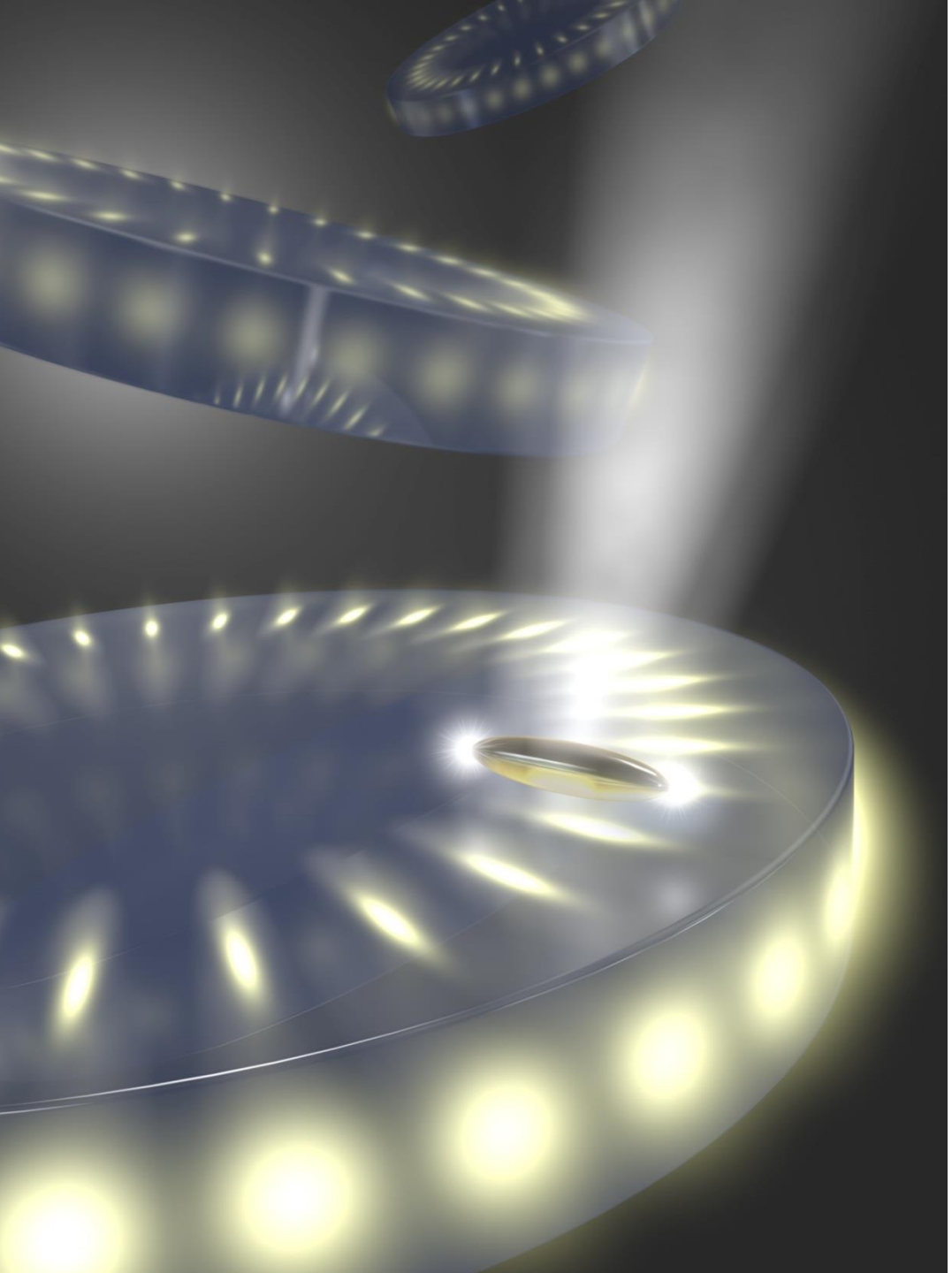

Better together:
Purcell enhancements at any linewidth in antenna-cavity hybrids

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Doeleman et al., 2016, *ACS Photonics,*
10.1021/acsphotonics.6b00453

