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### **RESEARCH EXPERIENCE**

<b>2003–current</b>	<b>Shtern Research and Consulting</b> , President
<b>2008-2010</b>	<b>General Vortex Energy Inc.</b> Senior Scientist
<b>1990-2003</b>	<b>University of Houston</b> , USA, Associate Research Professor
<b>1997 VII-VIII</b>	<b>University of Bristol</b> , England, Visiting Professor
<b>1994-IX 95</b>	<b>DLR Institute of Fluid Mechanics</b> , Germany, Visiting Professor
<b>1993 - 1994</b>	<b>University of Seville</b> , Spain, Visiting Professor
<b>1965 - 1990</b>	<b>Institute of Thermophysics</b> , Russia, Senior Scientist

### **CONSULTING EXPERIENCE**

<b>2013-current</b>	<b>University of Gent</b> , Belgium, Development of vortex chemical reactor
<b>2003-2004</b>	<b>Vicont, Inc.</b> , Modeling vortex tubes and flow meters
<b>2002-2003</b>	<b>Shell US Exp</b> , Modeling the swirl effect on sand deposit in wells
<b>1998-2001</b>	<b>BP-Amoco Exploration</b> , Modeling of oil production arrangement
<b>2016-current</b>	<b>SABIC Americas Inc.</b> Combustion and mixing improvements

### **EDUCATION**

<b>1990</b>	<b>Full Professor</b> , Russian Academy of Science (RAS)
<b>1978</b>	<b>Doctor of Phys.-Math. Sci.</b> , RAS
<b>1970</b>	<b>Ph. D.</b> , Institute of Thermophysics, Novosibirsk, Russia
<b>1963</b>	<b>M. S. Degree</b> , Novosibirsk University, Russia

**PUBLICATIONS**      3 books, 102 papers, 40 conference reports, 4 patents and applications

### **FIELD OF RESEARCH**

<b>Fluid Mechanics:</b>	Jets, swirling flows, stability, turbulence, magnetic jets
<b>Thermal physics:</b>	Heat transfer, combustion, thermal convection.

## **SUMMARY OF RESEARCH ACTIVITY**

Heat transfer and combustion in swirl-free and swirling jets was modeled. The development of temperature fronts was predicted and explained. New solutions were obtained which describe multi-cell flows and flame fronts in burners. Multiple flow states and jump transitions among them occurring, e.g. in vortex tube, aircraft vortices, and tornadoes, were explained and calculated. New mechanism of instability in diverging flows was revealed. Strong jet generation in geo- and astrophysics due to convergent motion was predicted and calculated. The mechanism of centrifugal convection was revealed. Efficient means of swirling flow control were developed and experimentally verified. New exact solutions of the Navier-Stokes, Boussinesq and MHD equations were obtained.

## **PRINCIPAL PUBLICATIONS**

### **Books**

1. Goldshtik, M.A. & Shtern, V.N. *Hydrodynamic stability and turbulence*, Novosibirsk: Nauka, 1977, 366 p. (in Russian)
2. Goldshtik, M.A., Shtern, V.N. & Yavorsky, N.I. *Viscous flows with paradoxical features*, Novosibirsk: Nauka, 1989, 336 p. (in Russian)
3. Shtern, V. *Counterflows*, New York: Cambridge University Press, 2012, 488 p.
4. Shtern, V. *Cellular Flows*, New York: Cambridge University Press, 2018, 573 p.

