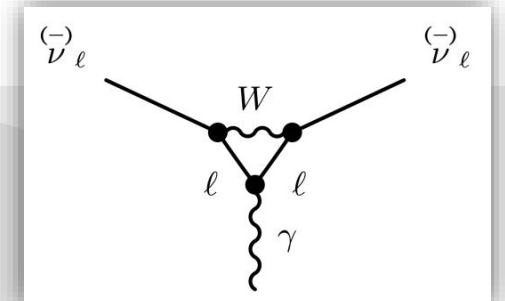
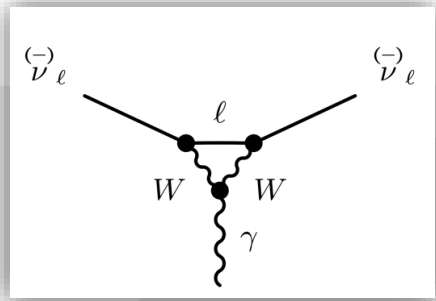


# Shedding light on neutrino charge radius with $CE\nu NS$ data



# INVISIBLES24

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01/07/2024

*In collaboration with*

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Istituto Nazionale di Fisica Nucleare

# Coherent effects of a weak neutral current

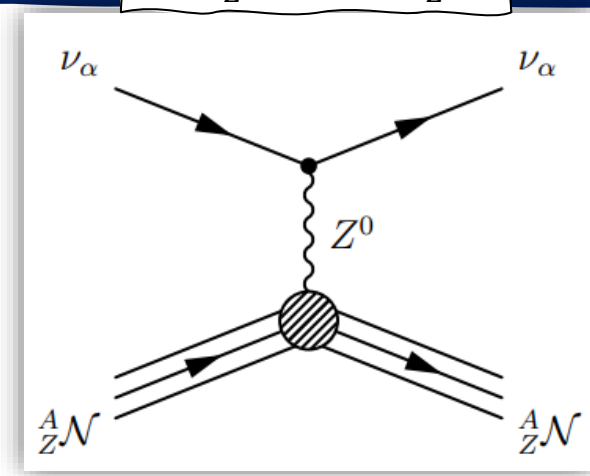
Daniel Z. Freedman†