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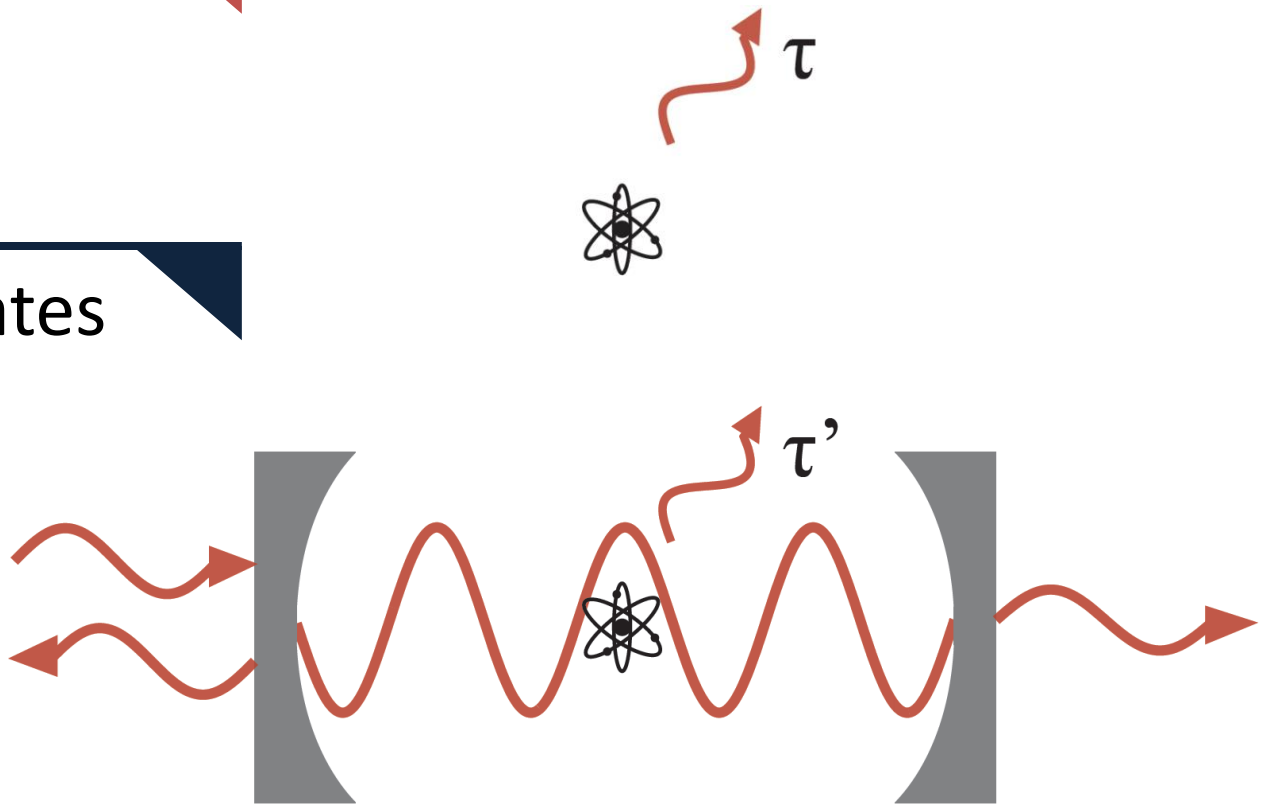
The Purcell effect