### Papers in refereed journals

1. Shtern V.N. Stability of plane Couette flow. *Appl. Mech. & Techn. Phys.*, 1969, **10** (5), 793-796.
2. Shtern V. N. Spectrum of small perturbations in plane Couette flow. *Appl. Mech. & Techn. Phys.*, 1970, **11** (1), 793-796.
3. Goldshtik, M.A., Sapozhnikov, V.A. & Shtern V. N. Verification of the Malkus hypothesis regarding the stability of turbulent flows. *Fluid Dyn.*, 1970, **5** (5), 863-867.
4. Goldshtik, M.A. & Shtern, V.N. Determination of the law of turbulent friction in the flow core on the basis of the principle of maximum stability. *Sov. Phys. Dokl.*, 1970, **14** (10), 955-957.
5. Goldshtik, M.A., Sapozhnikov, V.A. & Shtern V. N. Determination of the velocity profile in a viscous sublayer using the principle of maximum stability. *Sov. Phys. Dokl.*, 1970, **15** (8), 721-723.
6. Goldshtik, M.A., Sapozhnikov, V.A. & Shtern V. N. Locality properties of the problem of hydrodynamic stability. *J. Appl. Mech. & Techn. Phys.*, 1970, **11** (2), 246-251.
7. Sagalakov, A.M. & Shtern V.N. Stability of plane-parallel MHD flows in a transverse magnetic field. *J. Appl. Mech. & Techn. Phys.*, 1970, **11** (3), 474-478.
8. Sagalakov, A.M. & Shtern V.N. Energy analysis of the stability of MHD flows. *Fluid Dyn.*, 1970, **6** (4), 553-558.
9. Sagalakov, A.M. & Shtern V.N. Energy analysis of the stability of plane-parallel flows with an inflection in the velocity profile. *J. Appl. Mech. & Techn. Phys.*, 1971, **12** (6), 859-864.
10. Goldshtik, M.A., Sapozhnikov, V.A. & Shtern V. N. Local properties of the velocity distribution and hydrodynamic stability. *Fluid Mech. Sov. Res.* 1973, **2** (5).
11. Shtern, V.N. & Vil'gelmi, T.A. Stability of spiral flow in an annulus. *Fluid Dyn.*, 1974, **9** (3), 360-367.
12. Likhachov O.A. & Shtern V.N. Self-oscillation flow in the boundary layer. *Appl. Mech. & Techn. Phys.*, 1975, **16** (4), 564-569.
13. Likhachov O.A. & Shtern V.N. Stability of MHD flows in a channel with inclined external field. *Fluid Dyn.*, 1975, **10** (2), 189-192.
14. Likhachov O.A. & Shtern V.N. Auto-oscillating MHD flow in a channel with a longitudinal magnetic field. *Magnetohydrodynamics*, 1975, **11** (3), 279-283.
15. Shtern, V.N. Instability due to three-dimensional disturbances. *Fluid Dyn.*, 1976, **11** (5), 678-682.
16. Goldshtik, M.A. & Shtern, V.N. Approximate theory of wall turbulence. *Sov. Phys. Dokl.*, 1976, **21** (3), 135-137.
17. Goldshtik, M.A. & Shtern, V.N. The single-harmonic theory of a wall turbulence. *Fluid Mech. Sov. Res.* 1978, **7** (1), 132-142.
18. Goldshtik, M.A. & Shtern, V.N. The functional smoothing method in turbulent problems. *Sov. Phys. Dokl.*, 1978, **23** (6), 390-392.
19. Lifshitz, A.M. & Shtern, V.N. Evolution of resonant disturbances in Hartmann flow. *Fluid Dyn.*, 1978, **13** (5), 664-669.
20. Lifshitz, A.M. & Shtern, V.N. Monoharmonical analysis of the nonlinear stability of Hartmann flow. *Magnetohydrodynamics*, 1979, **15**(3), 243-248.
21. Kachan, M.A. & Shtern, V.N. Explosive welding and Stefan problem. *Combustion, Explosion, and Shock Waves*, 1980, **15** (2), 214-220.
22. Goldshtik, M.A. & Shtern, V.N. Theory of the structural turbulence. *Sov. Phys. Dokl.*, 1981, **26** (4), 132-142.
23. Goldshtik, M.A., Shtern, V.N. & Zametalin, V.V. Simplified theory of the near-wall turbulent layer of Newtonian and drag-reducing fluids. *J. Fluid Mech.*, 1982, **119**, 423-441.
24. Shtern, V.N. On the dimension of attractors of turbulent motion. *Sov. Phys. Dokl.*, 1983, **28** (5), 384-386.
25. Goldshtik, M.A., Lifshitz, A.M. & Shtern, V.N. Transition Reynolds number for two-dimensional channel flow. *Sov. Phys. Dokl.*, 1983, **28** (11), 923-925.
26. Shtern, V.N. Attractor dimension for generalized Baker's transformation. *Phys. Lett.*, 1983, **99 A**, 268-270.
27. Goldshtik, M.A. Shtern, V.N. & Zhdanova E.M. Onset of self-rotation in a submerged jet.

