Marco Falconi — Curriculum Vitæ

CONTATTI	Institut für Mathematik	Tel.: +41 44 63 56057/8
	Universität Zürich	Stanza: Y27H06
	Winterthurerstrasse 190	Mail: marco.falconi@math.uzh.ch
	CH-8057, Zürich	Pagina Web: http://user.math.uzh.ch/falconi
	Switzerland	

DATA DI NASCITA   5 Ottobre 1983 a Faenza (RA).

NAZIONALITÀ   Italiana

IMPIEGO

- **Institut für Mathematik – Universität Zürich**

    Postdoc.   **Aprile 2017 - Oggi**

- **Dipartimento di Matematica e Fisica — Università di Roma Tre**

    Assegnista di ricerca, progetto Cond-math.   **Aprile 2016 - Marzo 2017**

- **Institut für Analysis, Dynamik und Modellierung — Universität Stuttgart**

    Assistente di ricerca.   **Ottobre 2015 - Marzo 2016**

- **Centre Henri Lebesgue — Université de Rennes I**

    Postdoc.   **Gennaio 2014 - Settembre 2015**

- **Dipartimento di Matematica — Università di Bologna**

    Postdoc.   **Giugno 2012 - Dicembre 2013**

- **Dipartimento di Matematica — Università di Bologna**

    Dottorato.   **Gennaio 2009 - Maggio 2012**

STUDI   **Alma Mater Studiorum — Università di Bologna**

Dottorato in Matematica.   **Gennaio 2009 - Maggio 2012**

- Discussione: 8 Giugno, 2012
- Tesi: Classical limit of the Nelson model
- Direttore di tesi: Prof. Giorgio Velo
- Commissione: Prof. Piero D'Ancona, Prof. Alberto Parmeggiani, Prof. Marco Peloso

Laurea Specialistica, Fisica teorica   **2005 - 2007**

- Voto: 110/110 e lode
- Tesi: On the regularization of phase-space path integral in curved manifolds
- Relatore: Prof. Fiorenzo Bastianelli

Laurea Triennale, Fisica   **2002 - 2005**

- Voto: 110/110 e lode
- Tesi: Sulla nozione di distinguibilità e degenerazione (in italian)
- Relatore: Prof. Loris Ferrari

ARGOMENTI DI INTERESSE   *Analisi Semiclassica in Dimensione Infinita, Fisica Matematica, Analisi Funzionale*

- Misure di Wigner e Teoremi di Egorov in dimensione infinita

- Derivazione rigorosa di teorie effettive in materia condensata

- Teoria dello scattering per sistemi d'evoluzione lineari e non lineari

- Calcolo pseudodifferenziale proiettivo

- Rinormalizzazione non-perturbativa in Teorie di Campo Quantistiche

Concentration of cylindrical Wigner measures

Sunto: In this brief note we aim to characterize the cylindrical Wigner measures associated to regular quantum states in the Weyl C*-algebra of canonical commutation relations. In particular, we provide conditions, at the quantum level, sufficient to prove the concentration of all the corresponding cylindrical Wigner measures as Radon measures on suitable topological vector spaces. The analysis is motivated by variational and dynamical problems in the semiclassical study of bosonic quantum field theories.

Effective Potentials Generated by Field Interaction in the Quasi-Classical Limit (in collaborazione con M. Correggi)

Sunto: We study the *quasi-classical limit* of a quantum system composed of finitely many non-relativistic particles coupled to a quantized field in Nelson-type models. We prove that, as the field becomes classical and the corresponding degrees of freedom are traced out, the effective Hamiltonian of the particles converges in resolvent sense to a self-adjoint Schrödinger operator with an additional potential, depending on the state of the field. Moreover, we explicitly derive the expression of such a potential for a large class of field states and show that, for certain special sequences of states, the effective potential is trapping. In addition, we prove convergence of the ground state energy of the full system to a suitable effective variational problem involving the classical state of the field.