Single-photon sources

Quantum logic gates



Purcell, 1946, *Physical Review*

Lodahl et al., 2015, *Rev. Mod. Phys.*

O'Brien et al., 2009, *Nat. Phot.*

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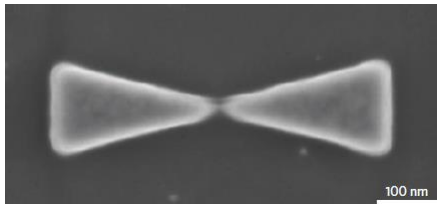
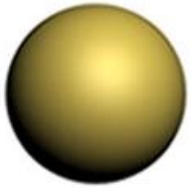
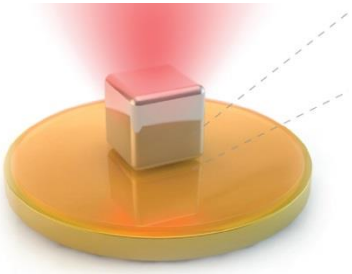
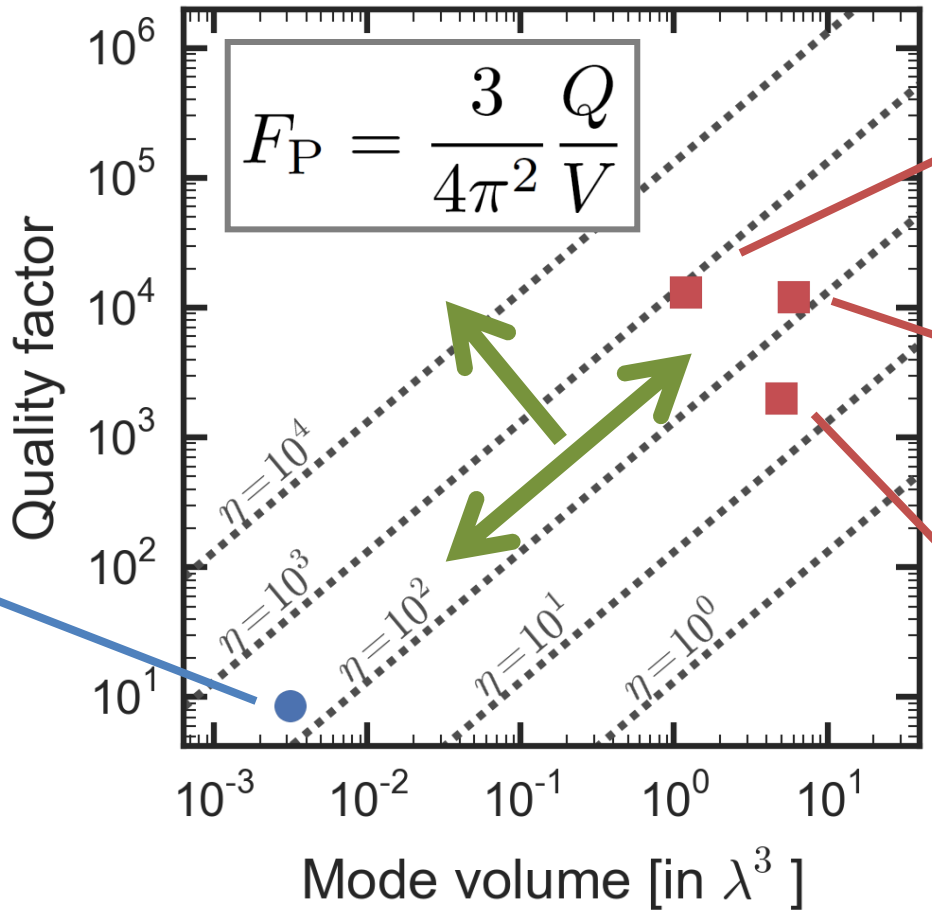
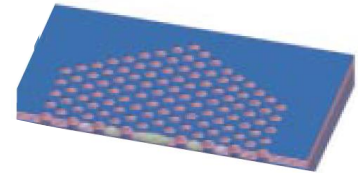
Cavities and Antennas

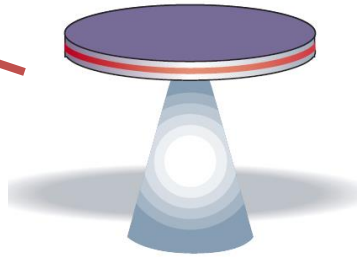


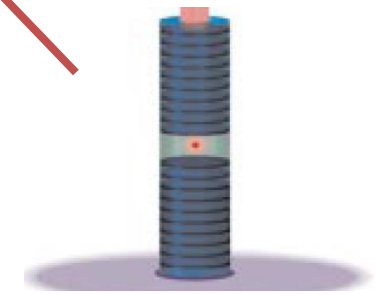












Vahala, 2003, Nature

Akselrod et al., 2014, Nat. Phot.