- Sov. Phys. Dokl.*, 1984, **29** (8), 615-617.
28. Shtern, V.N. & Shumova, L. V. Metamorphoses of preturbulence. *Phys. Lett.*, 1984, **103 A**, 167-170.
  29. Shtern, V.N. & Shumova, L. V. Preturbulence in a finite-dimensional convection model. *Fluid Dyn.*, 1985, **20** (4), 518-525.
  30. Goldshtik, M.A. Shtern, V.N. & Zhdanova E.M. Occurrence of rotational motion resulting from hydrodynamic instability. *Fluid Dyn.*, 1985, **20** (5), 707-714.
  31. Levin, V.B. & Shtern, V.N. Stability of MHD jet flow between nonconducting planes in transverse field. *Magnetohydrodynamics*, 1985, **21** (2), 121-126.
  32. Shtern, V.N. & Zinov'ev, A.M. Secondary self-excited oscillations in Hartmann Channel and boundary-layer flows. *Magnetohydrodynamics*, 1987, **23** (1), 24-30.
  33. Sergeev, K.A. & Shtern, V.N. Stability of azimuthal jet of a conducting fluid in an axial magnetic field. *Magnetohydrodynamics*, 1987, **23** (3), 263-270.
  34. Goldshtik, M.A. & Shtern, V.N. Conical flows of fluid with variable viscosity. *Proc. Roy. Soc. London*, 1988, **419 A**, 91-106.
  35. Goldshtik, M.A. & Shtern, V.N. Self-similar convection near a heat quadrupole. *Eng. Phys.*, 1988, **55** (6) 1349-1354.
  36. Goldshtik, M.A. & Shtern, V.N. Interaction of linear and conical viscous fluid sources with a plane. *Fluid Dyn.*, 1988, **23** (5), 653-659.
  37. Goldshtik, M.A. & Shtern, V.N. On the mechanism of astrophysical jets. *Sov. Phys. Dokl.*, 1989, **34** (2), 93-95.
  38. Goldshtik, M.A. & Shtern, V.N. Paradox analysis of interaction between a vortex filament and a plane. *J. Appl. Math. and Mech.*, 1989, **53** (3).
  39. Goldshtik, M.A. & Shtern, V.N. Generation of poloidal magnetic fields in jet flows. *J.E.T.P. Letters*, 1989, **49** (5), No 10.
  40. Goldshtik, M.A. & Shtern, V.N. Self-similar hydromagnetic dynamo. *J.E. T. P.*, 1989, **69**(5), 975-984.
  41. Goldshtik, M.A. & Shtern, V.N. Turbulent vortex dynamo. *Appl. Math. and Mech.*, 1989, **53** (4).
  42. Goldshtik, M.A. & Shtern, V.N. Loss of symmetry in viscous flows from a linear source. *Fluid Dyn.*, 1989, **24** (2), 191-199.
  43. Lifshitz, A.M., Rakhmatullaev, R.D. & Shtern, V.N. Threshold of development of three-dimensional structures in Blasius flow. *Fluid Dyn.*, 1989, **24** (4), 515-520.
  44. Goldshtik, M.A. & Shtern, V.N. Collapse in conical viscous flows. *J.Fluid Mech.*, 1990, **218**, 483-508.
  45. Goldshtik, M.A. & Shtern, V.N. Free convection near a thermal quadrupole. *Int. J. Heat Mass Transfer*, 1990, **33**, 1475-1484.
  46. Goldshtik, M.A. & Shtern, V.N. A model of creating and destroying a tornado. *Izv. AN SSR Phys. Atm. and Ocean*, 1990, **26** (1), 15-20.
  47. Goldshtik, M.A. & Shtern, V.N. Bifurcation in near-star convection. *Eur. J. Mech. B/Fluids*, 1991, **10**(2), 49-54.
  48. Petrunin, A.A. & Shtern, V.N. Bifurcation of the poloidal field and rotation in conical electrovortical flows. *Magnetohydrodynamics*, 1991, **27** (1), 63-68.
  49. Goldshtik, M.A., Hussain, F. & Shtern, V.N. Symmetry breaking in vortex-source and Jeffery-Hamel flows. *J. Fluid Mech.*, 1991, **218**, 483-508.
  50. Goldshtik, M.A. & Shtern, V.N. The solution for  $k > k_{C2}$ . *J. Fluid Mech.*, 1992, **244**, 643-644.
  51. Petrunin, A.A. & Shtern, V.N. Bifurcation of the poloidal field in a flow induced by radial electrical discharge. *Fluid Dyn.*, 1993, **28** (2), 4-11.
  52. Shtern, V. & Hussain, F. Hysteresis in a swirling jet as a model tornado. *Phys. Fluids A*, 1993, **5** (9), 2183-2195.
  53. Shtern, V. & Hussain, F. Azimuthal instability of divergent flows. *J. Fluid Mech.*, 1993, **256**, 535-560.
  54. Shtern, V., Goldshtik, M. & Hussain, F. Generation of swirl due to symmetry breaking. *Phys. Rev. E*, 1994, **49** (4), 2881-2886.
  55. Sozou C., Wilkinson, L. C. & Shtern, V. N. On conical swirling flows in an infinite fluid. *J. Fluid Mech.*, 1994, **276**, 261-271.

