1 Curriculum della propria attività accademica, scientifica e professionale

Curriculum Vitae

Name: Jean-Marc Delort.
Birth date: January, 3rd, 1961, in Toulouse (Haute-Garonne, France).
1980–1985: Student at École Normale Supérieure, Paris.
PhD defended in 1984, University of Paris–Sud.
1985–1989: C.N.R.S. Junior Researcher, University of Rennes 1.
1989–1991: C.N.R.S. Junior Researcher, University of Paris–Sud.
Habilitation à diriger des recherches, defended in October 1990, University of Paris–Sud.
1991–1994: 2nd class Professor, University of Paris–Nord.
1994–2006: 1st class Professor, University of Paris–Nord.
2006–2011: Exceptional class Professor, 1st scale, University of Paris–Nord.
2011– : Exceptional class Professor, 2nd scale, University of Paris–Nord.
Distinction: Langevin Prize 2003 of "Académie des Sciences de Paris".
Editorial Activity: **2006–2012** Member of the editorial committee of "Bulletin de la Société Mathématique de France".
PhD students: Nicolas Depauw (defended 1998), Alin-Laurentiu Benoaga (defended 2006), Qidi Zhang (defended 2010), Annalaura Stingo (started 2014).

Main visits and conferences abroad since 2001

- Two weeks invitation at the Department of Mathematics of the Science University of Tokyo, January 2001.
- Invited talk, Schrödinger Institute, Vienna, July 2001, in one of the conferences of the semester "Nonlinear Schrödinger and quantum Boltzmann equations".
- Two weeks invitation, Johns Hopkins University, Baltimore, March 2002.
- One week invitation Zhejiang University in Hangzhou and four days invitation at the Institute of Applied Physics and Computational Mathematics of Beijing, May 2002.
- Invited Speaker at the "EMS Mathematical Week-end" in Lisbon in September 2003.
- Invited Speaker at the conference "Nonlinear Wave and Dispersive Equations", Tohoku University, Sendaï and five days visit at the university of Osaka in December 2003.
- Invited Speaker at the "Workshop on the Mathematical Aspects of Non-linear PDE's" Institute for Advanced Study, Princeton, in March 2004.
- Invited Speaker at the conference "Équations aux dérivées partielles", Hammamet (Tunisia), in September 2005.
- Invited Speaker at the conference "Geometric and Analytical Aspects of Nonlinear Dispersive Equations", MSRI Berkeley, in December 2005.
- Plenary Speaker at the first Franco-Italian congress SIMAI-SMAI-SMF-UMI, "Mathematics and its Applications" Turin, in July 2006.
- Invited Speaker at the conference "Non-linear hyperbolic equations and related topics", Centro de Giorgi, Pisa, in September 2007.
- Talk at the analysis seminar of the ETH, Zürich, November 2007.
- Ten days invitation and conferences at Kyoto university, December 2007.
- Two weeks invitation and conferences, Zhejiang University in Hangzhou, June 2009.

- Two weeks invitation and conferences, Zhejiang University in Hangzhou, June 2010.
- Invited speaker, "JAMI Conference" March 2011, Johns Hopkins University, Baltimore.
- Invited speaker, Conference "KAM and Cauchy theory for PDEs", Ravello, May 2011.
- Invited speaker, Conference "Hamiltonian PDEs", Capri, June 2012.
- Invited speaker, Conference "Nonlinear Hamiltonian PDEs", Ascona, July 2012.
- Invited speaker, Conference "Dynamics of nonlinear dispersive and fluid mechanics equations" Beijing International Center for Mathematical Research, July 2012.
- Series of lectures at the summer school "Nonlinear PDE's from Geometry and Physics" , Università Roma Tre, September 2012.
- Ten days invitation and Conference, Fields Institute, Toronto, May-June 2013, in the framework of the thematic program "Mathematics of the Oceans".
- Invited speaker, Conference "Nonlinear Waves and Dispersive Equations", Oberwolfach, August 2013.
- Ten days invitation and series of lectures, Nanjing University, September 2013.
- Five weeks invitation, Hausdorff Research Institute for Mathematics of the university of Bonn, June-July 2014, in the framework of the program "Harmonic Analysis and Partial Differential Equations", and talk at the conference "Harmonic Analysis Methods in Dispersive PDEs".

