UNIVERSITY OF CAMBRIDGE

Few-atom approach to many-body physics

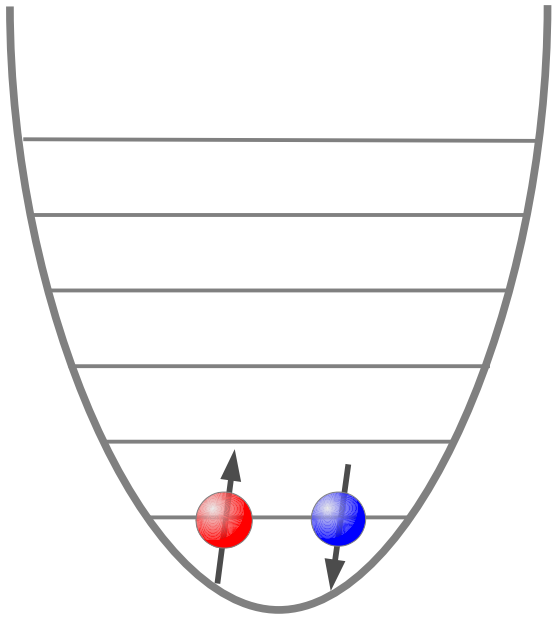
G.J. Conduit and P.O. Bugnion

POB, J. Lofthouse & GJC, Phys. Rev. Lett. **111**, 045301 (2013)

POB & GJC, Phys. Rev. A **87**, 060502(R) (2013)

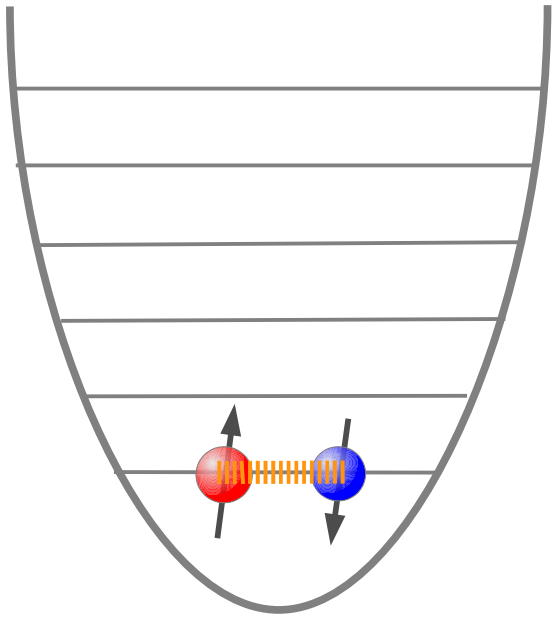
POB & GJC, Phys. Rev. A **88**, 013601 (2013)

