Wilczek Quantum Center (WQC)

维尔切克量子中心

上海交通大学
SHANGHAI JIAO TONG UNIVERSITY

WQC 维尔切克量子中心

维尔切克量子中心在2014年创始于杭州，2017年夏季正式加盟上海交通大学， 成立为新的理论物理研究中心。该中心依托物理与天文学院，并得到李政道研究所的大力支持，定位为世界一流的理论物理研究中心。目前，维尔切克量子中心已有正教授3人，长聘教轨副教授3人，国家外专局高端外国专家4名。其中诺贝尔物理学奖得主1人，芬兰皇家科学院院士1人，国家“海外高层次人才”1人， 国家“海外高层次青年人才” 2人。计划引进15名左右国家青年千人或以上级别专家。Wilczek量子中心的目标任务是从事量子物理的前沿研究，建设世界一流的理论物理研究中心，提升上海物理学科的国际显示度和知名度。

Wilczek Quantum Center (WQC), initially founded at Hangzhou in 2014, moved to SJTU to become a new center for theoretical physics in Summer 2017. WQC is a unit of School of Physics & Astronomy, and has a strong connection with Tsung-Dao Lee Institute (TDLI). Currently, WQC has 15 faculty members, including the Chief Scientist (Frank Wilczek), 6 full professors, 4 associate members, and 4 foreign adjunct professors. The research areas of WQC include theory of quantum matter, quantum optics, quantum information, and statistical physics. WQC is striving to become a world class theoretical quantum physics center with top-level reputation.

导师介绍 OUR FACULTY

Frank Wilczek 首席科学家
2004年诺贝尔物理学奖获得者
美国科学院，瑞典皇家科学院院士
李政道研究所所长，美国MIT,
Arizona State、**瑞典**Stockholm Univ **教授**

刘文胜 教授
美国物理学会会士 （2017）
国家“海外高层次人才”（2016）
全球华人物理和天文学会“杰出青年研究员”
研究领域： 凝聚态及冷原子物理

邢向军 教授
上海 “海外高层次人才”（2010）
研究领域： 统计物理，软凝聚态理论
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电子邮箱： xxing@sjtu.edu.cn

蔡子 副教授
国家 “海外高层次青年人才” (2017)
上海 “海外高层次人才” (2017)
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Matteo Baggioli **副教授**
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Carlos Navarrete-Benlloch **副教授**
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Mehdi ABDI **副教授**
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电子邮箱： mehabdi@gmail.com

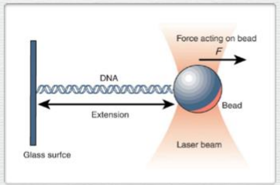
邢向军 教授 -非平衡态统计物理研究

邢向军教授，
1993年南京大学数学学士，2003年科罗拉多大学物理博士，
曾在美国UCSB，UIUC，Syracuse等地学习、工作。
2010年加入上海交通大学物理与天文学院。

研究领域：统计物理、软物质理论、复杂系统，
目前主要研究：非平衡态统计物理，社会科学中的多体现象
研究手段：场论、渐近分析、微分几何、数值模拟等。
欢迎对理论物理有强烈兴趣的学生加盟！

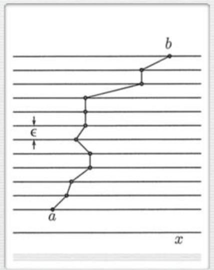
非平衡态小系统的热力学理论

- 非平衡态的熵如何定义？非平衡小系统的功、热如何定义？
- 如何建立与环境有强相互作用的小系统的热力学理论？
- 热力学第二定律对任意非平衡过程成立吗？
- 什么是强耦合极限下的涨落定理？
- 非平衡定态有涨落耗散定理吗？
- 非平衡态有极小耗散定律吗？



弯曲空间的路径积分方法

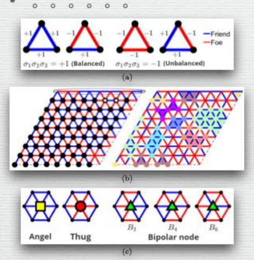
- 弯曲空间量子力学、量子场论（量子重力理论），随机过程等
- 路径积分表示：维纳，狄拉克-》费曼，
- 在弯曲空间中，路径积分方法存在极大的不确定性，存在性没有严格的数学证明
- 我们最近用渐近分析方法彻底解决了这些问题
- 下一步：弯曲空间量子场论的协变性问题