Organization of scientific activities

- **Since 1999:** Co-organization with Thomas Kappeler, Herbert Koch and Maciej Zworski of the monthly video-seminar Berkeley-Bonn-Paris-Zurich.
- **2007–2011:** Local coordinator of the ANR project "Equa-disp" involving researchers from the universities of Nice, Paris-Sud, Paris 13 and Rennes.
- Co-organization with F. Klopp of the conference "Théorie spectrale et analyse semi-classique", September 2009, University Paris 13, in honor of Alain Grigis.
- Co-organization with N. Burq of the meeting "Équations d'évolution non-linéaires dispersives", Centre International de Rencontres Mathématiques, Luminy, June 2010.
- Co-organization with Frédéric Klopp and Maciej Zworski of the conference "Ondes en limite semi-classique", in the framework of the Excellence Chair awarded by the University Paris 13 to M. Zworski in 2011.
- **2014–** : Local coordinator of the ANR project ANAÉ, involving researchers from the universities of Nantes, Paris 11 and Paris 13.
- Co-organization with Nicolas Burq, Olivier Lafitte, Laurent Michel and Fabrice Planchon of the conference "Analyse microlocale et applications", Nice, June 2014, in honor of Gilles Lebeau.

2 Elenco delle pubblicazioni

Monography

[1] *F.B.I. transformation. Second microlocalization and semilinear caustics.* Lecture Notes in Mathematics, 1522. Springer-Verlag, Berlin, 1992. vi+101 pp.

Publications in refeered journals

[2] *Estimations fines pour des opérateurs pseudo-différentiels analytiques sur un ouvert à bord de $\mathbb{R}^n$. Application aux équations d'Euler.* Comm. Partial Differential Equations 10 (1985), no. 12, 1465–1525.

[3] *Une propriété de borne uniforme pour la mesure d'une chaîne résolvant un bord sous-analytique.* C. R. Acad. Sci. Paris Sér. I Math. 300 (1985), no. 16, 577–580.

[4] (with G. Lebeau) *Microfonctions I-lagrangiennes.* J. Math. Pures Appl. (9) 67 (1988), no. 1, 39–84.

[5] *Problème mixte hyperbolique avec saut sur la condition aux limites.* Ann. Inst. Fourier (Grenoble) 39 (1989), no. 2, 319–360.

[6] *Deuxième microlocalisation simultanée et front d'onde de produits.* Ann. Sci. École Norm. Sup. (4) 23 (1990), no. 2, 257–310.

[7] *Conormalité des ondes semi-linéaires le long des caustiques.* Amer. J. Math. 113 (1991), no. 4, 593–651.

[8] *Oscillations semi-linéaires multiphasées compatibles en dimension 2 ou 3 d'espace.* Comm. Partial Differential Equations 16 (1991), no. 4-5, 845–872.

[9] *Existence de nappes de tourbillon en dimension deux.* J. Amer. Math. Soc. 4 (1991), no. 3, 553–586.

[10] *Une remarque sur le problème des nappes de tourbillon axisymétriques sur $\mathbb{R}^3$.* J. Funct. Anal. 108 (1992), no. 2, 274–295.

[11] *Singularités conormales non-lipschitziennes pour des lois de conservation scalaires incompressibles.* Comm. Partial Differential Equations 20 (1995), no. 1-2, 179–231. Erratum : Comm. Partial Differential Equations 20 (1995), no. 11-12, 2215–2220.

[12] *Microlocalisation simultanée et problème de Cauchy ramifié.* Compositio Math. 100 (1996), no. 2, 171–204.

[13] *Sur le temps d'existence pour l'équation de Klein-Gordon semi-linéaire en dimension 1.* Bull. Soc. Math. France 125 (1997), no. 2, 269–311.

[14] *Temps d'existence pour l'équation de Klein-Gordon semi-linéaire à données petites périodiques.* Amer. J. Math. 120 (1998), no. 3, 663–689.

[15] *Minoration du temps d'existence pour l'équation de Klein-Gordon non-linéaire en dimension 1 d'espace*, Ann. Inst. H. Poincaré Anal. Non Linéaire 16 (1999), no. 5, 563–591.

[16] (with D. Fang) *Almost global existence for solutions of semilinear Klein-Gordon equations with small weakly decaying Cauchy data*, Comm. Partial Differential Equations 25 (2000), no. 11-12, 2119–2169.

[17] *Existence globale et comportement asymptotique pour l'équation de Klein-Gordon quasi-linéaire à données petites en dimension 1*, Ann. Sci. École Norm. Sup. (4) 34 (2001), no. 1, 1–61. Erratum: Ann. Sci. École Norm. Sup. (4) 39 (2006), no. 2, 335–345.

