EDMMA (EDM in matrix)

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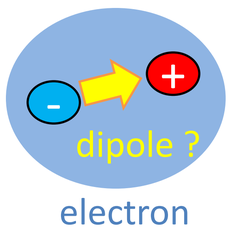
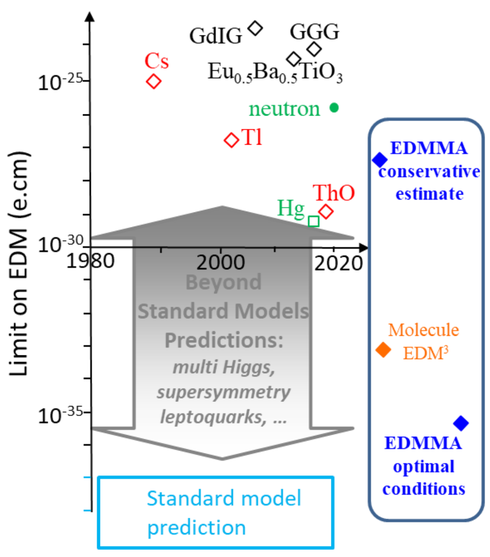
Introduction



Electric Dipole Moments (EDM) are sensitive probes for physics beyond the Standard Model. We propose to measure the electron-EDM using a Cs atoms embedded in a cryogenic solid matrix of inert gas or hydrogen.

State of the art

Historical perspective on selected EDM measures



Proposal in matrix

Electron EDM sensitivity $\sigma_d = \frac{\hbar}{\epsilon E_{eff} \tau \sqrt{N_T}}$

Method	System	N_T time integrated	Time τ [s]	Polarization ε	Eff. Field E_{eff} (V/cm)	EDM e.cm
Solid	$Eu_{0.5}Ba_{0.5}TiO_3$	10^{25}	0.2	$<10^{-10}$	10^{7}	$6\ 10^{-25}$
Gas	ThO	10^{13}	0.002	0.1	10^{11}	10^{-29}

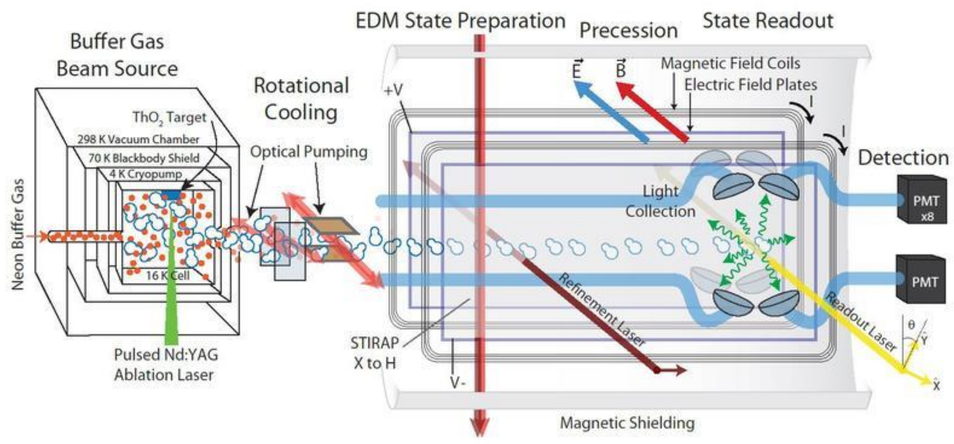
Proposed system in inert matrix

Method	System	N_T	τ [s]	ε	E_{eff} (V/cm)	EDM e.cm
Atom EDMMA	Cs (Conservative)	$\sim 10^{18}$	0.001	0.1	10^{6}	$\sim 10^{-27}$
	(optimal)	$\sim 10^{22}$	1	1	10^{9}	$\sim 10^{-36}$
Molecule (EDM^3)	BaF	$\sim 10^{20}$	0.1	0.1	10^{10}	$\sim 10^{-34}$

Usual method : gas phase measurement

Improved limit on the electric dipole moment of the electron

ACME Collaboration., Andreev, V., Ang, D.G. *et al.* Improved limit on the electric dipole moment of the electron. *Nature* **562,** 355–360 (2018).



