

Curriculum Vitae - Colin GUILLARMOU

August 18, 2020

Born 15/09/1977 in Brest, France
French Nationality

Professionnal address:
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Bâtiment 425
Faculté des Sciences d'Orsay, Université Paris-Saclay
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136, Bd de l'Hôpital
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Positions

2016-: Directeur de Recherche CNRS, Univ. Orsay Paris-Sud, France.

Sep. 2011-Aug. 2015: part time Professor at Ecole Polytechnique, France.

2009: Habilitation à diriger des recherches, Nice, 07/12/2009.

2009-2016: Chargé de Recherche CNRS 1st class, Ecole Normale Supérieure de Paris.

2005-2009 : Chargé de Recherche CNRS 2nd class, Université de Nice, France.

2004-2005: Visiting assistant professor at Purdue University, USA.

2000-2004: PhD Thesis, advised by Laurent Guillopé - Université de Nantes, France.

Title: *Resonances on asymptotically hyperbolic manifolds*

Defended on 16/06/2004.

Research areas

Spectral and scattering theory, PDE, analysis on manifolds, inverses problems, quantum chaos, hyperbolic dynamical systems, harmonic analysis, hyperbolic geometry and locally symmetric spaces, Teichmüller theory, Liouville quantum gravity and conformal field theory.

Teaching

2020: 24h lectures, Master 2 course in Orsay.

2015-2016: 22h working group seminar with master students from ENS Paris.

2014-2015: 72h teaching, Ecole Polytechnique 2nd year (4th year university level).

2013-2014: 72h teaching, Ecole Polytechnique 2nd year.

2013: 24h lectures, Master 2, Paris 6 Jussieu.

2013: working group seminar with ENS students, 2h per week.

2012: 72h teaching, Ecole Polytechnique, 2nd year.

2012: teacher and project advisor, ENS Paris, 2nd year (4th year university level).

2011-2012: 72h teaching, Ecole Polytechnique, 2nd year.

2011: working group seminar with ENS students, 2nd year.

2004-2005: 4 courses (about 180h teaching) for engineers at Purdue University .

2000-2004: more than 300h teaching at Université de Nantes, 1st and 2nd year.

Others: several mini-courses in summer schools.

Mentoring

PhD students

1) 2020-2023: Co-advisor of the thesis of Baptiste Cerclé with Vincent Vargas (Univ. Paris 13) at Université Paris Saclay.

2) 2019-2022: advisor of the thesis of Yann Chaubet at Univ. Paris Saclay, Orsay, on dynamical zeta functions and topological invariants.

3) 2017-2020: advisor of the thesis of Thibault Lefeuvre at Univ. Paris Saclay, Orsay. Defended december 2019. Title: *On the rigidity of Riemannian manifolds*. Thibault was hired as a Chargé de Recherche at CNRS in 2020.

4) 2014-2017: co-advisor with A. Moroianu (Versailles) of the thesis of Charles Hadfield at ENS Paris. Defended on 19th of june 2017: *Structures de Clifford paires et résonances quantiques*. C. Hadfield was a postdoc in UC Berkeley and got hired by Rigetti as a researcher in quantum computing, then by IBM in New York, where he is working now.

5) 2012-2015: co-advisor with N. Anantharaman (Strasbourg) of the thesis of Yannick Bonthouneau, 2012-2015, at ENS Paris. Defended on 10/07/2015. Title: *Résonances du laplacien sur les variétés à pointes*. Yannick was hired as a Chargé de Recherche at CNRS in 2016.

Postdocs

1) 2020-2022: Victor Arnaiz at Univ. Paris Saclay, Orsay.

2) 2019-2021: Mihajlo Cekic at Univ. Paris Saclay, Orsay

3) 2018-2020: Benjamin Küster at Univ Paris Saclay, Orsay.

Other advisees

2018: Master 2 project of Yann Chaubet.
2017: Master 2 project of Thibault Lefeuvre.
Summer 2013: advising during 4 months of P.atrik Munroe, PhD student of D.Jakobson at Mc Gill Univ (Montréal), then visiting at ENS .
2012: Master 1 project by ENS students A. Lourdeau and P.Jeunesse.
2011: Master 1 project by E. Scornet.
2011: Master 1 project by G. Emprin and K. Löser.
2010: Master 1 project by Y. Bonthonneau and R. Jaoui.