Lunneman et al., 2013, PRB

Novotny et al., 2011, *Nat. Phot.*

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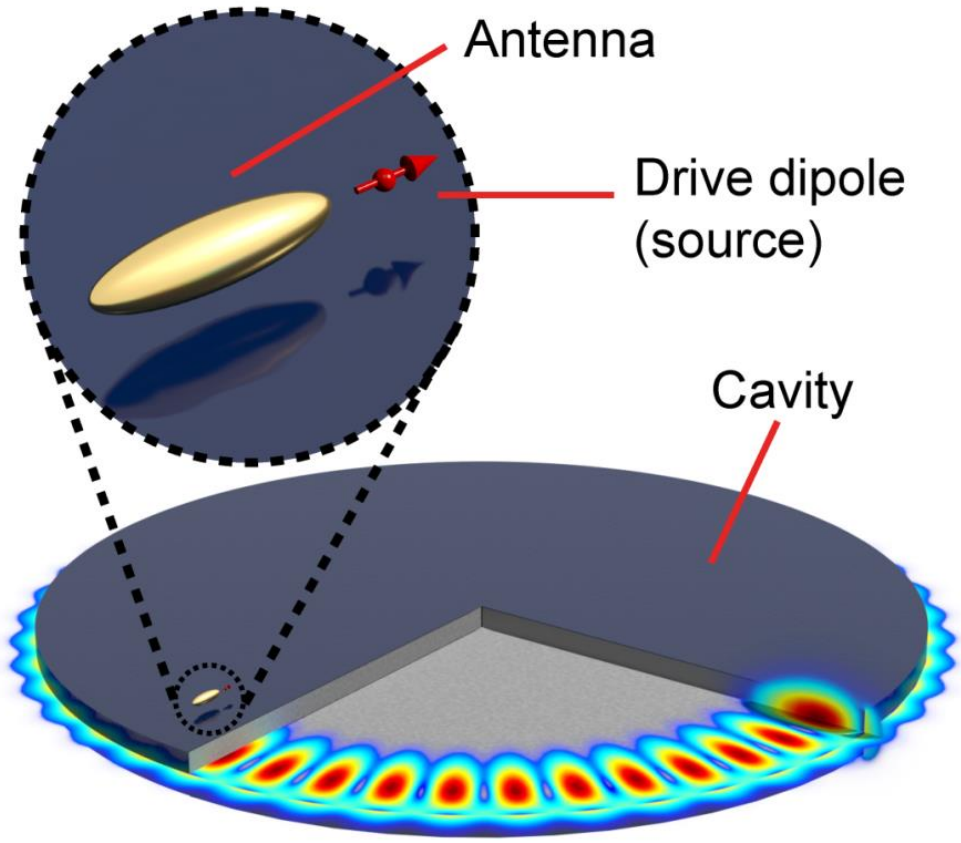
Analytical model

Antenna and cavity as coupled oscillators

System driven by a point dipole

Total emitted power by source gives Purcell factor

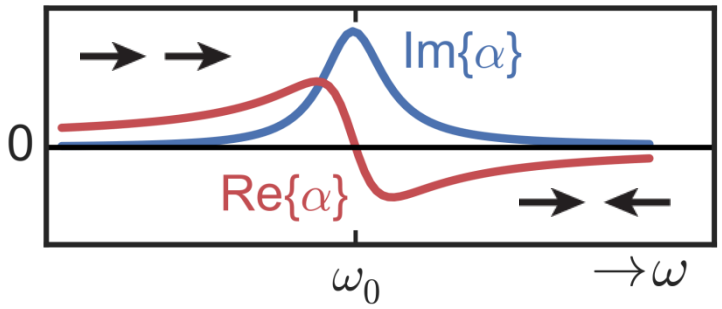
Holds for any antenna or cavity geometry

