SEARCHING FOR DARK MATTER

IUPAP C11 YOUNG SCIENTIST PRIZE

BEN SAFDI

LEINWEBER CENTER FOR THEORETICAL PHYSICS
UNIVERSITY OF MICHIGAN

BERKELEY CENTER FOR THEORETICAL PHYSICS
LAWRENCE BERKELEY NATIONAL LABORATORY
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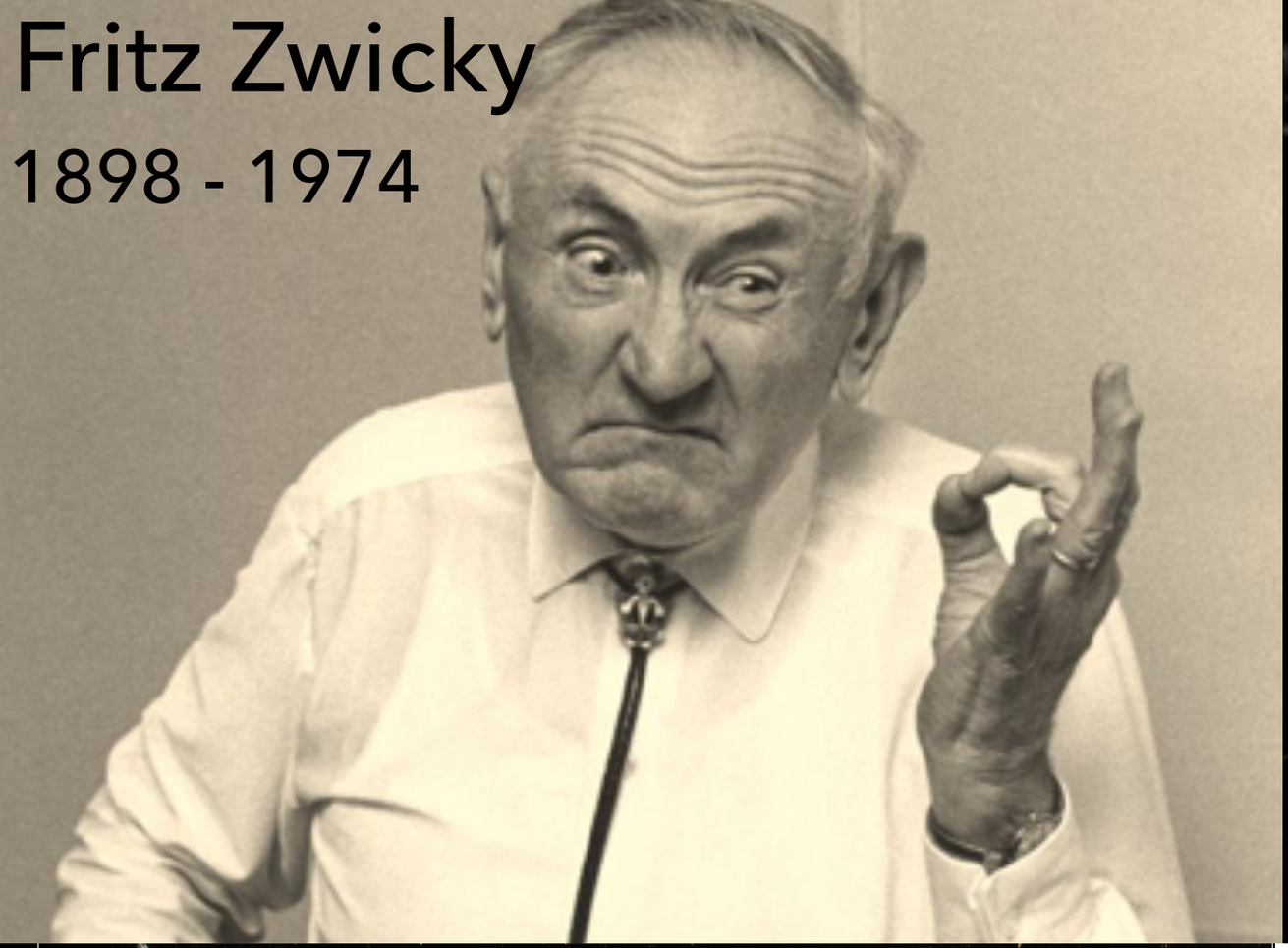
Dark Matter:

the stuff out there that we still really don’t understand

Fritz Zwicky

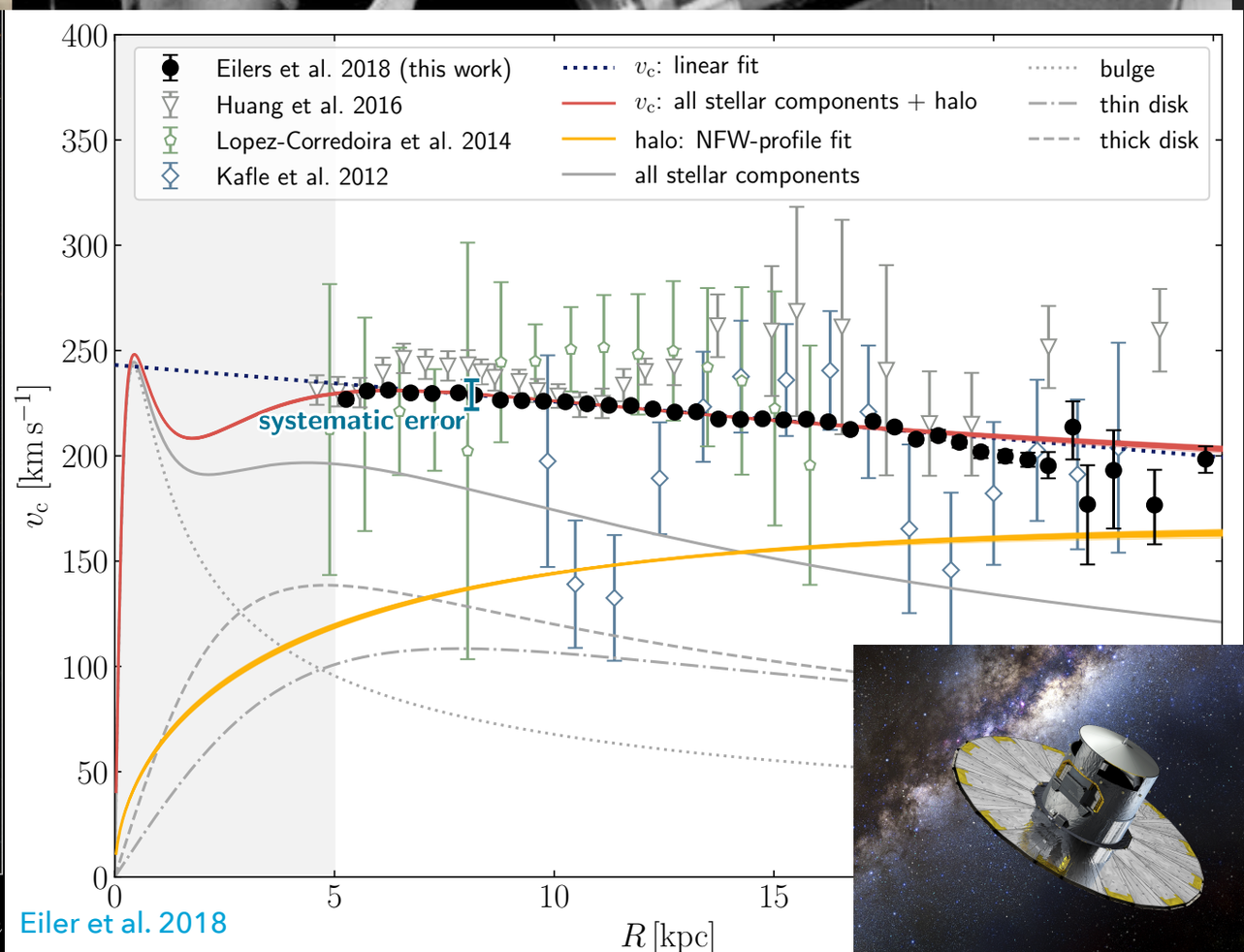
1898 - 1974



Vara Rubin

1928 - 1928 - 2016

Hubble Heritage



Eiler et al. 2018

Dark matter in a galaxy

Aquarius simulation

visible galaxy

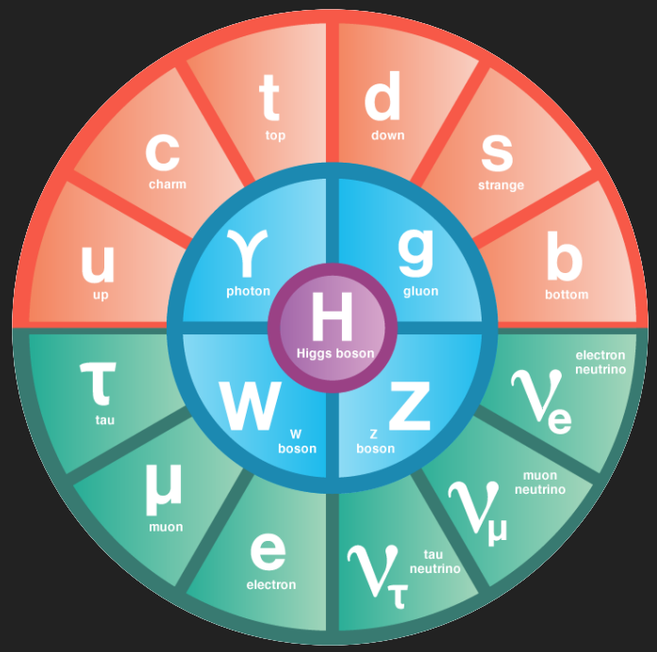
Aquarius simulation

dark matter

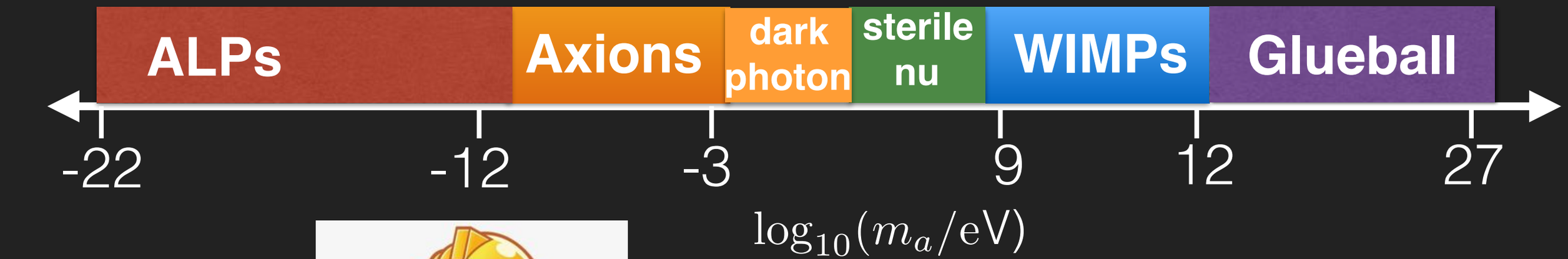

Friedrich Bertuch

1933

?????



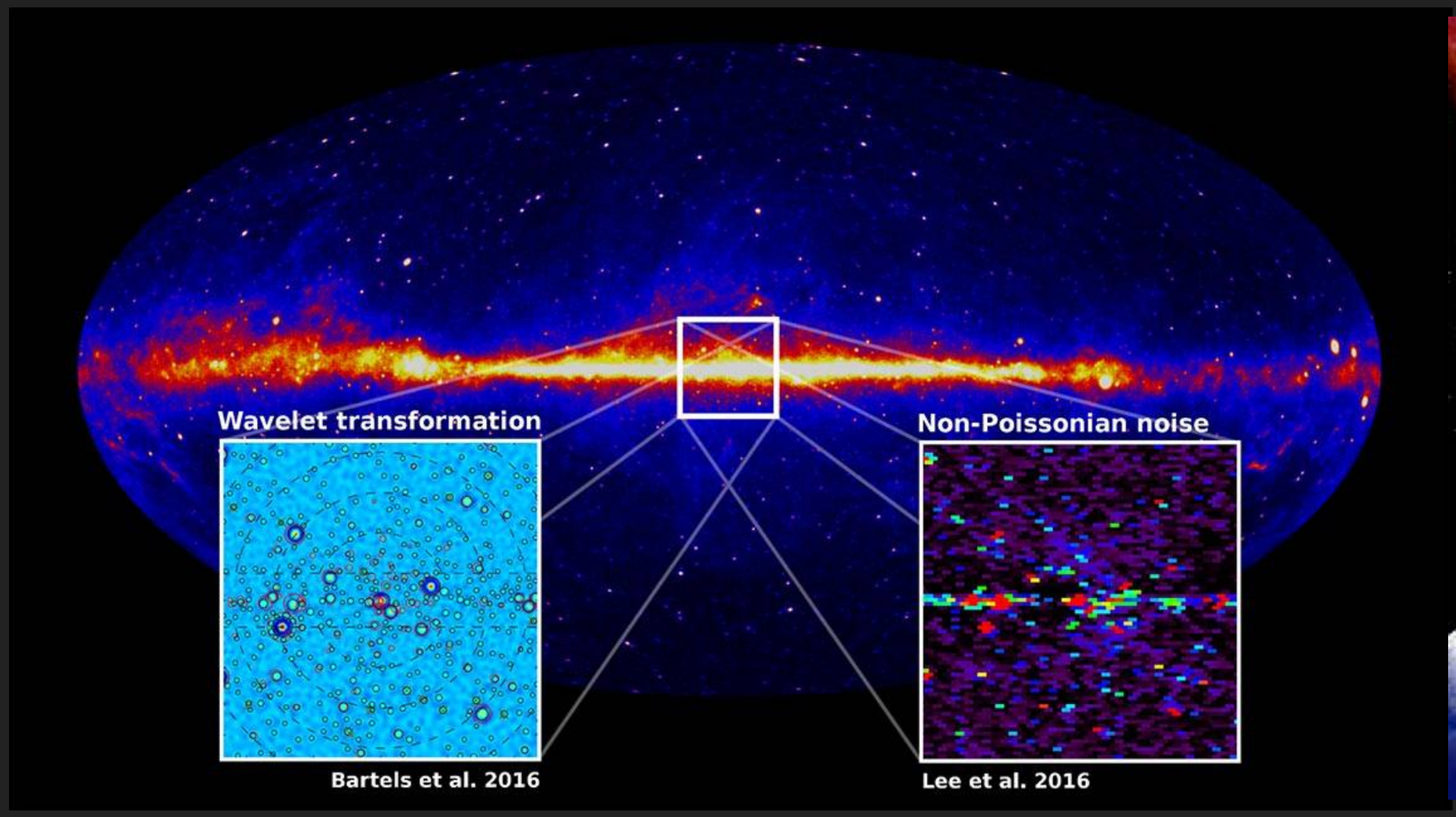
DM??



my approach: do what is necessary to discover particle dark matter

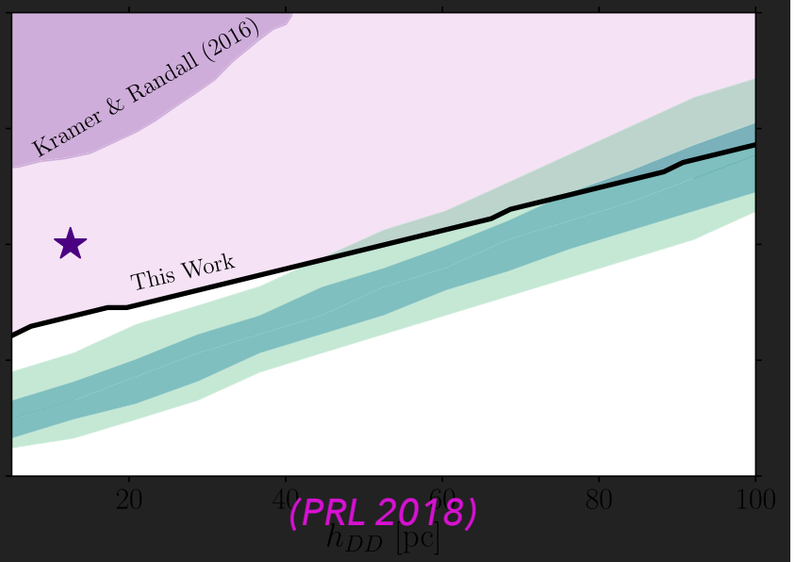
No Stone Left Unturned in Search For WIMP DM

Fermi GCE and the Non-Poissonian Template Fit



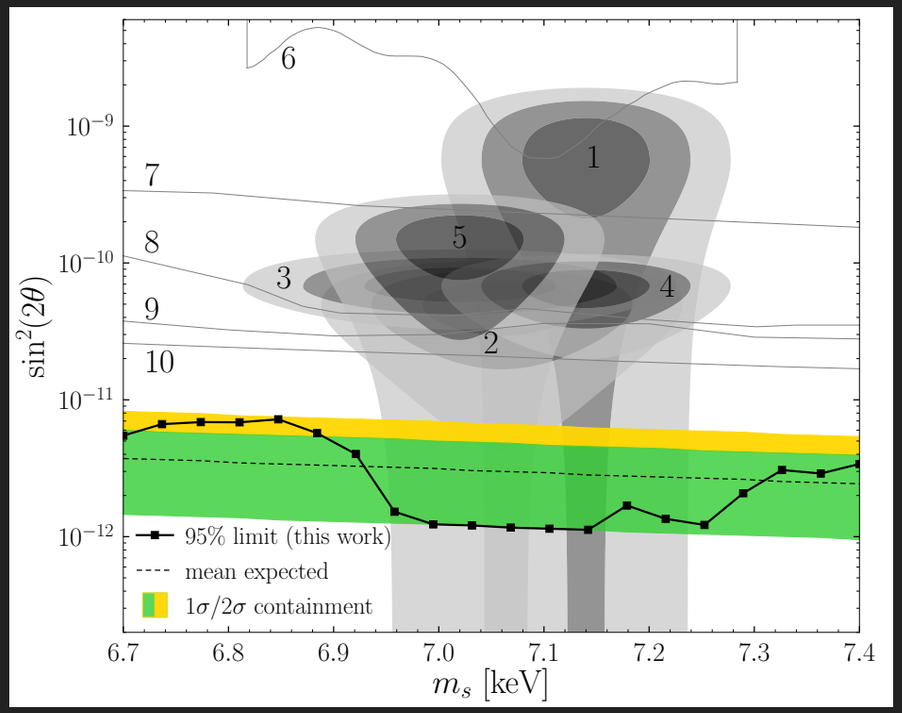
Theme of my work: stat. and physics tools for looking for particle DM in noisy astro. data sets