Invitations in foreign universities

- * 3 months at MSRI Berkeley as Simons Professor, fall 2019.
- * 2 month as visiting professor at Sydney University, Australia, 02-03/2019.
- * 1 month at CRM Montréal, 07/2012
- * 1 month at ANU, Canberra, Australie, 09/2011.
- * 1 month at MSRI Berkeley, 10/2010.
- * 1 semester at IAS Princeton, 01/2009 - 04/2009.
- * 1 month at MSRI Berkeley, 10/2008.
- * 2 months at Stanford, 10/2007 - 12/2007.
- * 3 months at ANU, Canberra, Australie, 07/2007-10/2007.
- * 6 months at ANU, Canberra, Australia, 11/2005 - 04/2006.

Grants

- * 2017-2022: PI of the ERC consolidator grant project IPFLOW.
- * 2015 - 2020: external member of the grant ARC (Australian Research Council) of A. Hassell, P. Portal, and A. Sikora in Harmonic Analysis.
- * 2014 - 2018: member of the ANR project *Géométrie spectrale, graphes et semi-classique* .
- * 2014 - 2018: member of the ANR project Jeunes Chercheurs *Problèmes Inverses*.
- * 2010-2014: member of the ANR project *Aspect Conforme de la géométrie*.
- * 2009-2013: PI of the ANR project Jeunes Chercheurs JC09-JCJC-0099-01.
- * 2005-2008: member of the ANR project Jeunes chercheurs JC05-46063.
- * 2005-2008: member of the ANR project Jeunes chercheurs JC05-52556.
- * Grant NSF DMS0500788 as Co-PI with A. Sa Barreto (Purdue University).

Honors

- * Bronze medal of CNRS, 2010 (one medal per year in mathematics in France)
- * Invited speaker at the International Congress of Mathematics in 2018, PDE section, Rio de Janeiro
- * Prix Paul Doistau-Emile Blutet of the French Academy of Sciences 2018
- * ERC Consolidator 2017-2022

Named Lectures

- * Pinsky Lectures, Northwestern Univ., 2019
- * Gilbarg Lectures, Stanford Univ., 2018
- * Hausdorff Kolloquium, Bonn, 2015

Member of editorial committees

- * Asterisque (SMF) (2019-)
- * Journal de l'École Polytechnique (2018-)

Responsibilities and evaluation

- * Director of the group *Harmonic Analysis* in the Mathematics Department in Orsay since 2020.
- * Director of the International GDR (CNRS) France-Romania-Hungary, 2018-2022.
- * Member of the hiring committee for Full Professors in Orsay since 2017.
- * Member of the scientific committee of the GDR PDE since 2017.
- * Member of the HCERES committee for the evaluation of Mulhouse Univ. 2016.
- * Hiring committees (assistant and full professor positions): Univ. Paris 12 (2008), Univ. d'Orléans (2011), Univ. Paris 13 (2012). Université de Grenoble (2013), Univ. de Créteil (2014), Univ. de Nice (2014), Univ. de Paris 11 (2016, 2017), Univ. de Metz (2017), Univ. de Nantes (2018), Univ. d'Orsay (2020).
- * Member of thesis juries: B. Devyver (Nantes, 2011), J. Magniez (Bordeaux, 2015), M. Ingremeau (Orsay, 2016), G. Becker (Luxembourg, 2017), S. Finski (Paris 7, 2019), T. Zhu (ENS, 2020).
- * Thesis referee: M. Santacesaria (École Polytechnique 2012), B. Küster (Marburg Univ., 2015), A. Agaltsov (Ecole Poytechnique, 2016), G. Dietrich (Montpellier, 2018), A. Adam (Paris 6, 2018), M. Dutour (Paris 6, 2020).
- * Jury Member for habilitation thesis: F. Naud (Avignon, dec. 2015), Y. Kian (Marseille, 2017), M. Wrochna (Grenoble, Dec 2018), referee for the habilitation of T. Daudé (2019) and S. Tapie (2020).
- * Referee for grants: NSF (US), ERC (EU), PIMS (Banff, Canada), CINECA (Italy), ISF (Israel).
- * Referee for many journals, including Annals of Math, Inventiones, JAMS, Duke Math etc.

