

Clark, Ed; Katzourakis, Nikos; Muha, Boris

Vectorial variational problems in L^∞ constrained by the Navier-Stokes equations. (English)

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MSC:

- 35Q30 Navier-Stokes equations
- 35D35 Strong solutions to PDEs
- 35A15 Variational methods applied to PDEs
- 76D05 Navier-Stokes equations for incompressible viscous fluids
- 49J40 Variational inequalities
- 49K20 Optimality conditions for problems involving partial differential equations
- 49K35 Optimality conditions for minimax problems
- 49M41 PDE constrained optimization (numerical aspects)

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Keywords:

Navier-Stokes equations; calculus of variations in L^∞ ; PDE-constrained optimisation; Euler-Lagrange equations; Aronsson-Euler systems; data assimilation

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References:

- [1] Amann, H., Compact embeddings of vector-valued Sobolev and Besov spaces, *Glas. Mat.*, 35, 161-177 (2000) · Zbl 0997.46029
- [2] Amann, H., On the strong solvability of the Navier-Stokes equations, *J. Math. Fluid Mech.*, 2, 16-98 (2000) · Zbl 0989.35107 · doi:10.1007/s000210050018
- [3] Ansini, N.; Prinari, F., On the lower semicontinuity of supremal functional under differential constraints, *ESAIM Control Optim. Calc. Var.*, 21, 1053-1075 (2015) · Zbl 1336.49015 · doi:10.1051/cocv/2014058
- [4] Aronsson, G., Minimization problems for the functional $\|(\cdot)\|_\infty$, *Ark. Mat.*, 6, 33-53 (1965) · Zbl 0156.12502 · doi:10.1007/bf02591326
- [5] Aronsson, G., Minimization problems for the functional $\|(\cdot)\|_\infty$. (II), *Ark. Mat.*, 6, 409-431 (1966) · doi:10.1007/bf02590964
- [6] Aronsson, G.; Barron, E. N., L^∞ variational problems with running costs and constraints, *Appl. Math. Optim.*, 65, 53-90 (2012) · Zbl 1242.49049 · doi:10.1007/s00245-011-9151-z
- [7] Ayanbayev, B.; Katzourakis, N., Vectorial variational principles in L^∞ and their characterisation through PDE systems, *Appl. Math. Optim.*, 83, 833-838 (2019) · Zbl 1465.35174 · doi:10.1007/s00245-019-09569-y
- [8] Ayanbayev, B.; Katzourakis, N., A pointwise characterisation of the PDE system of vectorial calculus of variations in L^∞ , *Proc. R. Soc. Edinburgh A*, 150, 1653-1669 (2019) · Zbl 1444.35058 · doi:10.1017/prm.2018.89
- [9] Barron, E. N.; Bocea, M.; Jensen, R. R., Viscosity solutions of stationary Hamilton-Jacobi equations and minimizers of L^∞ functionals, *Proc. Am. Math. Soc.*, 145, 5257-5265 (2017) · Zbl 1380.35051 · doi:10.1090/proc/13668
- [10] Barron, E. N.; Jensen, R., Minimizing the L^∞ norm of the gradient with an energy constraint, *Commun. Partial. Differ. Equ.*, 30, 1741-1772 (2005) · Zbl 1105.35028 · doi:10.1080/03605300500299976
- [11] Barron, E. N.; Jensen, R. R.; Wang, C. Y., The Euler equation and absolute minimizers of L^∞ functionals, *Arch. Rational Mech. Anal.*, 157, 255-283 (2001) · Zbl 0979.49003 · doi:10.1007/pl00004239
- [12] Barron, E. N.; Jensen, R. R.; Wang, C. Y., Lower semicontinuity of L^∞ functionals, *Ann. Inst. Henri Poincaré C*, 18, 495-517 (2001) · Zbl 1034.49008 · doi:10.1016/s0294-1449(01)00070-1
- [13] Bessail, H.; Olson, E.; Titi, E. S., Continuous data assimilation with stochastically noisy data, *Nonlinearity*, 28, 729-753 (2015) · Zbl 1308.35161 · doi:10.1088/0951-7715/28/3/729
- [14] Bocea, M.; Nesi, V., Γ -convergence of power-law functionals, variational principles in L^∞ , and applications, *SIAM J. Math. Anal.*, 39, 1550-1576 (2008) · Zbl 1166.35300 · doi:10.1137/060672388
- [15] Bocea, M.; Popovici, C., Variational principles in L^∞ with applications to antiplane shear and plane stress plasticity, *J. Convex Anal.*, 18, 403-416 (2011) · Zbl 1223.35040
- [16] Bröcker, J., What is the correct cost functional for variational data assimilation?, *Clim. Dyn.*, 52, 389-399 (2019) · doi:10.1007/s00382-018-4146-y

