

Dr Vincent Caudrelier

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RESEARCH INTERESTS

I am a mathematical physicist working in integrable systems. Although I specialise in the study of the boundary and defect/impurity problems in such systems, the breadth of my knowledge is not restricted to a particular area of integrable systems but rather covers many different aspects such as quantum and classical, discrete and continuous, finite and infinite dimensional integrable systems. I use algebraic (Yangians, Lie bialgebras), analytic (inverse scattering method, Riemann-Hilbert problems) and geometric (Poisson-Lie groups) methods as required for my investigation. My motivations are not just purely mathematical but I have also proven track records of investigating physical effects in certain quantum field theories. I introduced a new programme of research on the inverse scattering method for integrable PDEs on graphs. This is a natural extension of integrable models with boundaries and defects with the attractive possibility of application to networks of fiber optics. I also develop a covariant approach to integrable hierarchies and the classical r-matrix approach.

PROFESSIONAL BACKGROUND:

- Since March 2016: **Lecturer** at the School of Mathematics, **University of Leeds**.
- Oct 2007 to Feb 2016: **Lecturer** at the Department of Mathematics, **City University London**.
- Oct 2005 to Oct 2007: **EPSRC Research Fellow** at the department of Mathematics, **University of York**.
- Sept 2002 to Sept 2005: **PhD student and teaching assistant** at the Université de Savoie (France)

ACADEMIC BACKGROUND

- 7 June 2005: **PhD awarded with Distinction** (“mention très honorable”, highest grade) by **Université de Savoie**. Speciality: Mathematical Physics.
- June 2002: **Masters of Advanced Study awarded with Distinction** (highest grade) by **University of Cambridge** (UK). Part III of the Mathematical Tripos of DAMTP.
- Oct 2002: **Masters** awarded by the Ecole Nationale Supérieure de l’Aéronautique et de l’Espace (**ENSAE Toulouse**).

PUBLICATIONS

[26] *Interplay between the Inverse Scattering Method and Fokas's Unified Transform with an Application*, Stud. Appl. Math (2017) (published online) and [arXiv:1704.05306](https://arxiv.org/abs/1704.05306).

[25] *On the origin of dual Lax pairs and their r-matrix structure*, J. Geom. Phys. 120 (2017), 106 and [arXiv:1612.04281](https://arxiv.org/abs/1612.04281), with J. Avan.