Cylindrical Wigner measures

Sunto: In this work we characterize the semiclassical, or Wigner, measures associated to regular states that act on the tensor product of a unitary C*-representation of the Heisenberg group of *arbitrary* dimension, and a C*-algebra $\mathfrak{A}$. The Wigner measures are identified with the cluster points of (generalized) sequences of regular states, indexed by the semiclassical parameter $h \to 0$. All the measures are vector-valued, with values in the positive continuous functionals of $\mathfrak{A}$. If the Heisenberg group is infinite dimensional, the Wigner measures are cylindrical measures, *i.e.* finitely additive measures on the algebra of (dual) cylinders. Our analysis shows that, for infinite-dimensional Heisenberg groups, the semiclassical structure that emerges in the limit is richer than in the finite-dimensional case.

Scattering theory for Lindblad master equations (in collaborazione con J. Faupin, J. Fröhlich e B. Schubnel)

Sunto: We study scattering theory for a quantum-mechanical system consisting of a particle scattered off a dynamical target that occupies a compact region in position space. After taking a trace over the degrees of freedom of the target, the dynamics of the particle is generated by a Lindbladian acting on the space of trace-class operators. We study scattering theory for a general class of Lindbladians with bounded interaction terms. First, we consider models where a particle approaching the target is always re-emitted by the target. Then we study models where the particle may be captured by the target. An important ingredient of our analysis is a scattering theory for dissipative operators on Hilbert space.

Bohr's correspondence principle in quantum field theory and classical renormalization scheme: the Nelson model (in collaborazione con Z. Ammari)

Sunto: In the mid Sixties Edward Nelson proved the existence of a consistent quantum field theory that describes the Yukawa-like interaction of a non-relativistic nucleon field with a relativistic meson field. Since then it is thought, despite the renormalization procedure involved in the construction, that the quantum dynamics should be governed in the classical limit by a Schrödinger-Klein-Gordon system with Yukawa coupling. In the present paper we prove this fact in the form of a Bohr correspondence principle. Besides, our result enlighten the nature of the renormalization method employed in this model which we interpret as a strategy that allows to put the related classical Hamiltonian PDE in a normal form suitable for a canonical quantization.

On the rate of convergence for the mean field approximation of Bosonic many-body quantum dynamics (in collaborazione con Z. Ammari e B. Pawilowski)

Sunto: We consider the time evolution of quantum states by many-body Schrödinger dynamics and study the rate of convergence of their reduced density matrices in the mean field limit. If the prepared state at initial

time is of coherent or factorized type and the number of particles n is large enough then it is known that $1/n$ is the correct rate of convergence at any time. We show in the simple case of bounded pair potentials that the previous rate of convergence holds in more general situations with possibly correlated prepared states. In particular, it turns that the coherent structure at initial time is unessential and the important fact is rather the speed of convergence of all reduced density matrices of the prepared states. We illustrate our result with several numerical simulations and examples of multi-partite entangled quantum states borrowed from quantum information.

Self-Adjointness criterion for operators in Fock spaces **Math. Phys. Anal. Geom. 18, No.1 (2015)**

Sunto: In this paper we provide a criterion of essential self-adjointness for operators in the tensor product of a separable Hilbert space and a Fock space. The class of operators we consider may contain a self-adjoint part, a part that preserves the number of Fock space particles and a non-diagonal part that is at most quadratic with respect to the creation and annihilation operators. The hypotheses of the criterion are satisfied in several interesting applications.

Wigner measures approach to the classical limit of the Nelson model: Convergence of dynamics and ground state energy (in collaborazione con Z. Ammari) **J. Stat. Phys. 157, No.2 330-364 (2014)**

Sunto: We consider the classical limit of the Nelson model, a system of stable nucleons interacting with a meson field. We prove convergence of the quantum dynamics towards the evolution of the coupled Klein-Gordon-Schrödinger equation. Also, we show that the ground state energy level of N nucleons, when N is large and the meson field approaches its classical value, is given by the infimum of the classical energy functional at a fixed density of particles. Our study relies on a recently elaborated approach for mean field theory and uses Wigner measures.

Global Solution of the Electromagnetic Field-Particle System of Equations

J. Math. Phys. 55, 101502 (2014)

Sunto: In this paper we discuss global existence of the solution of the Maxwell and Newton system of equations, describing the interaction of a rigid charge distribution with the electromagnetic field it generates. A unique solution is proved to exist (for regular charge distributions) on suitable homogeneous and non-homogeneous Sobolev spaces, for the electromagnetic field, and on coordinate and velocity space for the charge; provided initial data belong to the subspace that satisfies the divergence part of Maxwell's equations.

