

# Mutual orientation of ultracold polar molecules

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Due to their large permanent electric dipole moment, heteronuclear bialkali molecules offer the possibility of an exceptional level of control of their quantum properties by external electric fields in the ultracold regime. To that end, a detailed modeling of the molecule-molecule long-range interactions and molecule-field interactions is requested [1].

We have computed the long-range interactions between two identical heteronuclear bialkali molecules in their ground state. In free space, their interaction is characterized by a huge van der Waals coefficient, larger by three orders of magnitude than the one for alkali atoms. In an external electric field this huge isotropic van der Waals interaction competes with the expected anisotropic dipole-dipole interaction, induced by the alignment of the molecules with the electric field.

Moreover below a critical intermolecular distance which is independent of the electric field magnitude, we predict the mutual orientation of the two molecules but with no preferential direction in the lab frame. This effect occurs for all bialkali molecules, with the noticeable exceptions of LiNa and KRb [2]. In its own frame, the tetramer possesses a strong dipole moment along the intermolecular axis. This opens the possibility of realizing a stimulated-emission photo-association of tetramers, by inducing a photon transition from two colliding molecules to a bound rovibrational level of the tetramer in its electronic ground state.

## References

- [1] M. Lepers, R. Vexiau, N. Bouloufa, O. Dulieu, and V. Kokoouline, *Phys. Rev. A* **83**, 042707 (2011).
- [2] S. Ospelkaus, K.-K. Ni, D. Wang, M. H. G. de Miranda, B. Neyenhuis, G. Quéméner, P. S. Julienne, J. L. Bohn, D. S. Jin, J. Ye, *Science* **327**, 853 (2010).