

# XINGYU GAO

Department of Physics and Astronomy, Purdue University, West Lafayette, IN

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## EDUCATION

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**Ph.D. in Physics** Purdue University 2018 - 2024 (Expected)

Advisor: Prof. Tongcang Li

**B.S. in Physics** University of Science and Technology of China (USTC) 2014 - 2018

## RESEARCH EXPERIENCE

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**Research Assistant in Department of Physics and Astronomy** Aug. 2018 - Now  
Purdue University

- Spin color centers in hexagonal boron nitride (hBN) and boron nitride nanotubes (BNNTs).
  - \* Built an ion implanter to create spin color centers in hBN
  - \* Demonstrate high contrast optically detected magnetic resonance using ensemble and single hBN color centers.
  - \* Realized polarization and coherent control of ensemble and single nuclear spins in hexagonal boron nitride
  - \* First realization of an electron-nuclear spin two qubit gate in hBN
  - \* First observation of single spin color centers in BNNTs.
  - \* Demonstrate scanning probe magnetometry using spin color centers in BNNTs.
- Near-field energy transfer via vacuum fluctuation and thermal radiation.
  - \* Built a vacuum dual-cantilever atomic force microscope (AFM).
  - \* Realized non-reciprocal energy transfer through Casimir interaction between two cantilevers.
  - \* Proposed thermal spin photonics in the near-field of nonreciprocal media.
- Levitated spin-optomechanics
  - \* Built an ion trap to levitate a nanodiamond and rotate it at 20 MHz.
  - \* Observed electron spin Barnett effect induced by Berry phase in a levitated diamond nitrogen-vacancy center.

## ACADEMIC AWARDS

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- Bravo Plus Award, Purdue University, 2024
- Bilsland Dissertation Fellowship, Purdue University, 2023
- Dr. Warner L. Black Award, Purdue University, 2023
- Lark-Horovitz Prize in Physics, Purdue University, 2023
- Ross Fellowship, Purdue University, 2018
- Best Bachelor's Thesis Award, USTC, 2018
- Seagate Fellowship, USTC, 2016

## PUBLICATION LIST

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2 Nature Nanotechnology, 1 Nature Materials, 5 Nature Communications

1. **Gao, X.**, Vaidya, S., Li, K., Dikshit, S., Zhang, S., Ju, P., Shen, K., Jin, Y., Ping, Y., and Li, T. Single nuclear spin detection and control in a van der Waals material arXiv:2409.01601v1 (2024) (Submitted to Nature)
2. Li, J., **Gao, X.**, Sajjan, M., Su, J. H., Li, Z. K., and Kais, S. "Møller-Plesset Perturbation Theory Calculations on Quantum Devices." arXiv:2308.01559 (2023).
3. **Gao, X.**, Vaidya, S., Dikshit, S., Ju, P., Shen, K., Jin, Y., Zhang, S., and Li, T. Nanotube spin defects for omnidirectional magnetic field sensing. **Nature Communications** 15, 7697 (2024)