- [17] Bröcker, J., On variational data assimilation in continuous time, *Q. J. R. Meteorol. Soc.*, 136, 1906-1919 (2010) · doi:10.1002/qj.695
- [18] Bröcker, J., Existence and uniqueness for variational data assimilation in continuous time (2018)
- [19] Bröcker, J.; Kuna, T.; Oljaca, L., Almost sure error bounds for data assimilation in dissipative systems with unbounded observation noise, *SIAM J. Appl. Dyn. Syst.*, 17, 2882-2914 (2018) · Zbl 1409.62183 · doi:10.1137/17M1162305
- [20] Champion, T.; De Pascale, L.; Prinari, F., Γ -convergence and absolute minimizers for supremal functionals, *ESAIM Control Optim. Calc. Var.*, 10, 14-27 (2004) · Zbl 1068.49007 · doi:10.1051/cocv:2003036
- [21] Chen, G.; Huang, X.; Yang, X., *Vector Optimization: Set-Valued and Variational Analysis* (2005), Berlin: Springer, Berlin
- [22] Crandall, M. G., *A visit with the ∞ -Laplacian, Calculus of Variations and Non-Linear Partial Differential Equations* (2005), Berlin: Springer, Berlin
- [23] Croce, G.; Katzourakis, N.; Pisante, G., ∞ -solutions to the system of vectorial calculus of variations in L^∞ via the singular value problem, *Discrete Contin. Dyn. Syst.*, 37, 6165-6181 (2017) · Zbl 1386.35081 · doi:10.3934/dcds.2017266
- [24] Dacorogna, B., *Direct Methods in the Calculus of Variations* (2008), Berlin: Springer, Berlin · Zbl 1140.49001
- [25] Di Nezza, E.; Palatucci, G.; Valdinoci, E., Hitchhiker's guide to the fractional Sobolev spaces, *Bull. Sci. Math.*, 136, 521-573 (2012) · Zbl 1252.46023 · doi:10.1016/j.bulsci.2011.12.004
- [26] D'Elia, M.; Perego, M.; Veneziani, A., A variational data assimilation procedure for the incompressible Navier-Stokes equations in hemodynamics, *J. Sci. Comput.*, 52, 340-359 (2012) · Zbl 1264.76076 · doi:10.1007/s10915-011-9547-6
- [27] Florescu, L. C.; Godet-Thobie, C., *Young Measures and Compactness in Metric Spaces* (2012), Berlin: de Gruyter & Co, Berlin · Zbl 1259.28002
- [28] Farhat, A.; Lunasin, E.; Titi, E. S., Abridged continuous data assimilation for the 2D Navier-Stokes equations utilizing measurements of only one component of the velocity field, *J. Math. Fluid Mech.*, 18, 1-23 (2016) · Zbl 1334.35202 · doi:10.1007/s00021-015-0225-6
- [29] Foias, C.; Mondaini, C. F.; Titi, E. S., A discrete data assimilation scheme for the solutions of the two-dimensional Navier-Stokes equations and their statistics, *SIAM J. Appl. Dyn. Syst.*, 15, 2109-2142 (2016) · Zbl 1362.35208 · doi:10.1137/16m1076526
- [30] Garroni, A.; Nesi, V.; Ponsiglione, M., Dielectric breakdown: optimal bounds, *Proc. R. Soc. A*, 457, 2317-2335 (2001) · Zbl 0993.78015 · doi:10.1098/rspa.2001.0803
- [31] Gerhardt, C., L^p estimates for solutions to the stationary Navier-Stokes equations in dimension two, *Pac. J. Math.*, 79, 375-398 (1978) · Zbl 0408.76011 · doi:10.2140/pjm.1978.79.375
- [32] Giaquinta, M.; Martinazzi, L., *An Introduction to the Regularity Theory for Elliptic Systems, Harmonic Maps and Minimal Graphs* (2012), Berlin: Springer, Berlin · Zbl 1262.35001
- [33] Giga, Y., Solutions of semilinear parabolic equations in L^p and regularity of weak solutions of the Navier-Stokes equations, *J. Diff. Equations*, 61, 186-212 (1982) · Zbl 0577.35058 · doi:10.1016/0022-0396(86)90096-3
- [34] Giga, Y.; Sohr, H., Abstract L^p estimates for the Cauchy problem with applications to the Navier-Stokes equations in exterior domains, *J. Funct. Anal.*, 102, 72-94 (1991) · Zbl 0739.35067 · doi:10.1016/0022-1236(91)90136-s
- [35] Katzourakis, N., *An Introduction to Viscosity Solutions for Fully Nonlinear PDE with Applications to Calculus of Variations in L^∞* (2015) · Zbl 1326.35006
- [36] Katzourakis, N., Generalised solutions for fully nonlinear PDE systems and existence-uniqueness theorems, *J. Differ. Equ.*, 263, 641-686 (2017) · Zbl 1362.35105 · doi:10.1016/j.jde.2017.02.048
- [37] Katzourakis, N., An L^∞ regularisation strategy to the inverse source identification problem for elliptic equations, *SIAM J. Math. Anal.*, 51, 1349-1370 (2019) · Zbl 1414.35066 · doi:10.1137/18m1226373
- [38] Katzourakis, N., A minimisation problem in L^∞ with PDE and unilateral constraints, *ESAIM Control Optim. Calc. Var.*, 26, 60 (2020) · Zbl 1451.35240 · doi:10.1051/cocv/2019034
- [39] Katzourakis, N., Inverse optical tomography through PDE-constrained optimisation in L^∞ , *SIAM J. Control Optim.*, 57, 4205-4233 (2019) · Zbl 1430.49037 · doi:10.1137/19m1239908
- [40] Katzourakis, N.; Moser, R., Existence, uniqueness and structure of second order absolute minimisers, *Arch. Ration. Mech. Anal.*, 231, 1615-1634 (2018) · Zbl 1407.49002 · doi:10.1007/s00205-018-1305-6
- [41] Katzourakis, N.; Pryer, T., On the numerical approximation of p -Biharmonic and ∞ -Biharmonic functions, *Numer. Methods Partial Differ. Equ.*, 35, 155-180 (2018) · Zbl 1419.65113 · doi:10.1002/num.22295
- [42] Korn, P., Data assimilation for the Navier-Stokes-equations, *Physica D*, 238, 1957-1974 (2009) · Zbl 1172.76015 · doi:10.1016/j.physd.2009.07.008
- [43] Kreisbeck, C.; Zappale, E., Lower semicontinuity and relaxation of nonlocal L^∞ -functionals, *Calc. Var. Partial Differ. Equ.*, 59, 1-36 (2020) · Zbl 1446.49011 · doi:10.1007/s00526-020-01782-w
- [44] Larios, A.; Pei, Y., Approximate continuous data assimilation of the 2D Navier-Stokes equations via the Voigt-regularization with observable data, *Evol. Equ. Control Theor.*, 9, 733-751 (2019) · Zbl 1452.35133 · doi:10.3934/eect.2020031
- [45] Moser, R.; Schwetlick, H., Minimizers of a weighted maximum of the Gauss curvature, *Ann. Global Anal. Geom.*, 41, 199-207 (2012) · Zbl 1236.53035 · doi:10.1007/s10455-011-9278-9
- [46] Miao, Q.; Wang, C.; Zhou, Y., Uniqueness of absolute minimizers for L^∞ -functionals involving Hamiltonians $H(x, p)$, *Arch. Ration. Mech. Anal.*, 223, 141-198 (2017) · Zbl 1356.35013 · doi:10.1007/s00205-016-1033-8
- [47] Prinari, F.; Zappale, E., A relaxation result in the vectorial setting and power law approximation for supremal functionals, *J. Optim. Theory Appl.*, 186, 412-452 (2020) · Zbl 1447.49024 · doi:10.1007/s10957-020-01712-y
- [48] Ribeiro, A. N.; Zappale, E., Existence of minimisers for nonlevel convex functionals, *SIAM J. Control Opt.*, 52, 3341-3370

