

# OMAR A. ASHOUR

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## Research Interests

I am interested in harnessing the interplay between topological order and collective excitations, primarily phonons and magnons, to develop new quantum sensing schemes for direct dark matter detection applications. My work employs various analytical and computational tools, such as density functional (perturbation) theory, tight-binding models, and spin Hamiltonians, to elucidate the electronic, magnetic, and vibrational properties of quantum materials. Additionally, I utilize effective field theories to study dark matter interaction with such materials.

## Education

2019 – 2025 **PhD, Physics.**

University of California, Berkeley, CA

Advisor Sinéad M. Griffin

2019 – 2020 **MA, Physics.**

University of California, Berkeley, CA

2017 – 2019 **MS, Applied Physics, GPA: 3.90.**

University of California, Berkeley, CA

Thesis The Nonlinear Schrödinger Hierarchy: from Quasi Rogue Waves to Nonlinear Talbot Carpets

2013 – 2017 **BS, Electrical Engineering (Optics), GPA: 4.0.**

Texas A&M University, College Station, TX

Thesis Maximal Intensity Higher-Order Breathers of the Nonlinear Schrödinger Equation

## Preprints and Publications

★ Equal Contribution    † Corresponding Author

2024 **Omar A. Ashour** and Sinéad M. Griffin. Solid helium as a pressure tunable dark matter detector, (*in preparation*) (2024).

2024 **Omar A. Ashour** and Sinéad M. Griffin. Phonon-based topological quantum sensors for dark matter detection, (*in preparation*) (2024).

2023 Na Hyun Jo\*, **Omar A. Ashour**\*, Zhixue Shu, Chris Jozwiak, Aaron Bostwick, Sae Hee Ryu, Kai Sun, Tai Kong, Sinéad M. Griffin, and Eli Rotenberg. On the effects of strain, defects, and interactions on the topological properties of HfTe<sub>5</sub> (2023). [[arXiv:2303.10836](#)] [↗](#)

- 2023 Thomas F. Harrelson, Ibrahim Hajar, **Omar A. Ashour**, and Sinéad M. Griffin. Theoretical investigation of decoherence channels in athermal phonon sensors (2023). [[arXiv:2109.10988](#)] [↗](#)
- 2022 **Omar A. Ashour**<sup>†</sup>, Siu A. Chin, Stanko N. Nikolić, and Milivoj R. Belić. Higher-order breathers as quasi-rogue waves on a periodic background, *Nonlinear Dynamics*, **107**, 3819–3832 [↗](#) (2022).
- 2022 Stanko N. Nikolić, Sarah Alwashahi, **Omar A. Ashour**, Siu A. Chin, Najdan B. Aleksić, and Milivoj R. Belić. Multi-elliptic rogue wave clusters of the nonlinear Schrödinger equation on different backgrounds, *Nonlinear Dynamics*, **108**, 479–490 [↗](#) (2022).
- 2022 Thais Chagas\*, **Omar A. Ashour**\*, Guilherme Ribeiro, Wendell Silva, Zhenglu Li, Rogério Magalhães-Paniago, Yves Petroff, and Steven G. Louie. Multiple strong topological gaps and hexagonal warping in Bi<sub>4</sub>Te<sub>3</sub>, *Physical Review B*, **105**, L081409 [↗](#) (2022).
- 2022 Milivoj R. Belić, Stanko N. Nikolić, **Omar A. Ashour**, and Najdan B. Aleksić. On different aspects of the optical rogue waves nature, *Nonlinear Dynamics*, **108**, 1655–1670 [↗](#) (2022).
- 2021 **Omar A. Ashour**<sup>†</sup>. NonlinearSchrodinger: higher-order algorithms and Darboux transformations for nonlinear Schrödinger equations (2021). [[arXiv:2103.14469](#)] [↗](#)
- 2019 Stanko N. Nikolić, **Omar A. Ashour**, Najdan B. Aleksić, Yiqi Zhang, Milivoj R. Belić, and Siu A. Chin. Talbot carpets by rogue waves of extended nonlinear Schrödinger equations, *Nonlinear Dynamics*, **97**, 1215–1225 [↗](#) (2019).
- 2019 Stanko N. Nikolić, **Omar A. Ashour**, Najdan B. Aleksić, Milivoj R. Belić, and Siu A. Chin. Breathers, solitons and rogue waves of the quintic nonlinear Schrödinger equation on various backgrounds, *Nonlinear Dynamics*, **95**, 2855–2865 [↗](#) (2019).
- 2017 Stanko N. Nikolić, Najdan B. Aleksić, **Omar A. Ashour**, Milivoj R. Belić, and Siu A. Chin. Systematic generation of higher-order solitons and breathers of the Hirota equation on different backgrounds, *Nonlinear Dynamics*, **89**, 1637–1649 [↗](#) (2017).
- 2017 Runze Li, **Omar A. Ashour**, Jie Chen, H. E. Elsayed-Ali, and Peter M. Rentzepis. Femtosecond laser induced structural dynamics and melting of Cu (111) single crystal: an ultrafast time-resolved x-ray diffraction study, *Journal of Applied Physics*, **121**, 055102 [↗](#) (2017).
- 2017 Siu A. Chin, **Omar A. Ashour**, Stanko N. Nikolić, and Milivoj R. Belić. Peak-height formula for higher-order breathers of the nonlinear Schrödinger equation on non-uniform backgrounds, *Physical Review E*, **95**, 012211 [↗](#) (2017).
- 2016 Siu A. Chin, **Omar A. Ashour**, Stanko N. Nikolić, and Milivoj R. Belić. Maximal intensity higher-order Akhmediev breathers of the nonlinear Schrödinger equation and their systematic generation, *Physics Letters A*, **380**, 3625–3629 [↗](#) (2016).
- 2015 Siu A. Chin, **Omar A. Ashour**, and Milivoj R. Belić. Anatomy of the Akhmediev breather: cascading instability, first formation time, and Fermi-Pasta-Ulam recurrence, *Physical Review E*, **92**, 063202 [↗](#) (2015).