Moving atoms, Low density

Vacuum simulation with inert solid matrix

"ARTIFICIAL VACUUM" FOR *T*-VIOLATION EXPERIMENT PHYSICS LETTERS B
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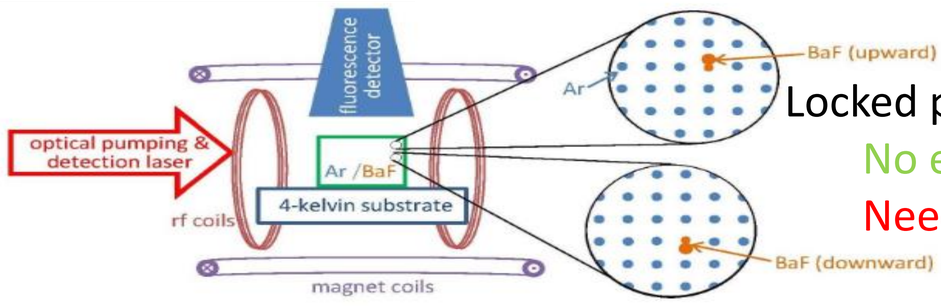
Lots of particles trapped "like" in gas phase : High density,
Long coherence time

atoms MDPI
http://www.yorku.ca/edmcubed
Article
Oriented Polar Molecules in a Solid Inert-Gas Matrix: A Proposed Method for Measuring the Electric Dipole Moment of the Electron
A. C. Vutha [1,*], M. Horbatsch [2] and E. A. Hessels [2]



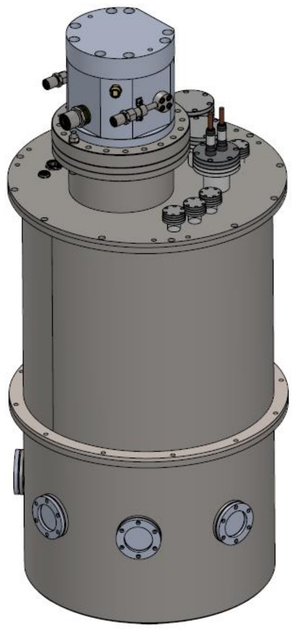
Locked polar molecules:
No external E field
Need mono–crystal

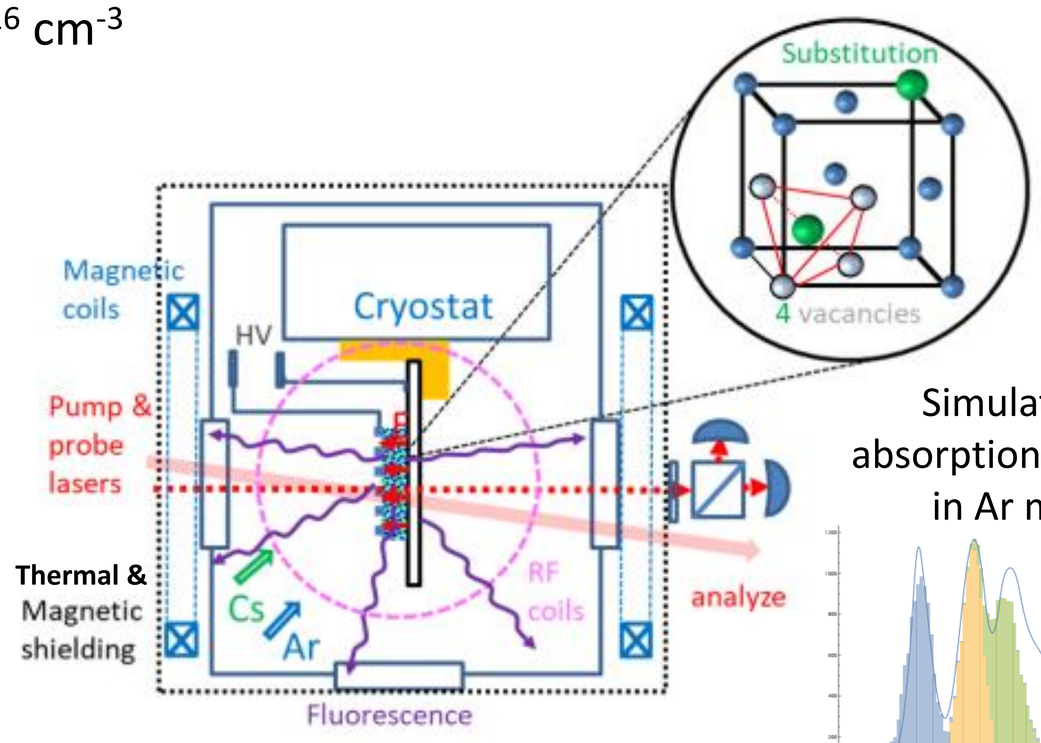
EDM measurement using Cs atoms

Spin coherence : 100 ms

Optical pumping : 10% in solid parahydrogen (PRA 100, 063419 (2019))

Density : > 10^{16} cm^{-3}





Simulated Cs absorption spectrum in Ar matrix