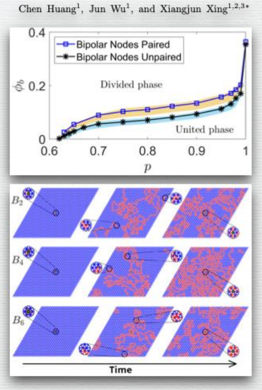


社会网络中极端性格导致的分裂现象

- “朋友的朋友是朋友”
- “敌人的敌人是朋友”
- “敌人的朋友是敌人”
- ○ ○ ○ ○ ○ ○

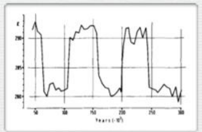
Chen Huang[1], Jun Wu[1], and Xiangjun Xing[1,2,3]

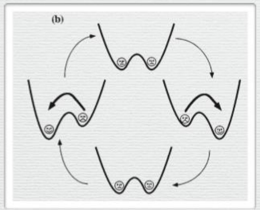


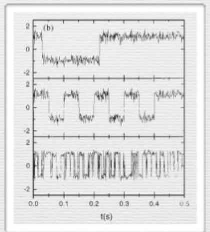


Study of Stochastic Resonance (随机共振)

- Laser, chemical reaction, biological systems, climate changes….
- Resonance between noises and periodic driving leads to barrier hopping.
- Using path integral method
- Instanton solution







蔡子 副教授 - 量子多体计算方法和非平衡强关联系统

- **个人简介** 2010年博士毕业于中科院物理所，2010~2016年分别在美国加州大学圣迭戈分校，德国慕尼 黑大学，奥地利科学院量子光学与量子信息研究所从事博士后研究， 2016年9月起任上海交通大学物 理与天文学院准聘副教授，博士生导师，入选为国家"海外高层次青年人才"。研究方向为量子多体物理数值计算， 包括量子蒙特卡洛和密度矩阵重整化群，超冷原子，量子非平衡开放系统，机器学习等。

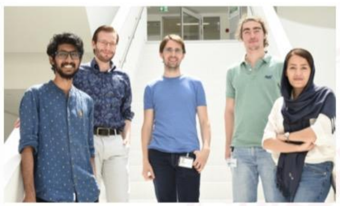
- **招生计划** 博士生1名

在研课题

Carlos Navarrete-Benlloch 副教授

Open and Nonequilibrium Quantum Optics group

THE TEAM



We are an international team led by Prof. Carlos Navarrete-Benlloch, and including two postdoc (from China and Iran), two PhD students (from Belgium and Pakistan), and two undergrad students (from Germany and China).

More info: **www.carlosnb.com**

What we expect from you:

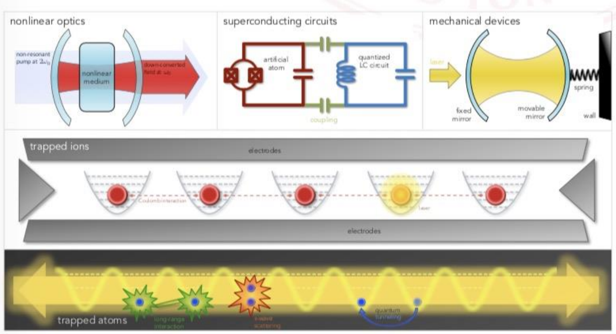
- Motivation to learn physics
- Desire to work in a team
- Passion for quantum physics
- Strength to bring your original ideas
- Humility to listen to others

Brief bio of your potential advisor:

Carlos Navarrete-Benlloch got his PhD in theoretical physics in 2011, for work developed mainly at the University of Valencia (Spain), but also at the Max-Planck Institute of Quantum Optics (Germany), the Massachusetts Institute of Technology (USA), and Swinburne University (Australia). He continued his postdoctoral career at the Max-Planck Institute of Quantum Optics (2012-2016) and the one for the Science of Light (2016-2019), where he became research group leader during the last two years. Now he is an Associate Professor (tenure track) at the Wilczek Quantum Center (School of Physics and Astronomy, SJTU).

OUR RESEARCH

Our research is at the interface between theoretical quantum physics and modern technological applications, in a field that has come to be known as *quantum optics*. Specifically, our main topics are:



- Theoretical description of modern quantum-optical platforms (see figure)
- Mathematical techniques for open and nonequilibrium quantum systems
- Experimental proposal for the implementation of interesting models
- Quantum phase transitions and their applications to state preparation
- Quantum simulation in novel regimes

More info and publications at:
www.carlosnb.com

- **个人简介**Carlos Navarrete-Benlloch于2011年获得西班牙瓦伦西亚大学物理博士学位。2012-2017年，在德国马普量子光学所（慕尼黑)和马普光科学所等著名研究组从事博士后研究. 2018年获得马普光科学所Junior research group leader职位。作为资深博后，本人曾协助指导数名博士生和博士后，其中一名博士生获得瓦伦西亚大学优秀毕业生的最高学术荣誉。本人从事量子光学理论的前沿研究，做出了多项有国际影响的研究成果，得到国际同行尤其是实验组的高度认可，已发表论文27篇，包括物理评论快报6篇，其中第一作者4篇（共同1篇）；撰写专著2本；曾获德国洪堡基金会的博士后奖，两次在国际光学大会上做邀请报告，并作为青年科学家代表参加与25名诺贝尔奖科学家的对话会（Lindau，2013）。