- [24] *The Quench Map in an Integrable Classical Field Theory: Nonlinear Schrödinger Equation*, J. Phys. **A49** (2016) 445201 and [arXiv:1512.08767](https://arxiv.org/abs/1512.08767), with B. Doyon.
- [23] *Lagrangian and Hamiltonian structures in an integrable hierarchy and space-time duality*, Nucl. Phys. **B902** (2016), 415 and [arXiv:1510.01173](https://arxiv.org/abs/1510.01173), with J. Avan, A. Doikou and A. Kundu.
- [22] *On the Inverse Scattering Method for Integrable PDEs on a Star Graph*, Comm. Math. Phys. **338** (2015), 893 and [arXiv:1409.5277](https://arxiv.org/abs/1409.5277).
- [21] *Multisymplectic approach to integrable defects in the sine-Gordon model*, J. Phys. **A48** (2015) 195203 and [arXiv:1411.5171](https://arxiv.org/abs/1411.5171).
- [20] *A multisymplectic approach to defects in integrable classical field theory*, JHEP **02** (2015), 088 and [arXiv:1411.0418](https://arxiv.org/abs/1411.0418), with A. Kundu.
- [19] *Exact scattering matrix of graphs in magnetic field and quantum noise*, J. Math. Phys. **55** (2014) 083524 and [arXiv:1401.4967](https://arxiv.org/abs/1401.4967), with M. Mintchev, E. Ragoucy.
- [18] *Integrable boundary for quad-graph systems: Three-dimensional boundary consistency*, SIGMA **10** (2014), 014 and [arXiv:1307.4023](https://arxiv.org/abs/1307.4023), with N. Crampé and Q.C. Zhang.
- [17] *Yang-Baxter and reflection maps from vector solitons with a boundary*, Nonlinearity **27** (2014) 1081-1103 and [arXiv:1205.1133](https://arxiv.org/abs/1205.1133), with Q. C. Zhang.
- [16] *Set-theoretical reflection equation: Classification of reflection maps*, J. Phys. **A46** (2013) 095203 and [arXiv:1210.5107](https://arxiv.org/abs/1210.5107), with N. Crampé and Q.C. Zhang.
- [15] *Quantum Wire Network with Magnetic Flux*, Physics Letters **A377** (2013) 1788-1793 and [arXiv:1202.4270](https://arxiv.org/abs/1202.4270), with M. Mintchev and E. Ragoucy.
- [14] *Vector nonlinear Schrödinger equation on the half-line*, J. Phys. **A45** (2012) 105201 and [arXiv:1110.2990](https://arxiv.org/abs/1110.2990), with Q.C. Zhang.
- [13] *Direct computation of scattering matrices for general quantum graphs*, Nucl. Phys. **B828** (2010), 515 and [arXiv:0907.5359](https://arxiv.org/abs/0907.5359), with E. Ragoucy
- [12] *Symmetries of Spin Calogero Models*, SIGMA **4** (2008), 090, and [arXiv:0809.3948](https://arxiv.org/abs/0809.3948) with N. Crampé.
- [11] *On a systematic approach to defects in classical integrable field theories*, IJGMMP **5**, No. 7 (2008), 1085-1108 and [arXiv:0704.2326](https://arxiv.org/abs/0704.2326)
- [10] *Exact energy spectrum for models with equally spaced point potentials*, Nucl. Phys. **B738** (2006), 351 and [cond-mat/0511619](https://arxiv.org/abs/cond-mat/0511619), with N. Crampé.
- [9] *Exact results for the one-dimensional many-body problem with contact interaction: Including a tunable impurity*, Rev. Math. Phys. **19** (2007), 349 and [cond-mat/0501110](https://arxiv.org/abs/cond-mat/0501110), with N. Crampé.
- [8] *Factorization in integrable systems with impurity*, [hep-th/0508157](https://arxiv.org/abs/hep-th/0508157), Czech. J. Phys. **55** (2005), 1365.

[7] *Reflection-Transmission Quantum Yang-Baxter Equations*, J. Phys. **A38** (2005), 3431 and [hep-th/0412159](#), with M. Mintchev, E. Ragoucy and P. Sorba.

[6] *Spontaneous symmetry breaking in the non-linear Schrödinger hierarchy with defect*, J. Phys. **A38** (2005), 2241 and [math-ph/0411022](#), with E. Ragoucy.

[5] *The quantum non-linear Schrödinger model with point-like defect*, J. Phys. **A37** (2004), L367-L376 and [hep-th/0404144](#), with M. Mintchev and E. Ragoucy.

[4] *Solving the quantum non-linear Schrödinger equation with delta-type impurity*, J. Math. Phys. **46** (2004) 042703 and [math-ph/0404047](#), with M. Mintchev and E. Ragoucy.

[3] *Integrable N-particle Hamiltonians with Yangian or Reflection Algebra Symmetry*, J. Phys. **A37** (2004), 6285-6298 and [math-ph/0310028](#), with N. Crampé.

[2] *Lax pair and super-Yangian symmetry of the non-linear super-Schrödinger equation*, J. Math. Phys. **44** (2003), 5706 and [math.QA/0306115](#), with E. Ragoucy.

[1] *Quantum Resolution of the nonlinear super-Schrödinger equation*, Int. J. Mod. Phys. **A19** (2004), 1559 and [math-ph/0306010](#), with E. Ragoucy.

MAJOR RESEARCH ACHIEVEMENTS

- [23,25]: **Uncovered a duality theory within the classical R -matrix method** of classical integrable systems that had remained unnoticed so far, despite decades of thorough investigation.
- [20,21]: **Settled a seven-year-old open question** dealing with the Liouville integrability of certain integrable field theories with defects. This was the origin of the above duality theory.
- [22]: **Provided the first general framework to deal with integrable PDEs on a (star) graph** within the inverse scattering method paradigm. This is the beginning of a major programme with potential applications to the exact analytical study of models for networks of optical fibers.
- [16,17,18]: **Discovered the set-theoretical reflection equation and the first ever solutions** to this equation, as well as a classification of such solutions. Applied this to discrete integrable systems on quad-graphs and discovered the notion of **3D-boundary consistency condition** encapsulating integrable boundary conditions for systems on quad-graphs.
- [15,19]: Identified a **physical effect** on a quantum ring in the form of a **modification of a well-established law** for the temperature dependence of the thermal noise (Johnson-Nyquist law) in the presence of a magnetic field.
- [4,5]: **Produced the first ever example of an integrable quantum field theory with an impurity** using the concept of Reflection-Transmission algebra.