Two distinguishable fermions

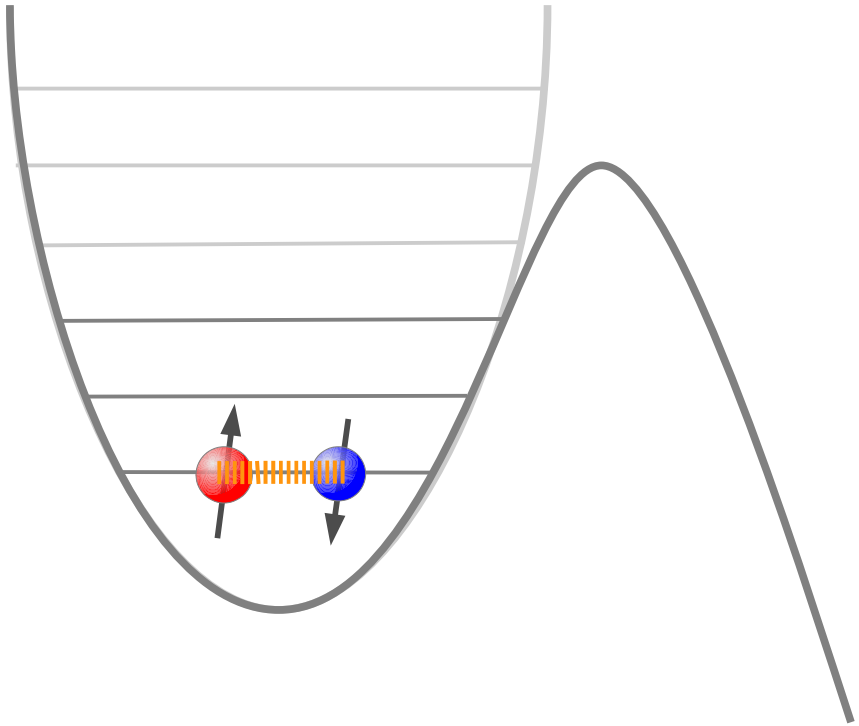


G. Zürn *et al*. PRL 108 075303 (2012)

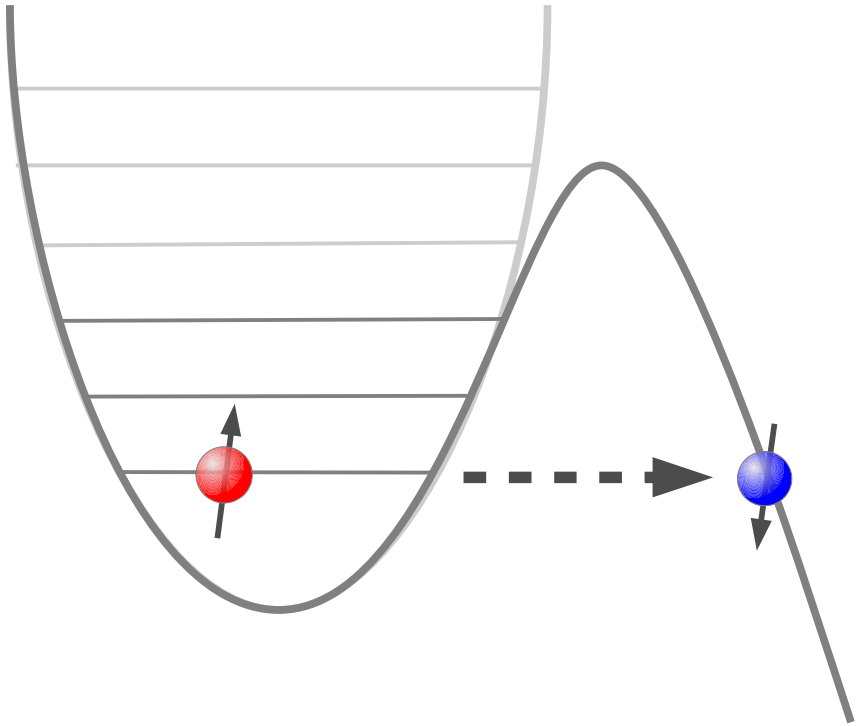
Two distinguishable fermions



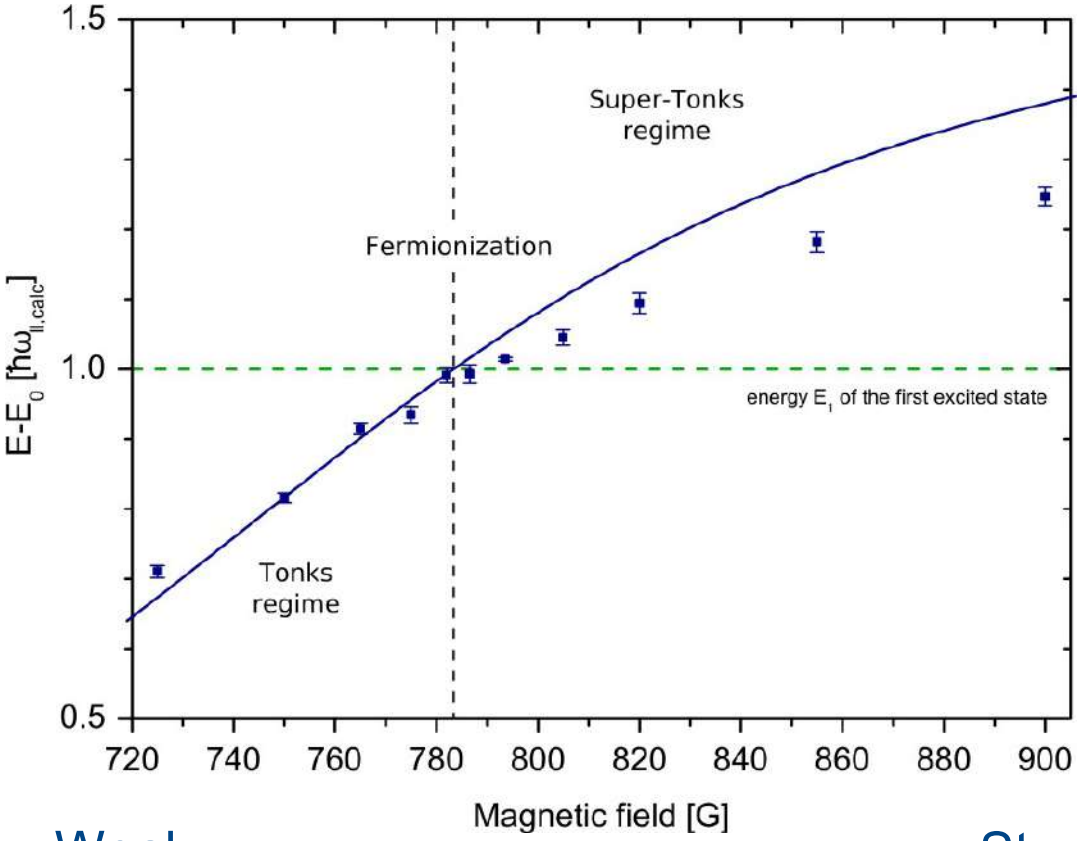
Two distinguishable fermions

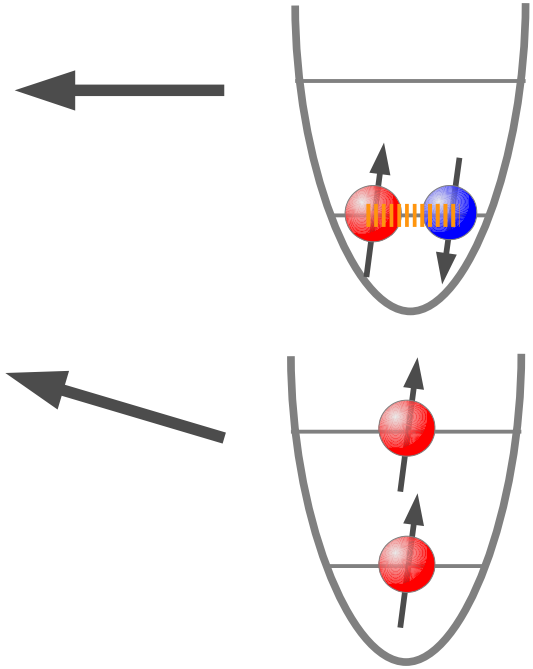


Two distinguishable fermions



Energy of states

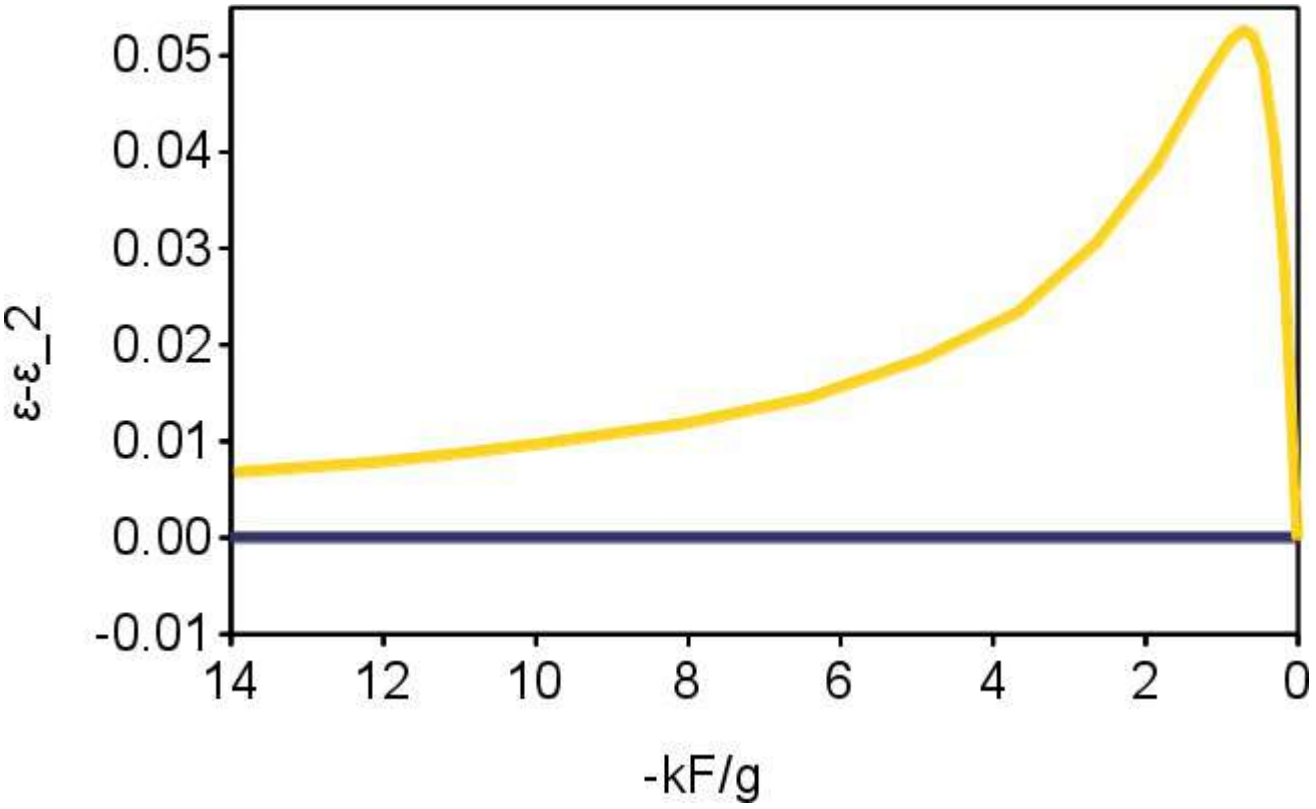


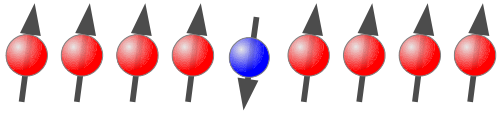


Weak repulsion

Strong repulsion

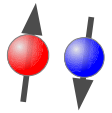
Polaron state





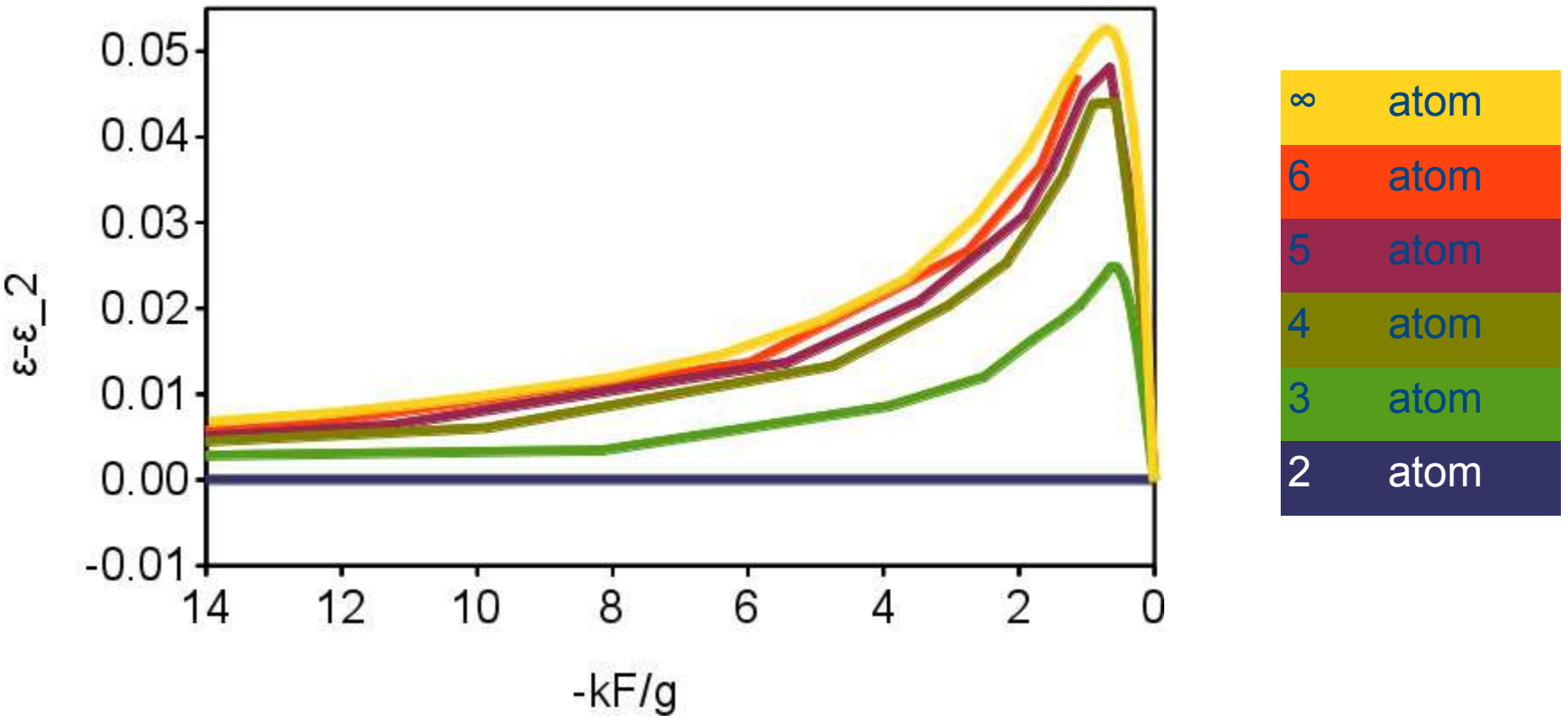
∞ atom

2 atom



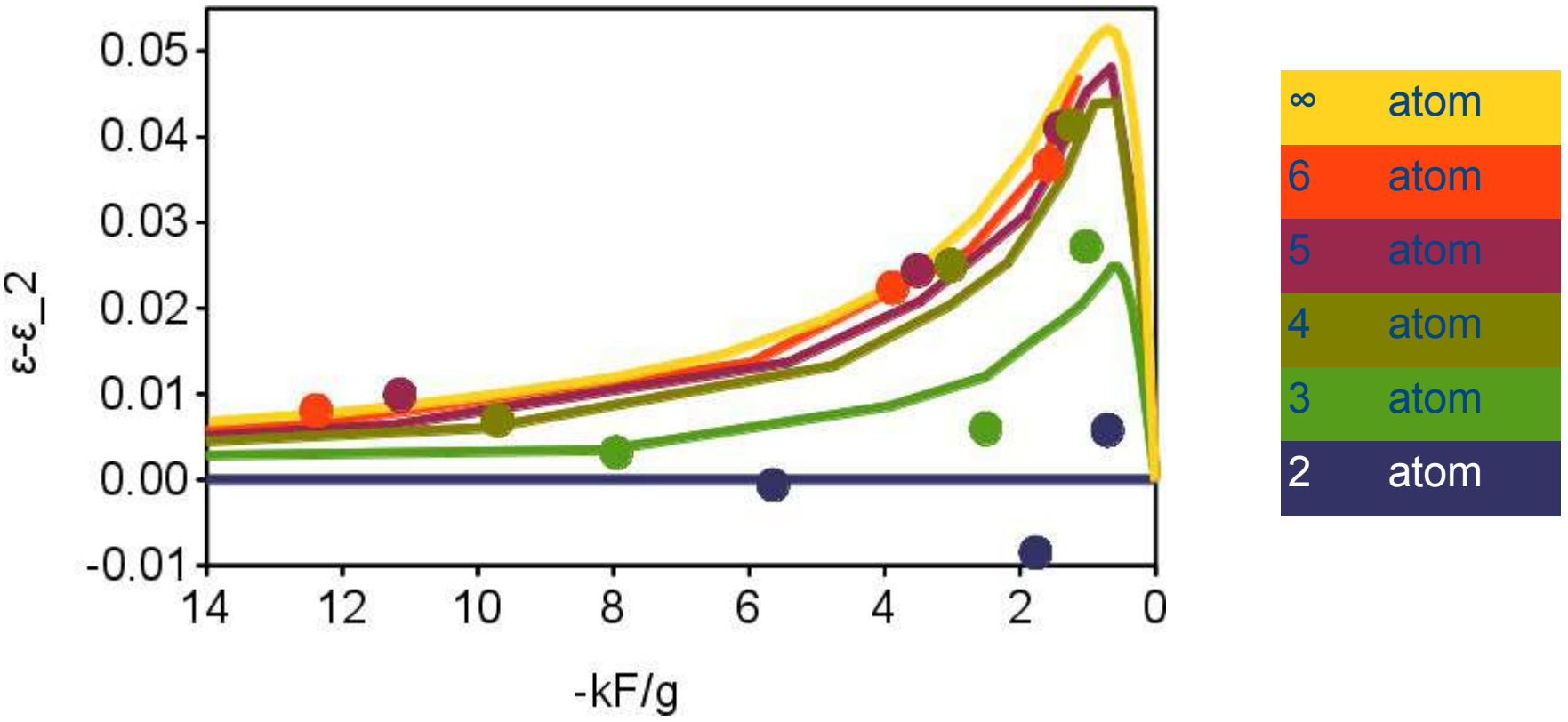
J.B. McGuire, J. Math. Phys. **6**, 432 (1965)

