev theorem and extensions, *Journal of the Astronautical Sciences* **11** (1964), 46–49.
- [609] V. E. Zakharov, Stability of periodic waves of finite amplitude on the surface of a deep fluid, *Journal of Applied Mechanics and Technical Physics* **9** (1968), 190–194.
- [610] V. E. Zakharov and L. A. Ostrovsky, Modulation instability: The beginning, *Physica D-Nonlinear Phenomena* **238** (2009), 540–548.
- [611] A. Zettl, *Sturm–Liouville Theory*, Mathematical Surveys and Monographs 121, AMS, Providence, RI, 2005.
- [612] A. A. Zevin, A theory of linear non-conservative systems, *J. Appl. Math. Mech.* **52** (1988), 300–304.
- [613] A. A. Zevin, On the theory of linear gyroscopic systems, *J. Appl. Math. Mech.* **60** (1996), 227–232.
- [614] Z. Zhang, J. Neubauer and D. Berry, Physical mechanisms of phonation onset: A linear stability analysis of an aeroelastic continuum model of phonation, *J. Acoust. Soc. Am.* **122** (2007), 2279–2295.
- [615] N. I. Zhinzher, Effect of dissipative forces with incomplete dissipation on the stability of elastic systems, *Izv. Ross. Akad. Nauk. MTT* **1** (1994), 149–155.
- [616] J. Zhou, Classification and characteristics of Floquet factorisations in linear continuous-time periodic systems, *International Journal of Control* **81** (2008), 1682–1698.
- [617] V. F. Zhuravlev, Generalization of the Rayleigh theorem to gyroscopic systems, *PMM J. Appl. Math. Mech.* **40** (1976), 606–610.
- [618] V. F. Zhuravlev, Decomposition of nonlinear generalized forces into potential and circulatory components, *Doklady Physics* **52** (2007), 339–341.
- [619] V. F. Zhuravlev, Analysis of the structure of generalized forces in the Lagrange equations, *Mechanics of Solids* **43** (2008), 837–842.
- [620] V. F. Zhuravlev and D. M. Klimov, Theory of the shimmy phenomenon, *Mechanics of Solids* **45** (2010), 324–330.
- [621] H. Ziegler, Stabilitätsprobleme bei geraden Stäben und Wellen, *ZAMP Z. angew. Math. Phys.* **2** (1951), 265–289.
- [622] H. Ziegler, Die Stabilitätskriterien der Elastomechanik, *Archive of Applied Mechanics* **20** (1952), 49–56.

-
- [623] H. Ziegler, Linear elastic stability. A critical analysis of methods, First part, *ZAMP Z. angew. Math. Phys.* **4** (1953), 89–121.
- [624] H. Ziegler, Linear elastic stability. A critical analysis of methods, Second part, *ZAMP Z. angew. Math. Phys.* **4** (1953), 167–185.
- [625] H. Ziegler, An attempt to generalize Onsager's principle, and its significance for rheological problems, *ZAMP Z. angew. Math. Phys.* **9** (1958), 748–763.
- [626] H. Ziegler, *Principles of structural stability*, Blaisdell Publ. Co., Waltham, Massachusetts, Toronto, 1968.

Index

- absolute instability, 93, 313
- absorption-dominated crystal, 348
- accelerator physics, 13
- acoustic tensor, 342
- acoustics of friction, 126, 294
- adjoint boundary conditions, 204
- adjoint boundary eigenvalue problem, 204
- adjoint differential expression, 203
- aircraft flutter, 233
- Alfvén frequency, 369
- algebraic multiplicity, 4, 47, 73
- anti-unitary symmetry, 95
- Arnold, V. I., viii, 233
- associated element, 73
- associated vector, 77
- asymptotic stability, 22, 39, 240
- attractive equilibrium, 39
- automotive brake squeal, 126
- autonomous dynamical system, 39, 304
- avoided crossing, 13, 80, 215, 278

- backward wave, 90
- Balbus, S. A., 364
- Barnett, S., 147
- baroclinic instability, 233
- Beck's column, 202, 234
- Beletsky, V. V., 146
- Benjamin-Feir instability, 19
- Berry phase, 16, 356
- Berry, M. V., 356
- Bespalov-Talanov instability, 19
- betatron, 267
- bifurcation diagram, 99
- Bilharz criterion, 61, 382
- Bilharz, H., 61
- bilinear form, 72
- Binding, P., 266
- binormal, 346

