Controlling relaxation of nuclear spin qubit ensembles for a more sensitive search for axion-like dark matter

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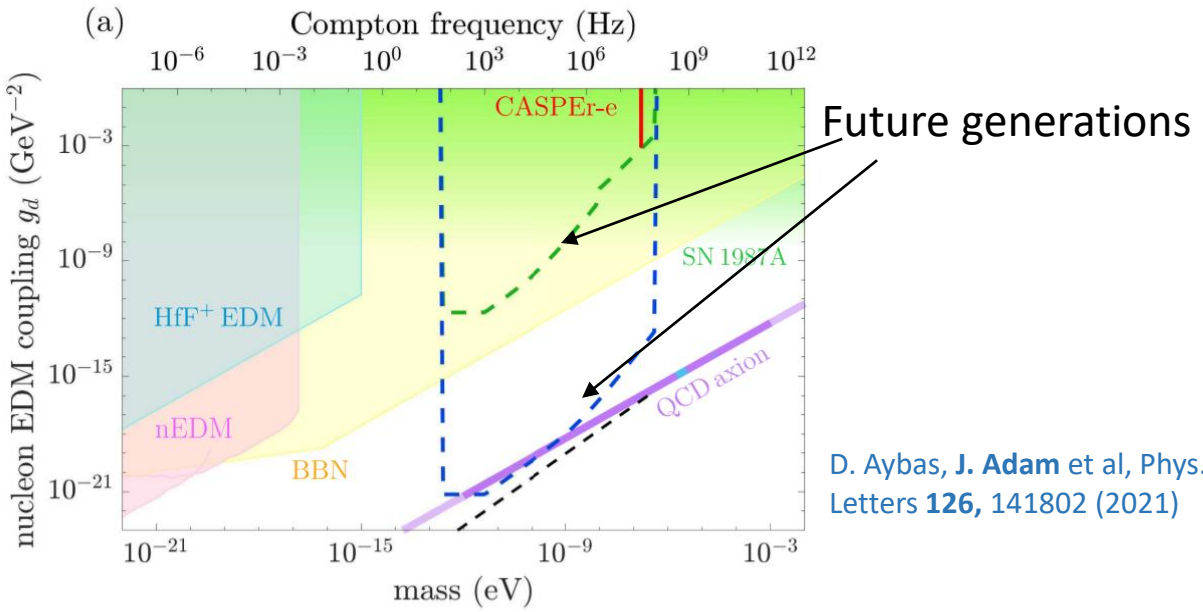
PATRAS 2021

Future phases of CASPEr-Electric

CASPEr-Electric Gen 1 results



Future generations

D. Aybas, **J. Adam** et al, Phys. Rev. Letters **126,** 141802 (2021)

How to increase sensitivity further?

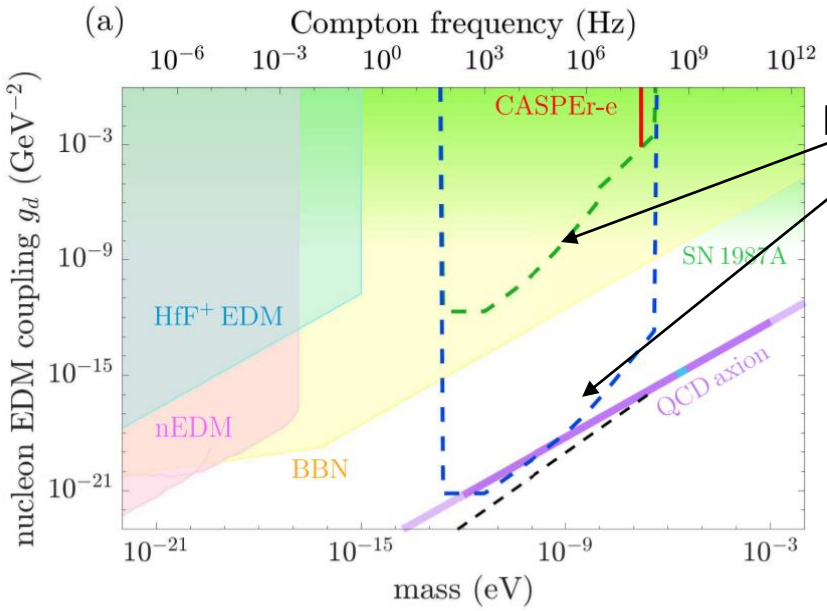
- Bigger sample (80 cm)
- **Increase Polarization**