Organization of research programs

- * Fall 2019: Organizer of the trimester *Microlocal Analysis* at MSRI, Berkeley, with P. Albin, N. Anantharaman, R. Felea, K. Datchev and A. Vasy.
- * Summer 2015: Organizer of the trimester *Modern theory of wave equations* at the Schrödinger Institute (ESI), with A. Strohmaier, A. Vasy and W. Müller.
- * Spring 2015: Organizer of the trimester *Problèmes Inverses* at IHP Paris, with D. Dos Santos Ferreira and J. Le Rousseau.

Organization of conferences

- * Conference *Ruelle-Pollicott Resonances in Dynamics and in Semi-classical Analysis*, Bernouilli Center Lausanne, 2021.
- * Conference *Rigidity problems in geometry*, Roscoff, 2021.
- * Conference *Ruelle resonances and hyperbolic dynamics*, Porquerolles 2021.
- * Conference *Analytic study of flows*, Peyresq, June 2018.
- * Summer school *Microlocal analysis and applications, LMS-Clay conference*, Cardiff, June 2017.
- * Conference *Mathematical Methods in Inverse Scattering and Spectral Theory*, Leeds, September 2017.
- * Conference *Analyse et Géométrie des résonances*, CIRM Luminy, March 2015
- * Conference *Geometric inverse problems* at IHP Paris, June 2015.
- * Introductory conference for the IHP trimestre Inverse Problems, April 2015, CIRM Luminy.
- * Mini-symposium *Spectral properties of hyperbolic dynamical systems*, during the conference Equadiff 2015 in Lyon, July 2015.
- * workshop *Semi-classical Analysis: Spectral Theory and Resonances* in ESI Vienna, August 2015.
- * Conference *Inverse Problems* at IHP Paris, April 2014.
- * Conference *Quantum chaos, resonances and semi-classical measures*, June 2013, Station Biologique de Roscoff.
- * Mini-workshop *Quantum Chaos*, June 2012, Peyresq.
- * Conference *Spectral gap in dynamical systems, number theory and PDEs* June 2011 at Peyresq.
- * Conference *Geometric Analysis* at CIRM Luminy, January 2011.
- * Conference *Geometric Analysis in Nice* in May 2007 at Université de Nice.

Publication List (available on arXiv and Hal)

10 Selected publications

- 1) N.V. Dang, C. Guillarmou, G. Riviere, S. Shen, *The Fried Conjecture in small dimensions*, **Inventiones Math.** 220 (2020), 525-579.
- 2) C. Guillarmou, R. Rhodes, V. Vargas, *Polyakov's formulation of 2d bosonic string theory*. **Publications mathématiques de l'IHES**, 130 (2019), 11-185.
- 3) C. Guillarmou, T. Lefeuvre, *The marked length spectrum of Anosov manifolds*, **Annals of Math** 190 (2019), no 1., 321-344.
- 4) C. Guillarmou, *Lens rigidity for manifolds with hyperbolic trapped set*, **Journal of AMS**, 30 (2017), 561-599.
- 5) C. Guillarmou, *Invariant distributions and X-ray transform for Anosov flows*, **Journal of Differential Geometry**, 105 (2017), 177-208.
- 6) S. Dyatlov, C. Guillarmou, *Microlocal limits of plane waves and Eisenstein functions*, **Annales de l'ENS**, 47 (2014) no 2, 371-448.
- 7) C. Guillarmou, R. Mazzeo, *Spectral analysis of Laplacian on geometrically finite hyperbolic manifolds*, **Inventiones Math.**, 187 (2012) no 1, 99-144.
- 8) 3) C. Guillarmou, L. Tzou, *Calderon inverse problem with partial data on Riemann surfaces*, **Duke Math. Journal** 158 (2011), no 1. 83-120
- 9) C. Guillarmou, *Generalized Krein formula, determinants and Selberg zeta function in even*

dimension, **American Journal of Math.** 131 (2009), no 5. 1359–1417.

10) C. Guillarmou, *Meromorphic properties of the resolvent on asymptotically hyperbolic manifolds*, **Duke Math. Journal** 129 (2005), no. 1., 1-37.

Full list of publications by year

2020

1) N.V. Dang, C. Guillarmou, G. Riviere, S. Shen, *The Fried Conjecture in small dimensions*, **Inventiones Math.** 220 (2020), 525-579.

2) C. Guillarmou, J. Hilgert, T. Weich, *High frequency limits for invariant Ruelle densities*, **Annales Henri Lebesgue**, to appear.

