Controlling collisional loss of ultracold dipolar molecules

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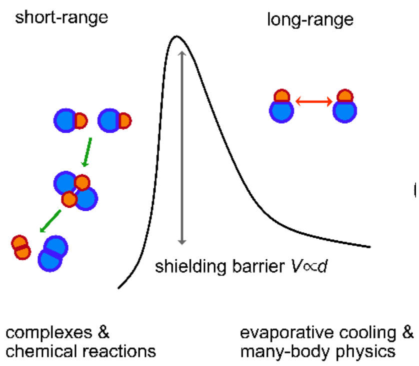
Ultracold polar molecules have many potential applications, ranging from quantum simulation and quantum computing to the creation of novel quantum phases [1]. These molecules possess long-range anisotropic interactions due to their permanent dipoles. A variety of such molecules have been produced at microkelvin temperatures by association of pairs of atoms, or by direct laser cooling. Many applications of ultracold molecules need high phase-space densities. For atoms, this is usually achieved by evaporative or sympathetic cooling. However, trapped samples of ultracold molecules are often short-lived because close collisions between them result in trap loss. Over the last decade, there has been tremendous efforts in understanding the collisional complexes that molecules form at short distances, how they impact chemical reactions, and how we can suppress their formation with *shielding* methods. In this talk, I will share recent research on we can control collisional loss of ultracold molecules by various shielding techniques [2-5]. This has enabled the achievement of a new regime, a molecular gas dominated by elastic interactions, which can then be cooled to quantum degeneracy to study complex dipolar systems.



References:

1. J. L. Bohn, A. M. Rey and J. Ye, *Science* 357, 1002 (2017).
2. K. Matsuda, L. De Marco, J.-R. Li, W. G. Tobias, G. Valtolina, G. Quéméner and J. Ye, *Science* 370, 1324 (2020).
3. A. Schindewolf, R. Bause, X.-Y. Chen, M. Duda, T. Karman, I Bloch and X.-Y. Luo, *Nature* 607, 677 (2022).
4. B. Mukherjee, M. D. Frye, C. R. Le Sueur, M. R. Tarbutt and J. M. Hutson, *Phys. Rev. Res.* 5, 033097 (2023).
5. B. Mukherjee and J. M. Hutson, *Phys. Rev. Res.* 6, 013145 (2024).