$$p = \frac{n_\uparrow - n_\downarrow}{n_\uparrow + n_\downarrow} \sim \frac{\mu B}{k_B T} \sim 10^{-4}$$

Future phases of CASPEr-Electric

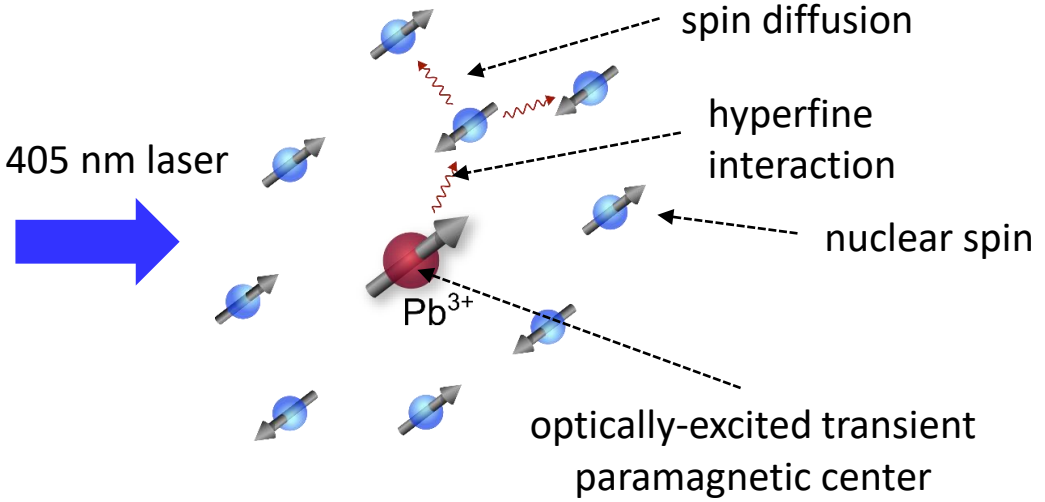
By shining laser we can create transient paramagnetic centers

CASPEr-Electric Gen 1 results



Future generations

D. Aybas, **J. Adam** et al, Phys. Rev. Letters **126,** 141802 (2021)



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Dynamic Nuclear Polarization (DNP)
DNP is transmitting polarization from electrons to nuclei