PROFESSIONAL ACTIVITIES

- Since July 2016: **Member of the Editorial Board** of the Proceedings of the Royal Society A
- **Conference organiser**: 21st UK Meeting on Integrable Models, Conformal Field Theory and Related Topics, Leeds, 2017 <https://conferences.leeds.ac.uk/icft2017/>
- **Internal and external examiner** for 6 PhD defences at various UK institutions (City University London, King's College London, University of Leeds)
- **Referee and reviewer** for the EPSRC and several peer-reviewed international journals: Inverse Problems, Nonlinearity, Stud. Appl. Math., J. Math. Phys, J. Phys. A, Phys. Lett. A, JSTAT.

SUPERVISION

- **PhD students**: Matteo Stoppato (since Sept 2017) on "Hamiltonian structures in classical integrable systems". Cheng Zhang (2010-13) on "Continuous and Quad-Graph Integrable Models with a boundary: Reflection Maps and 3D-Boundary Consistency".
- **BSc students**: 6 students on final year projects every year since 2007.

AWARDS and HONOURS

- Nov 2016: One-month **visiting professor position** at the Laboratoire d'Annecy-le-vieux de Physique Théorique, Université de Savoie.
- Oct 2016: One-month **CNRS visiting professor position** at the Laboratoire de Physique Théorique et Modélisation, Université de Cergy-Pontoise.
- 2015: Shortlisted nominee for the City University London **Vice-Chancellor's award for Excellence in Learning and Teaching**.
- 2015: Recipient of the **prestigious Dr V. Ramalingaswami INSA chair**, invited chair position for middle career outstanding scientists awarded by the Indian National Science Academy.
- 2014: Recipient of a **Shapiro visiting professor position** at the Department of Mathematics of Penn State University, USA.
- July/Sept 2014: **Invited professor** position. Two two-week positions at the LAPTH, Annecy-le-vieux, France. Collaboration with Profs E. Ragoucy and M. Mintchev.
- May 2010: **Invited professor** position. One-month position at the LAPTH, Annecy-le-vieux, France. Collaboration with Prof. E. Ragoucy on a project on quantum graphs.
- Jan. 2010: **Visiting researcher**. One-week invitation at the University of Pisa, Italy. Collaboration with Prof. M. Mintchev on a project on quantum graphs.

- December 2009: **Visiting researcher**. One-week invitation at the LAPTH, Annecy-le-vieux, France. Collaboration with Prof. E. Ragoucy on a project on quantum graphs.
- May 2009: **Invited research fellow**. One-month invitation at the LAPTH, Annecy-le-vieux, France. Collaboration with Prof. E. Ragoucy on a project on quantum graphs.
- 2005: Award of a **three-year EPSRC Post-doctoral Fellowship**.
- Oct 2004: One-week **invitation** from the theory group, University of Pisa. Collaboration with M. Mintchev.

INVITATIONS and TALKS

Invited seminars

- Feb 2017 : **Invited seminar** at the Department of Mathematics, University of York, UK.
- Oct 2016: **Invited seminar** at the “Séminaire de géométrie et physique mathématique” by Frédéric Hélein, Institut Mathématique de Jussieu.
- March 2016: **Invited seminar** at the Department of Applied Mathematics and Theoretical Physics, University of Cambridge, UK.
- May 2015: **Invited seminar** at the Department of Mathematics, Heriot-Watt University, Edinburgh, UK.
- May 2015: **Invited seminar** at the School of Mathematics, Statistics and Actuarial Science, University of Kent, UK.
- April 2015: **Invited speaker** at the South East Mathematical Physics Seminar conference, University of Hertfordshire, UK.
- March 2015: **Invited seminar** at the Department of Mathematics and Astrophysics, Northumbria University, UK.
- Nov. 2013: **Invited seminar** at the School of Mathematics and Statistics of the University of Glasgow.
- Feb. 2012: **Invited seminar** at Institut Jean Lamour, LPM Nancy, France.
- Feb 2012: **Invited seminar** at Laboratoire de Mathématiques et Applications de Metz, France.
- June 2011: **Invited talk** at a one-day workshop on final year projects in the School of Mathematics, Statistics & Actuarial Science, University of Kent.
- Feb 2007: **Invited seminar** at City University London.
- Feb 2007: **Invited seminar** at LPTHE Jussieu, Paris.