3) C. Guillarmou, A. Hassell, K. Krupchyk, *Eigenvalue bounds for non-self-adjoint Schrödinger operators with non-trapping metrics*, **Analysis and PDE**, to appear.

4) C. Guillarmou, G. Knieper, T. Lefeuvre, *Geodesic stretch, pressure metric and marked length spectrum rigidity*, **Ergodic Theory and Dynamical Systems**, Special Volume in memory of Anatole Katok. To appear.

5) C. Guillarmou, M. Mazzucchelli, L. Tzou, *Boundary and lens rigidity for non-convex manifolds*, **Amer. Journ. Math.**. To appear.

2019

6) C. Guillarmou, T. Lefeuvre, *The marked length spectrum of Anosov manifolds*, **Annals of Math** 190 (2019), no 1., 321-344.

7) C. Guillarmou, R. Rhodes, V. Vargas, *Polyakov's formulation of 2d bosonic string theory*. **Publications mathématiques de l'IHES**, 130 (2019), 11-185.

8) R. Graham, C. Guillarmou, P. Stefanov, G. Uhlmann, *X-ray transform and boundary rigidity for asymptotically hyperbolic manifolds*, Volume special: Past, Present and Future, an hommage to Marcel Berger, **Annales Institut Fourier**, 69 (2019), no. 7, 2857-2919.

9) C. Guillarmou, M. Salo, L. Tzou, *The linearized Calderón problem on complex manifolds*, special volume in honour of Carlos Kenig. **Acta Math Sinica**, English Series, 35 (2019), no 6 1043-1056.

2018

10) C. Guillarmou, S. Moroianu, J-M. Schlenker, *The renormalized volume and uniformisation of conformal structures*, **Journal Inst. Math. Jussieu**, 17 (2018), no 4, 853–912.

11) C. Guillarmou, M. Mazzucchelli, *Marked boundary rigidity for surfaces*, **Ergodic Theory and Dynamical Systems**, 38 (2018), Issue 4, 1459–1478.

12) C. Guillarmou, J. Hilgert, T. Weich, *Classical and quantum resonances for hyperbolic surfaces*, **Math Annalen** 370 (2018), Issue 3-4, 1231–1275.

13) F. Faure, C. Guillarmou, *Horocyclic invariance of Ruelle resonant states for contact Anosov flows in dimension 3*, **Math Research Letters**, 25 (2018), no 5, 1405–1427.

14) S. Dyatlov, C. Guillarmou, *Dynamical zeta functions for Axiom A flows*, **Bull. AMS**, 55 (2018), 337–342.

2017

- 15) C. Guillarmou, *Invariant distributions and X-ray transform for Anosov flows*, **Journal of Differential Geometry**, 105 (2017), 177-208.
- 16) C. Guillarmou, S. Moroianu, F. Rochon, *Renormalized volume on the Teichmüller space of punctured Riemann surfaces*, **Ann. Scuola Normale Pisa**, 5 (2017), Vol 17, 323-384.
- 17) C. Guillarmou, *Lens rigidity for manifolds with hyperbolic trapped set*, **Journal of AMS**, 30 (2017), 561–599.
- 18) C. Guillarmou, F. Monard, *Reconstruction formulas for X-ray transforms in negative curvature*, **Annales Institut Fourier** 67 (2017), no. 4, 1353–1392.

2016

- 19) C. Guillarmou, G. Paternain, M. Salo, G. Uhlmann, *Integral geometry inverse problem for connections on negatively curved manifolds*, **Comm. Math. Phys**, 343 (2016), no 1, pp 83-127.
- 20) S. Dyatlov, C. Guillarmou, *Pollicott-Ruelle resonances for open systems*, **Annales IHP**, 17 (2016), no 11, 3089–3146.
- 21) D. Borthwick, C. Guillarmou, *Upper bounds on the number of resonances on geometrically finite hyperbolic manifolds*, **Journal of the EMS**, Vol 18 (2016), Issue 5, 997-1041.

2015

- 22) C. Guillarmou, D. Sher, *Low energy resolvent for the Hodge Laplacian: applications to Riesz transform, Sobolev estimates and analytic torsion*, **IMRN**, 2015 (15): 6136–6210.
- 23) S. Dyatlov, F. Faure, C. Guillarmou, *Power spectrum of the geodesic flow on hyperbolic manifolds*, **Analysis and PDE** 8 (2015), 923–1000.