Polaron state



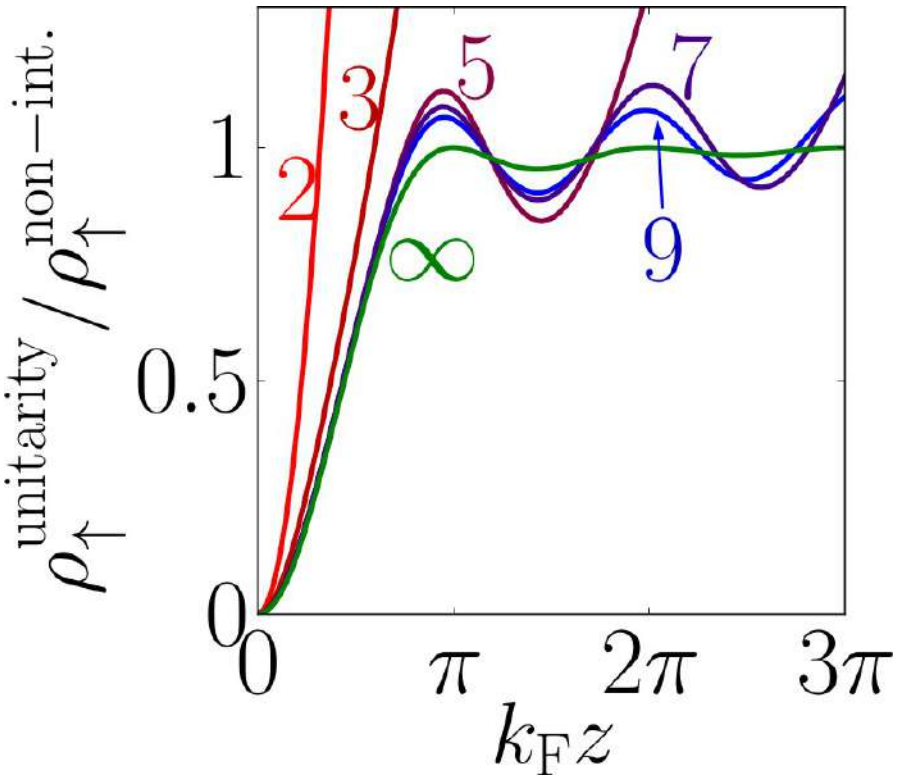
P.O. Bugnion & G.J. Conduit Phys. Rev. A **87**, 060502(R) (2013)

Polaron state



A. Wenz *et al.*, arXiv:1307.3443

Polaron state



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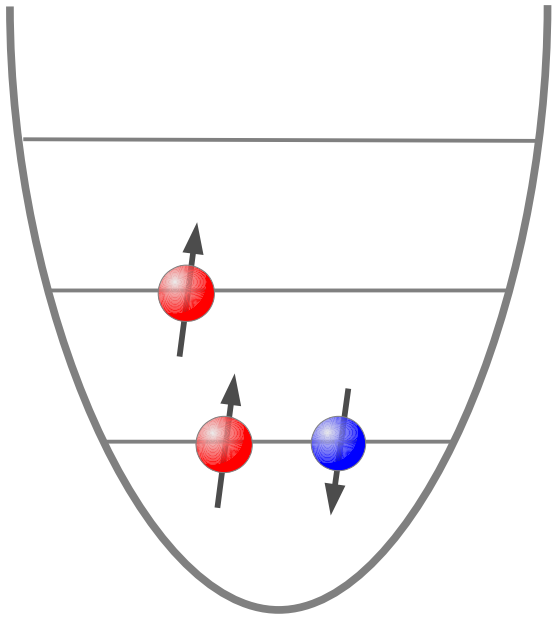

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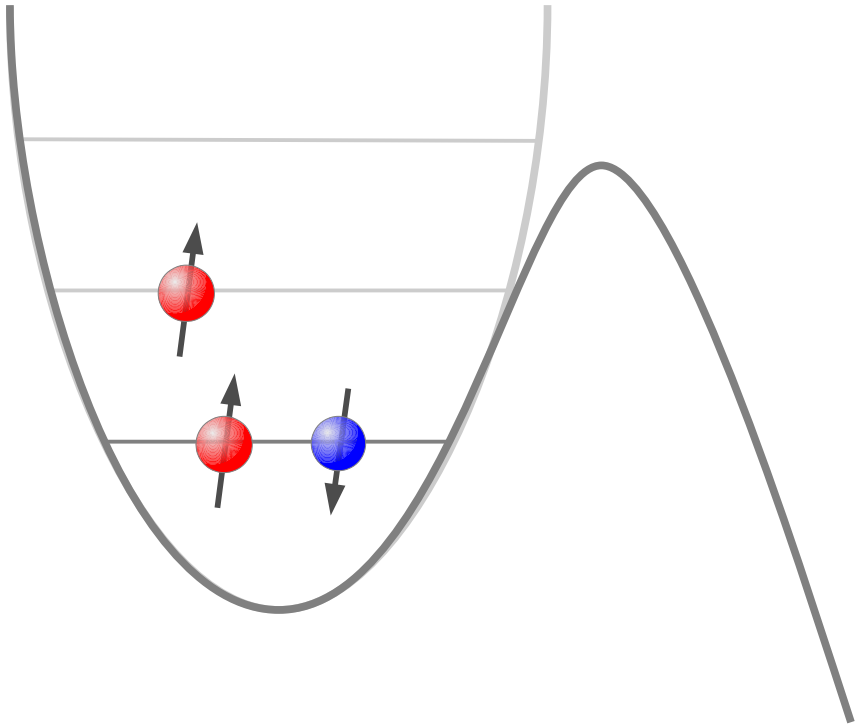

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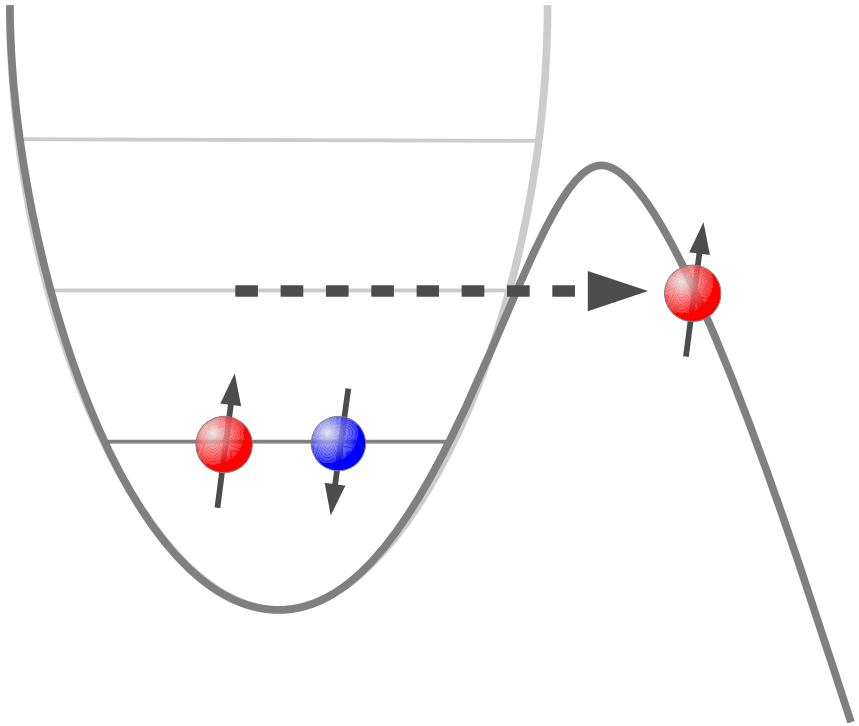

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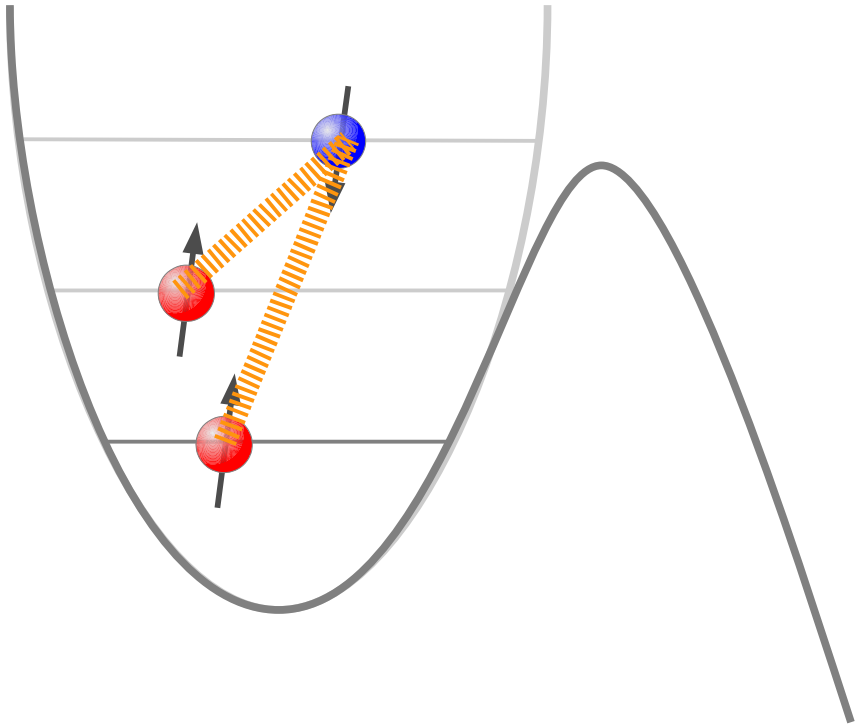