[18] (with J. Colliander, C. Kenig, G. Staffilani) *Bilinear estimates and applications to 2D NLS*, Trans. Amer. Math. Soc. 353 (2001), no. 8, 3307–3325.

[19] *Global solutions for small nonlinear long range perturbations of two dimensional Schrödinger equations*, Mém. Soc. Math. Fr. (N.S.) No. 91 (2002), vi+94 pp.

[20] (with D. Fang et R. Xue) *Global existence of small solutions for quadratic quasilinear Klein-Gordon systems in two space dimensions*, J. Funct. Anal. 211 (2004), no. 2, 288–323.

[21] (with J. Szeftel) *Long time existence for small data nonlinear Klein-Gordon equations on tori and spheres* Int. Math. Res. Not. (2004), no. 37, 1897–1966.

[22] (with J. Szeftel) *Long-time existence for semi-linear Klein-Gordon equations with small Cauchy data on Zoll manifolds*, Amer. J. Math. 128 (2006), no. 5, 1187–1218.

[23] (with J. Szeftel) *Bounded almost global solutions for non hamiltonian semi-linear Klein-Gordon equations with radial data on compact revolution hypersurfaces*, Ann. Inst. Fourier (Grenoble) 56 (2006), no. 5, 1419–1456.

[24] (with D. Bambusi, B. Grébert et J. Szeftel) *Almost global existence for Hamiltonian semi-linear Klein-Gordon equations with small Cauchy data on Zoll manifolds*, Comm. Pure Appl. Math. 60 (2007), no. 11, 1665–1690.

[25] *On long time existence for small solutions of semi-linear Klein-Gordon equations on the torus*, J. Anal. Math. 107 (2009), 161–194.

[26] *Long-time Sobolev stability for small solutions of quasi-linear Klein-Gordon equations on the circle*, Trans. Amer. Math. Soc. 361 (2009), no. 8, 4299–4365.

[27] *Growth of Sobolev norms of solutions of linear Schrödinger equations on some compact manifolds*, Int. Math. Res. Notices (2010), no. 12, 2305-2328.

[28] *Periodic solutions of non-linear Schrödinger equations: A para-differential approach*, Anal. PDE 4 (2011), no. 5, 639–676.

[29] *A quasi-linear Birkhoff normal forms method. Application to the quasi-linear Klein-Gordon equation on $\mathbb{S}^1$*, Astérisque No. 341 (2012), vi+113 pp. ISBN: 978-2-85629-335-5.

[30] *Growth of Sobolev norms for solutions of time dependent Schrödinger operators with harmonic oscillator potential*, Comm. Partial Differential Equations 39 (2014), no. 1, 1–33.

[31] *Quasi-linear perturbations of Hamiltonian Klein-Gordon equations on spheres*, Memoirs American Mathematical Society, Volume 234, Number 1103, ISBN: 978-1-4704-0983-8.

PREPRINTS

[32] (with T. Alazard) *Sobolev estimates for two dimensional gravity water waves*, preprint, (2013), 239 pages.

[33] (with T. Alazard) *Global solutions and asymptotic behavior for two dimensional gravity water waves*, preprint, (2013), 100 pages, to appear *Ann. scient. Ecole norm. sup.*.

[34] *Semiclassical microlocal normal forms and global solutions of modified one-dimensional KG equations*, preprint, (2014), 68 pages.

PROCEEDINGS

[35] (with G. Lebeau) *Majorations de deuxièmes micro-supports*. Journées "Équations aux dérivées partielles" (Saint Jean de Monts, 1986), No. XIV, 15 pp., École Polytech., Palaiseau, 1986.

[36] *Problème mixte hyperbolique avec saut sur la condition aux limites*. Journées "Équations aux dérivées partielles" (Saint Jean de Monts, 1987), Exp. No. XXII, 9 pp., École Polytech., Palaiseau, 1987.

[37] *Conormalité des ondes semi-linéaires le long des caustiques*. Séminaire sur les Équations aux Dérivées Partielles, 1988–1989, Exp. No. XV, 12 pp., École Polytech., Palaiseau, 1989.

[38] *Deuxième microlocalisation simultanée et applications*. Journées "Équations aux Dérivées Partielles" (Saint Jean de Monts, 1990), Exp. No. VIII, 13 pp., École Polytech., Palaiseau, 1990.