National Accelerator Laboratory, Batavia, Illinois 60510

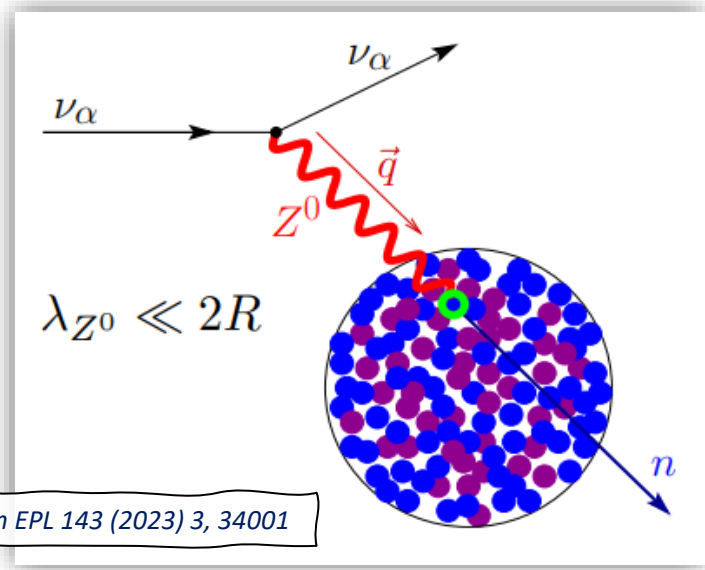
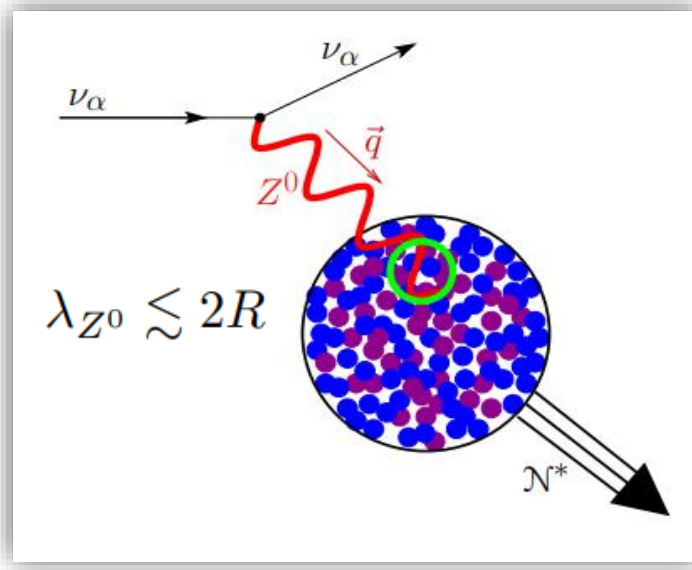
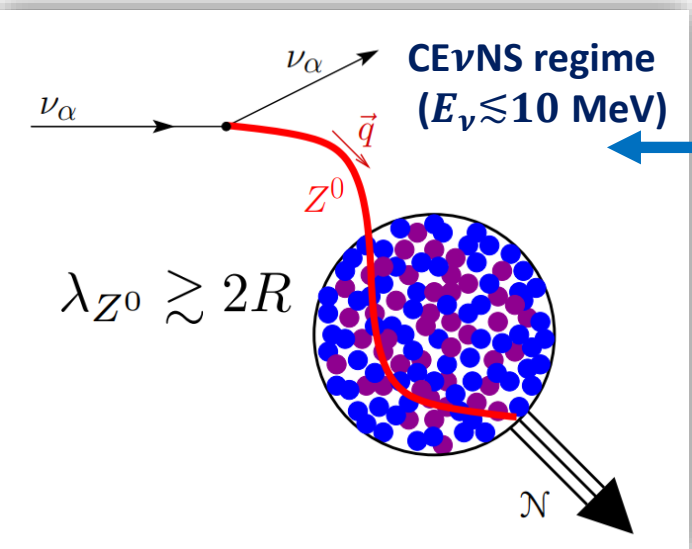
and Institute for Theoretical Physics, State University of New York, Stony Brook, New York 11790

- **Coherent elastic neutrino-nucleus scattering (CEvNS)** is a process mediated by the  $Z^0$  boson.
- The neutrino interacts coherently with the **whole nucleus**.