56. Shtern, V. & Barrero, A. Striking features of fluid flows in Taylor cones related to electrosprays. *J. Aerosol Sci.*, 1994, 25 (6), 1049-63.
57. Shtern, V. & Barrero, A. Instability nature of swirl appearance in liquid cones. *Phys. Rev. E*, 1995, **52** (1), 627-635.
58. Shtern, V. Cosmic jets as a pump for magnetic field. *Physics Letters A*, 1995, **206** (1-2), 96-100.
59. Shtern, V. & Barrero, A. Bifurcation of swirl in liquid cones. *J. Fluid Mech.*, 1995, **300**, 169-205.
60. Shtern, V. & Hussain F. Hysteresis in swirling jets. *J. Fluid Mech.*, 1996, **309**, 1-44.
61. Shtern, V., Borissov, A. & Hussain F. Vortex-sinks with axial flow. *Phys. Fluids*, 1997, 9, 2941-2959.
62. Shtern, V., Borissov, A. & Hussain F. Temperature distribution in swirling jets. *Int. J. Heat Mass Transfer*, 1998, **41** (16), 2455-2467.
63. Shtern, V. & Hussain F. Instabilities of conical flows causing steady bifurcations. *J. Fluid Mech.*, 1998, **366**, 33-85.
64. Borissov, A., Shtern, V. & Hussain F. Modeling flow and heat transfer in vortex burners. *AIAA Journal*, 1998, **36**, 1665-1670.
65. Shtern, V. & Hussain F. Collapse, symmetry breaking, and hysteresis in swirling flows. *Annu. Rev. Fluid Mech.*, 1999, **31**, 537-566.
66. Shtern, V. & Drazin, P.G. Instability of a free swirling jet driven by a half-line vortex. *Proc. Roy. Soc. Lond. A* 2000, **456** (N1997), 1139-1161.
67. Shtern, V. & Hussain, F. New features of swirling jets. *Phys. Fluids*, 2000, **12**, 2868-2877.
68. Shtern, V. Zimin, V. & Hussain, F. Analysis of centrifugal convection in rotating pipes. *Phys. Fluids*, 2001, **13**, 2296-2308.
69. Shtern, V. & Hussain, F. Generation of collimated jets by a point source of heat and gravity. *J. Fluid Mech.*, 2001, **449**, 39-59.
70. Shtern, V. & Hussain, F. Onset of convection near a point source of heat and gravity. *Phys. Rev. Lett.* 2001, **87**, 264301.
71. Shtern, V. Comment on "Nonuniform two-dimensional flow from a point source" [*Phys. Fluids* 12, 66 (2000)]. *Phys. Fluids*, 2002, **14**, 1816.
72. Shtern, V. & Hussain, F. Effect of deceleration on jet instability. *J. Fluid Mech.*, 2003, **480**, 283-309.
73. Husain, H. S., Shtern, V., and Hussain, F. Control of vortex breakdown by addition of near-axis swirl. *Phys. Fluids*, 2003, **15**, 271-279.
74. Herrada, M. A. & Shtern, V. Control of vortex breakdown by temperature gradients. *Phys. Fluids*, 2003, **15**, 3468-3477.
75. Herrada, M. A. & Shtern, V. Vortex breakdown control by adding near-axis swirl and temperature gradients. *Phys. Rev. E*, 2003, **68**, 041202.
76. Shtern, V. & Mi, J. Hysteresis and instability in a swirling jet normal to a wall. *Phys. Rev. E*, 2004, **69**, 016312.
77. Shtern, V. Instability versus collapse in a flow driven by the radial electric current. *Phys. Fluids*, 2004, **16**, L17-L19.
78. Shtern, V. Bifurcation of conical magnetic fields. *Phys. Rev. E*, 2004, **69**, 065301(R).
79. Borissov, A., Shtern, V. Modeling flow and temperature in a combustor with volume-distributed oxidation. *Clear Air*. Vol. 9, pp. 159-178, 2008
80. Shtern, V. & Borissov, A. Counter-flow driven by swirl decay. *Phys. Fluids*, 2010, **22**, 063601.
81. Shtern, V. & Borissov, A. Nature of counterflow and circulation in vortex separators. *Phys. Fluids*, 2010, **22**, 083601.
82. Borissov, A., Shtern, V. Turbulent counterflow induced by swirl decay. *Int. J. on Energy for a Clean Environment*. Vol. 11, pp. 203-225, 2010
83. Herrada, M.A., Shtern, V.N. & López-Herrera, J.M. Two-cell circulation in a liquid meniscus driven by a swirling gas jet. *Phys. Fluids*, **23**, 012003. 2011.
84. Shtern, V.N., Torregrosa, M.M., & Herrada, M.A. Development of a swirling double counterflow. *Phys. Rev. E*, **83**, 056322, 2011.

