LETTER

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Continuous-wave room-temperature diamond maser

Jonathan D. Breeze[1,2], Enrico Salvadori[3,4,5], Juna Sathian[1], Neil McN. Alford[1,2] & Christopher W. M. Kay[3,4,6]

Nature **volume555**, pages493–496 (22 March 2018)

2018-04-30 Journal Club

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Author

- Prof. Neil Alford
- Professor @ ICL

LETTER

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Room-temperature solid-state maser

Mark Oxborrow[1], Jonathan D. Breeze[2] & Neil M. Alford[2]

nature COMMUNICATIONS

ARTICLE

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Enhanced magnetic Purcell effect in room-temperature masers

Jonathan Breeze[1], Ke-Jie Tan[1], Benjamin Richards[1], Juna Sathian[1], Mark Oxborrow[1] & Neil McN Alford[1]

SCIENTIFIC REPORTS

OPEN

Nanosecond time-resolved characterization of a pentacene-based room-temperature MASER

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Enrico Salvadori[1,2,3], Jonathan D. Breeze[4], Ke-Jie Tan[4], Juna Sathian[4], Benjamin Richards[4], Mei Wai Fung[2], Gary Wolfowicz[1], Mark Oxborrow[4], Neil McN. Alford[4] & Christopher W. M. Kay[1,2]

npj | Quantum Information

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ARTICLE OPEN

Room-temperature cavity quantum electrodynamics with strongly coupled Dicke states

Jonathan D. Breeze[1,2], Enrico Salvadori[3,4,5], Juna Sathian[1], Neil McN. Alford[1,2] and Christopher W. M. Kay[3,4]

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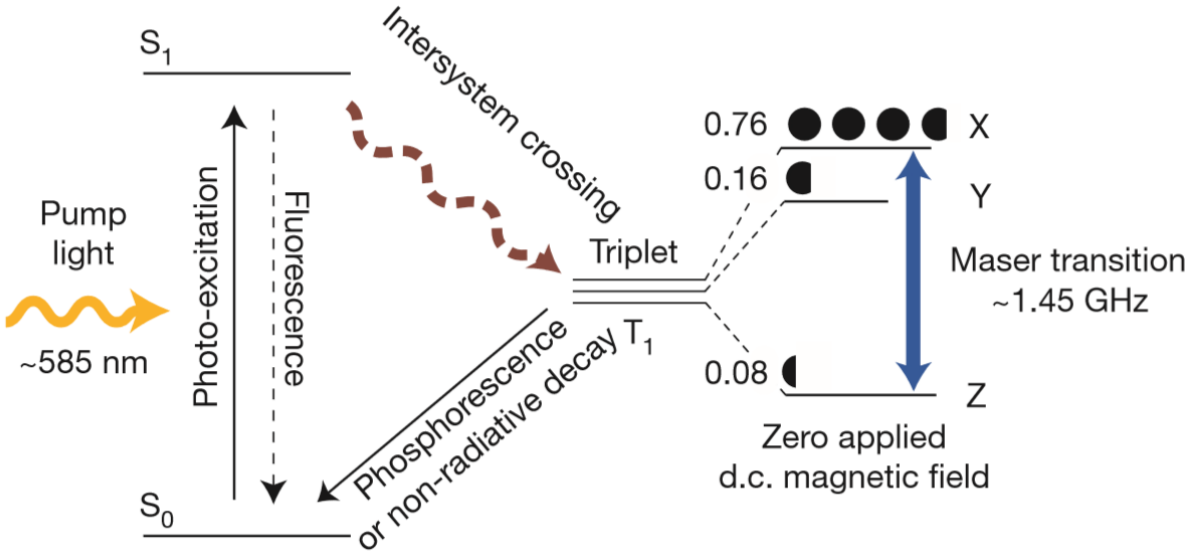
Recent Research

- *Continuous-wave room-temperature diamond maser*, Nature(2018)
- *Room-temperature cavity quantum electrodynamics with strongly coupled Dicke states*, NPJ Quantum Information(2017)
- *Nanosecond time-resolved characterization of a pentacene-based room-temperature maser*, Scientific Reports (2017)
- *Enhanced magnetic Purcell effect in room-temperature masers*, Nature communications(2015)
- *Room-temperature solid-state maser*, Nature(2012)

The first room-temp Maser

- Using p-terphenyl triplet state
- Long spin-lattice relaxation time (~135μs)



Nature **volume488**, pages353–356 (16 August 2012)