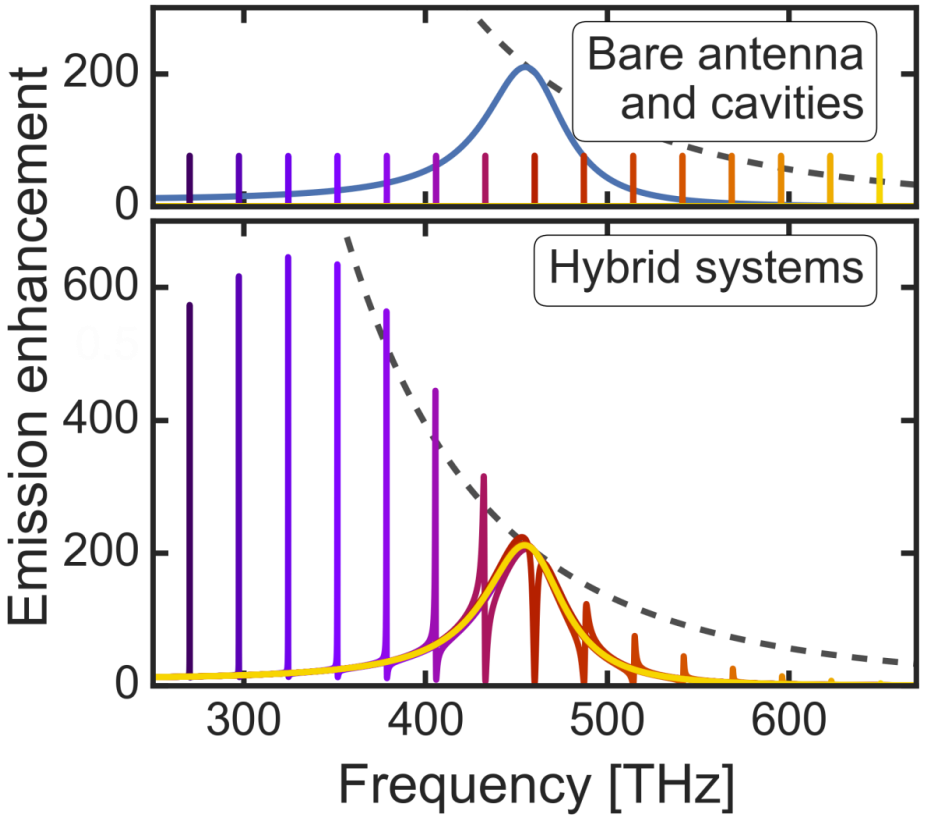


Hybrids vs. bare components

Red-detuned works best

- Antenna is enhanced, not spoiled off its resonance
- Cavity Q drop is modest
- Constructive interference