(2014) · [Zbl 1307.49022](#) · [doi:10.1137/13094390x](#)

- [49] Schwarz, A.; Dwight, R. P., Data assimilation for Navier-Stokes using the least-squares finite-element method, *Int. J. Uncertain. Quantification*, 8, 383-403 (2018) · [doi:10.1615/int.j.uncertaintyquantification.2018021021](#)
- [50] Solonnikov, V. A., Estimates for solution of nonstationary Navier-Stokes equations, *J. Sov. Math.*, 8, 467-529 (1977) · [Zbl 0404.35081](#) · [doi:10.1007/bf01084616](#)
- [51] Sohr, H., *The Navier-Stokes Equations An Elementary Functional Analytic Approach* (2001), Berlin: Springer, Berlin · [Zbl 0983.35004](#)
- [52] Triebel, H., *Interpolation Theory, Function Spaces, Differential Operators* (1978), Amsterdam: North-Holland, Amsterdam · [Zbl 0387.46032](#)
- [53] Triebel, H., Function spaces in Lipschitz domains and on Lipschitz manifolds, characteristic functions as pointwise multipliers, *Rev. Mat. Complut.*, 15, 475-524 (2002) · [Zbl 1034.46033](#) · [doi:10.5209/rev.ema.2002.v15.n2.16910](#)
- [54] Zeidler, E., *Nonlinear Functional Analysis and its Application III: Variational Methods and Optimization* (1985), Berlin: Springer, Berlin

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