Dark disk



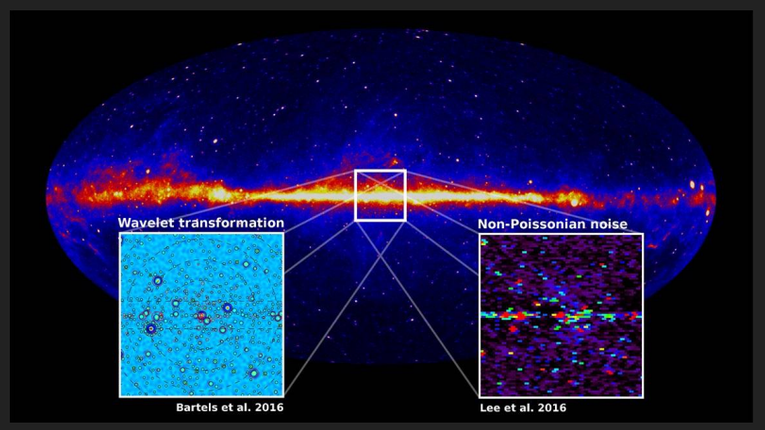
(PRL 2018)

3.5 keV line



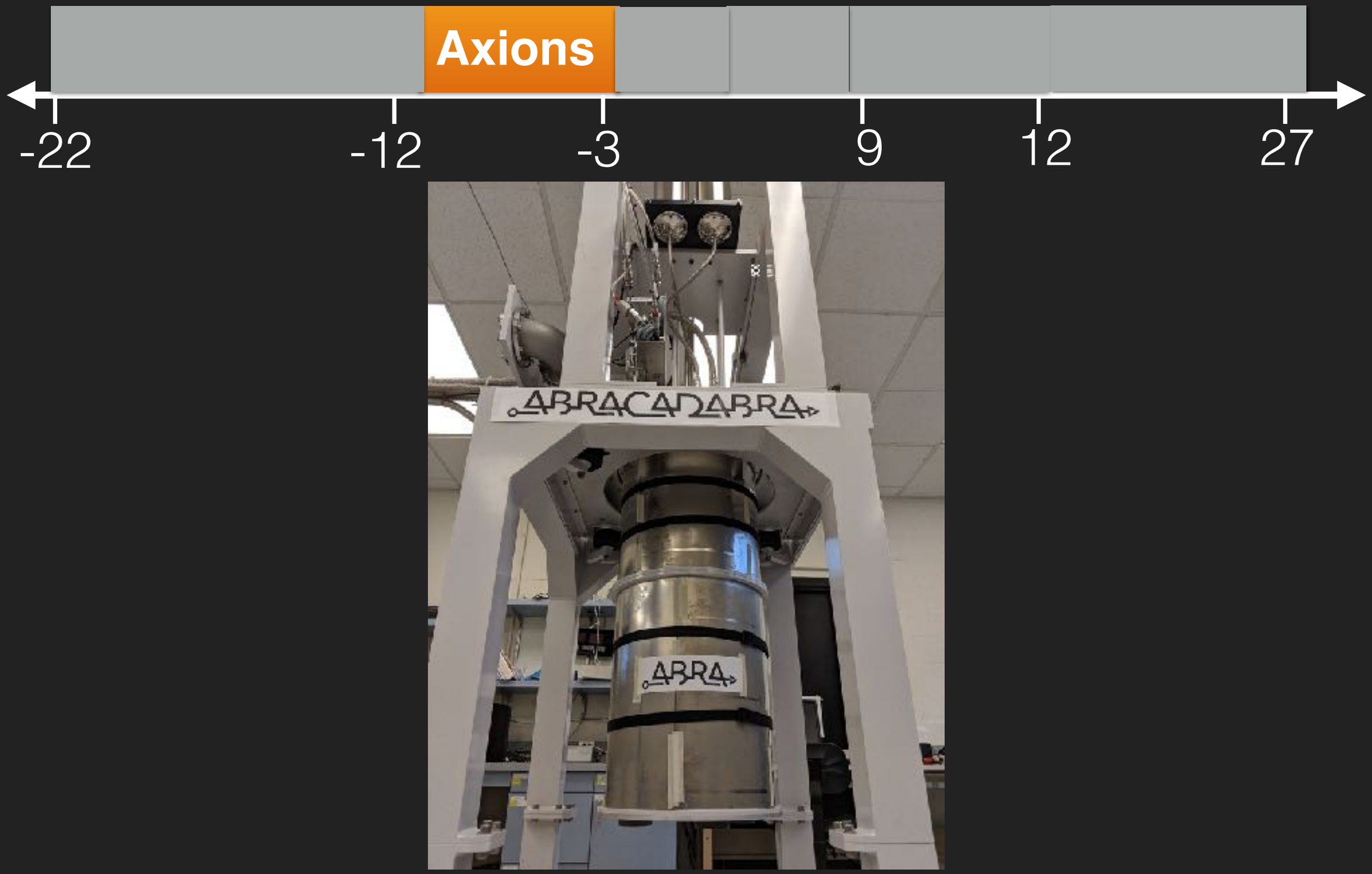
(Science 2020)

Fermi GCE



(PRL 2016)

