Bose-Einstein condensates of dipolar molecules: Testing the limits of mean-field theory

Haneul Kwak [1, †], **Asaf Toprakci** [1], **Weijun Yuan** [1], **Siwei Zhang** [1], **Ian Stevenson** [1], **and Sebastian Will** [1]

[1]Department of Physics, Columbia University, New York, New York, 10027, USA
†Corresponding author's email: hk3290@columbia.edu

Recently, we have demonstrated the Bose-Einstein condensation of dipolar molecules [1]. A key enabling technology is microwave dressing which allows us to simultaneously suppress inelastic losses and sensitively control molecule-molecule interactions [2]. In the presence of microwave dressing, intermolecular interactions feature a strong repulsive barrier at about 1000 a_0 separation and dipole-dipole interactions at long range, giving rise to a quantum gas of hardcore bosons with tunable dipolar interactions. How well does a mean-field description based on the extended Gross-Pitaevskii equation (eGPE) capture the physics of this system?

In this talk, we report the comparison of our experimental observations of electrostriction and other thermodynamic properties of our dipolar BECs with theoretical modeling and assess the quality of the mean-field description as we approach the strongly interacting regime.

Acknowledgments

We acknowledge funding from NSF, AFOSR, ONR, and the Gordon and Betty Moore Foundation.

References

[1] N. Bigagli, W. Yuan, S. Zhang *et al.*, *Nature* **631**, 289-293 (2024).
[2] T. Karman *et al.*, arXiv:2501.08095 (2025)