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## Research Experience

- 2021 – **Molecular Foundry, Lawrence Berkeley National Lab**, Berkeley, CA.  
PI Sinéad M. Griffin  
Topic Dark matter interaction with collective excitations in quantum materials
- 2019 – 2021 **Physics Department, UC Berkeley**, Berkeley, CA.  
PI Steven G. Louie  
Topic DFT and GW calculations of topological insulators
- 2017 – 2018 **NSF Nanoscale Science & Engineering Center, UC Berkeley**, Berkeley, CA.  
PI Xiang Zhang  
Topic Ultrafast spectroscopy of transition metal dichalcogenide monolayers
- 2014 – 2017 **Department of Physics and Astronomy, Texas A&M University**, College Station, TX.  
PIs Siu A. Chin, Milivoj R. Belić  
Topic Mathematical and computational studies of nonlinear Schrödinger equations
- 2016 – 2017 **Texas A&M Engineering Experiment Station (TEES)**, College Station, TX.  
PI Peter Rentzepis  
Topic Ultrafast X-ray studies of thin films, and ultrafast optical studies of bacteria
- 2015 **Institute of Electronic Structure and Laser (IESL-FORTH)**, Heraklion, Greece.  
PI Stelios Tzortzakis  
Topic Femtosecond laser machining of low-loss waveguides

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## Fellowships and Awards

- 2024 **Ovshinsky Travel Award**, Division of Materials Physics, American Physical Society
- 2018 – 2019 **Anselmo J. Macchi Graduate Fellowship**, UC Berkeley
- 2017 – 2019 **Berkeley Graduate Fellowship**, UC Berkeley
- 2017 – 2018 **Cornell Graduate Fellowship** (declined), Cornell University
- 2016 **Richard E. Ewing Award** for excellence in student research, Texas A&M University
- 2014, '15, '17 **Gathright Scholar Award** for outstanding academic achievement, Texas A&M University

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## Mentoring and Community Service

- 2021 – **Undergraduate Mentoring**, I am involved in mentoring longer-term undergraduate students in the group, and have given talks to and mentored summer intern cohorts at LBL.
- 2020 **Scientist Ambassador**, I spent four weeks as an ambassador to a first-grade class, teaching them about the day-to-day life of a scientist.
- 2018 **Be A Scientist**, I worked with students at a local middle school for 6 weeks to design and conduct science experiments and foster critical thinking skills