- biradial, 346
- Bloch function, 53
- Bloch wave, 53
- Bolotin, V. V., vii, 233
- Bottema, O., viii, 28, 62, 233
- Bottema-Lakhadanov-Karapetyan theorem, 166, 197, 300
- boundary conditions, 203
- boundary form, 202
- Braginsky, S. I., 364
- branch cut, 314, 354, 361
- Brillouin zone, 53
- Brouwer, L. E. J., 1, 10
- Brouwer's particle in a rotating vessel, 1, 52
- Bryan, G. H., 11
- Bryan's effect, 11
- bubble of instability, 13, 80, 133, 135, 215, 278, 296
- Bulatovic, R. M., 125, 150
- Bulatovic's flutter condition, 125, 166

- calender barring, 98, 294
- Campbell, W., 13
- Campbell diagram, 13, 200, 295
- canonical equation, 75
- Chandrasekhar, S., viii
- characteristic equation, 3
- characteristic exponent, 44
- Chetaev, N. G., 42, 163
- Chetaev instability theorem, 42
- Chetaev-Malkin-Massera criterion, 46
- chirality, 17, 53, 267
- chirality-dominated crystal, 348
- circular polarization, 10
- circulatory forces, 25, 97, 146, 172, 267, 295
- circulatory system, 27, 97, 146, 234
- codimension, 63, 72, 337

- coefficient of irregularity, 45
 combination parametric resonance, 215, 310
 combination parametric resonance of difference type, 305
 combination parametric resonance of summation type, 216
 comfortable walking, 115
 companion matrix, 58
 complete spectrum of a linear system, 45
 condition number of an eigenvalue, 208
 conical wedge of Wallis, 329, 340
 conservation law, 92
 conservative forces, 97
 convective instability, 93, 313
 Coriolis force, 11
 Coriolis vibratory gyroscope, 10
 Couette, M., 364
 Couette–Taylor flow, 333, 364
 coupled parametric oscillators, 51
 Crandall, S. H., 171
 Crandall’s gyropendulum, 171
 critical load functional, 142
 critical rotor speed, 296
 crossing of eigencurves, 132
 curl force, 267
 cuspidal edge, 118
 cuspidal point, 6, 112, 248
 CVG, 10
- damping forces, 146, 172
 De Laval, K., 12
 decrescent function, 40
 defect (of an eigenvalue), 6
 defective eigenvalue, 6
 definite Krein signature, 14, 77, 274
 Demidovich, B. P., 44
 deviation, 37
 deviator, 97
 diabolical point, 1, 21, 202, 216, 311, 333
 differential expression, 202
 discriminant, 151, 386
 discriminant matrix, 164
 discriminant sequence, 164
 dispersion, 53
 dispersion curve, 53, 92
 dispersion relation, 36, 53, 92, 377
- dissipation-induced instabilities, 24, 97
 divergence, 5, 78, 98, 148
 domain of attraction of an equilibrium, 39
 double-coffee-filter, 315, 340, 349
 double refraction, 330
 DRESDYN experiment, 68
 drop in the critical flutter frequency, 244
 drop in the critical flutter load, 246
 dynamic materials, 312
- eigencurve, 53, 83, 128, 133, 200, 215, 295, 331
 eigenelement, 201
 eigensurface, 331
 eigenvalue, 3, 73
 eigenvalue assignment, 309
 eigenvalue problem, 3
 eigenvector, 3
 elastoplastic continuum, 342
 energy band, 53
 energy density, 92
 energy flux, 92
 EP-set, 64, 332, 358
 equilibrium, 2, 38
 Erugin, N. P., 49
 Erugin theorem, 49
 Evans–Krein function, 83
 exceptional point, 1, 28, 31, 136, 202, 216, 283, 312, 331, 334, 357
 exceptional ring, 342
 extended Beck’s problem, 223
 external conical refraction, 347
 external damping, 25
- Föppl, A., 10
 fast precession, 176
 first Lyapunov instability theorem, 42
 Floquet, G., 50
 Floquet exponent, 50
 Floquet factor, 50
 Floquet multiplier, 50
 Floquet representation theorem, 50
 fluid–structure interaction, 233
 flutter, 6, 78, 98
 flutter condition, 208
 flutter domain, 80, 216
 flutter ill-posedness, 342