The first room-temp Maser

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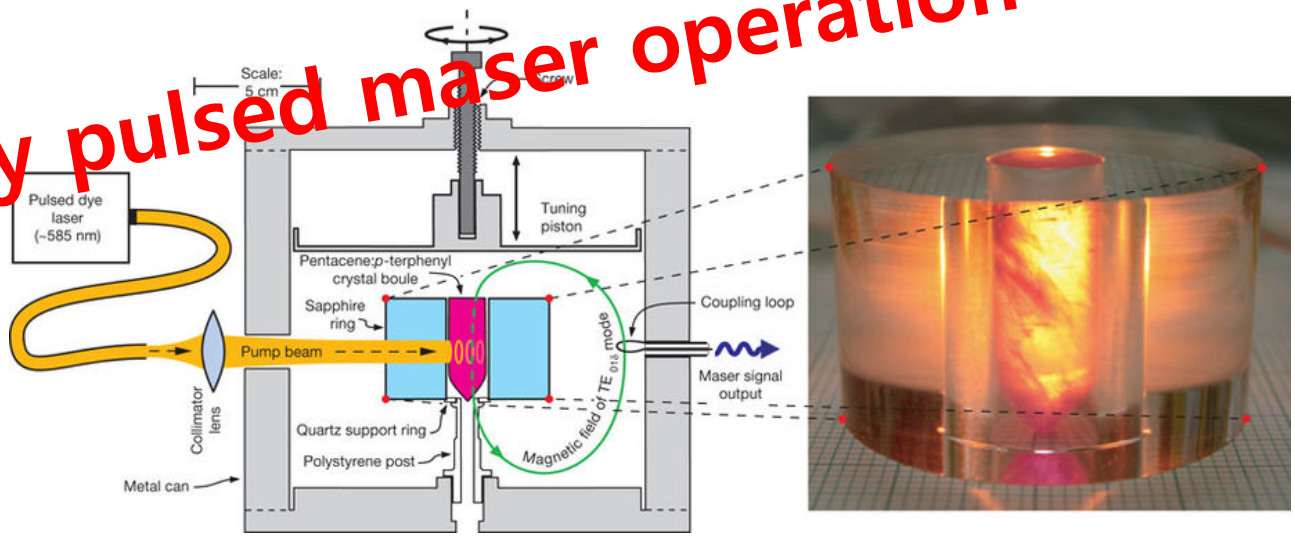
Room-temperature solid-state maser

Mark Oxborrow[1], Jonathan D. Breeze[2] & Neil M. Alford[2]

Poor thermal and mechanical properties

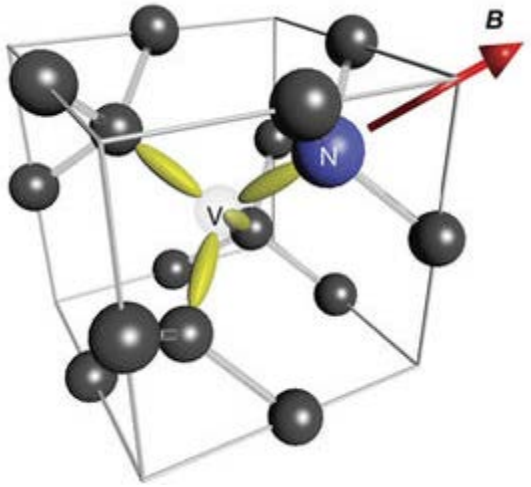
Only pulsed maser operation



Nature **volume488**, pages353–356 (16 August 2012)