2014

- 24) C. Guillarmou, S. Moroianu, J. Park, *Calderón and Bergman projectors on spin manifolds with boundary*, **Journ. Geom. Anal.**, 24 (2014), no. 1, 298–336.
- 25) C. Guillarmou, S. Moroianu, *Chern-Simons line bundle on Teichmüller space*, **Geometry and Topology**, 18 (2014) 327–377.
- 26) C. Guillarmou, F. Naud, *Equidistribution of Eisenstein series on convex co-compact hyperbolic manifolds*, **Amer. Journ. Math.**, 136 (2014), no 2, 445–479.
- 27) S. Dyatlov, C. Guillarmou, *Microlocal limits of plane waves and Eisenstein functions*, **Annales de l'ENS**, 47 (2014) no 2 ,371–448.
- 28) C. Guillarmou, A. Hassell, *Uniform Sobolev estimates for non-trapping metrics*, **Journ. Inst. Math. Jussieu**, Vol 13, Issue 3, (2014), 599–632.

2013

- 29) C. Guillarmou, A. Hassell, A. Sikora, *Resolvent at low energy III: the spectral measure*, **Trans. AMS**, 365 (2013), no. 11, 6103–6148.
- 30) C. Guillarmou, A. Hassell, A. Sikora, *Restriction and spectral multiplier theorems on asymptotically conic manifolds*, **Analysis and PDE**, 6 (2013), no. 4, 893–950.

- 31) P. Albin, C. Guillarmou, L. Tzou, G. Uhlmann, *Inverse boundary problems for systems in 2 dimensions*, **Annales IHP**, 14 (2013), no. 6, 1551–1571.
- 32) S. Dyatlov, C. Guillarmou, *Scattering phase asymptotics with fractal remainders*, **Comm. Math. Phys.** 324 (2013), no. 2, 425–444. 20 pages. [arXiv:1205.5955]

2012

- 33) C. Guillarmou, R. Mazzeo, *Spectral analysis of Laplacian on geometrically finite hyperbolic manifolds*, **Inventiones Math.**, 187 (2012) no 1, 99–144.

2011

- 34) C. Guillarmou, L. Tzou, *Calderon inverse problem with partial data on Riemann surfaces*, **Duke Math.** 158 (2011), no 1. 83-120.
- 35) C. Guillarmou, M. Salo, L. Tzou, *Inverse scattering at fixed energy for surfaces with Euclidean ends*, **Comm. Math. Phys.**, 303 (2011), no 3, 761-784.
- 36) H. Christianson, C. Guillarmou, L. Michel, *Random walk on surfaces with hyperbolic cusps*, **Annales IHP**, 12 (2011), 743-775.
- 37) C. Guillarmou, L. Michel, *Spectral analysis of random walk operators on Euclidean space*, **Math. Research Letters**, 18 (2011), no 3, 405-424.
- 38) C. Guillarmou, L. Tzou, *Identification of a connection from Cauchy data space on a Riemann surface with boundary*, **GAF**, 21 (2011), no 2, 393–418.
- 39) E. Aubry, C. Guillarmou, *Conformal harmonic forms, Branson-Gover operators and Dirichlet problem at infinity*, **Journ. Eur. Math. Soc.** 13 (2011), no 4, 911-957.

2010

- 40) C. Guillarmou, S. Moroianu, J. Park, *Eta invariant and Selberg zeta function of odd type over convex co-compact hyperbolic manifolds*, **Advances in Math.** 225 (2010), no 5, 2464-2516.
- 41) C. Guillarmou, J. Qing, *Spectral characterization of Poincare-Einstein manifold with infinity of positive Yamabe type*, **Int. Math. Res. Not.** (2010), no. 9, 1720–1740.
- 42) N. Burq, C. Guillarmou, A. Hassell, *Strichartz estimates without loss on manifolds with hyperbolic trapped geodesics*, **GAF** 20 (2010), no. 3, 627–656.