- follower force, 25, 97, 128, 139
 follower torque, 128
 forward wave, 90
 Foucault pendulum, 12, 15
 fractional derivative, 237
 Franklin, B., 294
 Freitas, P., 152, 155
 Fresnel's equation of wave normals, 345
 Fresnel's wave surface, 346
 friction-induced instabilities, 126
 Frobenius matrix, 58
 full observability, 58, 149
 fundamental matrix, 43
 fundamental symmetry, 72

 Galilei, G., 294
 Gallina criterion, 139, 165
 Gamow state, 357
 general nonconservative system, 146, 171
 generalized coordinates, 76
 generalized eigenvector, 6
 generalized momenta, 76
 generator of a ruled surface, 63, 329
 generic singularity, 63
 geometric multiplicity, 6, 47, 332
 geometric phase, 16, 357, 359
 geometrical optics expansions, 373
 glass harmonica, 294
 Gram matrix, 78
 granular flow, 342
 Greenhill, A. G., 29, 67, 128
 gyrator, 30
 gyroscopic force, 17, 87, 146
 gyroscopic pendulum, 171
 gyroscopic stabilization, 5, 26, 67, 161
 gyroscopic system, 14, 88, 146

 Hagedorn, P., 161
 Hahn, W., 38
 Hamilton's conical refraction, 330
 Hamiltonian, 76
 Hamiltonian equation, 75
 Hamiltonian system, 14
 Hamiltonian–Hopf bifurcation, 6, 78, 96
 Hannay's angle, 16
 heavily damped system, 150, 275, 296
 helical MRI, 370

 hereditary damping, 237
 Hermite, Ch., 60
 Hermite's criterion for asymptotic stability, 60
 Hermite's matrix, 59
 Herrmann-Smith paradox, 217
 homogenization, 53
 Hurwitz determinants, 57
 Hurwitz matrix, 57
 Hurwitz polynomial, 60
 Huseyin, K., 161

 imperfect merging of modes, 31, 173, 242, 352
 indefinite damping, 21, 31, 152, 154, 181, 294
 indefinite metric, 70, 72
 inertia forces, 146
 inertia of a matrix, 57
 inertial circle, 53
 inertial oscillations, 7
 inertial wave, 7, 371, 380
 infinitesimally symplectic matrix, 14
 instability, 38
 instability degree, 82
 internal conical refraction, 331, 346
 internal damping, 25
 Ioshizawa, T., 39
 Ioshizawa Theorem, 39
 isoperimetric constraint, 140

J-selfadjoint operator, 73
 Jacobian matrix, 43
 Jeffcott, H., 10
 Jeffcott rotor, 10, 26
 Jellett's egg, 67
 Jordan block, 47
 Jordan canonical form, 47
 Jordan chain, 6, 73

 Kármán, Th. von, 10
 Kalman, R. E., 59
 Kapitsa, P. L., 126
 Keldysh, M. V., viii
 Keldysh chain, 6, 207
 Kelvin, W., 1, 36, 67, 163
 Kelvin–Tait–Chetaev theorem, 26, 91, 163

