

# Short Curriculum Vitae

Diego Córdoba Gazolaz

June 2017

## Address

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## Education

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<b>Undergraduate</b>	June 1994
Universidad Autónoma de Madrid, Madrid. Mathematics.	
<b>Master</b>	January 1996
Princeton University, Princeton, New Jersey. Mathematics.	
<b>Ph.D</b>	June 1998
Princeton University, Princeton, New Jersey. Mathematics. Ph.D Advisor: Prof. Charles Fefferman	

## Appointments

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<b>Member in the Institute for Advanced Study</b>	Sep 1998 - Jul 1999
Institute for Advanced Study, Princeton.	
<b>L. E. Dickson Instructor</b>	Sep 1998 - Jul 2001
Department of Mathematics, University of Chicago, Chicago.	
<b>Assistant Professor</b>	Sep 2001 - Sep 2002
Department of Mathematics, Princeton University, Princeton.	
<b>Ramon y Cajal</b>	Jan 2002 - Jun 2003
IMAFF, Consejo Superior de Investigaciones Científicas, Madrid.	
<b>Investigador Científico</b>	Jun 2003 - May 2009
IMAFF, Consejo Superior de Investigaciones Científicas, Madrid.	
<b>Profesor de Investigación</b>	Jun 2009 - Current
ICMAT, Consejo Superior de Investigaciones Científicas, Madrid.	

## Visiting Positions

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<b>Research Collaborator</b> Department of Mathematics, Princeton University, Princeton.	Jan 1999 - Apr 1999
<b>Research Visitor</b> Department of Mathematics, University of Texas, Austin.	Sep 2000 - Nov 2000
<b>Profesor Titular Interino</b> Departamento de Matemáticas, Universidad Autónoma de Madrid.	Oct 2001 - Jan 2002
<b>Profesor Honorario</b> Departamento de Matemáticas, Universidad Autónoma de Madrid.	Oct 2003 - Oct 2005
<b>Profesor Honorario</b> Departamento de Matemáticas, Universidad Autónoma de Madrid.	Oct 2010 - Oct 2011
<b>Visiting Research Scholar</b> Department of Mathematics, Princeton University, Princeton.	Sep 2014 - Jul 2015

## Research Interests

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Partial Differential Equations, Analysis and Fluid Mechanics.

## Awards and Honors

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- American Institute of Mathematics Postdoctoral Fellowship (January 99- April 99).
- Alfred P. Sloan Doctoral Dissertation Fellowships (1997-1998).
- Clay Mathematical Emissary (September 2000).
- Programa Ramon y Cajal. 1 position in Mathematics. Ministerio de Ciencia y Teconología, año 2001.
- SEMA Prize (Sociedad Española de Matemática Aplicada) for young researcher (September 2005).
- Starting independent research grant of the European Research Council (2008-2013).
- Miguel Catalán young Award 2011 from Comunidad Autónoma de Madrid.
- Minerva Distinguished Visitor at the Math. Department of Princeton University from September 2014 until February 2015.
- Scientific director of the Severo Ochoa program at the ICMat from January 2016 until December 2019.
- Invited speaker (PDE session), International Congress of Mathematicians, Rio de Janeiro 2018.

## Current Ph.D students

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- Tania Pernas (FPI Fellowship)
- Daniel Lear (Caixa Fellowship)

## Former Ph.D students

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Francisco Gancedo, Ph.D 2007 (FPU Fellowship 2003-2007)  
First job after leaving ICMat: L.E. Dickson Instructor at University of Chicago  
Currently Associate Professor at the Universidad de Sevilla

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Angel Castro, Ph.D 2010 (FPI Fellowship 2006-2010)  
First job after leaving ICMat: Postdoc at Ecole Normale Sup. in Paris  
Currently Científico Titular at the ICMat-CSIC

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Rafael Granero, Ph.D 2013 (FPI Fellowship 2009-2013)  
Advised jointly with Rafael Orive  
First job after leaving ICMat: 'Arthur J. Krener' Assistant Prof. at Univ. of California, Davis.  
Currently 'MILyon' Postdoctoral researcher at the Institut Camille Jordan, Lyon.

