

# Quantum Transport in Topological Materials

XXIV International Summer School 'Nicolás Cabrera'

September 4-8, 2017

Miraflores de la Sierra

When: September 4-8, 2017

Where: Residencia La Cristalera, Miraflores de la Sierra, Madrid, Spain

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Alfredo Levy Yeyati, IFIMAC, UAM

School Scopes and Goals

**T**opological materials constitute an exciting and very active research area in condensed matter physics. It studies new states of matter whose bulk properties are similar to those of 'ordinary' materials but that, at the same time, display edge or boundary states with very exotic properties. Since the discovery of topological insulators, roughly a decade ago, the field has rapidly expanded with the identification of other topological materials, such as topological superconductors and Weyl semimetals. This Summer School will gather leading international experts to provide an introduction to the basic concepts underlying topology in condensed matter systems, followed by a discussion of recent developments, with a focus on quantum transport and hybrid devices. The goal is to cover not only theoretical aspects, but to also address the experimental progress, including the detection and manipulation of states associated with these materials.

School Topics

Hybrid devices (quantum dots, nanowires, heterostructures).

Topological insulators and superconductors.

Weyl semimetals.

Topological quantum computing.

Invited Speakers

Ramón Aguado (ICMM-CSIC, Madrid)

Alberto Cortijo (ICMM-CSIC, Madrid)

Silvano De Franceschi (CEA, Grenoble)

Reinhold Egger (Heinrich Heine Univ., Düsseldorf)

Klaus Ensslin (ETH, Zürich)

Claudia Felser (Max Planck Inst. for Chemical Physics of Solids, Dresden)

Marcelo Goffman (CEA, Saclay)

Sophie Guéron (Univ. Paris Sud, Orsay)

Jelena Klinovaja (Univ. Basel)

Leo Kouwenhoven (QuTech, Delft Univ. of Technology)

Rosa López (Univ. Balears)

Fabrizio Nichele (Niels Bohr Institute, Copenhagen)

Yuval Oreg (Weizmann Inst. of Science)

Pablo San-Jose (ICMM-CSIC, Madrid)

Jörg Schäfer (Univ. Würzburg)

Patrik Recher (TU Braunschweig)

Shinsei Ryu (Univ. Chicago)

Felix von Oppen (Freie Univ. Berlin)

Organized with the collaboration of

The logo for Fundación BBVA, featuring the word "Fundación" in a blue sans-serif font and "BBVA" in a larger, bold, blue sans-serif font.

Further information:

Nicolás Cabrera Institute - [INC website](#)

XXIV International Summer School Nicolás Cabrera in the newspapers - [Atlasagencia](#)

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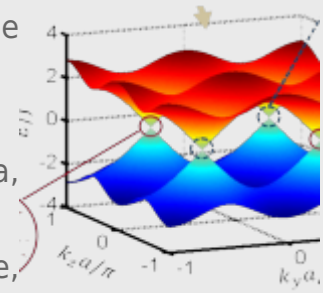
[Weyl Semimetals in 3D Optical Lattices, and Synthetic Gauge Fields in Strongly Interacting 1D Bose Gases](#)

Title: Weyl Semimetals in 3D Optical Lattices, and Synthetic Gauge Fields in Strongly Interacting 1D Bose Gases.

When: Friday, November 25, (2016), 12:00.

Place: Departamento de Física Teórica de la Materia Condensada, Facultad Ciencias, Module 5, Seminar Room (5th Floor).

Speaker: Hrvoje Buljan, Department of Physics, Faculty of Science, University of Zagreb, Bijenička c. 32, 10000 Zagreb, Croatia.



**W**e discuss two important directions of research of synthetic topological quantum matter [1]: (i) topological phases in 3D optical lattices, more specifically Weyl semimetals in ultracold atomic gases [2], and (ii) strongly interacting Bose gases in synthetic gauge fields [3]. Interacting Bose gases in synthetic magnetic fields [1] hold great potential for discovering and exploring novel topological states of matter [4], in a similar fashion as the fractional quantum Hall effect for electrons in strong magnetic fields. Here we investigate laser assisted tunneling in a strongly interacting one-dimensional Bose gas [3] (the Tonks-Girardeau gas [5]) in optical lattices. We find that the stroboscopic dynamics of the Tonks-Girardeau gas in a continuous Wannier-Star-ladder potential, supplemented with laser assisted tunneling, effectively realizes the ground state of one-dimensional hardcore bosons in a discrete lattice [6] with nontrivial hopping phases. Next, we show that, in three-dimensional optical lattices, laser assisted tunneling can be used for realizing a Hamiltonian with Weyl points [3]. Weyl points are synthetic magnetic monopoles that exhibit a robust, three-dimensional linear dispersion, identical to the energy-momentum relation for relativistic Weyl fermions [3], which are not yet discovered in particle physics. Relation to analogous studies in optics will be mentioned [8].

#### References

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grating assisted tunneling, *New J. Phys.* 17, 125002 (2015).

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