Theme of my work: new ways of searching for particle dark matter



axion dark matter

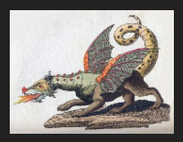
mass

proton

1

electron

1/1000



axion

1/100000000000000

fixed total mass

axion dark matter

mass

1

proton

electron

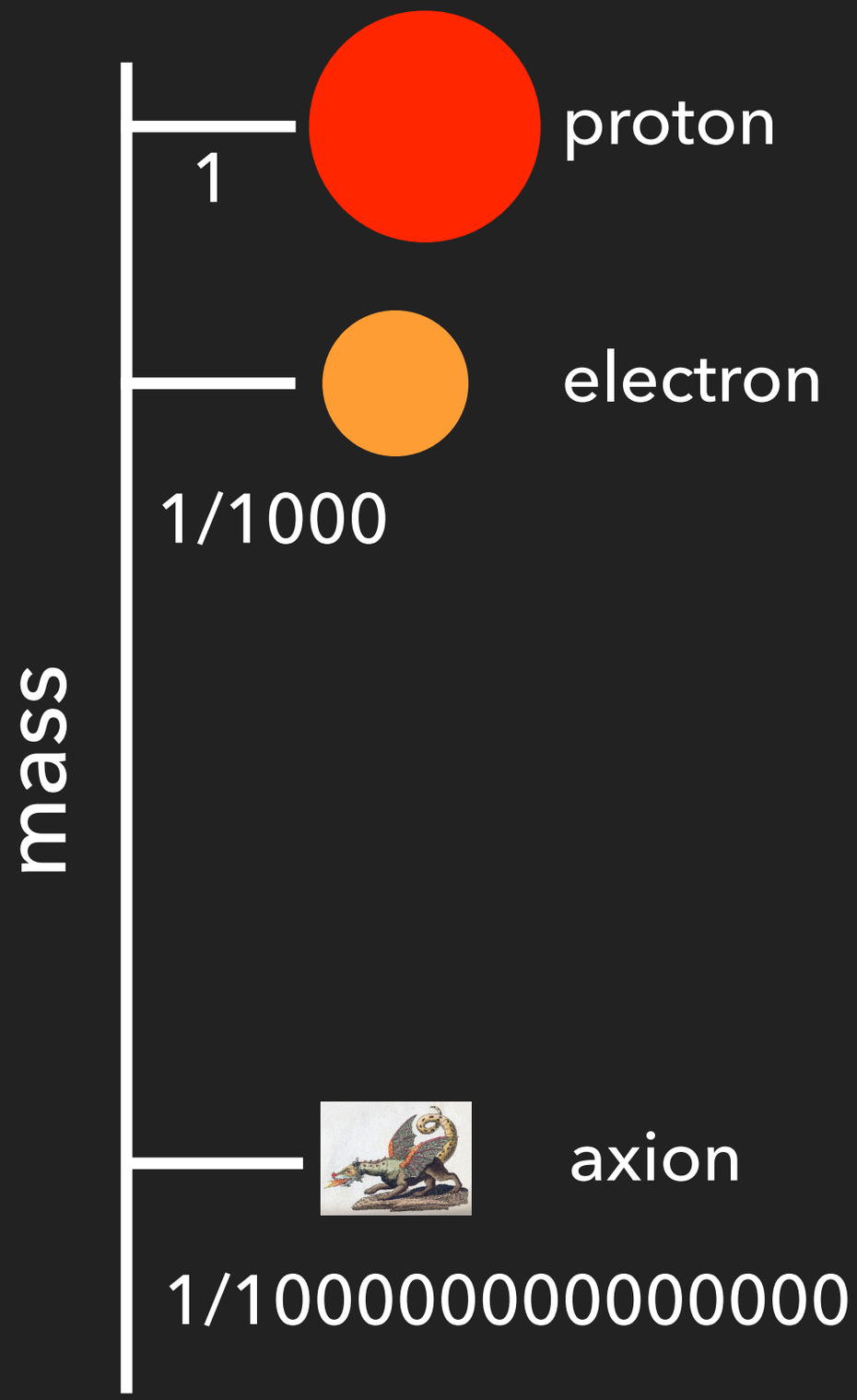
1/1000

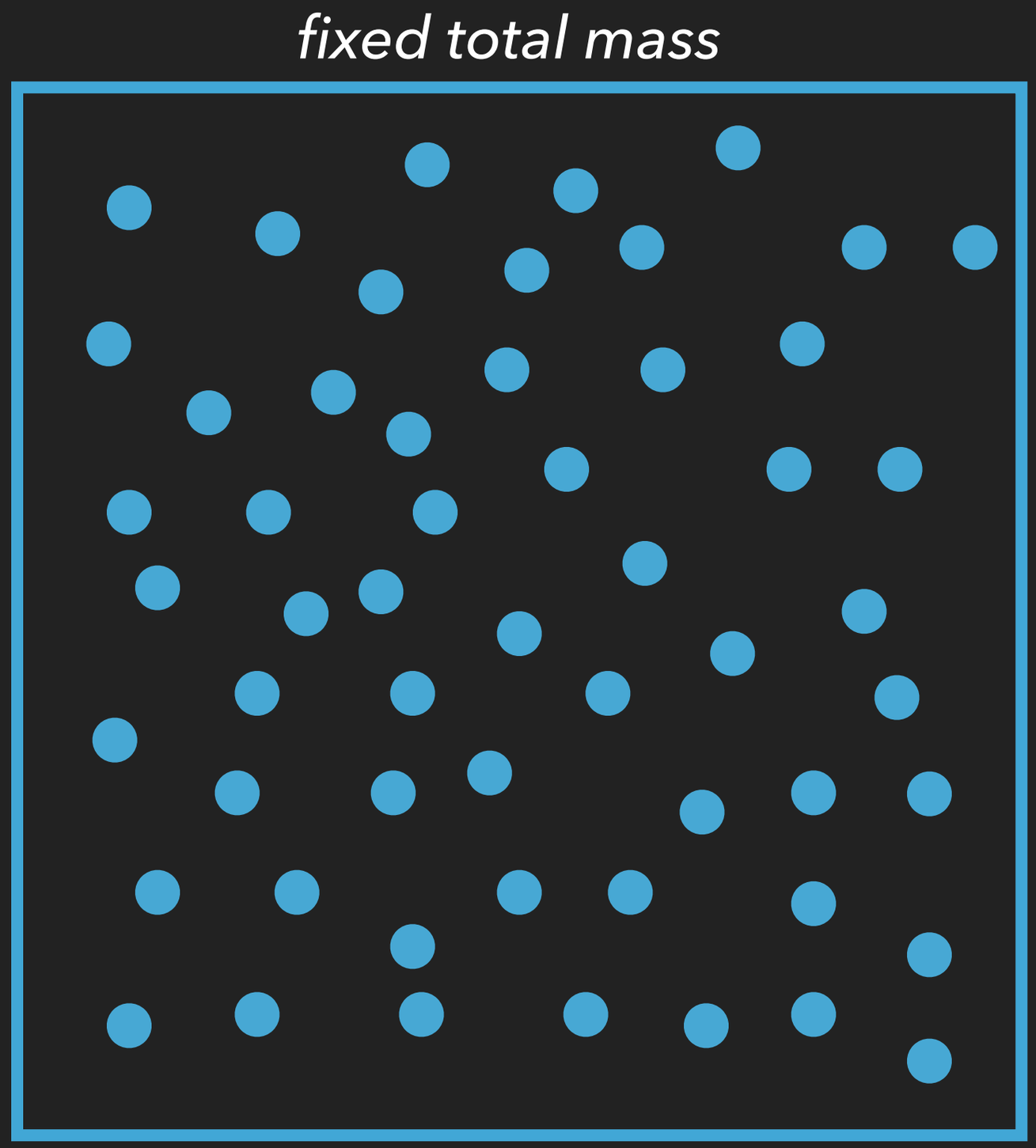