[39] *Existence de nappes de tourbillon pour l'équation d'Euler sur le plan*. Séminaire sur les Équations aux Dérivées Partielles, 1990–1991, Exp. No. II, 12 pp., École Polytech., Palaiseau, 1991.

[40] *Microlocalisation simultanée et problème de Cauchy ramifié*. Séminaire sur les Équations aux Dérivées Partielles, 1992–1993, Exp. No. XI, 20 pp., École Polytech., Palaiseau, 1993.

[41] *Existence des nappes de tourbillon de signe fixe en dimension deux*. Nonlinear partial differential equations and their applications. Collège de France Seminar, Vol. XII (Paris, 1991–1993), 65–74, Pitman Res. Notes Math. Ser., 302, Longman Sci. Tech., Harlow, 1994.

[42] *L'équation de Klein-Gordon à données petites faiblement décroissantes*. Séminaire sur les Équations aux Dérivées Partielles, 1996–1997, Exp. No. V, 14 pp., École Polytech., Palaiseau, 1997.

[43] *Temps d'existence pour l'équation de Klein-Gordon à données petites faiblement décroissantes*, Séminaire sur les Équations aux Dérivées Partielles, 1999–2000, Exp. No. V, 14 pp., École Polytech., Palaiseau, 2000.

[44] *Solutions globales pour l'équation de Schrödinger à non-linéarités quadratiques et à données petites*, Séminaire sur les Équations aux Dérivées Partielles, 2001–2002, Exp. No. XIII, 14 pp., École Polytech., Palaiseau, 2002.

[45] *Presque orthogonalité de produits de fonctions propres et existence en temps grand pour les équations de Klein-Gordon semi-linéaires sur les variétés de Zoll*, Séminaire sur les Équations aux Dérivées Partielles, 2004–2005, Exp. No. XIII, 13 pp., École Polytech., Palaiseau, 2005.

[46] (with J. Szeftel) *Long time existence for small data semilinear Klein-Gordon equations on spheres*, Mathematical aspects of nonlinear dispersive equations, 171–179, Ann. of Math. Stud., 163, Princeton Univ. Press, Princeton, NJ, 2007.

[47] *Normal forms and long time existence for semi-linear Klein-Gordon equations*, Boll. Unione Mat. Ital. Sez. B Artic. Ric. Mat. (8) 10 (2007), no. 1, 1–23.

[48] *Stabilité en temps grand pour les petites solutions d'équations de Klein-Gordon quasilinéaires sur* $\mathbb{S}^1$, Séminaire Équations aux Dérivées Partielles. 2007–2008, Exp. No. XI, 19 pp., École Polytech., Palaiseau, 2009.

3 Titoli utili ai fini della selezione

The title of the planned course is "Global solutions of Klein-Gordon type equations and semi-classical microlocal normal form". This topic is at the heart of some of my research since the beginning of the 2000. Actually, the question of long time existence for solutions of wave or Klein-Gordon equations on $\mathbb{R} \times \mathbb{R}^d$, for small smooth and decaying Cauchy data has been of current interest since the works of John, Klainerman, Shatah during the 1980's. In these problems, the lower the space dimension d, the harder the problem, because the dispersive properties of the linear part of the equation, reflected by the rate of uniform decay of linear solutions, becomes worse and worse as the dimension decreases. For instance, for Klein-Gordon equations, solutions of the problem are global for small enough Cauchy data in dimensions d larger or equal to 2, but are not in dimension one. Several authors worked at finding examples of specific non-linearities for which global existence holds true, and the most general structural condition on the non-linearities that ensures that has been uncovered in my paper [17]. This gave birth to other related works of mine and co-authors (see [19, 20]).
More recently, in related works on water waves equation in collaboration with Thomas Alazard [32, 33], a new approach, relying on semi-classical analysis, has been found for this type of problems. It relies still on the Klainerman vector fields method, that has been paramount in these kind of problems for more than thirty years. Nevertheless, it appeared that it can be modified to work as well for equations that do not possess Klainerman vector fields. This is important, as some equation coming from physics, like the water waves equation in finite depth, do not have Klainerman vector fields, and thus escape the traditional approach of questions of global existence. In [34], a model of such equations has been studied, and it has been shown that combining semi-classical analysis and idea coming from normal forms method, one may bypass the absence of Klainerman vector fields, and obtain global existence results.
The aim of the course will be to give an introduction to semi-classical analysis, apply it to some results of global existence for Klein-Gordon equations, and to discuss next microlocal normal forms and their application to cases for which Klainerman vector fields are not available.