85. Shtern, V.N., Torregrosa, M.M., & Herrada, M.A. Development of colliding counterflows. *Phys. Rev. E*, 2011, **84**, 046306.
86. Shtern, V.N., Torregrosa, M.M., & Herrada, M.A. Effect of swirl decay on vortex breakdown in a confined steady axisymmetric flow. *Phys. Fluids*, 2012, **24**, 043601.
87. Shtern, V. A flow in the depth of infinite annular cylindrical cavity. *J. Fluid Mech.* **711**, 667-680, 2012.
88. Herrada, M. A., Shtern, V. N., & Lopez-Herrera, J. M. Off-axis vortex breakdown in a shallow whirlpool. *Phys. Rev. E*, 2013, **87**, 063016.
89. Shtern, V. Asymptotic flow in the depth of narrow cavity. *Phys. Fluids*, 2013, **25**, 083604.
90. Herrada, M. A., Shtern, V. N., & Lopez-Herrera, J. M. Vortex breakdown in a water-spout flow. *Phys. Fluids*, 2013, **25**, 093604.
91. Herrada, M. A. & Shtern, V. N., Patterns of a creeping water-spout flow. *J. Fluid Mech.*, **744**, 65-88, 2014.
92. Herrada, M. A. & Shtern, V. N., Air-water centrifugal convection. *Phys. Fluids*, **26**, 072102 (2014).
93. Shtern, V. Moffatt eddies at an interface. *Theor. Comput. Fluid Dyn.* **28**, 651-656 (2014).
94. Herrada, M. A., Shtern, V. N., & Torregrosa, M.M. The instability nature of the Vogel-Escudier flow. *J. Fluid Mech.*, **766**, 590-610, 2015.
95. Herrada, M. A. & Shtern, V. N. Stability of centrifugal convection in a rotating pipe, *Phys. Fluids*, **27**, 064106 (2015).
96. Pantzali, M. N, Kovacevic, J. Z., Heynderickx, G. J. & Marin. G. B. and Shtern, V. N. Radial Pressure profiles in a cold-flow Gas-Solid Vortex Reactor. *AIChE J.* **61**, 4114-4125. doi: 10.1002/aic. 14912 (2015).
97. Balci, A., Brøns, M., Herrada, M. A. & Shtern, V. N. Vortex breakdown in a truncated conical bioreactor. *Fluid Dyn. Res.* **47**(6) 065503, 2015.
98. Herrada, M. A. & Shtern, V. N. Velocity reversals via bifurcation in thermal convection. *Int. J. Heat Mass Transfer* **92**, 66-75, 2016.
99. Balci, A., Brøns, M., Herrada, M. A. & Shtern, V. N. Patterns of a slow air-water flow in a semispherical container. *Eur. J. Mech. B/Fluids* **58**, 1-8, 2016.
100. Balci, A., Brøns, M., Herrada, M. A. & Shtern, V. N. Bifurcations of a creeping air-water flow in a conical container, *Theor. Comput. Fluid Dyn.* **30** (5), 485-496. DOI: 10.1007/s00162-016-0391-z (2016).
101. Carrión, L., Herrada, M. A. & Shtern V. N. Instability of a water-spout flow. *Phys. Fluids*, **28**, 034107 (2016).
102. Herrada, M. A. & Shtern V. N. Stability of thermal convection in a rotating cylindrical container. *Phys. Fluids*, **28**, 083601 (2016).
103. Niogi, K., Torregrosa, M., Pantzali, M. N., Shtern, V. N., Heynderickx, G. J. & Marin. G. B. On near-wall jets in a disc-like gas vortex unit. *AIChE Journal* **63**, 1740-1756 (2017).
104. Carrión, L., Herrada, M. A. & Shtern V. N. Topology and stability of water-soybean-oil swirling flow. *Phys. Rev. Fluids* **2**, 024702 (2017).
106. Carrión, L., Herrada, M. A. & Shtern V. N. Patterns and stability of a whirlpool flow. *Fluid. Dyn. Res.* **49**, 025519 (2017). doi: [10.1088/1873-7005/aa5e7c](https://doi.org/10.1088/1873-7005/aa5e7c)
107. Carrión, L., Herrada, M. A. & Shtern V. N. Topology changes in a water-oil swirling flow. *Phys. Fluids*, **29**, 032109 (2017). <http://dx.doi.org/10.1063/1.4979277>
108. Naumov, I. V., Sharifullin, B. R. & Shtern, V. N. Capillary hysteresis in a confined swirling two-fluid flow. *J. Eng. Thermophysics*, **26**, 391-398 (2017). ISSN 1810-2328.
109. Carrión, L., Herrada, M. A. & Shtern V. N. Stability of an air-water flow in a semispherical container. *Eur. J. Mech. B/Fluids* **67**, 377-384 (2017).
110. Herrada, M. A. & Shtern V. N. Convection in Air water Layer with Side Heating. *Fluid Mech. Res. Int.* **1**(1): 00002, 2017. doi: 10.15406/fmrij.2017.01.00002.
111. Niyogi, K., Torregrosa, M. M., Shtern, V. N., Marin. G. B., Heynderickx G. J. On the Mechanisms of Secondary Flows in a Gas Vortex Unit. *AIChE Journal* **64**, 1859-1873.