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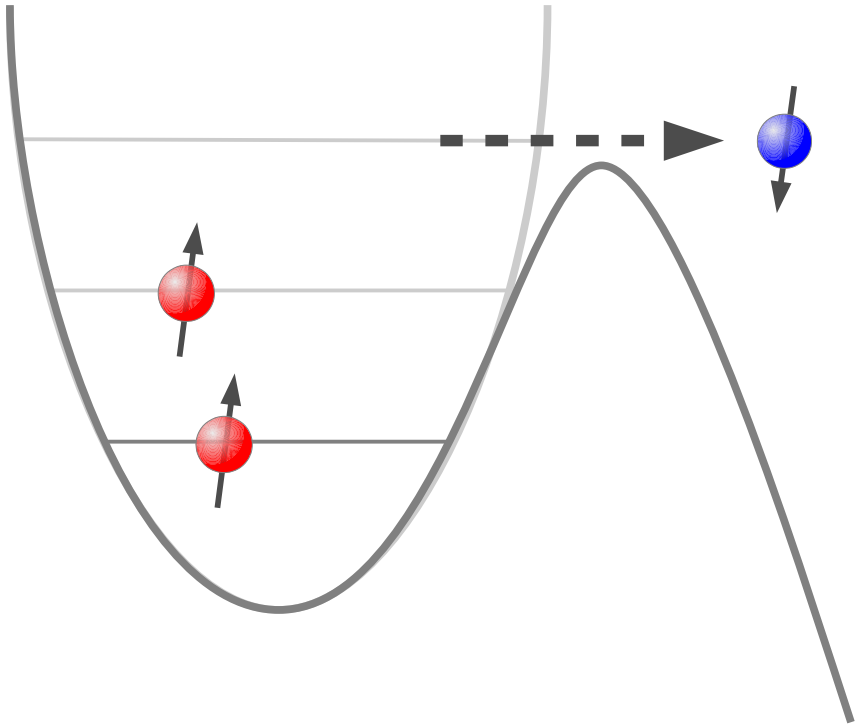
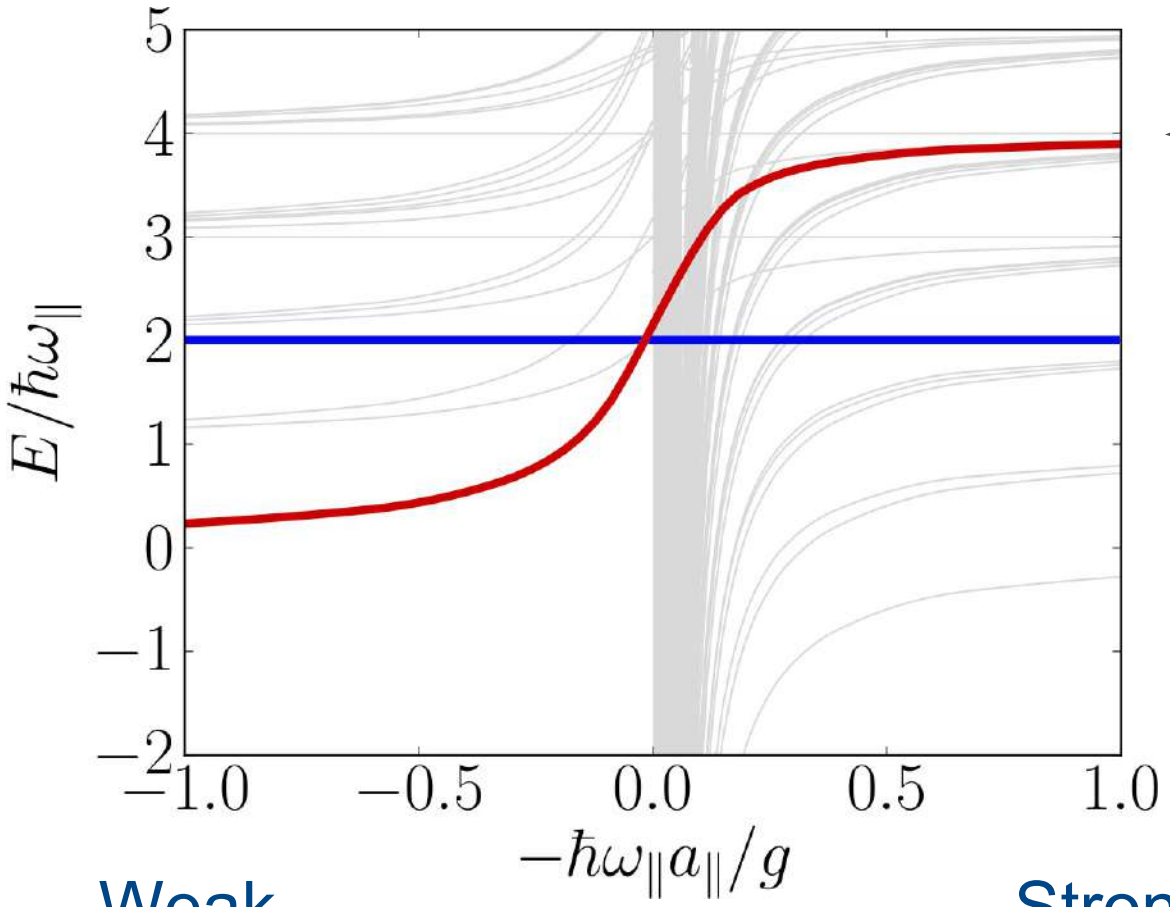
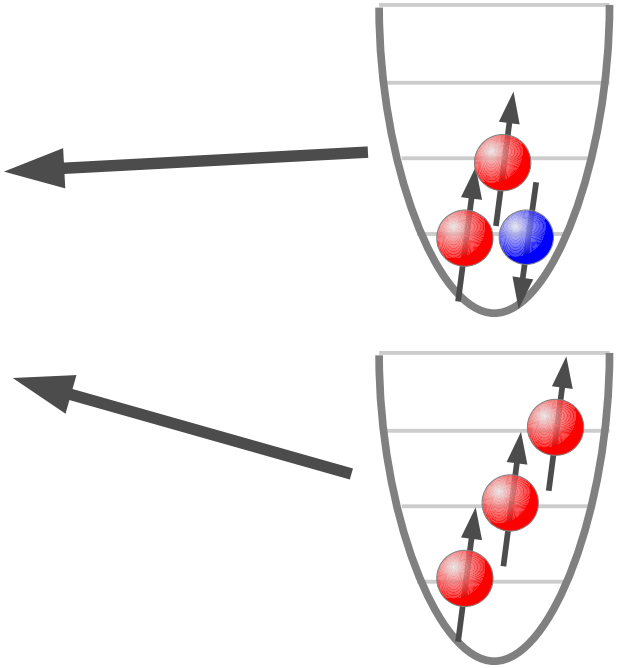