- Nov 2006: **Invited seminar** at University of Kent.
- Oct 2006: **Invitation** from University of Pisa. Collaboration with M. Mintchev and talk
- April 2006: **Invitation** from LPS Orsay, Paris. Collaboration with J.N. Fuchs and Talk
- April 2006: **Invited seminars** at LPTHE Jussieu, Paris and LPTA, Montpellier.
- Feb 2005: **Invitations** from the University of York, University of Durham and University Heriot-Watt, Edinburgh. Collaboration with N. Crampé and Talks.

Conferences

- August 2016: RAQIS conference, Geneva.
<https://lapth.cnrs.fr/conferences/RAQIS/RAQIS16/>
Speaker: "*Dual Hamiltonian structures in an integrable hierarchy*"
- May 2015: NEEDS 2015 International Conference, Italy.
<http://bugs.unica.it/NEEDS2015/>.
Plenary speaker: "*On the inverse scattering method for the nonlinear Schrödinger equation on a star-graph*".
- Sept 2014: Conference **RAQIS'14: Recent Advances in Quantum Integrable Systems**, Dijon, <http://raqis14.sciencesconf.org/resource/page/id/6>
Speaker: "*Set-theoretical reflection equation in integrable field theories and fully discrete systems*"
- Aug 2014: **New Trends in Quantum Integrability**, Surrey, UK.
- Aug 2014: SIAM Conference on **Nonlinear Waves and Coherent Structures**, Cambridge, UK, <http://www.siam.org/meetings/nw14/>.
- Jan. 2014: **Invited speaker** at the Analysis on Graphs workshop in Royal Holloway, UK.
- Dec. 2013: **Invited speaker** at the Quantum Integrable Systems International Workshop, Bose National Centre, Kolkata, India.
- Sept. 2012: **Plenary Speaker** at the international conference RAQIS in Angers, France. <http://lapth.cnrs.fr/conferences/RAQIS/RAQIS12/>
- Sept. 2011: Conference **CFT And Integrable Models**, Bologna, <http://cft-im.bo.infn.it/2011/>
- Aug. 2011: Conference **Quantum Theory and Symmetries**, Prague, <http://www.km.fjfi.cvut.cz/qts7/>
- July 2007: Conference **Infinite Dimensional Algebras and Quantum Integrable Systems**, <http://www.ualg.pt/idaquis/welcome.html>
Speaker: "*On defects in classical integrable field theories*"

- April 2007: Workshop **Graph Models of Mesoscopic Systems, Wave-Guides and Nano-Structures**, Newton Institute Cambridge.
Website: <http://www.newton.cam.ac.uk/programmes/AGA/agaw03.html>
- Dec 2006: Conference and workshop **Themes in the interface of representation theory and physics**, City University, London.
Website: <http://www.staff.city.ac.uk/~ra359/MEETINGS/conf06.html>
- Sept 2006: Euclid international workshop **Integrable models and applications**, ENS Lyon. Website : <http://perso.ens-lyon.fr/jean-michel.maillet/index.html#table>
- July 2006: 7th Bologna workshop **CFT and Integrable Models**
Website: <http://www-th.bo.infn.it/conferences/cft06/>
Speaker: "*Some applications of the Bethe ansatz in solid state physics*"
- Mai 2006: **Invited speaker** at the conference **Integrable and Conformal Field Theory**, University of Durham. Website : <http://www.cpt.dur.ac.uk/ICFT06/>
- Sept 2005: Workshop **Recent Advances in Quantum Integrable Systems**, LAPTH Annecy. Website : <http://lappweb.in2p3.fr/lapth/RAQIS05/index.html>
Speaker: "*Integrable N-particle Hamiltonians with reflection algebra symmetry*"
- June 2005: International colloquium **Integrable systems and quantum groups**, Prague. Website : <http://kmlinux.fjfi.cvut.cz/~intsystems/2005.php>
Speaker: "*Factorization in integrable systems with impurity*"