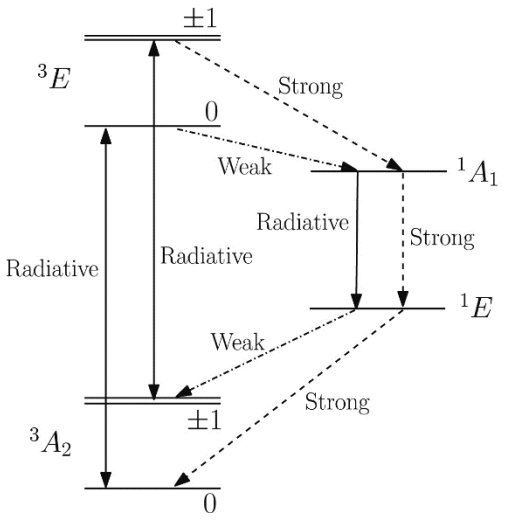
NV^- center

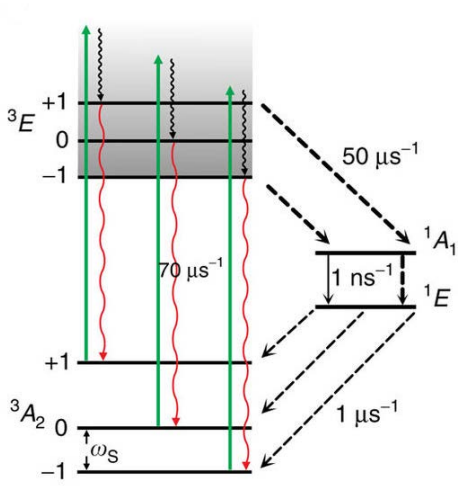
- Long spin polarization time (~5ms)
- Long spin dephasing time (>1μs)
- Good thermal conductivity (1000 W/m·K)
- Good stability
- Easy to achieve the population inversion