Three-atom bound state

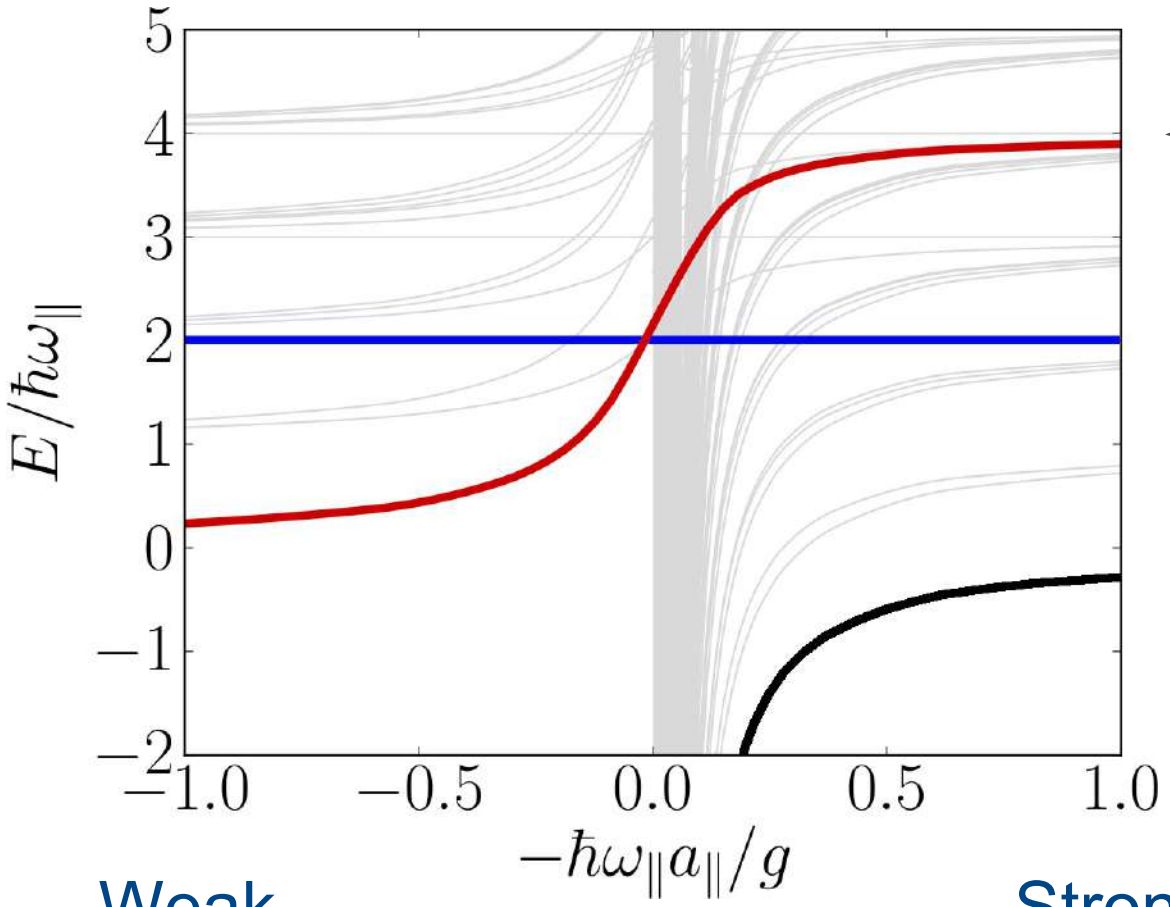


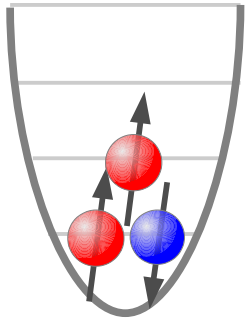


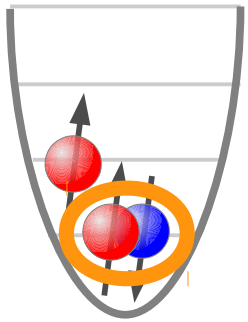
Weak

Strong

Three-atom bound state



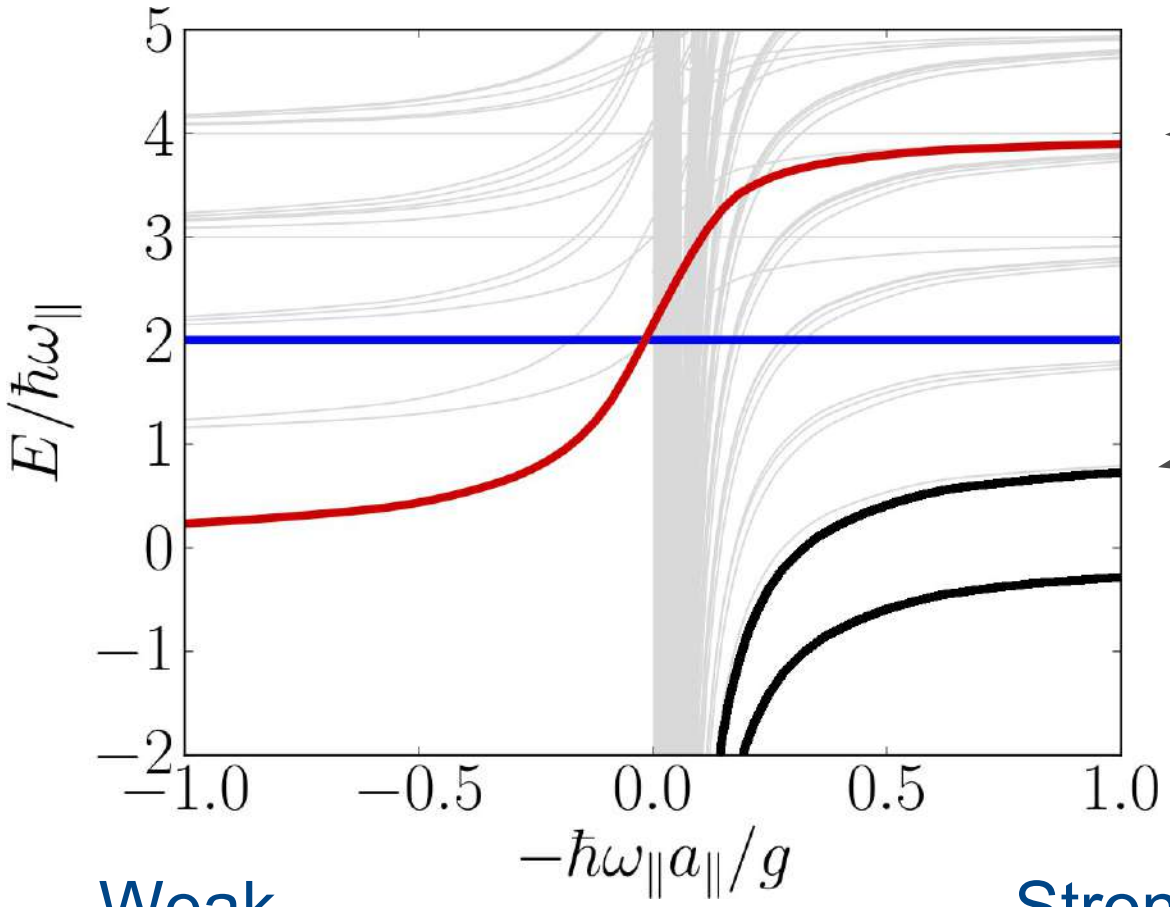




Weak

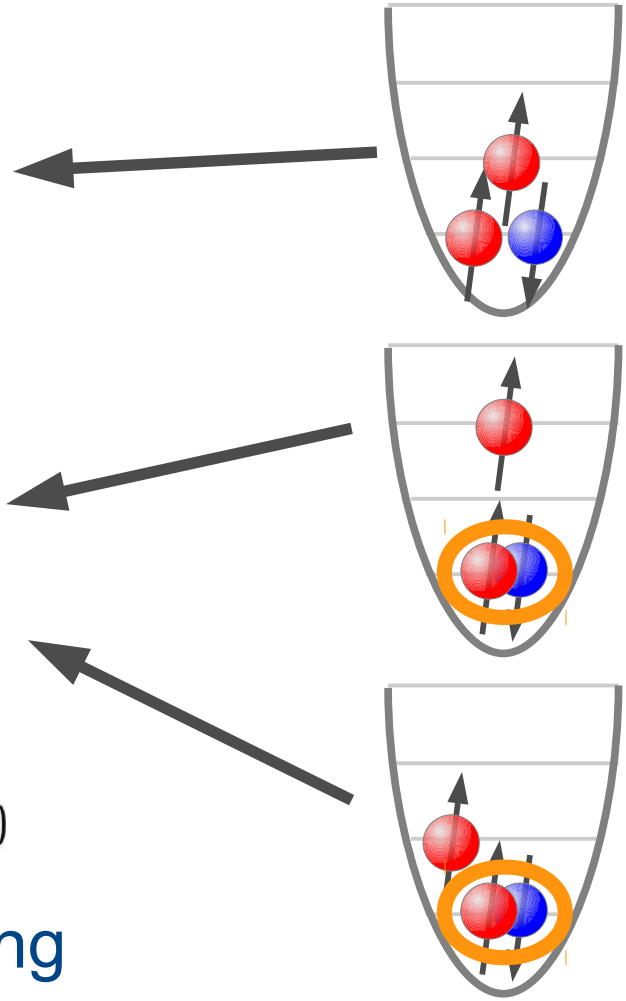
Strong

Three-atom bound state

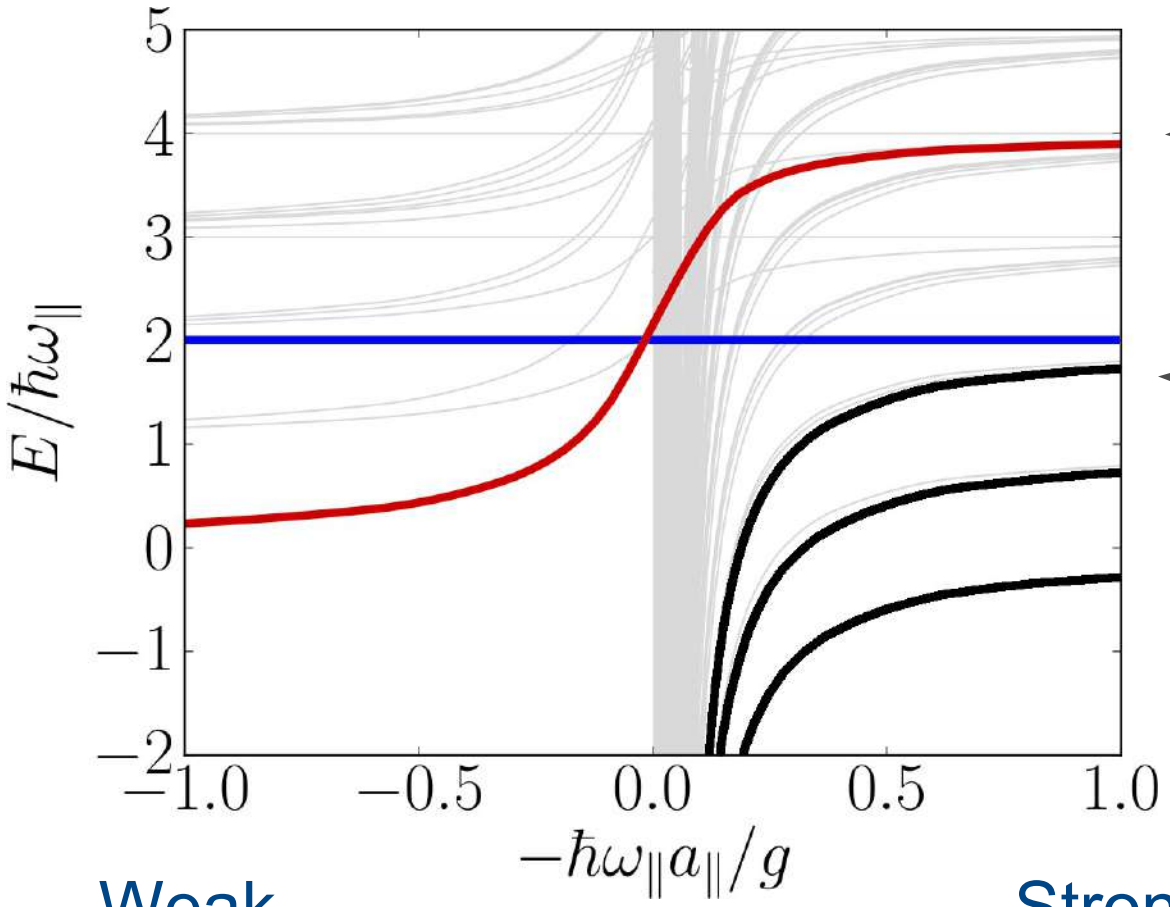


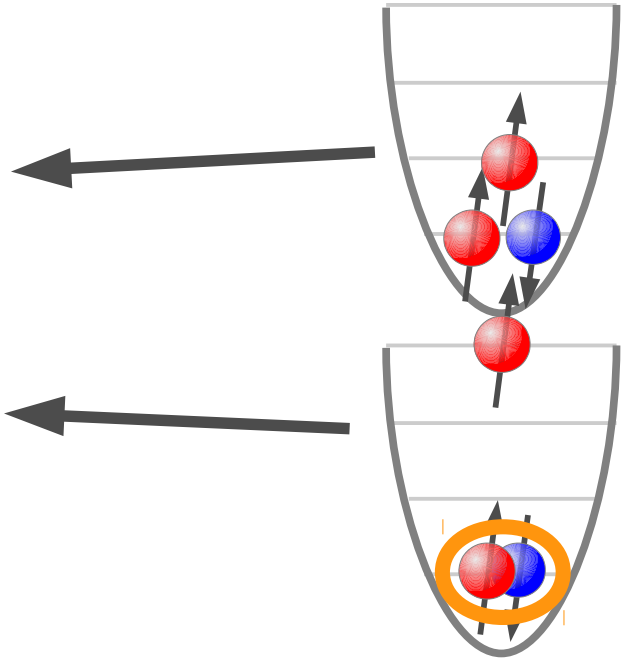
Weak

Strong



Three-atom bound state