$$\nu + \frac{A}{Z} \mathcal{N} \rightarrow \nu + \frac{A}{Z} \mathcal{N}$$



**Schematic view of energy regimes for  $\nu - \mathcal{N}$  scattering**

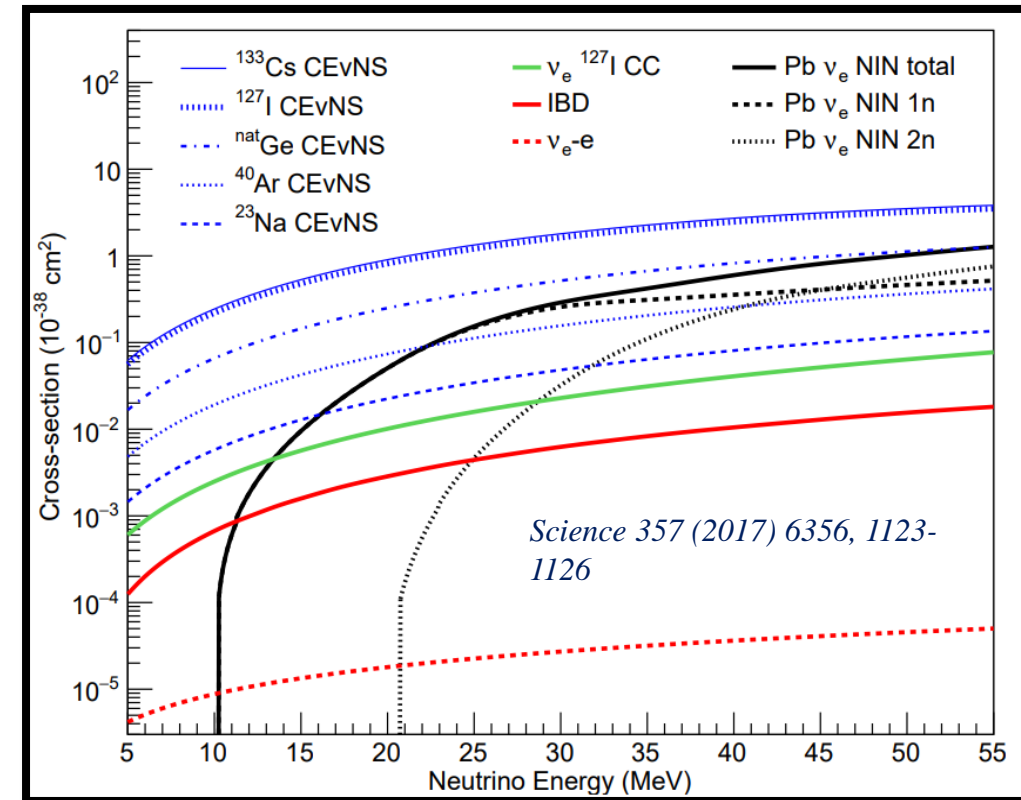
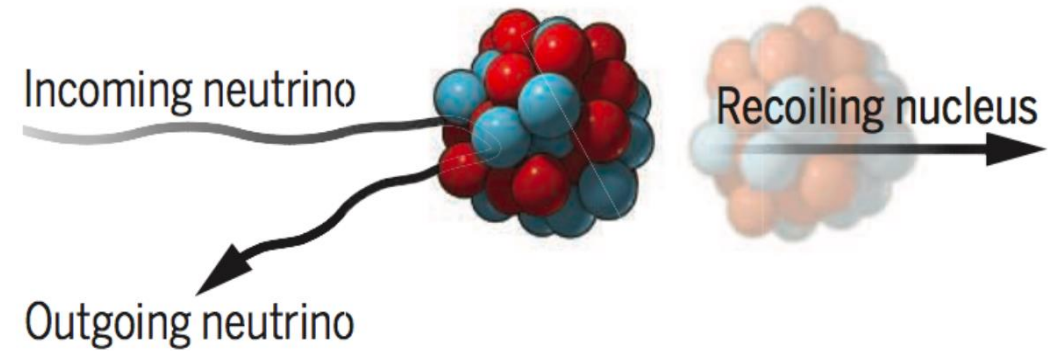


From EPL 143 (2023) 3, 34001

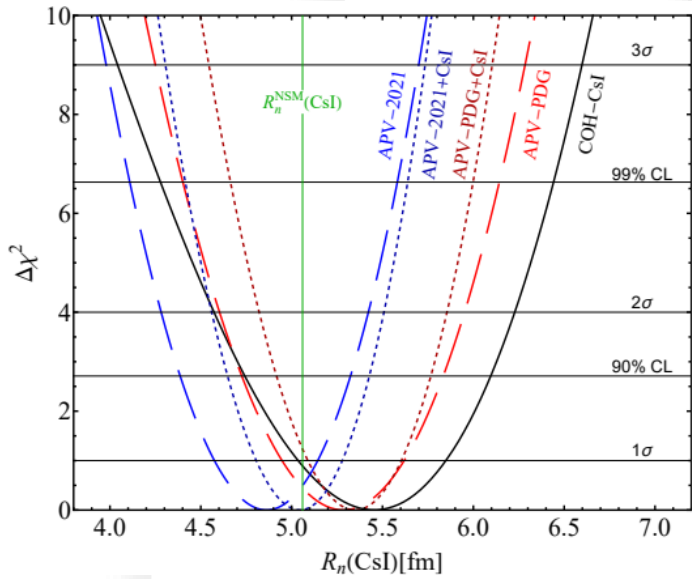


# CEνNS (Short) User Manual

- **Big cross section** ( $\propto N^2$ ) compared to other low-energy neutrino processes
- **Low-threshold** ( $\sim$  keV) and **low-background** experiment needed
- A compromise is needed between a big cross-section and a low detection threshold
- High intensity and low-energetic Neutrino source  $\sim$  10 MeV
- Observed for the first time in 2017 in **CsI**. Data on **Ar, Ge** are available