BUT… **Our sample doesn't have unpaired electron spins**

Decrease temperature

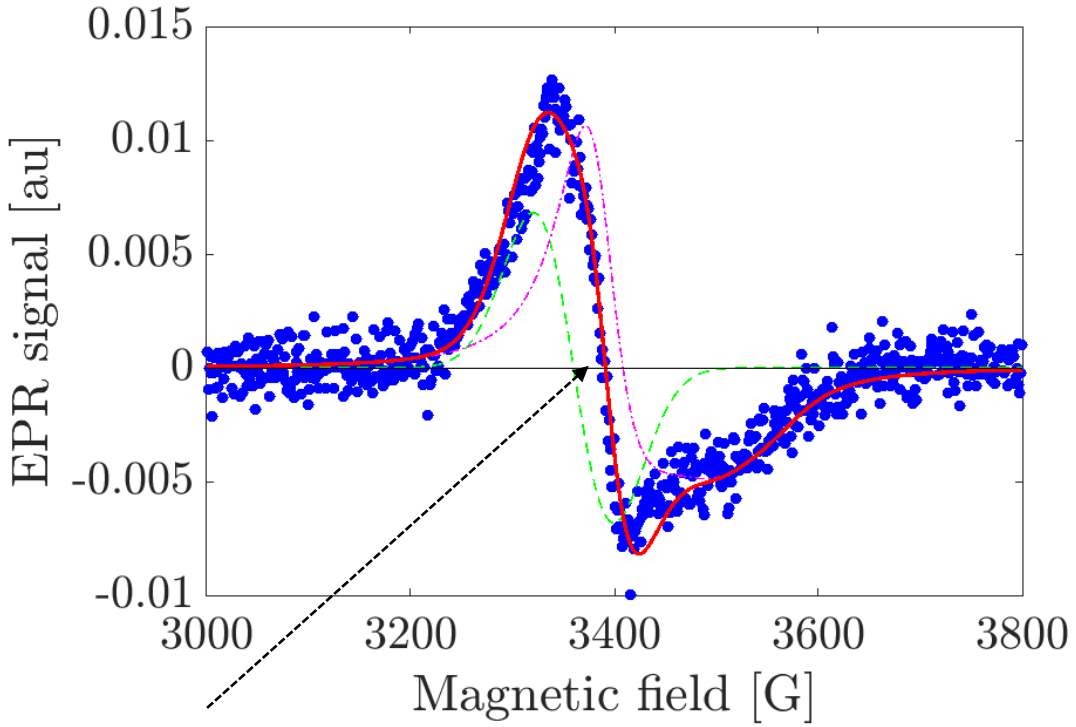
BUT… **T1 (spin-lattice relaxation) becomes long (~ hours)**

L.-S. Bouchard et al, Phys. Rev. A **77**, 022102 (2008)

Reduction of relaxation time by paramagnetic centers

Detecting light induced paramagnetic centers using electron paramagnetic resonance (EPR)

EPR spectrum of PMN-PT at 10K, 9.4 GHz, illuminated by 405 nm



Signal around g = 2 only if illuminated

[Manuscript in preparation]

Extracted parameters:

Spin density, relaxation times

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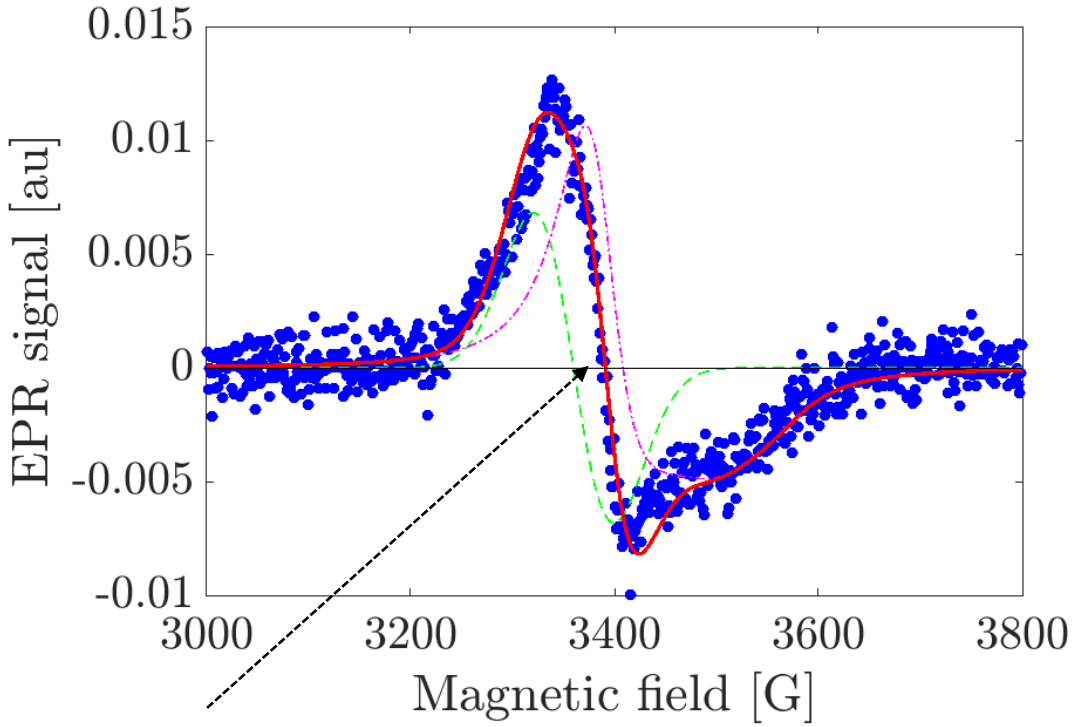