- **招生计划** 博士生1名

Matteo Baggioli 副教授 TheoryLab Group Interdisciplinary theoretical physics

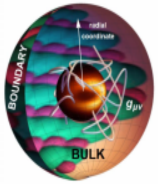
SJTU

- **个人简介** Matteo Baggioli于2016年在西班牙Universitat Autonoma de Barcelona 获得物理博士学位。2016-2018年，在希腊University of Crete,从事博士后研究，2018年获得马普光科学所Junior research group leader职位。2018年开始在Institute for Theoretical Physics IFT-CSIC/UAM, Madrid, Spain任职Severo Ochoa Postdoctoral fellow。长期以来，Baggioli 教授从事量子引力和凝聚态理论的前沿研究，做出了多项有国际影响的研究成果，得到国际同行尤其是实验组的高度认可，已经发表论文43篇，包括物理评论快报4篇；撰写专著1本；在各种学术机构和会议上做报告70多次。

- **招生计划** 博士生1名

在研课题

Applied Holography



What do gravity and field theory have in common ?

Can we understand condensed matter systems using black holes ?

Why do black holes behave as strongly coupled fluids ?

In recent years, surprising and deep connections between gravity, hydrodynamics, quantum field theory and quantum information have been revealed. The most profound of them is the so-called holographic correspondence which establishes a direct connection between gravitational theories and strongly coupled/correlated systems. This theoretical framework has emerged as an incredibly powerful tool to investigate several unresolved problems from different fields: condensed matter, QCD, hydrodynamics, and many more. The full shebang is highly interdisciplinary and it mixes a large variety of methods and systems providing a very broad view on some of the most important open questions in Theoretical physics. At TheoryLab, we are investigating this theoretical framework in several aspects with the goal of shedding light on these fundamental connections and especially with the goal of applying this tool to some of the most profound mysteries in Nature.

Effective field theory & Hydrodynamics

Why hydrodynamics is ubiquitous in nature and why does it work so well ?

How much can we explain of a system knowing only few relevant degrees of freedom ?

Can we classify all phases of matter using symmetries ?

Complex systems involve usually a large plethora of emergent collective phenomena which are hidden behind a complicated many body dynamics. "More is different" and more is usually complicated. A microscopic reductionist approach is hopeless. Could you imagine to describe the waves in the Ocean using the dynamics of the single water molecules?! Nevertheless, most of these systems display several universal features which are often insensitive to the specific details of the system. The idea is to stop being slaves of the microscopics and assume a broader perspective on the problem based on few but fundamental ingredients. Symmetries are the key. The big question in this picture is how far can we go only knowing few information such as symmetries? And surprisingly the answer is a lot! This is exactly the main logic behind effective field theories and hydrodynamics. Given the independence on the microscopic details, these theories display a huge range of applicability which span very different scales and systems.

Soft matter theory

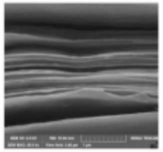
What is a glass ?

Are liquids and solids different from a symmetric point of view ? Can we predict liquids properties from theory ?

Can we predict the properties of amorphous & disordered systems using field theory ?

Liquids, amorphous systems and glasses are ubiquitous around us and they are extremely importance for material design, technological applications and life. Nevertheless, differently from gases and solids, these systems are extremely poorly understood from the theoretical point of view. We do not have even a precise definition accounting for their differences based on fundamental principles and symmetries. Fortunately, we have at our disposal a large number of experiments and simulations results which scream for a theoretical explanation. How are liquids different from solids? Are glasses liquids, solids or a class on their own? How can we explain from fundamental principles the differences in thermodynamic, vibrational modes, mechanical response, etc ? These are only few of the questions which we are addressing at TheoryLab in Shanghai.

Theoretical condensed matter



Can we enhance superconductivity using strain, pressure and topology ?

Do universal bounds on transport & diffusive processes exist in nature (and why) ?

What is the origin of strange metals ?

Condensed matter physics is both useful and fundamental. Condensed matter systems are very diverse and they present incredibly interesting properties such as superconductivity, topological phases, anomalies and many more. Condensed matter is not only the study, design and implementation of materials but it is also an endless factory of questions for theorists which especially in the recent years have produced impressive results and overlaps with high energy theory, hydrodynamics, quantum information theory and even gravity. Theory without data is myth, but data without theory is madness. Here, at TheoryLab, we are eager to help our condensed matter colleagues to reveal the most intricate theoretical structures in nature and predicts new and useful properties for the materials in our labs.