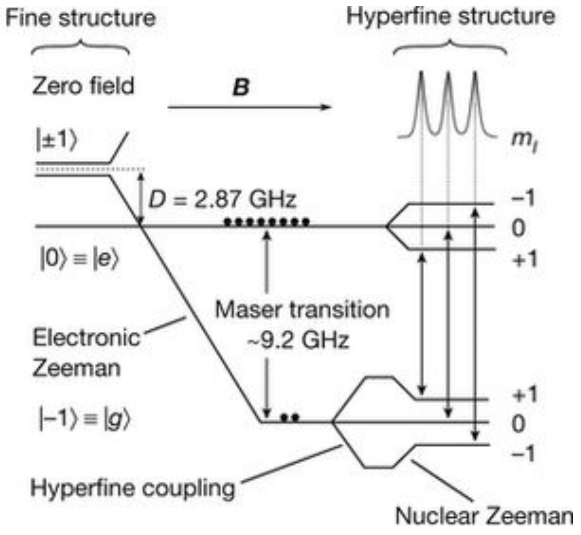


Population inversion

- ~80% of electrons in $|0\rangle$







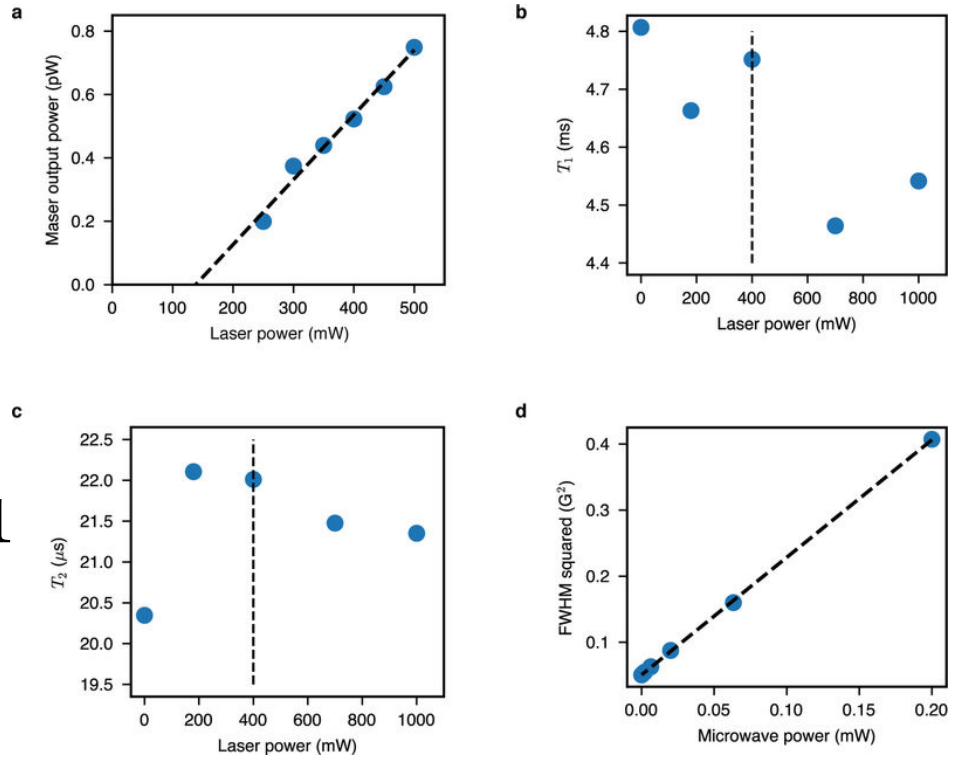
Physics Reports, 528 (2013), 1-45

N. Comm 6, 8251 (2015)

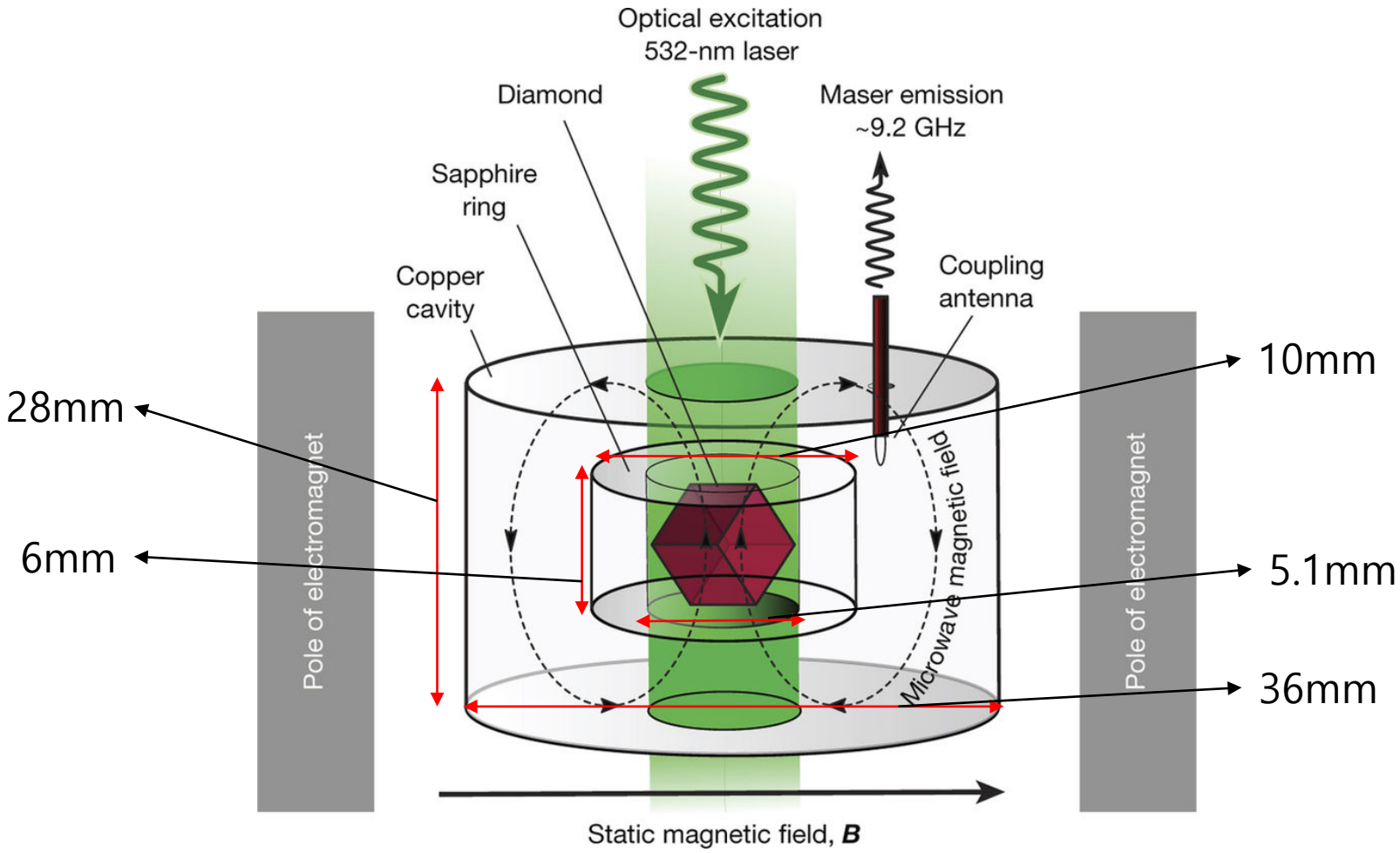
Experimental Validity

- $\mathrm{Q} = 30000$
- $\mathrm{N} = 4.0 \times 10^{13}$
- $g_s = 0.7\mathrm{MHz}$
- $\kappa_c = \omega_c/\mathrm{Q} = 1.9\mathrm{MHz}$
- $\kappa_s = 2/\mathrm{T}_2^* = 3.9\mathrm{MHz}$
- $\mathrm{C} = 4{g_s}^2\mathrm{N}/\kappa_c\kappa_s = 10.6 \gg 1$