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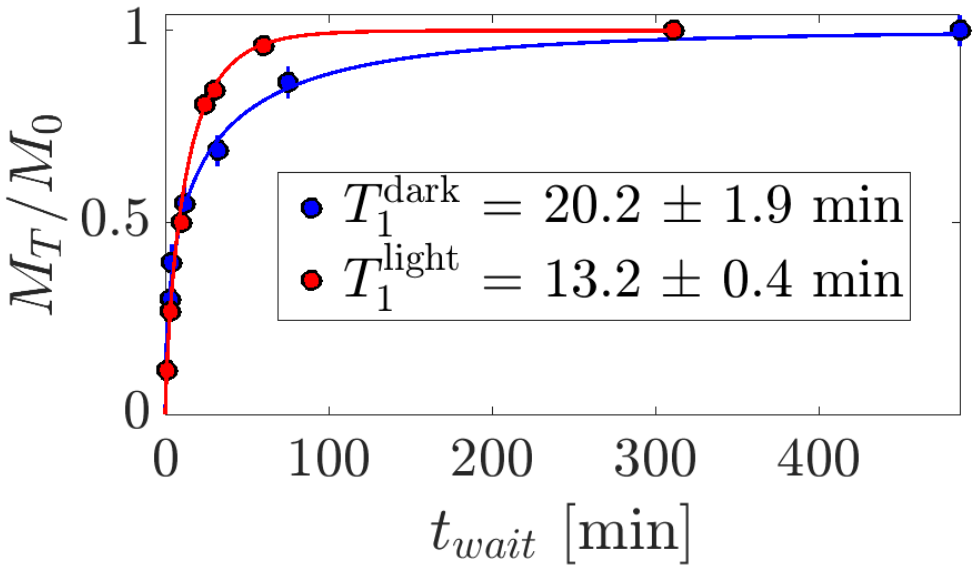
Spin relaxation time measurement of 207 Pb nuclear spins at 4K