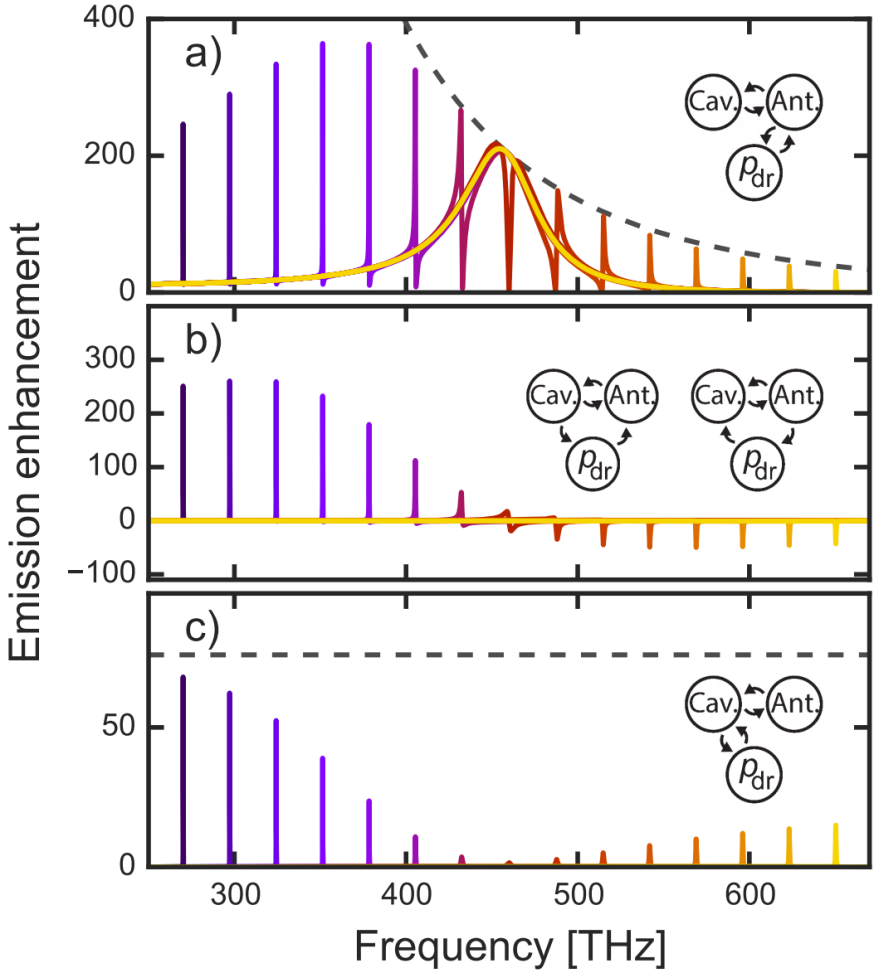


Separation in multiple scattering channels

"Via antenna" term never exceeds bare antenna limit

"Via cavity" term never exceeds bare cavity Purcell factor

(a)+(b)+(c) exceeds constituent limits

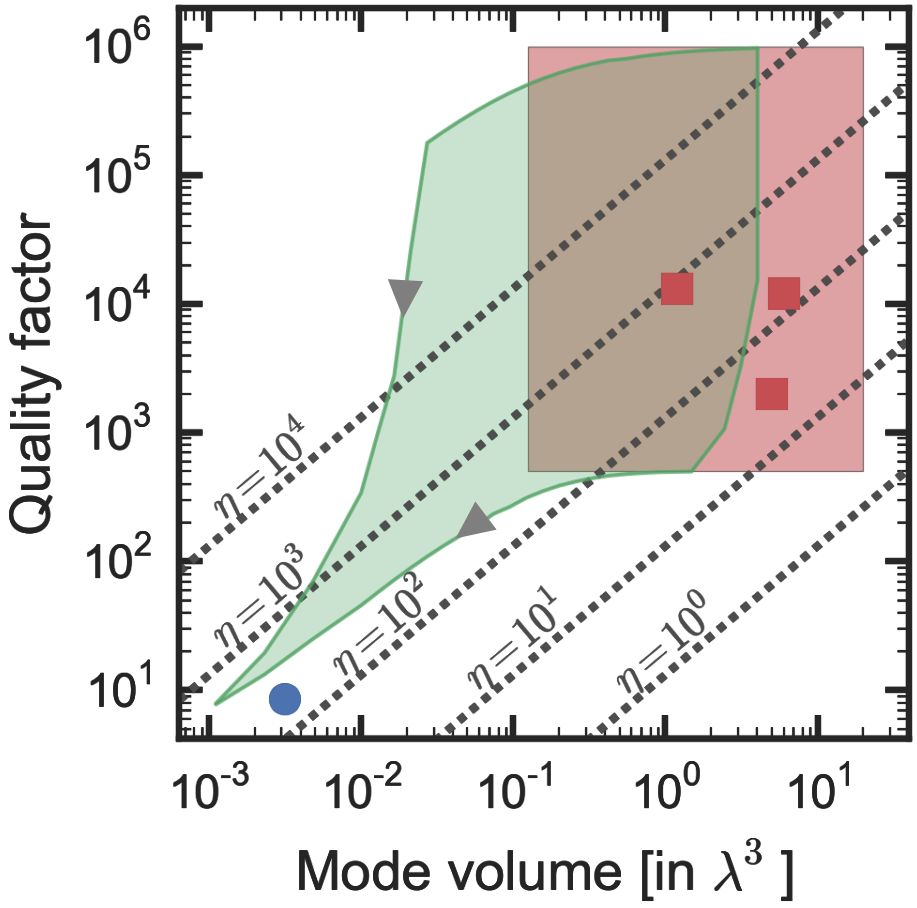


Bridging the gap with hybrids

Tune Q and V over wide range

Freedom to choose:

- Higher Purcell factors than cavity at same Q
- Same Purcell factor, at lower Q



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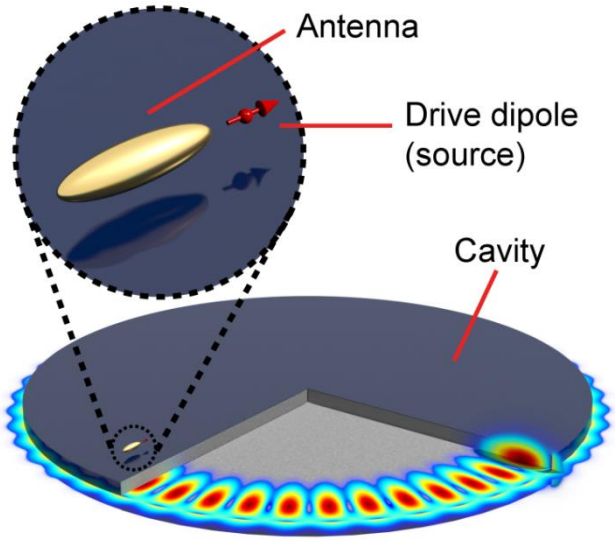
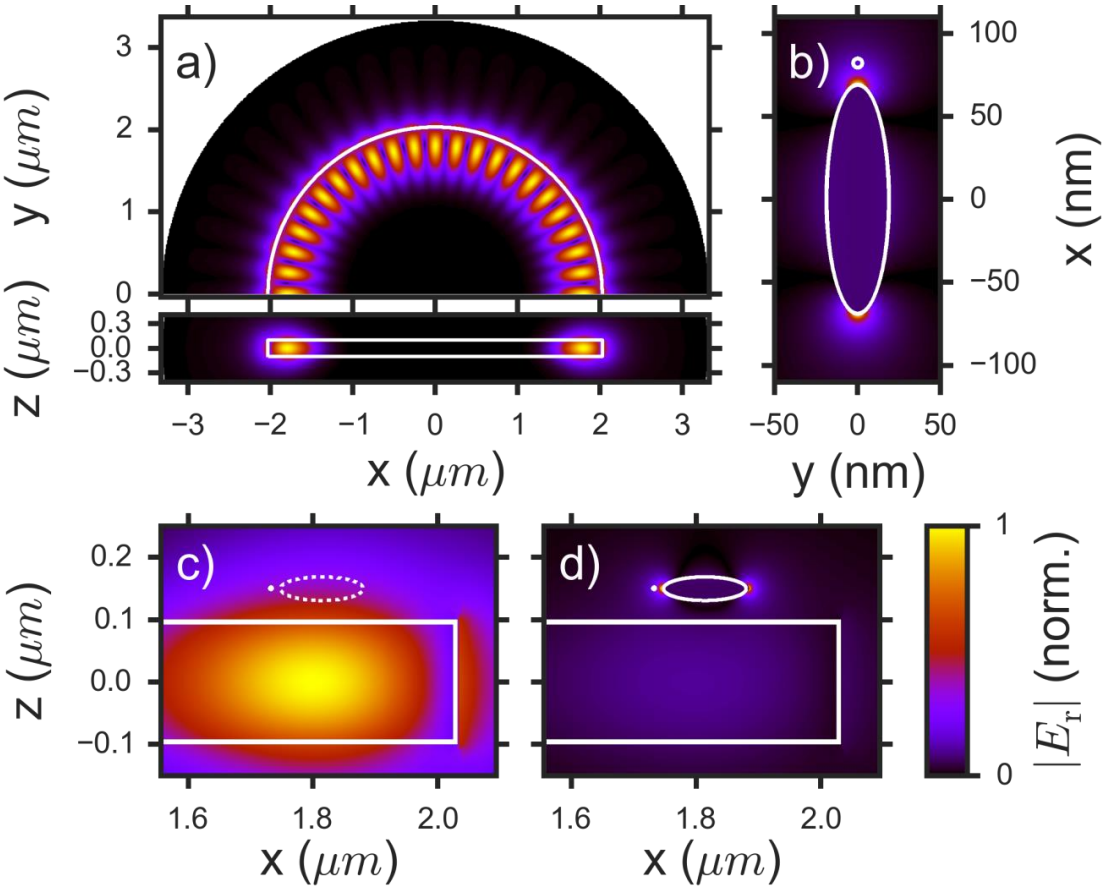
Finite element simulations