Mean field limit of bosonic systems in partially factorized states and their linear combinations

arXiv e-Print (2013)

Sunto: We study the mean field limit of one-particle reduced density matrices, for a bosonic system in an initial state with a fixed number of particles, only a fraction of which occupies the same state, and for linear combinations of such states. In the mean field limit, the time-evolved reduced density matrix is proved to converge: in trace norm, towards a rank one projection (on the state solution of Hartree equation) for a single state; in Hilbert-Schmidt norm towards a mixed state, combination of projections on different solutions (corresponding to each initial datum), for states that are a linear superposition.

Classical limit of the Nelson model with cut off **J. Math. Phys. 54 012303 (2013)**

Sunto: In this paper we analyze the classical limit of the Nelson model with cut off, when both non-relativistic and relativistic particles number goes to infinity. We prove convergence of quantum observables to the solutions of classical equations, and find the evolution of quantum fluctuations around the classical solution. Furthermore we analyze the convergence of transition amplitudes of normal ordered products of creation and annihilation operators between different types of initial states. In particular the limit of normal ordered products between states with a fixed number of both relativistic and non-relativistic particles yields an unexpected quantum residue: instead of the product of classical solutions we obtain an average of the product of solutions corresponding to varying initial conditions.

Mode Regularization for N = 1,2 SUSY Sigma Model (in collaborazione con R. Bonezzi)

Sunto: Worldline $N = 1$ and $N = 2$ supersymmetric sigma models in curved background are useful to describe spin one-half and spin one particles coupled to external gravity, respectively. It is well known that worldline path integrals in curved space require regularization: we present here the mode-regularization for these models, finding in particular the corresponding counterterms, both in the case of flat and curved indices for worldline fermions. For $N = 1$, using curved indices we find a contribution to the counterterm from the fermions that cancels the contribution of the bosons, leading to a vanishing total counterterm and thus preserving the covariance and supersymmetry of the classical action. Conversely in the case of $N = 2$ supersymmetries we obtain a non-covariant counterterm with both curved and flat indices. This work completes the analysis of the known regularization schemes for $N = 1,2$ nonlinear sigma models in one dimension.

ATTI DI SEMINARI   *Semiclassical Analysis in Infinite Dimensions: Wigner Measures*

Sunto: We review some aspects of semiclassical analysis for systems whose phase space is of arbitrary (possibly infinite) dimension. An emphasis will be put on a general derivation of the so-called Wigner classical measures as the limit of states in a non-commutative algebra of quantum observables.

COMUNICAZIONI ORALI

LAGA, Université Paris 13, Paris (Francia)
- *Cylindrical Wigner Measures in Bosonic systems*   **5 Luglio, 2017**
  Champ moyen quantique et problèmes liés

Universität Stuttgart, Stuttgart (Germania)
- *External Potentials Generated by the Interaction with a Semiclassical Field.*   **5 Aprile, 2017**
  Spectral Days 2017

IRMAR, Rennes (Francia)
- *Potentiels effectifs dans l'approximation quasi-classique.*   **16 Marzo, 2017**
  Journée Thématique EDP: Mathematical Analysis of Interacting Quantum Systems

Università La Sapienza, Roma (Italia)
- *External Potentials Generated by the Interaction with a Semiclassical Field*   **23 Novembre, 2016**
  Seminario di Fisica Matematica

Université de Reims, Reims (Francia)
- *Wigner semiclassical measures in bosonic quantum field theories*   **17 Novembre, 2016**
  Journées Mesures en dimension infinie et applications

IMI Kyushu University, Fukuoka (Giappone)
- *Bohr's correspondence principle in the Nelson model*   **6 Giugno, 2016**
  Mathematical quantum field theory and related topics

Dipartimento di Matematica e Fisica Roma Tre, Roma
- *Scattering theory for Lindblad-type open systems*   **26 Aprile, 2016**
  Seminari di Fisica matematica

Casa della Gioventù Universitaria, Bressanone
- *Scattering theory in open quantum systems: Lindblad-type evolutions*   **11 Febbraio, 2016**
  Mathematical Challenges in Quantum Mechanics