- Kelvin–Voigt damping, 234
 Kharitonov, V. L., 62
 Kharitonov theorem, 61, 62
 ‘kidneys’, 355
 Kimball, A. L., 25
 kinematic dynamo, 266
 kinetic energy, 88, 96
 Kozlov, V. V., 82
 Krein collision, 6, 78, 201
 Krein signature, 14, 76, 311
 Krein space, 73, 271
 Krein, M. G., viii, 73, 76
 Krein–Gelfand–Lidskii theorem, 87
- Lagrange formula, 203
 Lagrange’s stability theorem, 148
 Lagrangian, 96
 Lagrangian system, 96
 Lamb, H., 26
 Lancaster, P., 150
 Lavrent’ev, M. A., 68
 Levantovskii, L. V., 110
 Leverrier, U., 36, 55
 Leverrier–Barnett algorithm, 147, 177
 Leverrier–Faddeev algorithm, 55
 Lewin, M., 56
 Lewin’s formula, 56
 Lidskii, V. B., ix
 Liénard–Chipart criterion, 61, 377
 lineal, 72
 linear stability, 3, 82
 linearization, 43
 Lippmann, G., 364
 LRC circuit, 156
 Lyapunov, A. M., 37
 Lyapunov functions, 40
 Lyapunov inequality, 44
 Lyapunov matrix, 49
 Lyapunov reducibility theorem, 50
 Lyapunov regularity, 45
 Lyapunov stability, 38, 82
 Lyapunov theorem on stability, 41
 Lyapunov theorem on uniform asymptotic stability, 41
 Lyapunov transformation, 49
 Lyusternik, L. A., ix
- MacKay, R. S., 67
 MacKay’s eigenvalue cone, 13, 80, 310
 MacKay’s formula, 189
 Maddocks, J. H., 76
 magnetic Prandtl number, 367
 magneto-Coriolis wave, 371, 380
 magnetohydrodynamics, 266
 Malkin, I. G., 39
 marginal stability, 3
 matrix Lyapunov equation, 54
 matrix polynomial, 3
 Maxwell, J. C., 36
 Merkin’s theorem, 29, 126, 165
 Merkin, D. R., 165, 166
 metamorphoses of the eigencurves, 134
 MHD, 266
 MHD dynamo, 68, 266
 microwave cavity, 360
 mixed Krein signature, 14, 77, 274
 modulational instability, 19, 233
 monochromatic wave, 19, 344
 monodromy matrix, 50
 motion, 37
 Motzkin–Tausky theorem, 84
 Müller, P. C., 56, 59
 Müller’s formula, 56, 59
 multiparameter eigenvalue problem, 53, 83, 91
 multiplicity of the characteristic exponent, 44
- near-Hamiltonian system, 188
 negative definite function, 40
 negative energy mode, 27, 89, 175, 367
 negative Krein signature, 76
 negative semidefinite function, 40
 Newton–Puiseux series, 208
 Nicolai, E. L., 29, 128
 Nicolai’s paradox, 29, 128
 NLS, 19
 NLS, dissipatively perturbed, 20
 nonautonomous dynamical system, 39
 noncommuting limits, 378
 nonconservative forces, 25, 146
 nonconservative positional forces, 97, 125, 295
 nonderogatory eigenvalue, 66, 207

- nonderogatory matrix, 66
 nonequilibrium thermodynamics, 97
 nonholonomic systems, 98
 nonlinear Schrödinger equation, 19
 nonoscillatory instability, 201
 nonselfadjoint boundary eigenvalue problem, 200, 204, 234
 nonsemisimple 1 : 1 resonance, 6, 27, 78
 nonsmooth and nonconvex optimization, 64
 normal fundamental matrix, 44

 observability index, 58
 observability matrix, 58
 Onsager, L., 97
 optic axis, 331, 345
 orthogonal projector, 72
 oscillatory damped system, 146, 155
 oscillatory instability, 98, 201
 Ostrowski, A., 57
 Ostrowski–Schneider inertia theorem, 58
 overdamped system, 150
 overlapping of eigencurves, 132

 paradox of inductionless HMRI, 371
 parametric resonance, 19
 parity, 30
 Parks, P. C., 59
 partially follower force, 223
 passing, 7, 78
 Paul trap, 18
 Pedersen, P., 200
 periodic dynamical system, 39
 Perron, O., 45
 Perron’s regularity test, 45
 Persidskii, K. P., 38
 Persidskii theorem on uniform stability, 41
 phase velocity, 344
 Plücker, J., 32, 331
 Plücker conoid, 32, 198, 379
 Poincaré instability degree, 88, 148
 point spectrum, 74
 Pontryagin, L. S., viii, 74
 Pontryagin space, 73
 Pontryagin’s theorem, 74
 positional forces, 146
 positive definite function, 40
 positive energy mode, 89, 175, 367
 positive Krein signature, 76
 positive semidefinite function, 40
 potential energy, 88, 96
 potential forces, 97, 146
 potential forces of hyperbolic type, 97, 125
 potential forces of spherical type, 97, 125
 potential system, 146
 Prandtl, L., 10
 principal parametric resonance, 215, 310
 principle of exchange of stabilities, 201, 268
 PROMISE experiment, 370
 pseudo-gyroscopic force, 97
 \mathcal{PT} -symmetry, 21, 31, 156