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Name: Javier Gomez-Serrano, Ph.D 2013 (ERC contract 2009-2013)  
First job after leaving ICMat: Instructor at Princeton University  
Currently Assistant Professor at Princeton University

## Publications

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### Research Papers

1. "On the geometry of solutions of the quasi-geostrophic and Euler equations", *Proc. Natl. Acad. Sci.*, 94 (1997), 12769-12770.
2. "Nonexistence of simple hyperbolic blow-up for the quasi-geostrophic", *Ann. of Math.*, 148 (1998), 1135-1152.
3. "On the behavior of hyperbolic neutral points in two-dimensional ideal magnetohydrodynamics", (with C. Marliani), *Proc. Natl. Acad. Sci.*, 96 (1999), 2612-2614.
4. "Evolution of Current Sheets and Regularity of Ideal Incompressible Magnetic Fluids in 2D", (with C. Marliani), *Comm. Pure and Appl. Math.* Vol LIII (2000), 0512-0524.
5. "Behavior of several 2D fluid equations in singular scenarios" (with C. Fefferman) *Proc. Natl. Acad. Sci.*, 98 (2001), 4311-4312.
6. "On the collapse of tubes carried by 3D incompressible flows", (with C. Fefferman) *Comm. Math. Phys.*, 222 (2001), 293-298.
7. "On the critical dissipative quasi-geostrophic equation", (with P. Constantin & J. Wu) *Indiana Univ. Math. J.*, 50 (2001), 97-107.

8. "Scalars convected by a 2D incompressible flow", (with C.Fefferman) *Comm. Pure and Appl. Math.* 55 (2002), 255-260.
9. "Growth of solutions for QG and 2D Euler equations" (with C.Fefferman) *Journal Amer. Math. Soc.*, 15 (2002), 665-670.
10. "Potato chip singularities of 3D flows", (with C.Fefferman) *SIAM J. Math. Anal.*, 33 (2002), 786-789.
11. "Drops: The collapse of capillary jets" (with A. Córdoba, C.Fefferman & M. Fontelos) *Proc. Natl. Acad. Sci.*, 99 (2002), 11006-11007.
12. "A pointwise estimate for fractionary derivatives with applications to P.D.E." (with A. Córdoba) *Proc. Natl. Acad. Sci.*, 100 (2003), 15316-15317.
13. "Almost sharp fronts for the surface quasi-geostrophic equations" (with C. Fefferman & J.L. Rodrigo) *Proc. Natl. Acad. Sci.*, 101 (2004), 2687-2691.
14. "On Squirt singularities in hydrodynamics" (with C.Fefferman & R. de la LLave) *SIAM J. Math. Anal.*, 36 (1), 204-213, (2004).
15. "A geometrical constraint for capillary jet breakup" (with A. Córdoba, C.Fefferman & M. Fontelos) *Adv. Math.*, 187 (1), 228-239, (2004).
16. "A maximum principle applied to Quasi-geostrophic equations" (with A. Córdoba) *Comm. Math. Phys.*, 249 (3), 511-528, (2004).
17. "Finite time singularities in a 1D model of the quasi-geostrophic equations." (with D. Chae, A. Córdoba & M. Fontelos) *Advances in Math*, 194, 203-223, (2005).
18. "Evidence of singularities for a contour dynamical system"(with M. Fontelos, A. Mancho & J.L. Rodrigo) *Proc. Natl. Acad. Sci.*, 102 (17), 5949-5952, (2005).
19. "Formation of singularities for a transport equation with nonlocal velocity" (with A. Córdoba & M. Fontelos) *Annals of Math*, 162 (3), 1377-1389, (2005).
20. "Integral inequalities for the Hilbert transform applied to a non-local transport equation" (with A. Córdoba & M. Fontelos) *J. Math. Pure Appl.*, 86 (6), 529-540, (2006).
21. "Analytical behavior of 2D incompressible flow in porous media" (with F. Gancedo & R. Orive), *J. Math. Phys.* (2007), no. 6, 065206, 19 pp.
22. "Contour dynamics of incompressible 3-D fluids in a porous medium with different densities" (with F. Gancedo), *Comm. Math. Phys.* (2007), no. 2, 445471.
23. "Global existence, singularities and Ill-posedness for a non-local flux" (with A. Castro), *Advances in Math.* 219 (2008), 6, 1916-1936.
24. "A note on the interface dynamics for convection in porous media" (with F. Gancedo & R. Orive), *Physica D* 237 (2008), 1488-1497.
25. "Self-similar solutions for a transport equation with non-local flux" (with A. Castro) *Chinese Annals of Math. Series B.* 30 (2009), 5, 505-512.
26. "Incompressible flow in porous media with fractional diffusion" (with A. Castro, F. Gancedo & R. Orive) *Nonlinearity* 22 (2009), 8, 1791-1815.