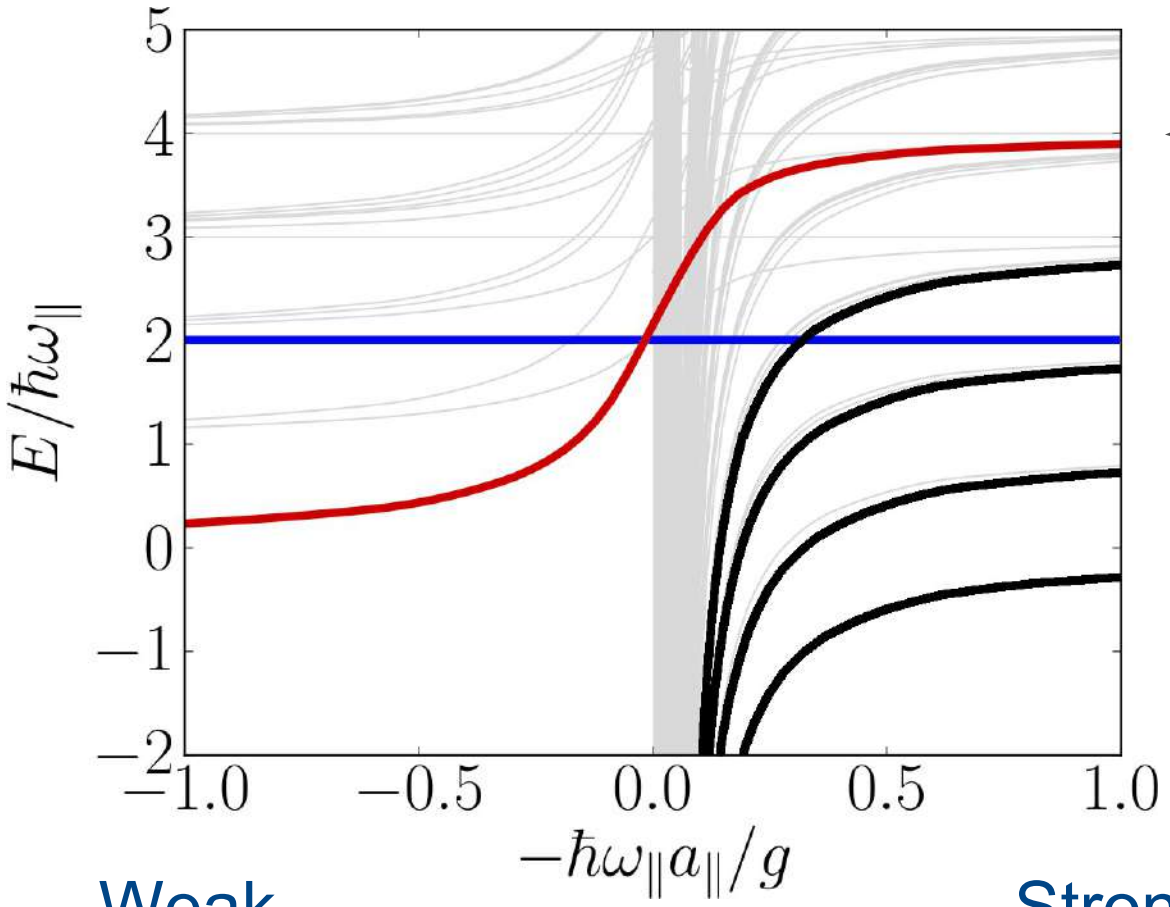


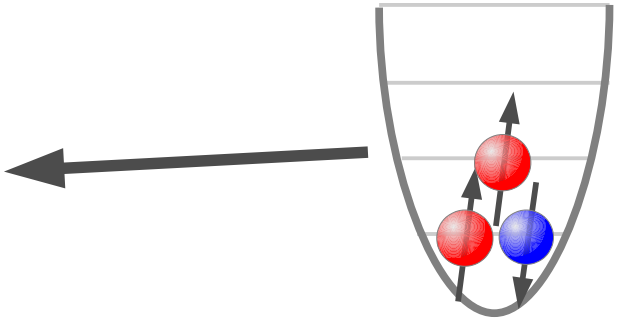


Weak

Strong

Three-atom bound state

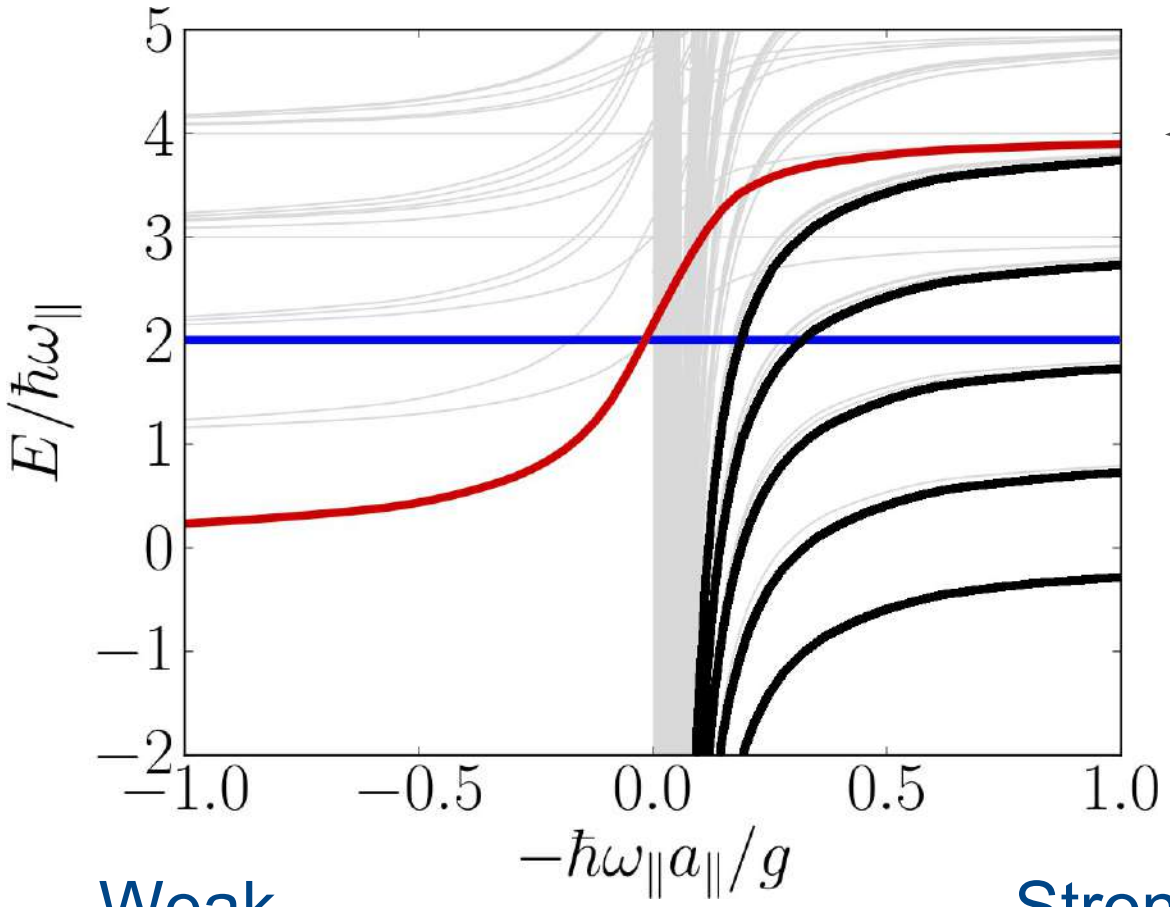


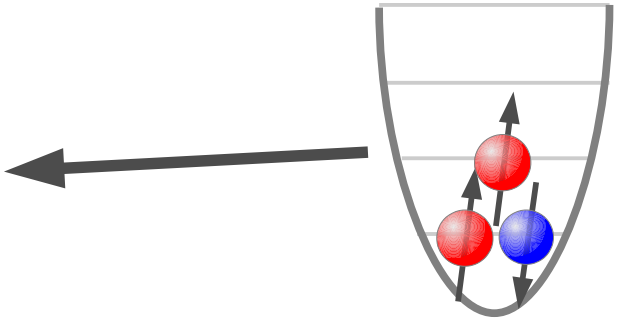


Weak

Strong

Three-atom bound state

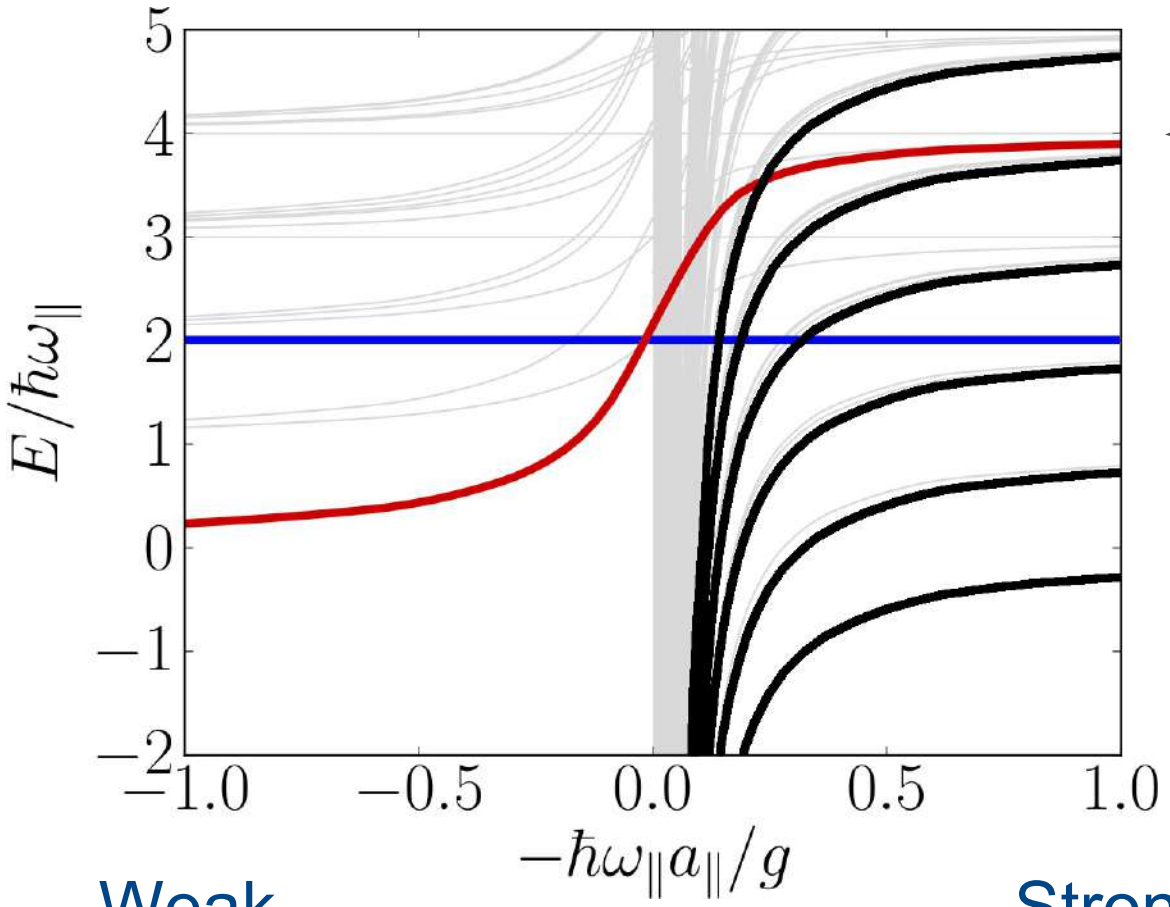


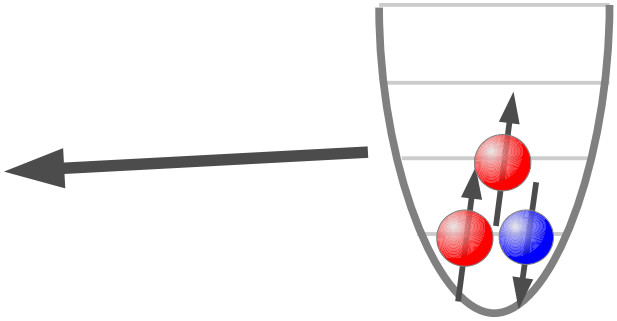


Weak

Strong

Three-atom bound state

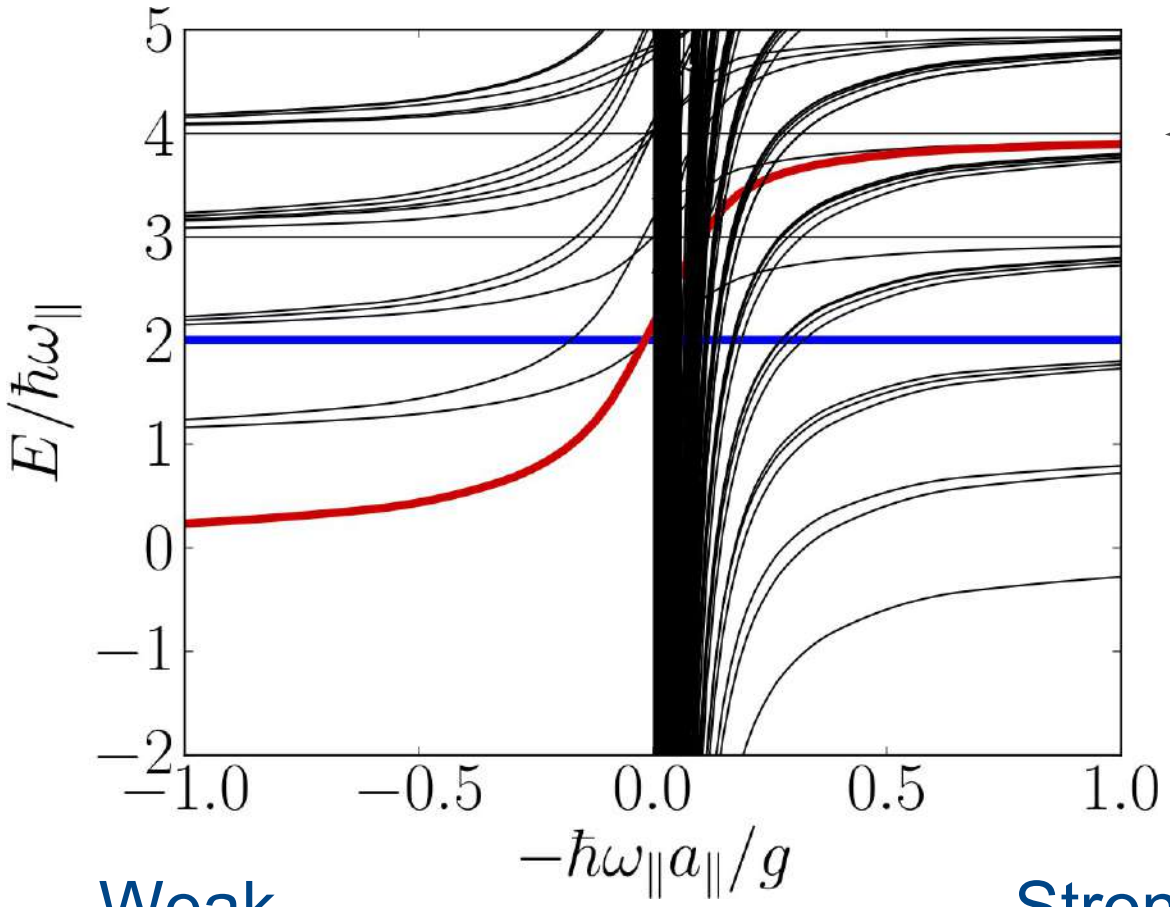


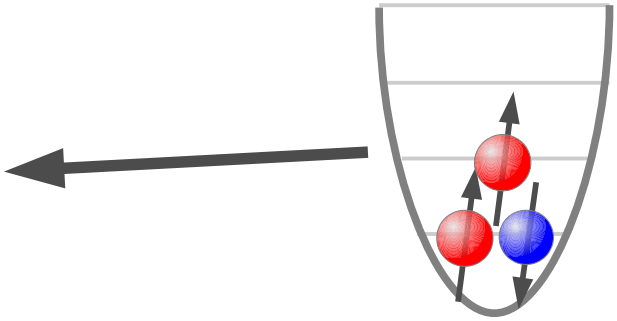


Weak

Strong

