

Simultaneous nondestructive measurement of many polar molecules using Rydberg atoms

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Tweezer arrays of polar molecules present new opportunities for quantum science and quantum information. However, a major challenge, especially in alkali molecule platforms, is the fact that current measurement schemes for the internal states are destructive. I will present a theoretical proposal to use Rydberg atoms to nondestructively measure the internal state of a molecular qubit. This is achieved via microwave dressing of both molecules and Rydberg atoms, allowing one to tune the interactions so that there are minimal Rydberg-Rydberg interactions, which allows for many simultaneous measurements of the molecules to take place. To demonstrate this approach, I consider two experimentally motivated examples of detecting NaCs and RbCs with Cs atoms. Finally, I discuss several possible strategies for mitigating various sources of crosstalk.

References

- [1] J.T. Young, K.-K. Ni, A.V. Gorshkov, arXiv:2601:08921 (2026).

Figures

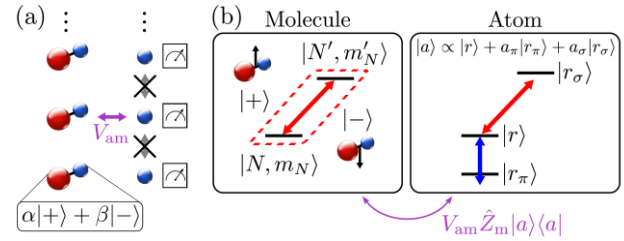


Figure 1: (a) Molecules are entangled pairwise with neutral atoms. By measuring the internal state of the atom, the molecular internal state is determined. (b) Microwave dressing scheme used to realize entanglement interaction while minimizing Rydberg-Rydberg interactions.

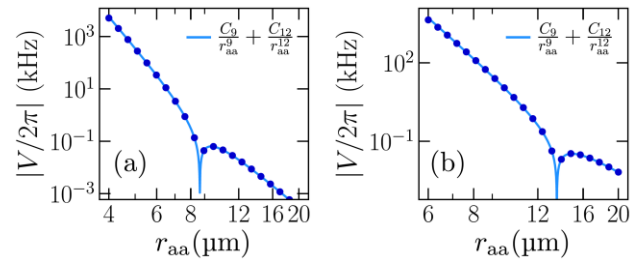


Figure 2: Nullification of both dipolar and van der Waals interactions of Cs atoms when measuring (a) NaCs and (b) RbCs as a function of the distance between atoms r_{aa} , leaving only C_9 and C_{12} interactions.

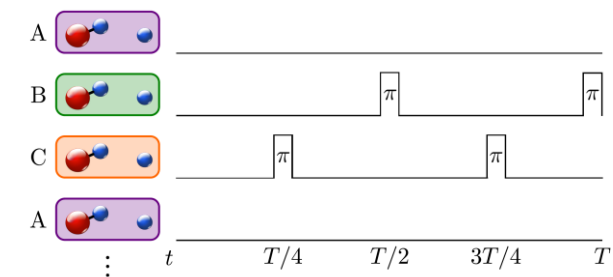


Figure 3: Spin-echo pulse sequence for eliminating remaining crosstalk between atom-molecule pairs. Pairs with different labels (A,B,C) have interactions which are echoed away and become effectively 0. Additional pair labels can be realized through further pulses.