axion

1/100000000000000

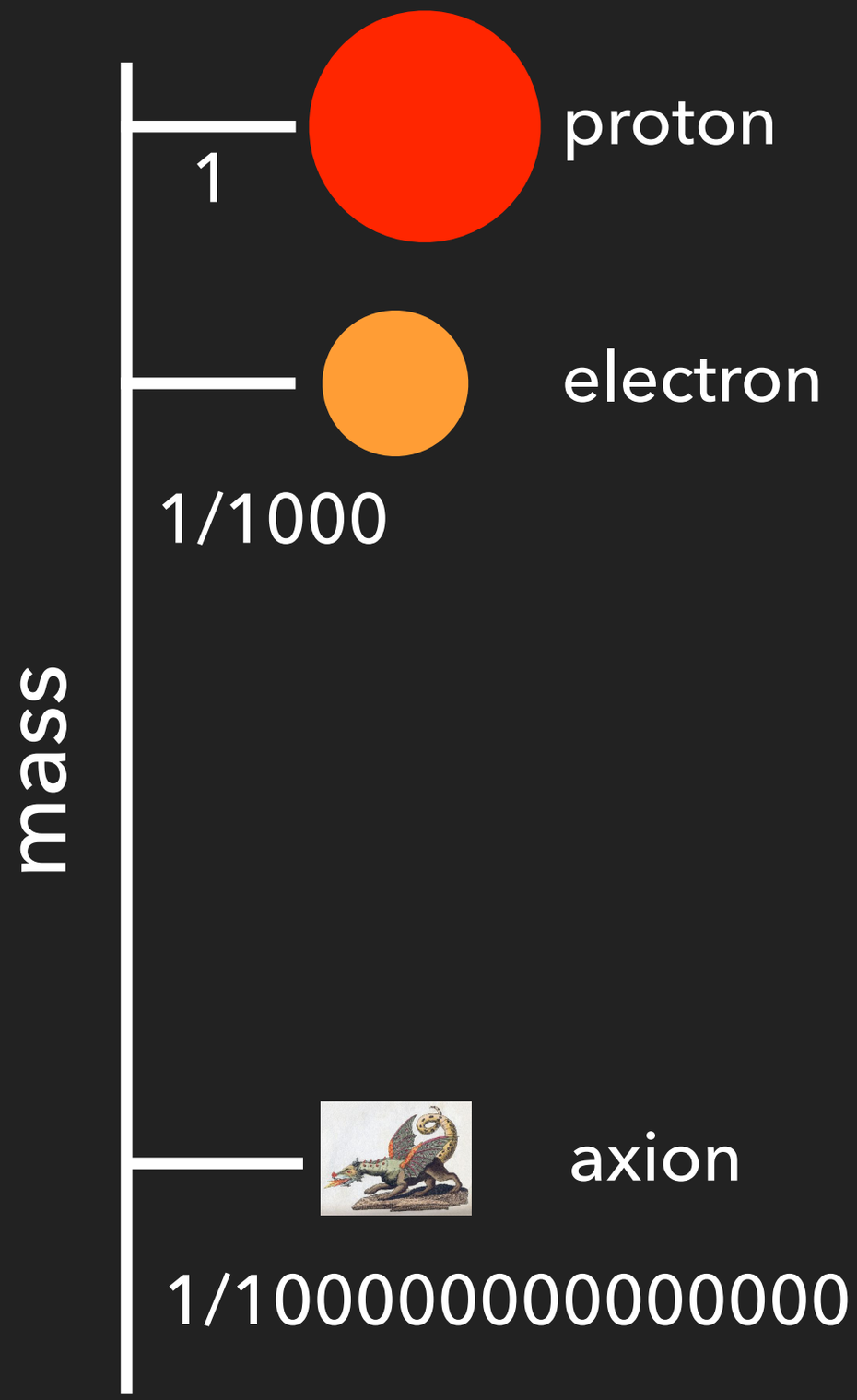
fixed total mass

axion dark matter





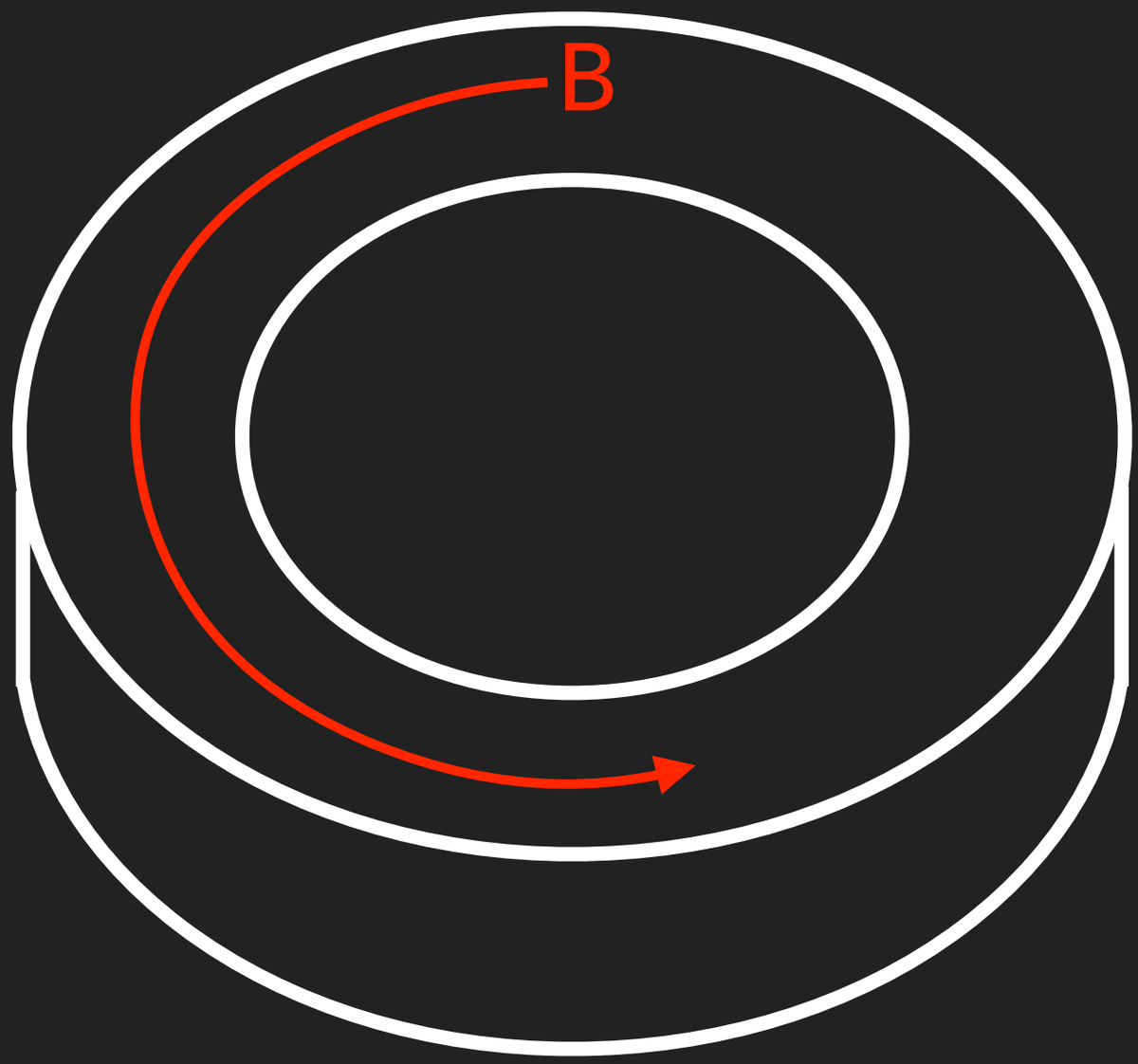
axion dark matter



A **B**roandband / **R**esonant **A**pproach to **C**osmic **A**xion **D**etection with an **A**mplifying **B**-field **R**ing **A**pparatus