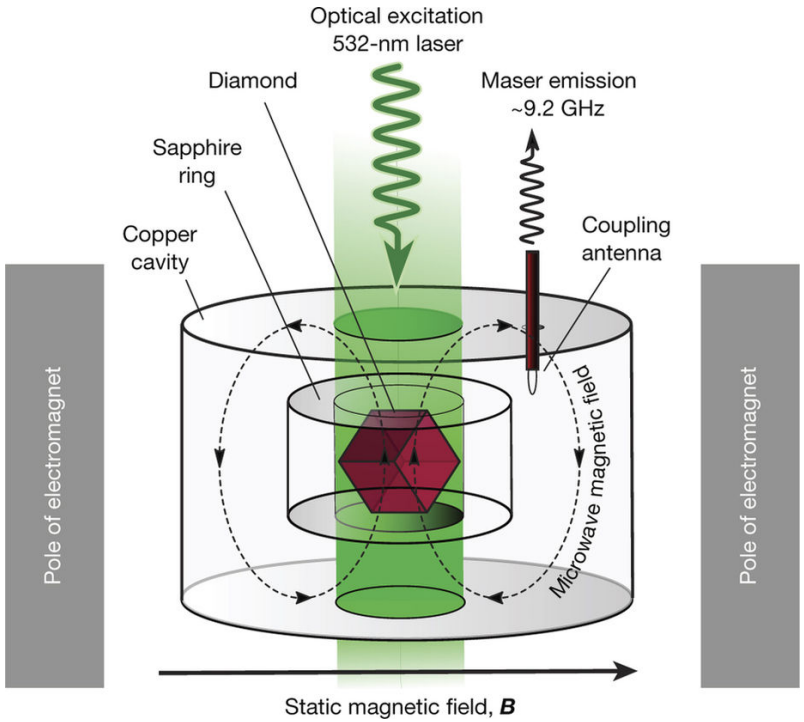
  $\rightarrow$ 180mW threshold

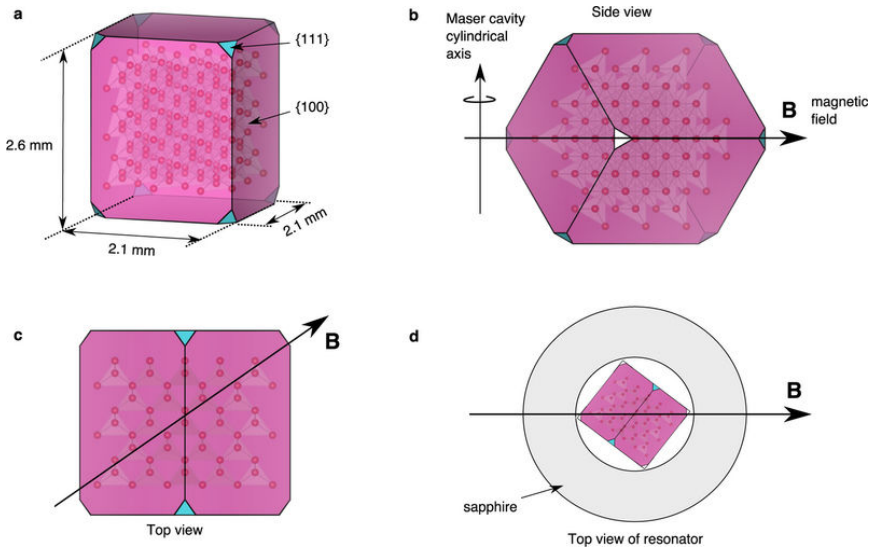


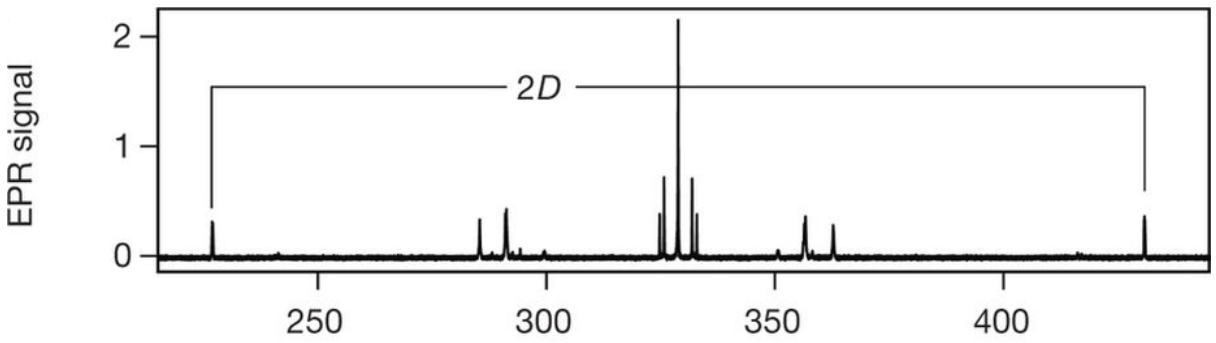