2009

- 43) C. Guillarmou, *Scattering operator on some geometrically finite hyperbolic manifolds*, **Cubo Journal**, 11 (2009), no 5. Special issue for the Proceedings of the 2nd symposium in spectral and scattering theory.
- 44) C. Guillarmou, *Generalized Krein formula, determinants and Selberg zeta function in even dimension*, **American Journal of Math.** 131 (2009), no 5. 1359–1417.
- 45) C. Guillarmou, A. Hassell, *Low-energy asymptotics of the resolvent and Riesz transform for Schrödinger operator on asymptotically conic manifolds. II.*, **Ann. Inst. Fourier** 59 (2009), no 2, 1553-1610.
- 46) C. Guillarmou, A. Sá Barreto, *Inverse Problems for Einstein manifolds*, **Inverse Problems and Imaging**. 3 (2009), no 1, 1-15.

47) C. Guillarmou, F. Naud, *Wave decay on convex co-compact hyperbolic manifolds*, **Comm. Math. Phys.** 287, (2009), no 2, 489-511.

2008

48) C. Guillarmou, A. Sa Barreto, *Scattering and inverse scattering on ACH manifolds*, **J. Reine Angew. Math.** 622 (2008), 1-55.

49) C. Guillarmou, A. Hassell, *Low-energy asymptotics of the resolvent and Riesz transform for Schrödinger operator on asymptotically conic manifolds. I.*, **Math. Annalen.** 341 (2008), no 4, 859-896.

2007

50) C. Guillarmou, L. Guillopé, *The determinant of the Dirichlet-to-Neumann map for surfaces with boundary*, **I.M.R.N.** (2007) no. 22, Art. ID rnm099.

2006

51) C. Guillarmou, *Resonances on some geometrically finite hyperbolic manifolds*, **Comm. in Partial Differential Equations** 31 (2006), 445-467.

52) C. Guillarmou, F. Naud, *Wave 0-trace and length spectrum on convex co-compact hyperbolic manifolds* **Comm. in Analysis and Geometry**, 14 (2006), no 5. 945-967.

2005

53) C. Guillarmou, *Meromorphic properties of the resolvent on asymptotically hyperbolic manifolds*, **Duke Math. Journal** 129 (2005), no. 1., 1-37.

54) C. Guillarmou, *Multiplicity of resonances on asymptotically hyperbolic manifolds*, **Math Research Letters** 12 (2005), no 1, 103-119.

55) C. Guillarmou, *Absence of resonance near the critical line on asymptotically hyperbolic manifolds*, **Asymptotic Analysis** 42 (2005), no 1-2, 105-121.

Preprints

56) C. Guillarmou, M. Mazzucchelli, L. Tzou, *Asymptotically Euclidean metrics without conjugate points are flat*, Preprint arXiv:1909.01488.

57) C. Guillarmou, M. Lassas, L. Tzou, *X-ray transform in asymptotically conic spaces*, Preprint arXiv:1910.09631.

58) C. Guillarmou, B. Kuster, *Spectral theory of the frame flow on hyperbolic 3-manifolds*(with an appendix by Charles Hadfield), Preprint arXiv:2005.08387

59) C. Guillarmou, A. Kupiainen, R. Rhodes, V. Vargas, *Conformal bootstrap in Liouville Theory*, Preprint arXiv:2005.11530.

60) Y. Guedes Bonthonneau, C. Guillarmou, J. Hilgert, T. Weich, *Ruelle-Taylor resonances for Anosov actions*, Preprint arXiv:2007.14275

Books and book chapters

- 1) Z. Djadli, C. Guillarmou, M. Herzlich, *Operateurs geometriques, invariants conformes et varietes asymptotiquement hyperboliques*. Panorama et Synthese SMF, (2008), 171 pages..
- 2) C. Guillarmou, L. Tzou, *Survey on Calderón inverse problem in dimension 2*, Inverse Problems and Applications, Inside Out II, publications MSRI (2012), ed. G. Uhlmann, 119-166. 68 pages.
- 3) C. Guillarmou, *Scattering for the geodesic flow on surfaces with boundary*, **Contemporary Math** 700 (2017), pages 267–284.

Proceedings

- 1) C. Guillarmou, L. Tzou, *Calderon inverse problem on Riemann surfaces*. Proceedings of CMA 44 (2009), 129-142. Volume for the AMSI/ANU workshop on Spectral Theory and Harmonic Analysis.
- 2) C. Guillarmou, *Analytic tools for the study of flows and inverse problems*, Proceeding ICM 2018 Rio de Janeiro, Vol. 2, 2305–2328.