Y. Kahn, **B.S. ,** J. Thaler (PRL 2016)

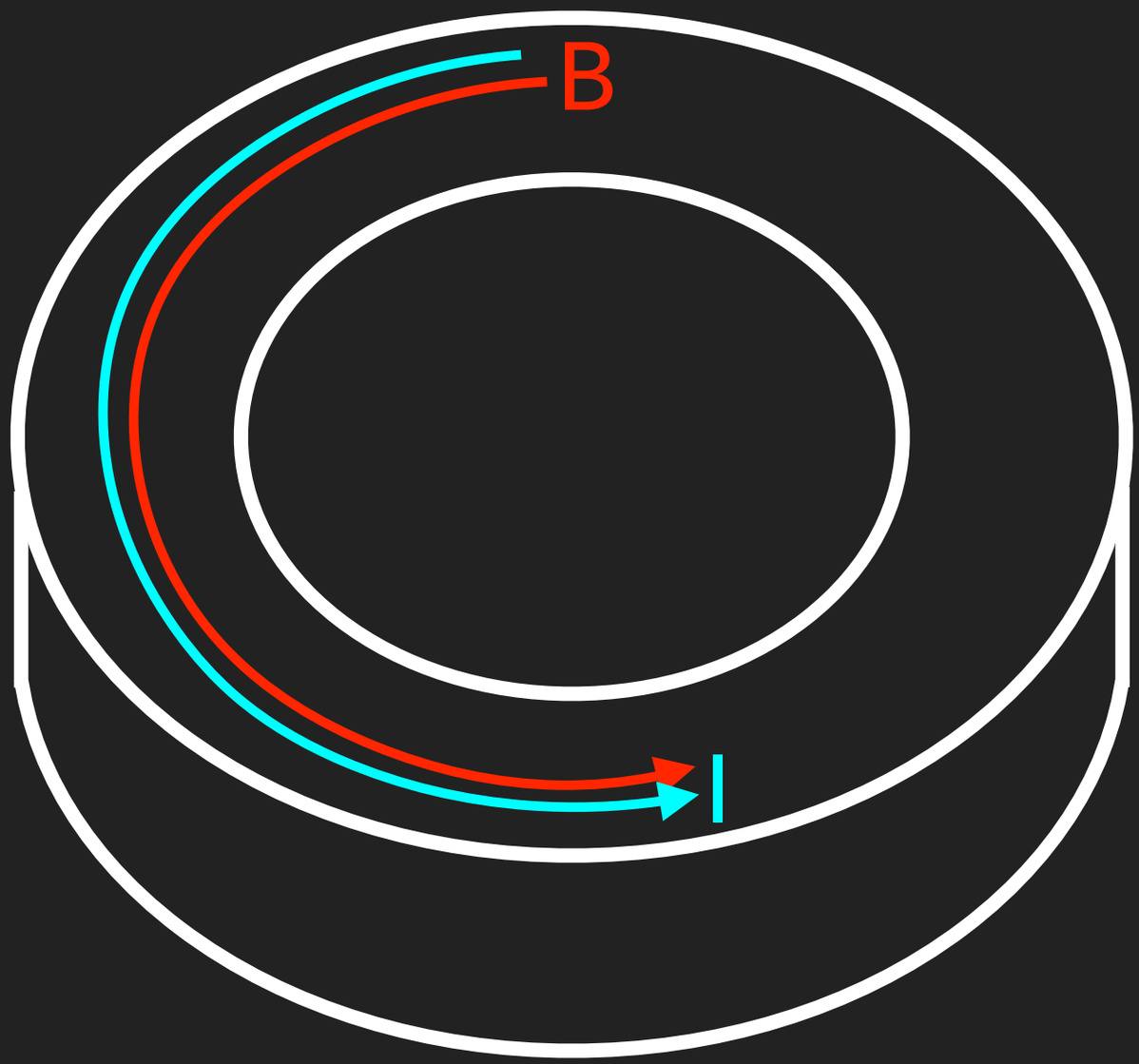
Toroidal Magnetic Field: B



$$\mathcal{L} = g_{a\gamma\gamma} a \mathbf{E} \cdot \mathbf{B}$$

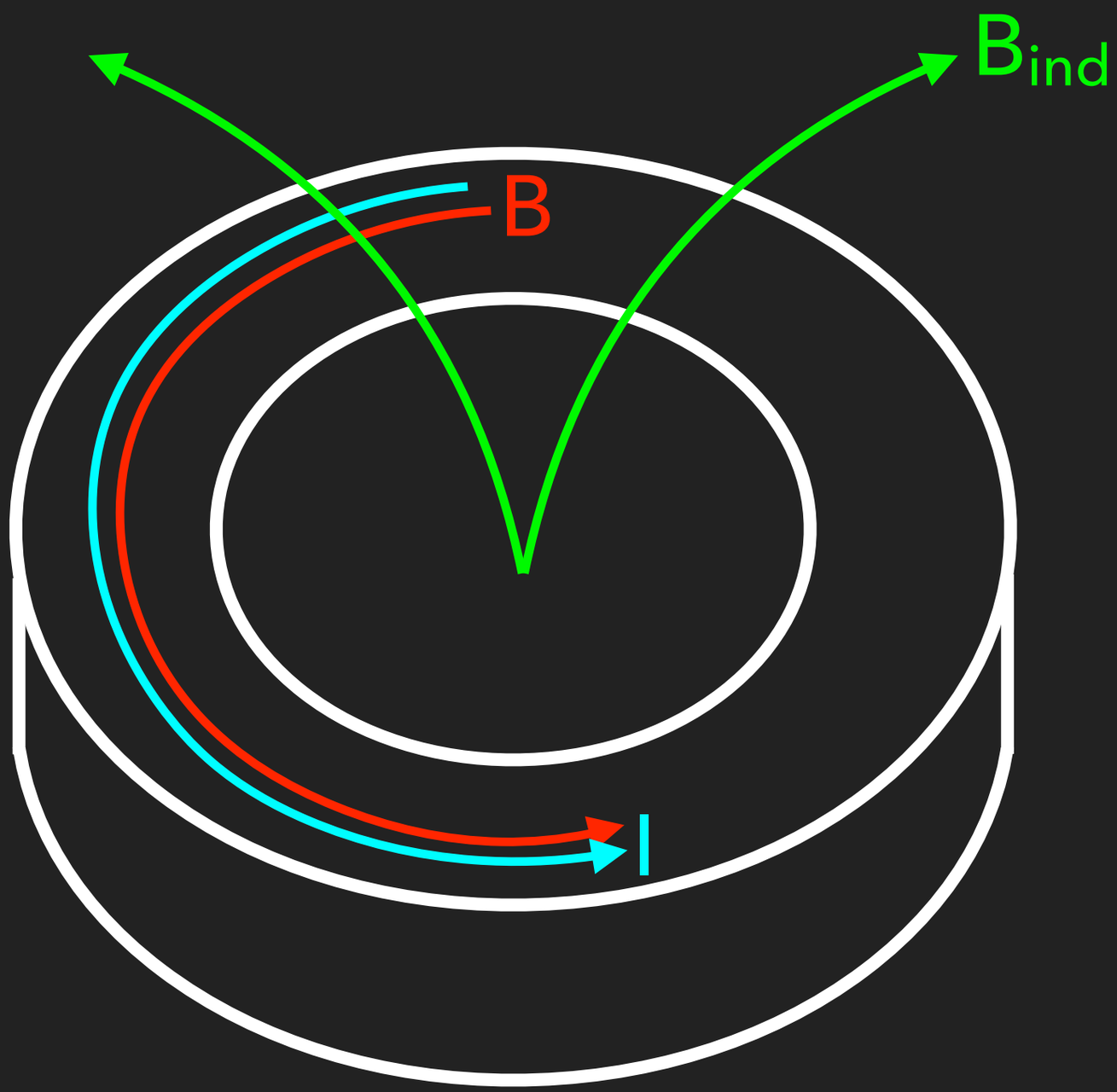
m_a^{-1} >> size of experiment: $\nabla \times \mathbf{B} = g_{a\gamma\gamma} \mathbf{B} \frac{\partial a}{\partial t}$

Axion Effective Electric Current: I



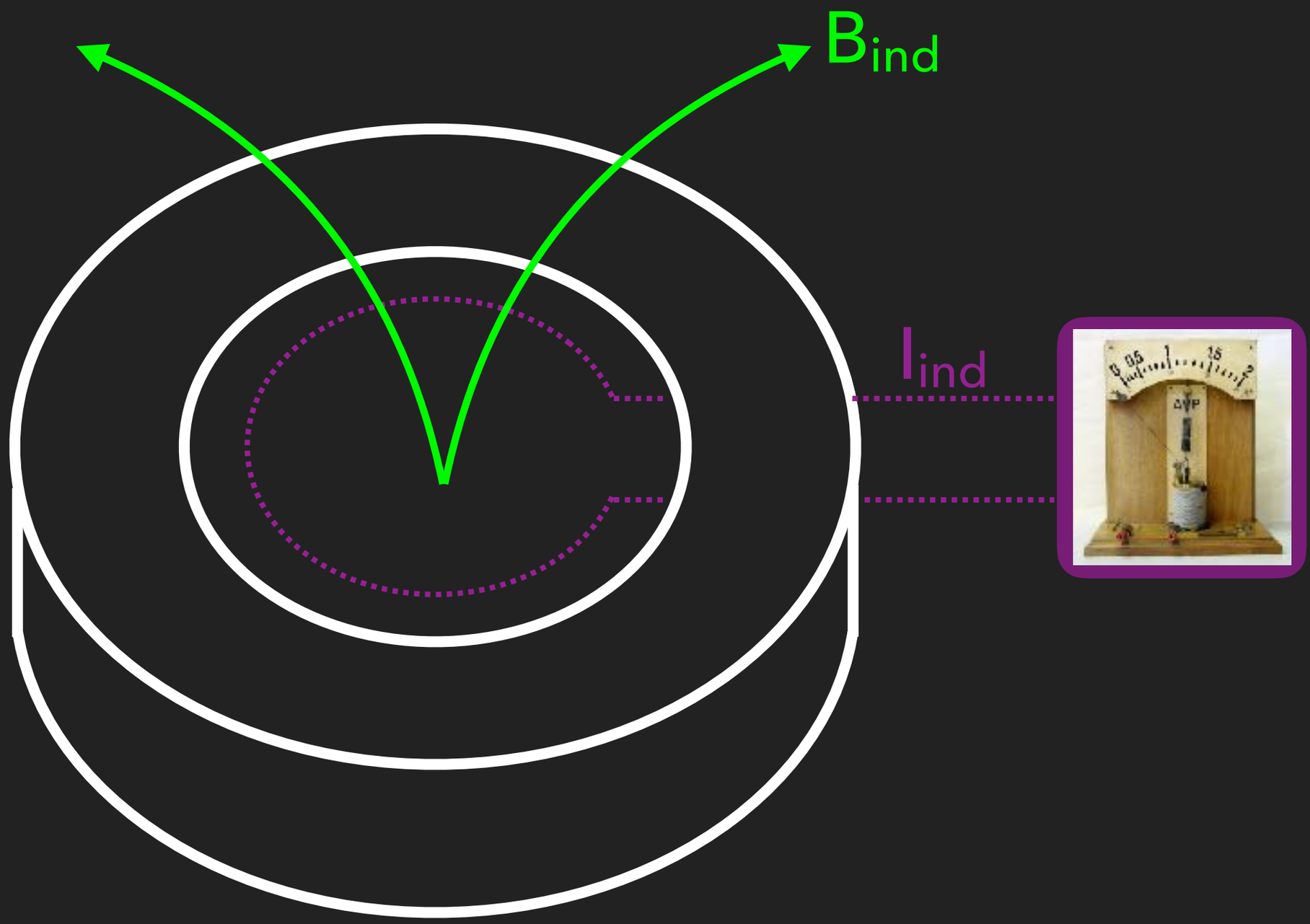
$$\mathcal{L} = g_{a\gamma\gamma} a \mathbf{E} \cdot \mathbf{B}$$

m_a^{-1} >> size of experiment: $\nabla \times \mathbf{B} = g_{a\gamma\gamma} \mathbf{B} \frac{\partial a}{\partial t}$