Experimental Setup



Experimental Setup

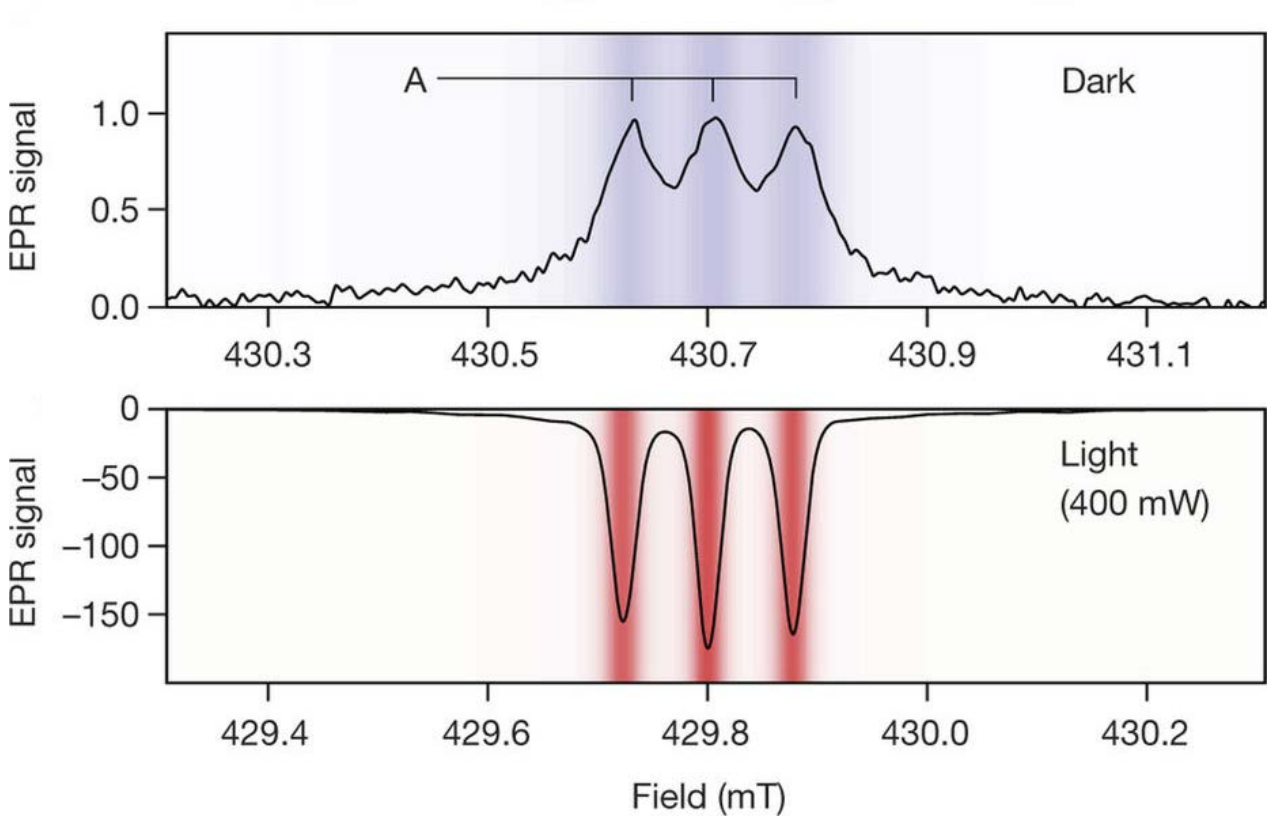






EPR spectroscopy

- A=0.075mT
- -25MHz shifted (35℃ increased)



Maser emission