Invited talk

Bose-Einstein condensation of dipolar molecules

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We have created the first Bose-Einstein condensate (BEC) of dipolar molecules[1], a deeply degenerate quantum system at temperatures as low as 5 nanokelvin. Using microwave dressing, we suppress inelastic losses by four orders of magnitude, dramatically improving evaporative cooling of molecules over previous efforts. Microwave dressing also provides us with an unprecedented level of control over the strength and anisotropy of dipole-dipole interactions, enabling continuous tuning from the weakly to the strongly interacting regime. Our latest results reveal intriguing quantum liquid behavior, including the observation of self-bound droplets and droplet arrays.
In this talk, I will discuss our approach to creating molecular BECs[1,2,3], describe powerful new tools for controlling both s-wave and dipolar interactions[4], and give an update on our latest results. Making connections with degenerate atomic gases, liquid helium, and quantum materials - degenerate molecular gases offer exciting prospects for new discoveries in many-body quantum physics.

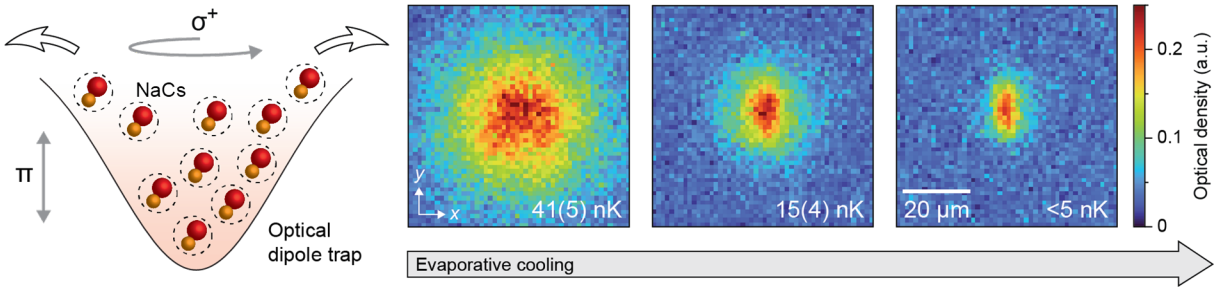

Figure 1: Evaporative cooling of NaCs molecules into a BEC.

[1] N. Bigagli, W. Yuan, S. Zhang, B. Bulatovic, T. Karman, I. Stevenson, S. Will, *Nature* **631**, 289-293 (2024).
[2] N. Bigagli, C. Warner, W. Yuan, S. Zhang, I. Stevenson, T. Karman, S. Will, *Nature Physics* **19**, 1579-1584 (2023).
[3] I. Stevenson, A. Z. Lam, N. Bigagli, C. Warner, W. Yuan, S. Zhang, S. Will, *Phys. Rev. Lett.* **130**, 113002 (2023).
[4] T. Karman, N. Bigagli, W. Yuan, S. Zhang, I. Stevenson, S. Will, arXiv:2501.08095 (2025).