Secondary axion-induced B-field: B_{ind}

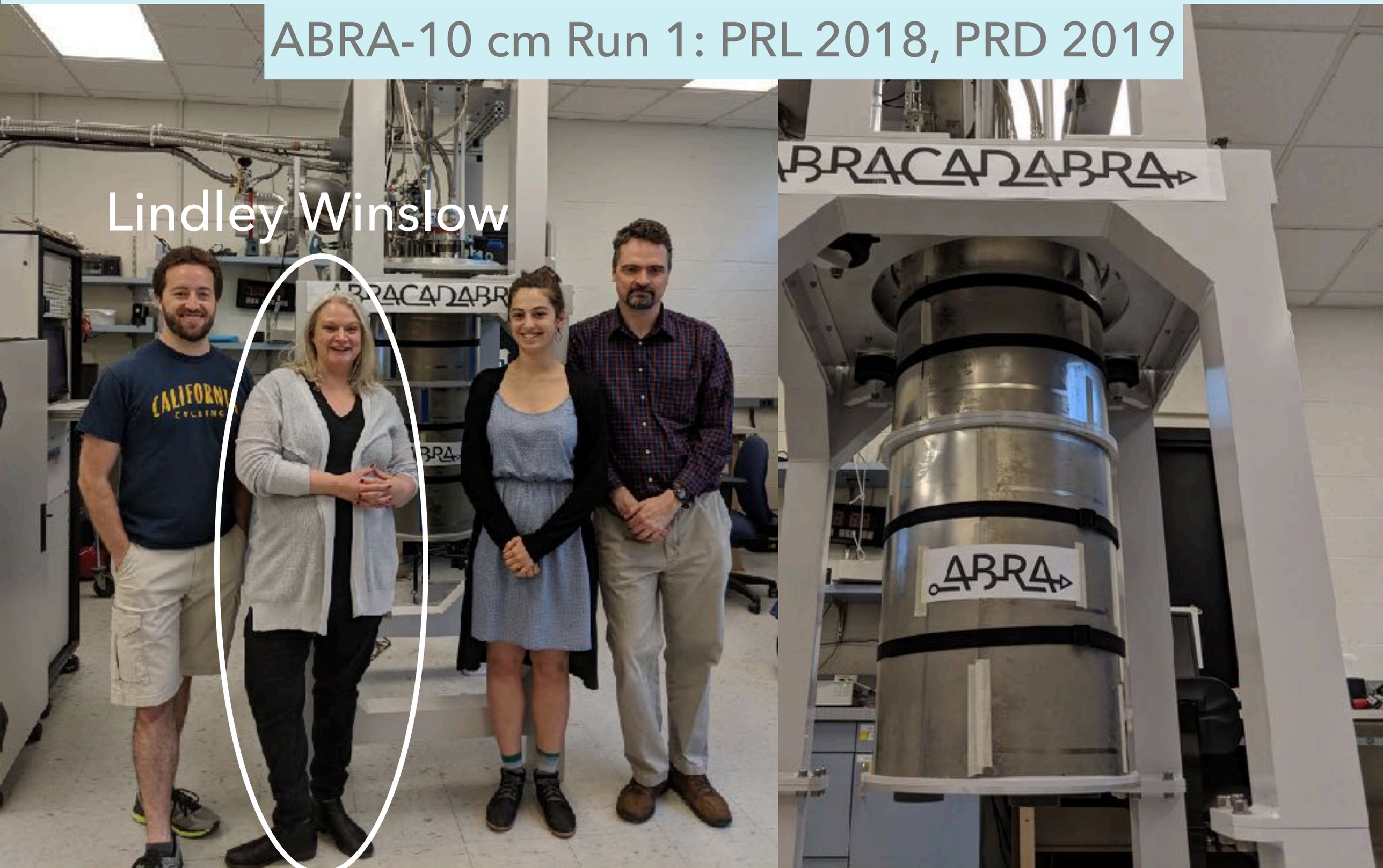
m_a^{-1} >> size of experiment: $\nabla \times \mathbf{B} = g_{a\gamma\gamma}\mathbf{B}\frac{\partial a}{\partial t}$

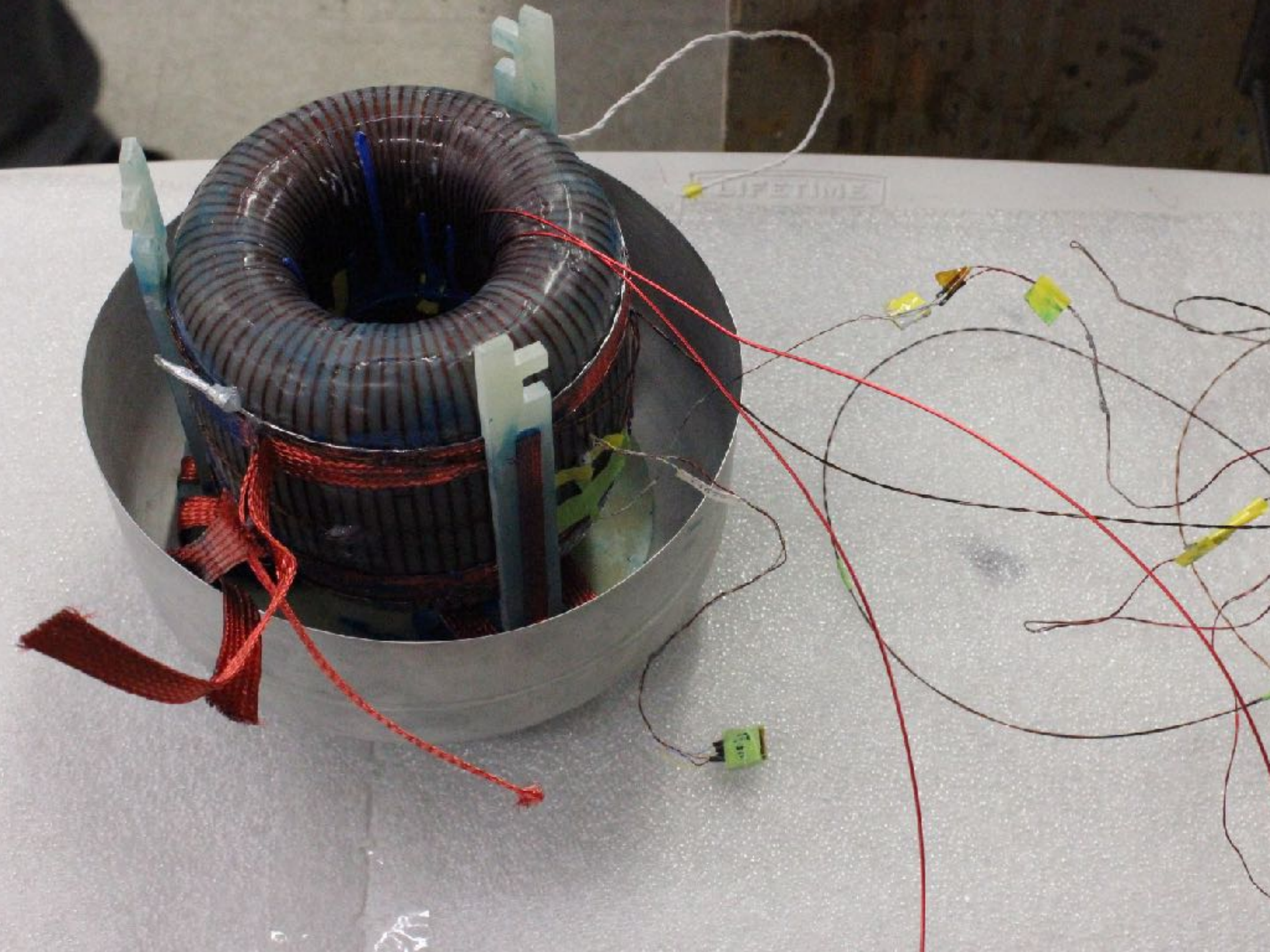


Pickup-loop current: I_{ind}

m_a^{-1} >> size of experiment: $\nabla \times \mathbf{B} = g_{a\gamma\gamma}\mathbf{B}\frac{\partial a}{\partial t}$