27. “ The Rayleigh-Taylor condition for the evolution of irrotational fluid interfaces” (with A. Córdoba & F. Gancedo ), Proc. Natl. Acad. Sci. 106 (2009), 27, 10955-10959.
28. “ A maximum principle for the Muskat problem with different densities” (with F. Gancedo ) Comm. Math. Phys. 286 (2009), 2, 681-696.
29. “On the regularity of the solutions to the 3D Navier-Stokes equations: a remark on the role of the helicity” (with Luigi C. Berselli), Comptes Rendus Mathematique 347 (2009), 613-618.
30. “Interface evolution: water waves in 2-D” (with A. Córdoba & F. Gancedo ), Advances in Math. 223 (2010), 1, 120-173.
31. “Absence of squirt singularities for the multi-phase Muskat problem.” (with F. Gancedo.) Comm. Math. Phys. 299 (2010), 2, 561-575.
32. “Infinite energy solutions of the surface quasi-geostrophic equation.” (with A. Castro.) Advances in Math. 225 (2010) 18201829.
33. “Singularity formations for a surface wave model” (with A. Castro & F. Gancedo.) Nonlinearity 11 (2010) 2835-2849.
34. “Interface evolution: the Hele-Shaw and Muskat problems” (with A. Córdoba & F. Gancedo ), Annals of Math. 173 (2011), (1), 477-544.
35. “Turning waves and breakdown for incompressible flows” (with A. Castro, C. Fefferman, F. Gancedo & M. Lopez ), Proc. Natl. Acad. Sci. 108 (2011), 12, 4754-4759.
36. “ Lack of uniqueness for weak solutions of the incompressible porous media equation.” (with D. Faraco & F. Gancedo.), Archives Rational Mech. Ana. 200 (2011), 3, 725-746.
37. “ Splash singularity for water waves”. (with A. Castro, C. Fefferman, F. Gancedo, and J. Gómez-Serrano.), *Proceedings of the National Academy of Sciences*, 109(3):733-738, (2012).
38. “Rayleigh-Taylor breakdown for the Muskat problem with applications to water waves” (with A. Castro, C. Fefferman, F. Gancedo & M. López-Fernández ), Annals of Math. 175 (2): 909-948 (2012).
39. “Generalized SQG equation with singular velocities” (with D. Chae, P. Constantin, F. Gancedo & J. Wu ), Comm. Pure Appl. Math. 65 (8): 1037-1066 (2012).
40. “Finite time singularities of water waves with surface tension” (with A. Castro, C. Fefferman, F. Gancedo & J. Gómez-Serrano). J. Math. Phys. 53, 115622 (2012).
41. “On the global existence for the Muskat problem” (with P. Constantin, F. Gancedo & R. Strain), J. Eur. Math. Soc. 15, 201-227, (2013).
42. “Porous media: the Muskat problem in 3D ” (with A. Córdoba & F. Gancedo ), Analysis & PDE., 6, no. 2, 447497 (2013).
43. “Breakdown of smoothness for the Muskat problem” (with A. Castro, C. Fefferman & F. Gancedo ), Arch. Ration. Mech. Anal., 208, no. 3, 805-909 (2013).
44. “Finite time singularities for the free boundary incompressible Euler equations” (with A. Castro, C. Fefferman, F. Gancedo & J. Gomez-Serrano), Annals of Math, 178, no. 3, 1061-1134 (2013).