 quadratic form, 72
 quasilinear system, 43

 Rabinovich, B. I., 67
 Rankine, W. J. M., 10
 Rayleigh quotient, 184
 Rayleigh’s criterion, 365
 Rayleigh’s theorem, 81, 148, 161
 reducible system, 49
 reflected wave, 91
 regular perturbation, 205, 237
 resolvent set, 73
 resonance tongue, 216
 Reut’s column, 227
 reversible 1 : 1 resonance, 96
 reversible Hopf bifurcation, 27, 96
 reversible system, 95
 rhodonea curve, 15
 rigidity of a potential system, 148
 Robin boundary conditions, 268
 robust Hurwitz stability, 61
 root element, 73
 root lineal, 73
 root subspace, 74
 Rossby, K.-G. A., 369
 Rossby number, 11, 369
 rotating damping, 25, 171
 rotating saddle trap, 6
 Routh, E. J., 36

- Routh–Hurwitz criterion, 22, 60
ruled surface, 62, 182, 329
- Saffman, P. G., 67
Schneider, H., 57
second Lyapunov instability theorem, 42
secular term, 6
selfadjoint boundary eigenvalue problem, 204
selfadjoint operator, 72
semisimple 1 : 1 resonance, 333
semisimple eigenvalue, 7, 49, 78
sensitivity analysis, 200, 201
Seyranian, A. P., 110
shimmy, 98
shipwright’s circular wedge, 329
Shkalikov, A. A., 72
simple eigenvalue, 5
singular axis, 348, 354
slow precession, 176
slowness surface, 346
slowness vector, 346
Smith, D. M., 12, 25
Smith’s rotor, 25, 52
Sobolev, S. L., viii, 68
Sobolev’s top, 68
soliton, 19
spectral abscissa, 63, 64, 151
spectral mesh, 200, 214, 273, 295
spectral parameter, 3, 332
spectral stability, 3, 165
spectrum, 73
splitting, 7, 78
Spurr, R. T., 294
stability by linearization, 43
stability degree, 82
stability diagram, 100
standard MRI, 370
Starzhinskii, V. M., 81
state transition matrix, 44
static instability, 5, 98
stationary damping, 25, 171
steady-state bifurcation, 78, 96, 148
Stokes, G. G., 36
strong stability, 86
structural instability, 64, 233
subcritical rotor speed, 296
supercritical instability, 25
supercritical rotor speed, 296
swallowtail, 124, 154
Sylvester criterion, 60
symplectic matrix, 75
symplectic signature, 14, 311
- Tait, P. G., 163
tangent cone, 65, 110, 158, 169, 240
Tellegen, B. D. H., 30, 345
Thomson, W., 1, 36
time reversal, 27, 30, 95, 356
tippe-top, 185
topological phase, 357, 359, 361
transfer of instability between modes, 182, 243
transport equations, 375
transversal intersection, 112
trapping, 5
trihedral spike, 122, 153
- uniform asymptotic stability, 39
uniform stability, 38
uniformly attractive equilibrium, 39
unperturbed motion, 37
- veering of eigencurves, 13, 80, 132, 133, 278
- Velikhov, E. P., viii, 364
Velikhov–Chandrasekhar paradox, 367
velocity-dependent forces, 146, 242
versal deformation, 121
Veselic, K., 162
viaduct, 315, 340, 349
Vishik, M. I., ix
Volkmer, H., 266
- Walker, J. A., 168
walking robot, 114
Wallis, J., 329
wave inertia effect, 11
whirling, 10
Whitney umbrella, 23, 28, 63, 154, 169, 174, 182, 233, 353
Williamson’s normal form, 89
Wimmer, H. K., 58, 149
Wimmer’s theorem, 58
Winkler elastic foundation, 217

-
- Yakubovich, V. A., 81
- Zajac, E. E., 163
- Zevin, A. A., 82
- Zhuravlev, V. F., 161
- Ziegler, H., viii, 97, 128, 233
- Ziegler's paradox, 28, 168
- Ziegler's pendulum, 97, 139
- Ziegler's pendulum with a dash-pot, 259
- Ziegler's principle of maximum entropy production, 97
- Ziegler–Bottema destabilization paradox, 28, 97, 168, 188, 233, 262