COMSOL simulation reproduces analytical theory with no adjustable parameters





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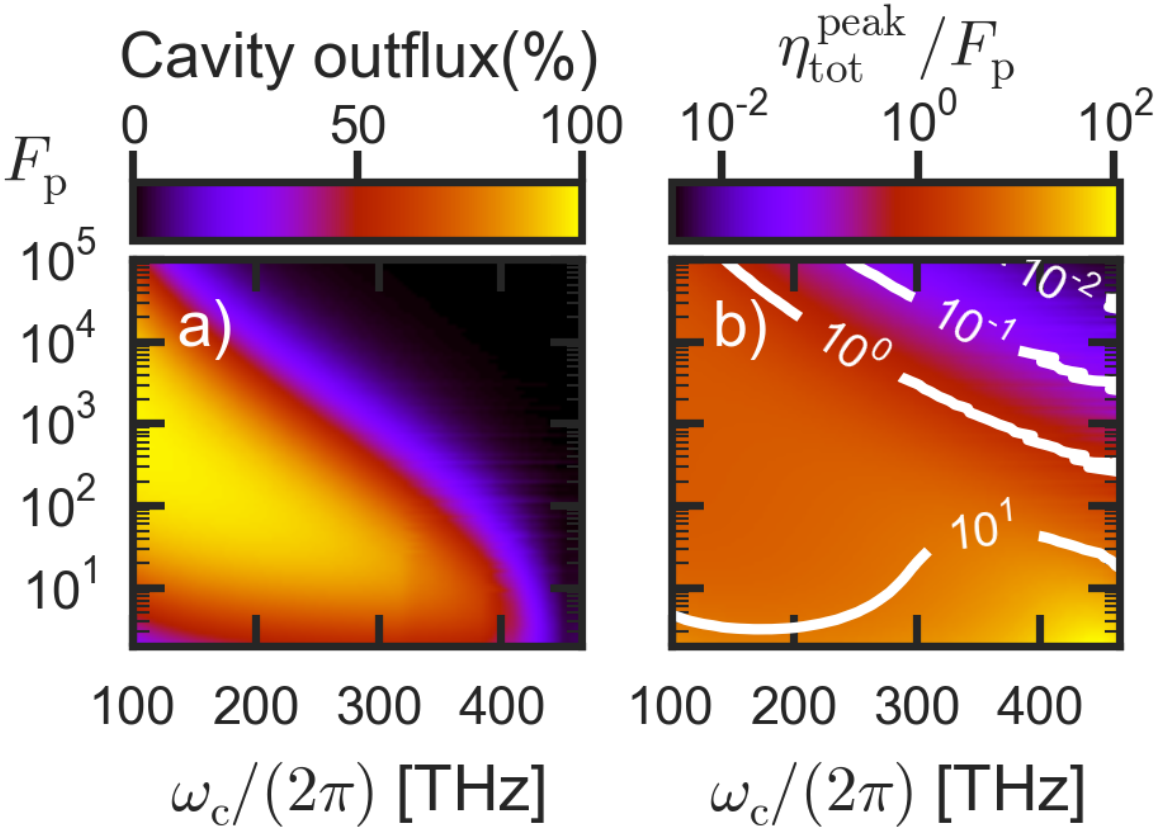
Efficient extraction in hybrids

Near 100% efficient extraction of power through a waveguide is possible



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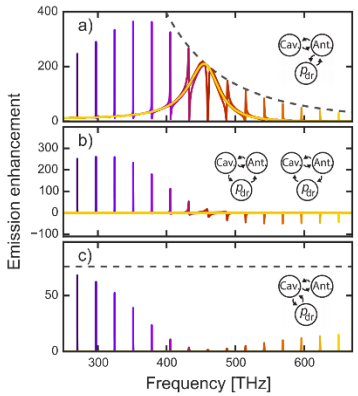
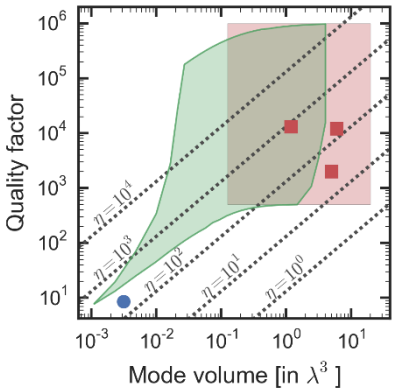
Conclusions

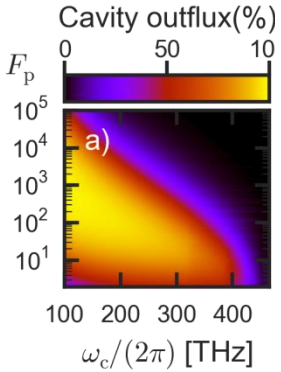
Hybrids break antenna limit



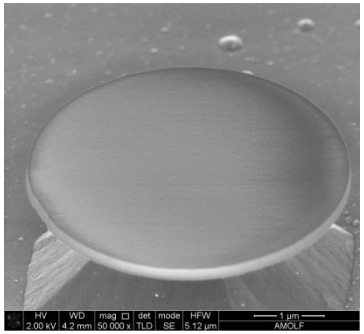
Tunable Q



High extraction efficiency



Experiments underway



Doeleman et al., 2016, *ACS Photonics,* 10.1021/acsphotonics.6b00453

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