45. “Structural stability for the splash singularities of the water waves problem.” (with A. Castro, C. Fefferman, F. Gancedo & J. Gomez-Serrano), *Discrete Contin. Dyn. Syst.*, 34, no. 12, 49975043 (2014).
46. “Local solvability and turning for the inhomogeneous Muskat problem” (with L. Berselli & R. Granero). *Interfaces and Free Boundaries*, 16, no. 2, 175213 (2014) .
47. “The confined Muskat problem: differences with the deep water regime” (with R. Granero & R. Orive). *Comm. Math. Sci.*, 12, no. 3, 423455 (2014).
48. “Remarks on geometric properties of SQG sharp fronts and  $\alpha$ -patches” (with A. Castro, J. Gomez-Serrano & A. Martin). *Discrete Contin. Dyn. Syst.*, 34, no. 12, 50455059 (2014).
49. “A note in stability shifting for the Muskat problem” (with J. Gómez-Serrano & A. Zlatos). *Philos. Trans. R. Soc. Lond. Ser. A Math. Phys. Eng. Sci.* 373 (2015) no.2050, 20140278,10pp.
50. “Splash and almost-Splash stationary solutions to the Euler equations” (with A. Enciso & N. Grubic). *Advances in Math.* 288(2016) 922-941.
51. “Existence and regularity of rotating global solutions for the generalized surface quasi-geostrophic equations” (with A. Castro & J. Gómez-Serrano), *Duke Math Journal.* 165 (2016), no. 5, 935984.
52. “Splash singularities for the one-phase Muskat problem in stable regimes”(with A. Castro, C. Fefferman & F. Gancedo), *Arch. Ration. Mech. Anal.* (2016), Volume 222, Issue 1, pp 213243
53. “Uniformly rotating analytic global patch solutions for active scalars” (with A. Castro & J. Gómez-Serrano), *Annals of PDE* 2 (2016), no. 1, Art. 1, 34 pp.
54. “On the Muskat problem: global in time results in 2D and 3D” (with P. Constantin, F. Gancedo, Luis Rodriguez-Piazza & R. Strain), *Amer. J. Math.* 138 (2016), no. 6, 14551494.
55. “Non-splat singularity for the one-phase Muskat problem (with T. Pernas), *Trans. Amer. Math. Soc.* Vol. 369, no.1, (2017), 711-754.
56. “A note on stability shifting for the Muskat problem II: Stable to Unstable and back to Stable” (with J. Gómez-Serrano & A. Zlato), *Anal. PDE* 10 (2017), no. 2, 367378.

Articles in Proceedings, Surveys and Chapter of books

1. “Vortex stretching by a simple hyperbolic saddle”, “Applied and Industrial Mathematics Venice-2, 1998” , *Kwler Acad. Pub*, January 2000.
2. “Finite time singularities in trasport equations with nonlocal velocities and fluxes”, (with A. Córdoba & M. Fontelos), *Proceedings of Equadiff.*, (2005).
3. “Charles Louis Fefferman, la potencia del Análisis”, (with A. Córdoba)*La Gaceta, de la RSME.*, Vol. 7 (3), 757-765, (2004).

4. “Las matemáticas de los fluidos: torbellinos, gotas y olas”, (with M. Fontelos & J.L. Rodrigo), *La Gaceta, de la RSME.*, Vol. 8 (3), 53-83, (2005).
5. “On the search of singularities in incompressible flows”, *Mathematical theory in Fluid Mechanics*, Paseky , *No 4 Appl. Math. - Paseky Proceedings*, (2006).
6. “Dinámica de frentes de la ecuación 2D Quasi-geostrófica”, *Boletín de SEMA* (2007).
7. “Contour dynamics for 2D active scalars”, (with F. Gancedo), *Newsletter of the European Mathematical Society* 71 (2009), March, 25-28.
8. “Some recent results on the Muskat problem”, (with A. Castro & F. Gancedo.), *Proceedings de Journées "Equations aux Derivées Partielles" (Port d'Albret, 2010)*.
9. “Las ecuaciones de Navier-Stokes”, *Jornadas RSME 2011, Los problemas del milenio (Barcelona, 1-3 junio 2011)*.
10. “A naive parametrization for the vortex-sheet problem.”, (with A. Castro & F. Gancedo.), *Mathematical aspects of fluid mechanics. London Math. Soc. Lecture Notes Series: 402, Cambridge Univ. Press, Cambridge (2012)*.
11. “La dinámica de las olas del mar”, *La Gaceta, de la RSME.*, Vol. 15 (4), 751-763, (2012).
12. “La tierra: un planeta con mares y atmósfera”, (with A. Córdoba), *Unidad Didáctica "Matemáticas del Planeta Tierra": Fundación Española para la Ciencia y la Tecnología* , 47-61, (2014).

Preprints (submitted)

1. “Global smooth solutions for the inviscid SQG equation” (with A. Castro & J. Gómez-Serrano). Preprint arxiv:1603.03325.
2. “Mixing solutions for the Muskat problem” (with A. Castro & D. Faraco). Preprint arxiv:1605:04822.
3. “Splash singularities for the free boundary Navier-Stokes equations” (with A. Castro, C. Fefferman, F. Gancedo & J. Gómez-Serrano), Preprint arxiv:1504.02775.
4. “Uniqueness for SQG patch solutions” (with A. Córdoba & F. Gancedo). Preprint arxiv: 1605.06663.
5. “Uniformly rotating smooth solutions for the incompressible 2D Euler equations” (with A. Castro & J. Gmez-Serrano). Preprint arxiv: 1612.08964.
6. “Global solutions for the generalized SQG patch equation” (with J. Gómez-Serrano & A. D. Ionescu). Preprint arxiv:1705.10842.