Mathematisches Institut LMU, München (Germania)
- *Bohr's Correspondence Principle for the Nelson Model*   **3 Febbraio, 2016**
  Oberseminar Mathematische Physik

Dipartimento di Matematica, Bologna
- *Semiclassical Analysis in Infinite Dimensions: Wigner measures*   **27 Novembre, 2015**
  Seminario di analisi matematica Bruno Pini

Dipartimento di Matematica e Fisica, Roma
- *Bohr's correspondence principle and renormalization:*   **5 Novembre, 2015**
  linking the Nelson model and the Schrödinger-Klein-Gordon system
  Seminario di fisica matematica, Università di Roma Tre

ANR SQFT, Île de Porquerolles (Francia)
- *Bohr's correspondence principle and classical dressing renormalization*   **11 Giugno, 2015**
  in the Nelson model
  ANR SQFT 3rd Meeting

Mathematik fakultät, Stuttgart (Germania)
- *Essential self-adjointness of operators in Fock space:*   **2 Giugno, 2015**
  a simple proof for "quadratic interactions"
  Graduiertenkolleg 1838 Guest Lecture

IRMAR, Rennes (Francia)
- *Auto-adjonction des opérateurs quadratiques dans les espaces de Fock*   **23 Marzo, 2015**
  Séminaire Landau

Institut Élie Cartan de Lorraine, Metz (Francia)
- *Rate of convergence towards Hartree dynamics for generic quantum states*   **6 Marzo, 2015**
  Séminaire EDP, Analyse et Applications

ANR LODIQUAS, Saint-Malo (Francia)
- *Bounds on the convergence towards mean field dynamics*   **9 Dicembre, 2014**
  for systems of many bosons
  Rencontre LODIQUAS 2014

Università di Milano-Bicocca, Milano
- *Global solution of the Newton-Maxwell equations by energy-type inequalities*   **28 Novembre, 2014**
  Seminari del Dipartimento di Matematica e Applicazioni

IRMAR, Rennes (Francia)
- *Limite classique et équations de Schrödinger-Klein-Gordon*   **23 Ottobre, 2014**
  Séminaire d'équations aux dérivées partielles

Wolfgang Pauli Institute, Vienna (Austria)
- *Schrödinger-Klein-Gordon system as the classical limit*   **10 Ottobre, 2014**
  of a Quantum Field Theory dynamics
  Workshop on Dispersive equations with nonlocal dispersion - III

GDR DynQua, Roscoff (Francia)
- *Classical and mean field limit of field-particle systems*   **5 Febbraio, 2014**
  2014 Annual Meeting

IRMAR, Rennes (Francia)
- *Global Solution of the Electromagnetic Field-Particle System of Equations*   **10 Gennaio, 2014**
  Groupe de travail EDP

SOGGIORNI SCIENTIFICI

Corta durata

- *IRMAR Rennes (invitato da Zied Ammari)*   **13-17 Marzo, 2017**

- *Kyushu University (invitato da Fumio Hiroshima)*   **6-17 Giugno, 2016**

- *Ludwig-Maximilians-Universität München (invitato da Peter Pickl)*   **2-4 Febbraio, 2016**

- *Stuttgart Universität (invitato da Marcel Griesemer)*   **1-3 Giugno, 2015**

- *Institut Élie Cartan de Lorraine (invitato da Jérémy Faupin)*   **6-14 Marzo, 2015**

- *Università di Milano-Bicocca (invitato da Diego Noja)*   **24-28 Novembre, 2014**

INSEGNAMENTO	**Università La Sapienza**

Università La Sapienza

Minicorso per gli studenti di dottorato   **Novembre 2016**

- *An introduction to semiclassical analysis in infinite dimensions, and its applications to mean and quantum field theories*

Universität Stuttgart

Assistente all'insegnamento   **Ottobre 2015-Marzo 2015**

- Analysis I, Lehramtsstudiengang Mathematik (Analisi I, corso di Laurea in Matematica).

