

Abstract Submitted
for the DAMOP17 Meeting of
The American Physical Society

Anisotropic blockade using pendular Rydberg butterfly molecules

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Purdue University Department of Physics and Astronomy — The photoassociation spectrum of "butterfly" Rydberg molecules in a weak electric field has been recently observed, revealing that these molecules are, due to their dipole moments and bond lengths, deep in the pendular regime even at small field strengths (1V/cm)¹. Their properties – excellent field alignment and orientation, extended charge distributions, and the parameter tunability determined by the Rydberg state – make these molecules ideal candidates for exploring many-body physics in dipolar gases. We have calculated the long-range interaction between molecules prepared in a quasi-one-dimensional trap; this interaction is dominated at long range by the anisotropic dipole-dipole force. By varying the angle between the applied field and the trap axis, this contribution can be tuned to zero at the magic angle, which presents a clear experimental signature in the density of Rydberg molecules which rises sharply near the magic angle due to the anisotropic excitation "blockade" mechanism. Verification of these interactions through this straightforward experimental scheme will encourage the use of these molecules to study polaron physics in a mixed system, angulon/pendulon interactions, or crystal phase formation.

¹T. Niederpruem, et al. Nat. Commun. 10, 1038 (2016)

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Date submitted: 27 Jan 2017

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