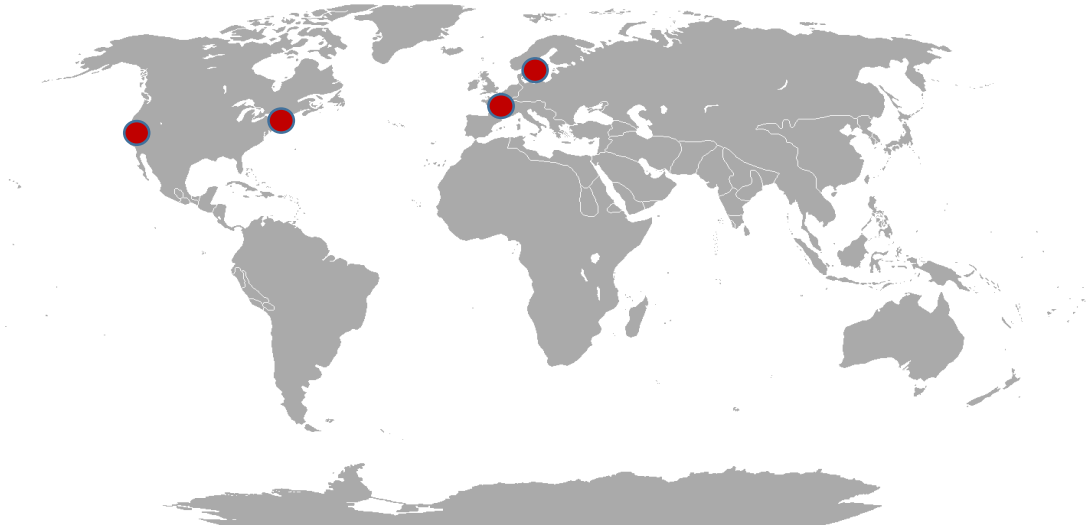


Estimate is consistent with observation

M. Goldman, Phys. Rev. **138**, A1675 (1965)

We are able to control nuclear relaxation time by light-induced transient paramagnetic centers

CASPER collaboration

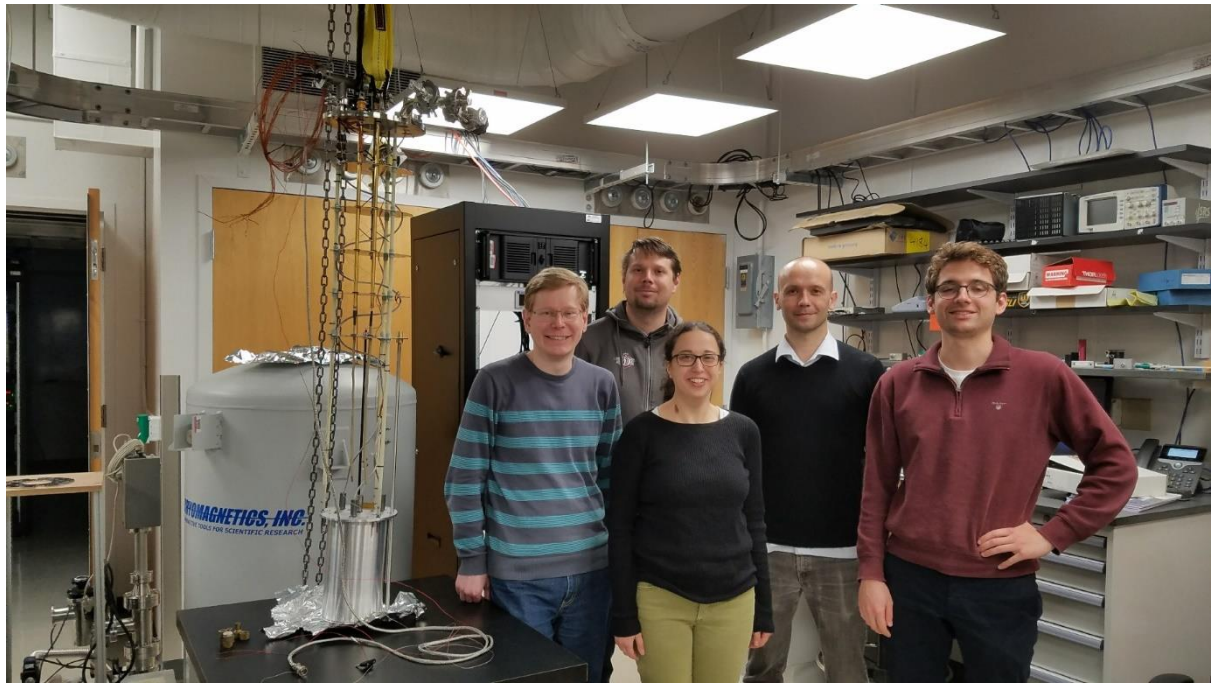


Alfred P. Sloan FOUNDATION

SIMONS FOUNDATION

HEISING - SIMONS FOUNDATION

CASPEr-Electric Team



Thank you!

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