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112. Naumov, I. V., Herrada, M. A., Sharifullin, B. R. & Shtern, V. N. Hysteretic growth and decay of a waterspout column. *Phys. Rev. Fluids* **3**, 024701 (2018).
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### Papers in international conference proceedings

1. Goldshtik, M.A., Sapozhnikov, V.A. & Shtern V. N. Differential factorization method in problem of hydrodynamic stability. GAMM conference on numerical methods in fluid mech., Köln, 1975.
2. Goldshtik, M.A. & Shtern, V.N. Structural turbulence in dissipating systems. *GAMM-tagung Zusammenfassung*. Budapest, 1982.
3. Goldshtik, M.A. & Shtern, V.N. Structural approach to turbulent motion calculation. *Proc. of the Fifth GAMM-conf. on numerical methods in fluid mechanics*. 1984, 93-98.
4. Goldshtik, M.A., Lifshitz, A.M. & Shtern, V.N. Threshold regimes in the plane channel flow. In: *Laminar-Turbulent Transition*, Berlin: Springer Verlag, 1985, 191-198.
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10. Goldshtik, M.A. & Shtern, V.N. Structural turbulence. In: *Continuum Models of Discrete Systems*, **1**, Longman Sci. & Techn., 1990, 255-276.
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12. Goldshtik, M.A. & Shtern, V.N. Self-similar separation. In: *Separation Flows and Jets*, Springer-Verlag, 1991, 89-96.
13. Shtern, V. & Hussain, F. Azimuthal instability of Marangoni convection driven by a point surface source. *Bull. APS*, 1991, **36** (10), 2713, JE3.
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17. Sergeev, K.A. & Shtern, V.N. Bifurcations of self-oscillating and almost periodical regimes in an azimuthal MHD jet. *Progress in Astronautics and Aeronautics*, 1993, **149**, 103-115.
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