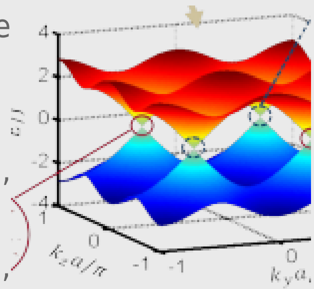
# Weyl Semimetals in 3D Optical Lattices, and Synthetic Gauge Fields in Strongly Interacting 1D Bose Gases




Title: Weyl Semimetals in 3D Optical Lattices, and Synthetic Gauge Fields in Strongly Interacting 1D Bose Gases.
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Speaker: Hrvoje Buljan, Department of Physics, Faculty of Science, University of Zagreb, Bijenička c. 32, 10000 Zagreb, Croatia.

We 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

N. Goldman, G. Juzeliunas, P. Ohberg, I. B. Spielman, Rep. Prog. Phys. 77, 126401 (2014).

Tena Dubček, Colin J. Kennedy, Ling Lu, Wolfgang Ketterle, Marin Soljačić, Hrvoje Buljan, Weyl points in three-dimensional optical lattices: Synthetic magnetic monopoles in momentum space, Phys. Rev. Lett. 114, 225301 (2015).

Karlo Lelas, Nikola Drpić, Tena Dubček, Dario Jukić, Robert Pezer, and Hrvoje Buljan, Laser assisted tunneling in a Tonks-Girardeau gas, New J. of Phys. 18, 095002 (2016).

X. Chen, Z.-C. Gu, Z.-X. Liu, X.-G. Wen, arXiv:1301.0861 [cond-mat.str-el]; Science 338, 1604 (2012).

M. Rigol and A. Muramatsu, Phys. Rev. Lett. 93, 230404 (2004).

R. Pezer and H. Buljan, Phys. Rev. Lett. 98, 240403 (2007).
Jorge Bravo-Abad, Ling Lu, Liang Fu, Hrvoje Buljan and Marin Soljačić, Weyl points in photonic-crystal superlattices, 2D Mater. 2, 034013 (2015).
Tena Dubček, Karlo Lelas, Dario Jukić, Robert Pezer, Marin Soljačić and Hrvoje Buljan, The Harper–Hofstadter Hamiltonian and conical diffraction in photonic lattices with grating assisted tunneling, New J. Phys. 17, 125002 (2015).
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