Three-atom bound state

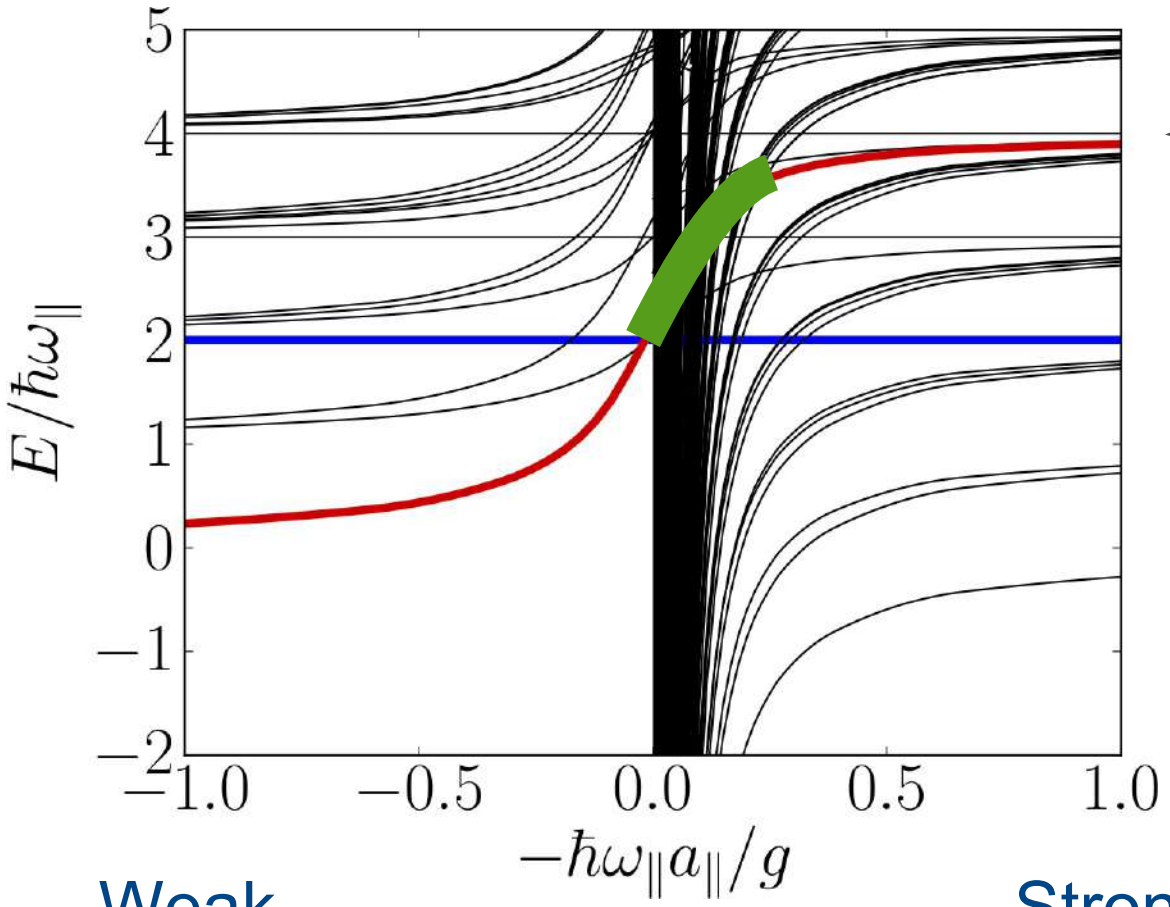


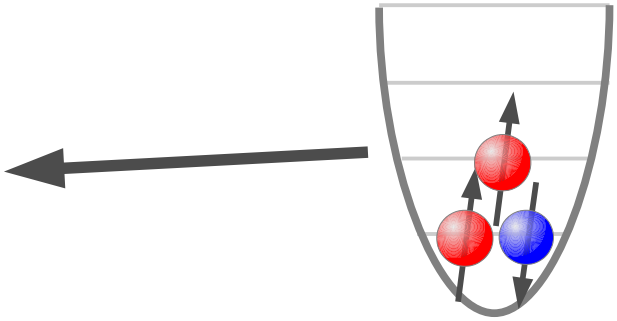


Weak

Strong

Three-atom bound state

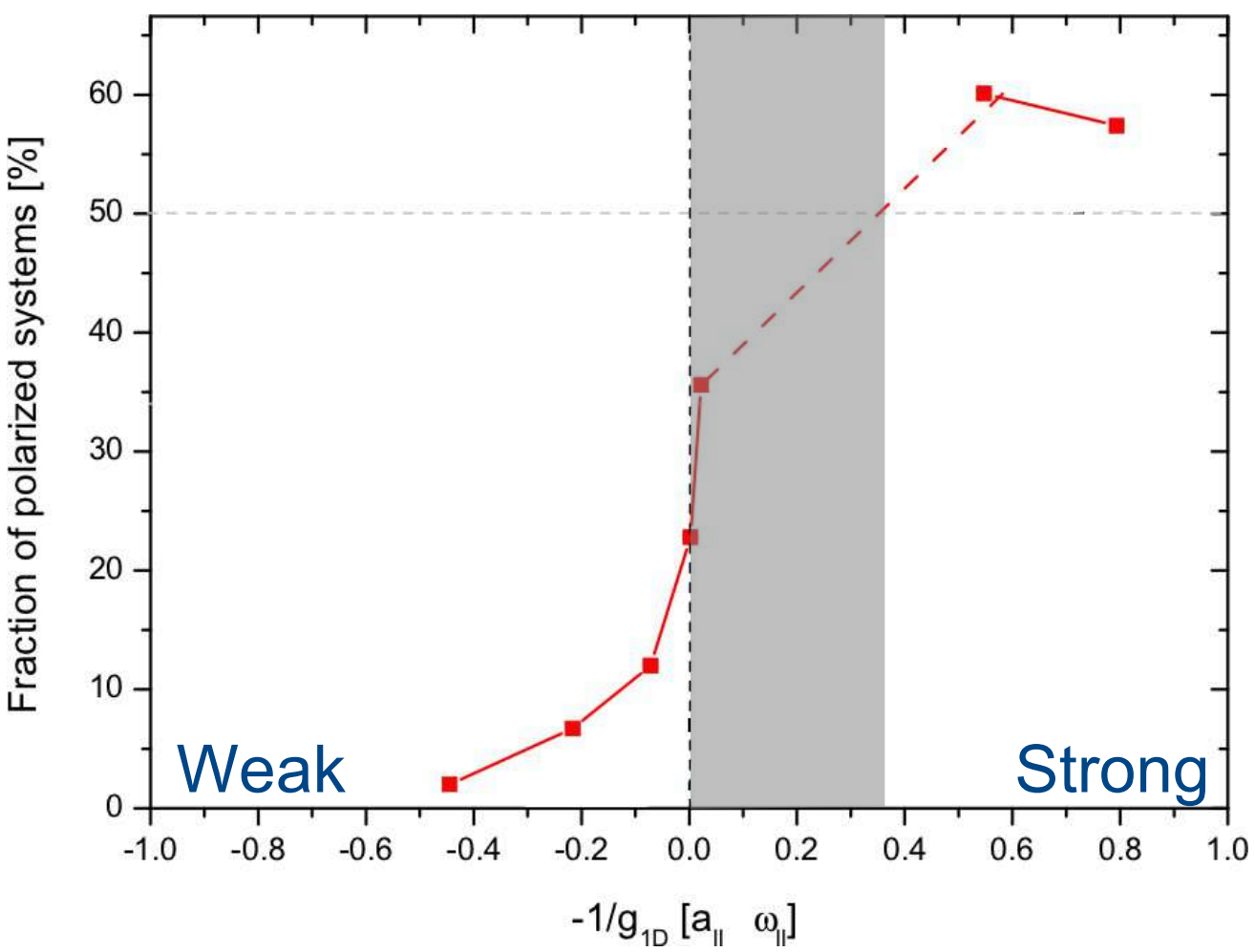


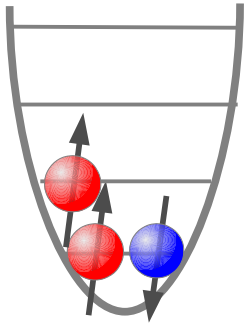


Weak

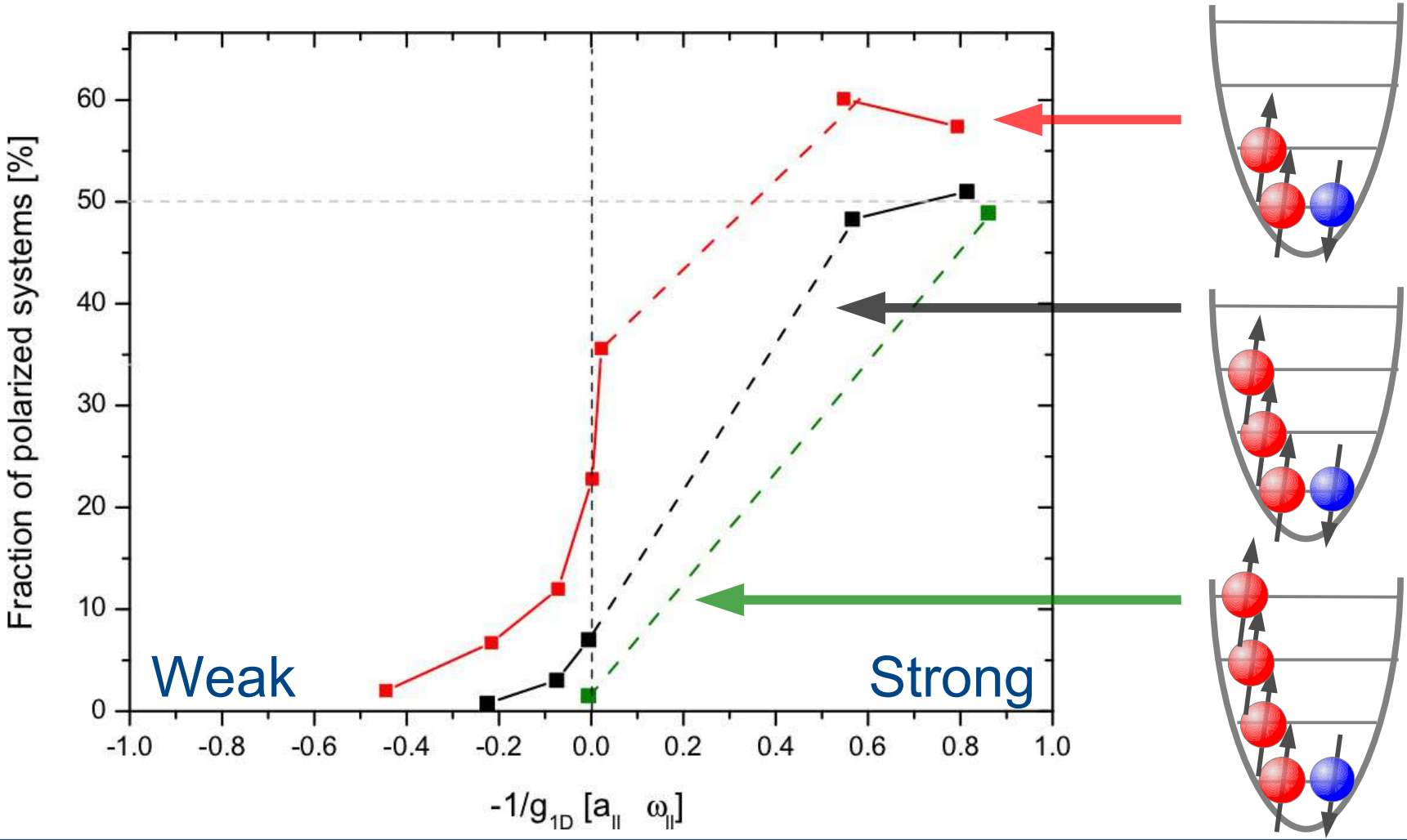
Strong

Loss region

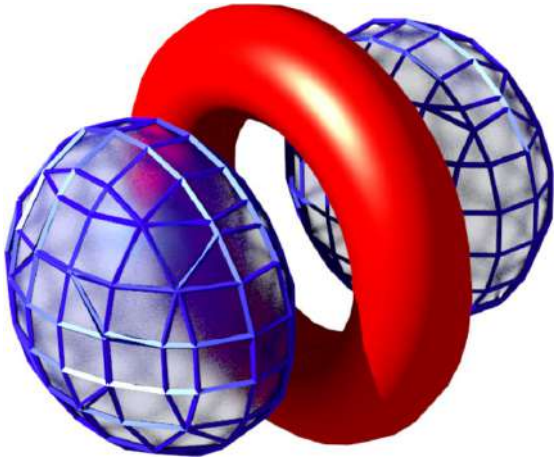

Fraction of polarized systems [%]
60
50
40
30
20
10
0
-1.0
-0.8
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