IRMAR — Université de Rennes I

Corso di dottorato (in francese)   **Gennaio-Febbraio 2015**

- *Relations de commutation canoniques: représentations en systèmes fini ou infini-dimensionnels*

Alma Mater Studiorum — Università di Bologna

Tutor/Membro delle commissioni d'esame, Facoltà di Architettura   **2009-2013**

- Istituzioni di Matematica, CdL Architettura e Processo Edilizio
- Istituzioni di Matematiche I e II, Cdl Architettura

Facoltà di Ingegneria, Tutor   **2010**

- Analisi Matematica per l'Ingegneria Informatica, CdL in Ingegneria Informatica

QUALIFICHE E ABILITAZIONI

Maître de Conferences

Qualification aux fonctions de Maître de conférences   **2014-2018**
Ministère de l'Enseignement supérieur et de la Recherche

AFFILIAZIONI

Progetto FIR "Cond-Math"   **2016**

Graduiertenkolleg 1838: Spectral Theory and Dynamics of Quantum Systems (GRK1838)   **2015, 2016**

Laboratoire d'Excellence Centre Henri Lebesgue   **2014, 2015**

Société Mathématique de France (SMF)   **2014, 2015, 2016, 2017**

European Mathematical Society (EMS)   **2015, 2016, 2017**

American Mathematical Society (AMS)   **2016, 2017**

*International Association of Mathematical Physics (*M∩Φ*)*   **2014, 2015, 2016, 2017**

PREMI, BORSE DI STUDIO, FINANZIAMENTI

Contratti di Postdoc

Sei mesi, Universität Zürich   **Aprile - Settembre 2017**
Research Assistant

Dodici mesi, Università di Roma Tre   **Aprile 2016 - Marzo 2017**
Assegnista di Ricerca --- FIR project Cond-Math

Sei mesi, Universität Stuttgart   **Ottobre 2015 - Marzo 2016**
Research Assistant

Dodici mesi, Centre Henri Lebesgue   **Ottobre 2014 - Settembre 2015**
programme "Investissements d'avenir" --- ANR-11-LABX-0020-01

Nove mesi, Centre Henri Lebesgue   **Gennaio - Settembre 2014**
programme "Investissements d'avenir" --- ANR-11-LABX-0020-01

Borsa di Dottorato

Tre anni, Università di Bologna   **2009, 2010, 2011**

PARTECIPAZIONE A CONVEGNI	*Journées mesures en dimension infinie et applications* Reims, France Relatore invitato	**17-18 Novembre, 2016**
	Mathematical quantum field theory and related topics Fukuoka, Giappone Relatore invitato	**6-8 Giugno, 2016**
	Meeting SQFT 2016 Île de Porquerolles, Francia	**23-27 Maggio, 2016**
	GRK1838 Workshop 2016 Heinrich Fabri Institut Blaubeuren, Germania	**14-18 Marzo, 2016**
	Mathematical Challenges in Quantum Mechanics Bressanone Relatore	**8-13 Febbraio, 2016**
	Meeting SQFT 2015 Île de Porquerolles, Francia Relatore invitato	**11-13 Giugno, 2015**
	Mathematical physics (GDR DynQua—ANR Nosevol) Nantes, Francia	**2-6 Febbraio, 2015**
	Rencontre LODIQUAS 2014 Saint-Malo, Francia Relatore invitato	**8-10 Dicembre, 2014**
	Dispersive equations with nonlocal dispersion - III Wolfgang Pauli Institute Vienna, Austria Relatore invitato	**6-10 Ottobre 2014**
	Workshop SQFT 2014 Île de Porquerolles, Francia	**5-7 Giugno, 2014**
	Rencontre Nosevol #3 IRMAR Rennes, Francia	**7-9 Aprile, 2014**
	GDR DynQua annual meeting 2014 Roscoff, Francia Relatore invitato	**5-7 Febbraio, 2014**
	Perspectives in Phase Space Analysis of PDE's Bertinoro	**27-30 Settembre, 2011**
	Asymptotic Properties of Solutions to Hyperbolic Equations Imperial College London, Regno Unito	**21-25 Marzo, 2011**
	Fourth School and Workshop on Mathematical Methods in Quantum Mechanics Bressanone	**14-19 Febbraio, 2011**
	Seminal Interactions between Mathematics and Physics Accademia Nazionale dei Lincei, Roma	**22-25 Settembre, 2010**
CONOSCENZE LINGUISTICHE	*Italiano*	Madrelingua
	Inglese	Fluente
	Francese	Conoscenza ottima