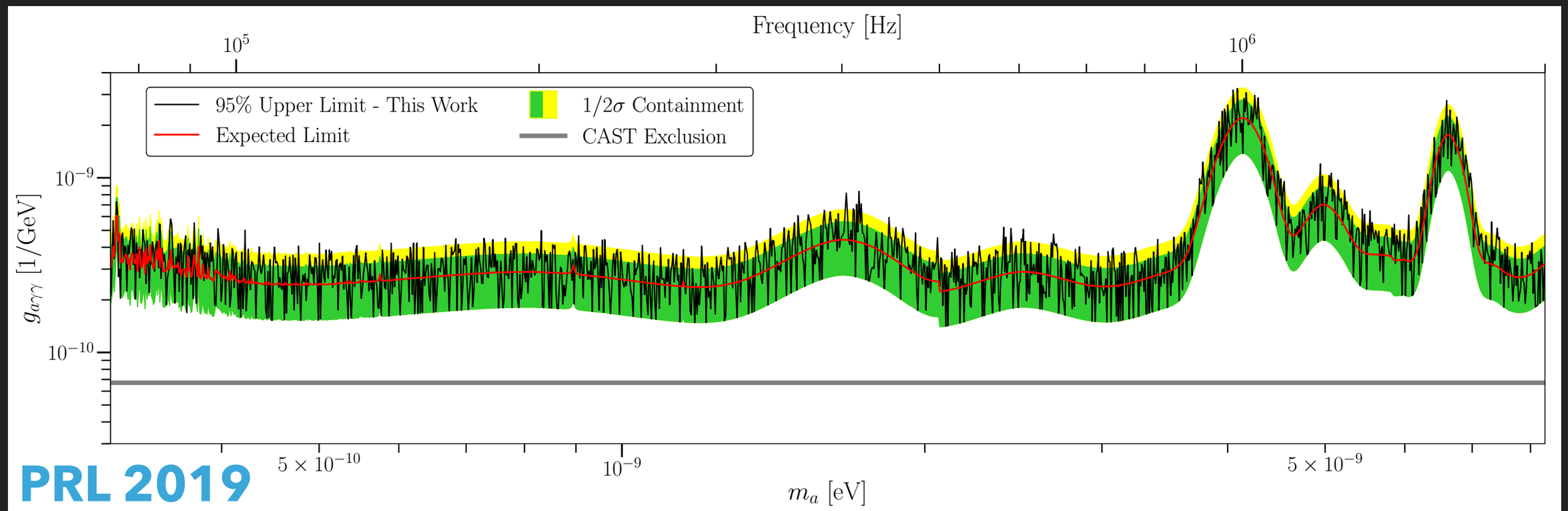
ABRA-10 cm Run 1: PRL 2018, PRD 2019



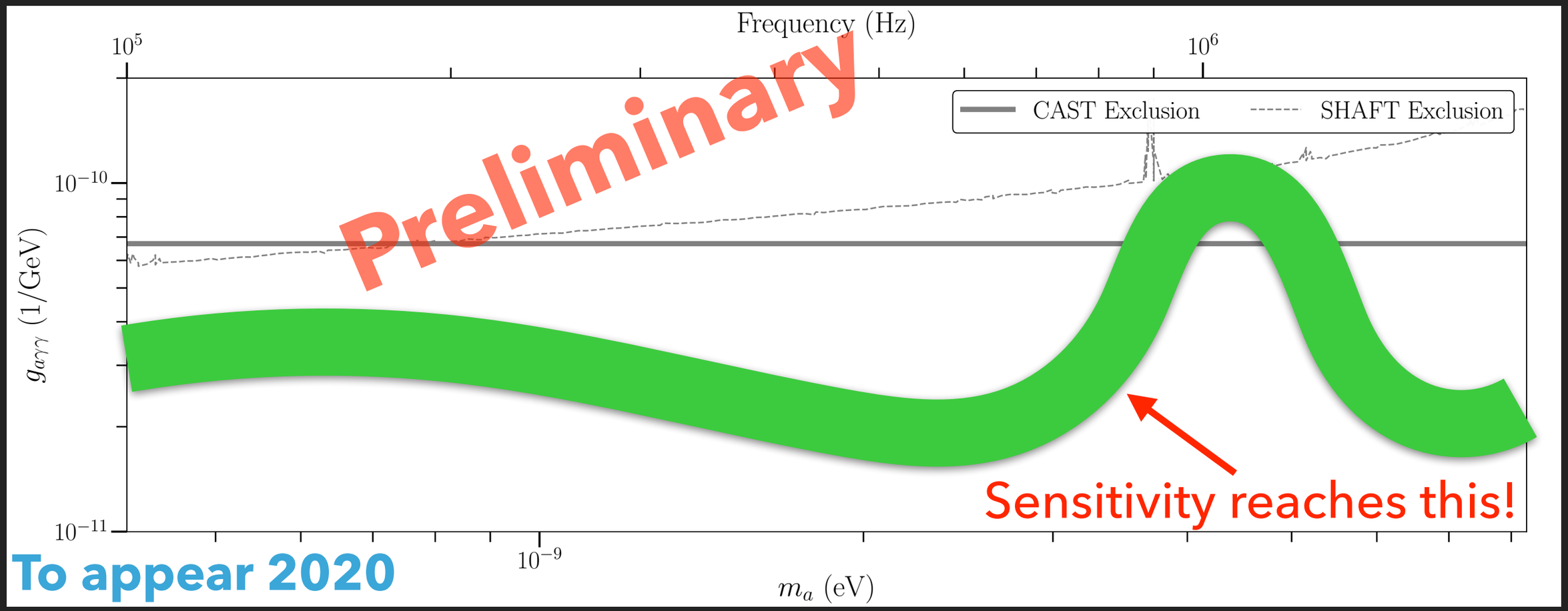


data

ABRA-10cm Results

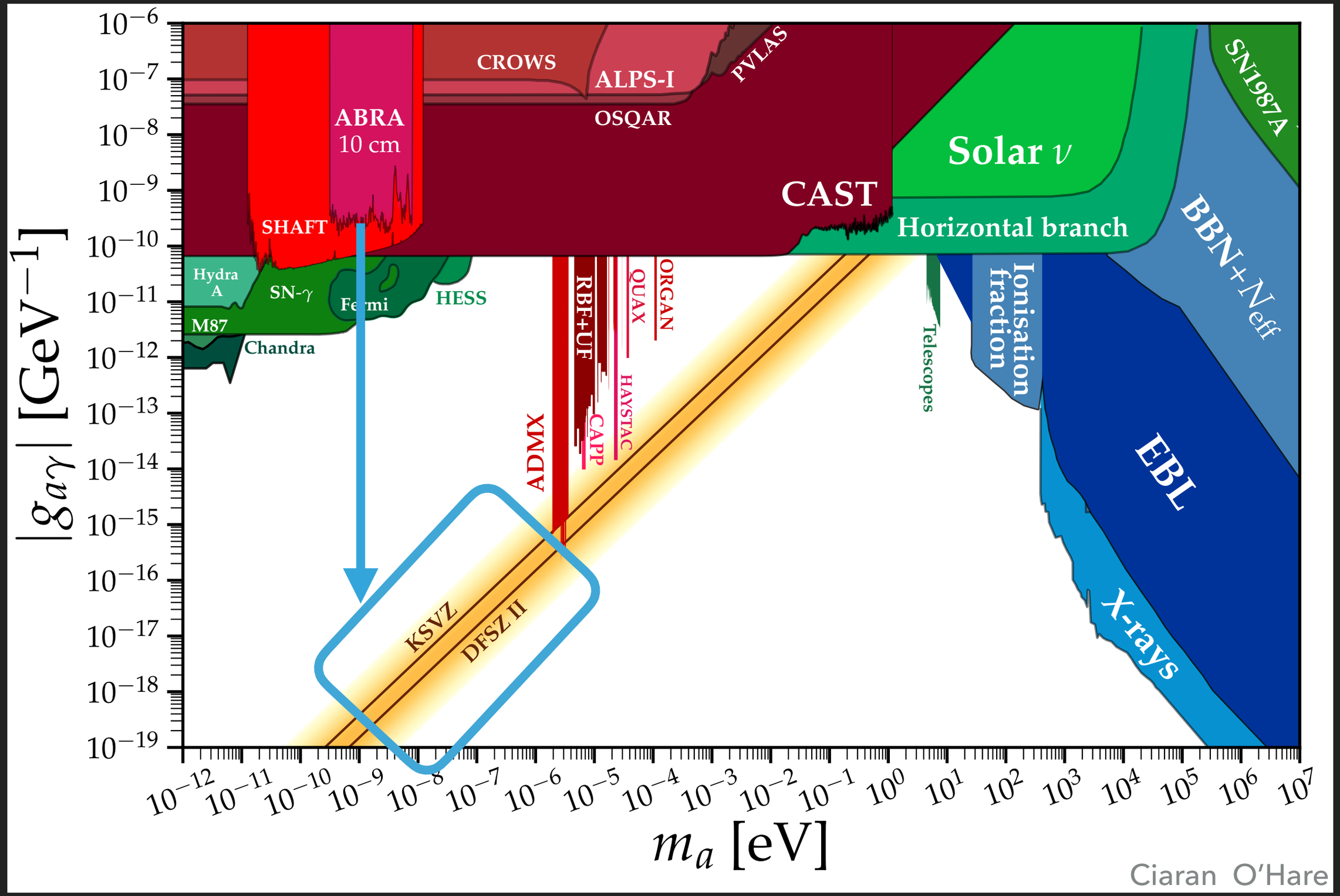


PRL 2019



To appear 2020

ABRA-1m +



Ciaran O'Hare

Our (realistic) Goal: GUT Scale Axion Dark Matter

Thank you

Advisors and mentors

Igor Klebanov

Mariangela Lisanti

Tracy Slatyer

Collaborators

Nick Rodd, Yoni Kahn, Siddharth Mishra-Sharma, Christoph Weniger, Jonathan Ouellet, Lindley Winslow, Anson Hook, Katelin Schutz, Joachim Kopp, Tongyan Lin, …

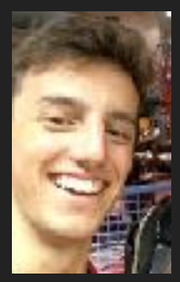
Students

Y. Park

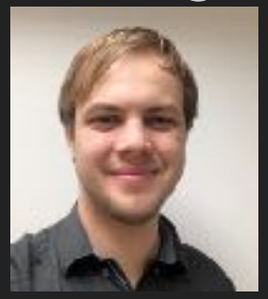
J. Foster

C. Dessert

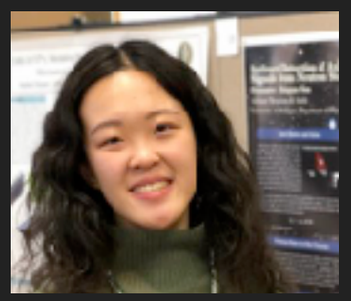
M. Wentzel



M. Kongsoere



Z. Sun



Postdocs

Malte Buschmann

Raymond Co

Andrew Long