0.8
1.0
Weak
Strong
-1/g1D [all ωll]



Tunneling probability

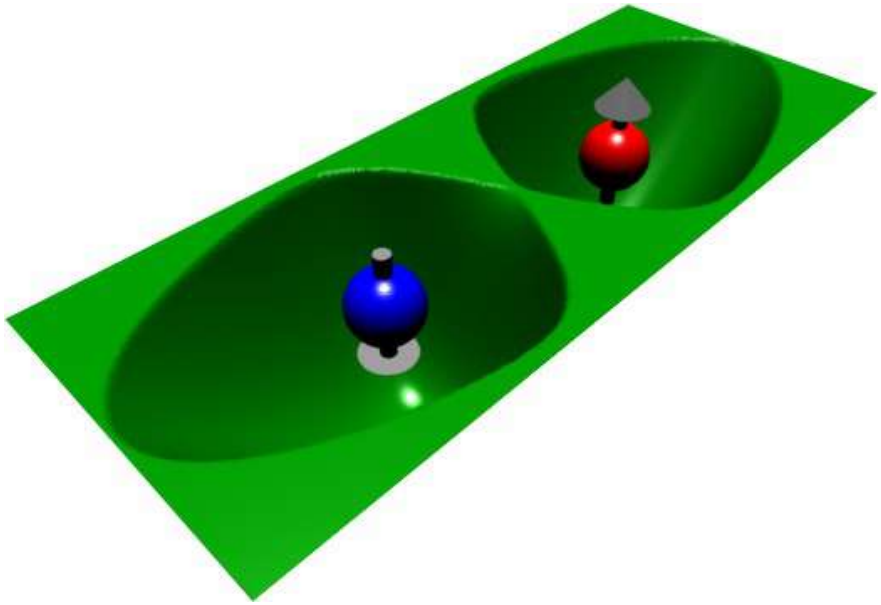


Other phenomena



Inhomogeneous pairing

P.O. Bugnion, J.A. Lofthouse & GJC
Phys. Rev. Lett. in press



Exchange interactions

P.O. Bugnion & GJC
Phys. Rev. A **88**, 013601 (2013)

Summary

A few-fermion system provides insight into many-body physics

Discretization of energy levels inhibits losses, allowing observation of magnetic correlations