4. Jin, Y., Shen, K., Ju, P., **Gao, X.**, Zu, C., Grine, A. J., and Li, T. Quantum control and Berry phase of levitated diamonds in high vacuum. **Nature Communications**, 15(1), 5063. (2024).
5. **Gao, X.**, Vaidya, S., Ju, P., Dikshit, S., Shen, K., Chen, Y. P., and Li, T. "Quantum sensing of paramagnetic spins in liquids with spin qubits in hexagonal boron nitride." **ACS Photonics** 10, 8, 2894–2900 (2023).
6. Vaidya, S., **Gao, X.**, Dikshit, S., Aharonovich, I., and Li, T. "Quantum sensing and imaging with spin defects in hexagonal boron nitride." **Advances in Physics: X** 8:1, 2206049 (2023).
7. Gong, R., He, G., **Gao, X.**, Ju, P., Liu, Z., Ye, B., Henriksen, E. A., Li, T., & Zu, C. Coherent Dynamics of Strongly Interacting Electronic Spin Defects in Hexagonal Boron Nitride. **Nature Communications** 14, 3299 (2023).
8. Ju, P., Jin, Y., Shen, K., Duan, Y., Xu, Z., **Gao, X.**, and Li, T. Near-field GHz rotation and sensing with an optically levitated nanodumbbell. **Nano Letters** 23, 10157–10163 (2023).
9. **Gao, X.**, Vaidya, S., Li, K., Ju, P., Jiang, B., Xu, Z., Allcca, A. E., ..., Bhawe, S. A., Chen, Y. P., Ping, Y., & Li, T. Nuclear spin polarization and control in hexagonal boron nitride. **Nature Materials**, 21, 1024-1028 (2022).
10. Xu, X., Solanki, A. B., Sychev, D., **Gao, X.**, ..., Chen, Y. P., Taniguchi, T., Watanabe, K., Rodionov, I. A., Kildishev, A. V., Li, T., Upadhyaya, P., & Shalaev, V. M. Greatly Enhanced Emission from Spin Defects in Hexagonal Boron Nitride Enabled by a Low-Loss Plasmonic Nanocavity. **Nano Letters** 23, 25–33 (2022).
11. Xu, Z., Ju, P., **Gao, X.**, Shen, K., Jacob, Z., & Li, T. Observation and control of Casimir effects in a sphere-plate-sphere system. **Nature Communications**, 13, 6148 (2022).
12. Mathur, N., Mukherjee, A., **Gao, X.**, Luo, J., McCullian, B. A., Li, T., Vamivakas, A. N. & Fuchs, G. D. Excited-state spin-resonance spectroscopy of  $V_B^-$  defect centers in hexagonal boron nitride. **Nature Communications**, 13, 3233 (2022).
13. Xu, Z., **Gao, X.**, Bang, J., Jacob, Z., & Li, T. Non-reciprocal energy transfer through the Casimir effect. **Nature nanotechnology**, 17, 148-152 (2022).
14. Hu, Z., **Gao, X.**, & Li, T. Stability of the discrete time-crystalline order in spin-optomechanical and open cavity QED systems. **Photonics** (Vol. 9, No. 2, p. 61). MDPI (2022).
15. **Gao, X.**, Jiang, B., ... & Li, T. High-contrast plasmonic-enhanced shallow spin defects in hexagonal boron nitride for quantum sensing. **Nano Letters**, 21, 7708-7714 (2021).
16. **Gao, X.**, Pandey, S., Kianinia, M., Ahn, J., Ju, P., Aharonovich, I., ... & Li, T. Femtosecond laser writing of spin defects in hexagonal boron nitride. **ACS Photonics**, 8, 994-1000 (2021).
17. **Gao, X.**, Khandekar, C., Jacob, Z., & Li, T. Thermal equilibrium spin torque: Near-field radiative angular momentum transfer in magneto-optical media. **Physical Review B**, 103, 125424 (2021).
18. Wang, Y., Khandekar, C., **Gao, X.**, Li, T., Jiao, D., & Jacob, Z. Broadband circularly polarized thermal radiation from magnetic Weyl semimetals. **Optical Materials Express**, 11, 3880-3895 (2021).
19. **Gao, X.**, Yin, Z. Q., & Li, T. High-Speed Quantum Transducer with a Single-Photon Emitter in a 2D Resonator. **Annalen der Physik**, 532, 2000233 (2020).
20. Bang, J., Seberson, T., Ju, P., Ahn, J., Xu, Z., **Gao, X.**, Robicheaux, F., & Li, T. Five-dimensional cooling and nonlinear dynamics of an optically levitated nanodumbbell. **Physical Review Research**, 2, 043054 (2020).
21. Ahn, J., Xu, Z., Bang, J., Ju, P., **Gao, X.**, & Li, T. (2020). Ultrasensitive torque detection with an optically levitated nanorotor. **Nature Nanotechnology**, 15, 89-93.
22. Xie, T., Shi, F., Chen, S., Guo, M., Chen, Y., Zhang, Y., Yang, Y., **Gao, X.**, Kong, X., Wang, P. and Tateishi, K., 2018. Mesoscopic magnetic resonance spectroscopy with a remote spin sensor. **Physical Review Applied**, 9(6), p.064003 (2018).

## TEACHING AND MENTORING

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Teaching Assistant, Department of Physics and Astronomy, Purdue University

August 2018- May 2020

## SERVICE

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- **Quantum open house** 2022, 2023  
Department of Physics and Astronomy, Purdue University  
Introduced the basic idea of quantum physics and related technologies to high school students
- **Physics Inside Out Program** 2019  
Department of Physics and Astronomy, Purdue University  
Introduced scientific research to elementary and middle school students
- **NSIE Birck Nanodays Event** 2019  
Birck Nanotechnology Center, Purdue University  
Volunteered for Nanodays event for K-12 grade students from Indiana schools