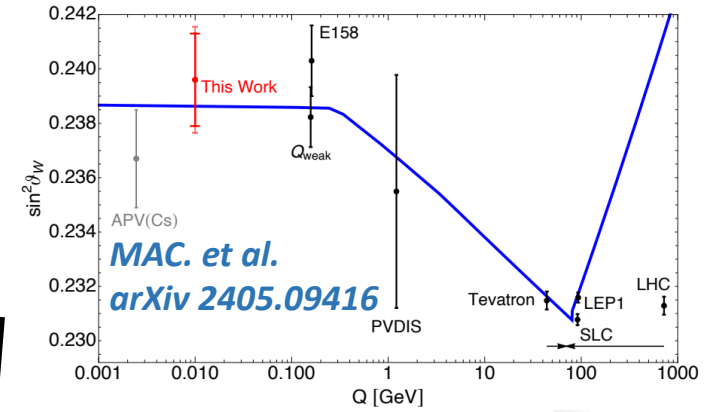
## Nuclear Physics



*Eur.Phys.J.C 84 (2024) 1, 24*



## Electroweak Physics

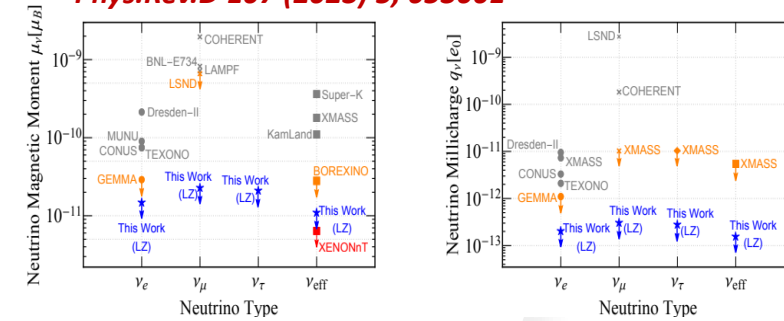


*MAC. et al. arXiv 2405.09416*

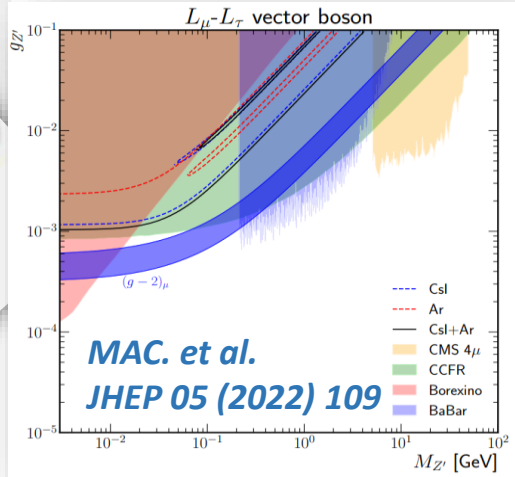
# CE<sub>ν</sub>NS

## Neutrino Electromagnetic properties

*MAC. et al Phys.Rev.D 107 (2023) 5, 053001*



## New light mediators



*MAC. et al. JHEP 05 (2022) 109*

- + Sterile Neutrinos
- + Supernovae physics
- + Irreducible background for DM Searches....



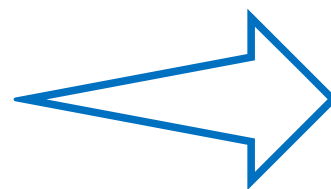
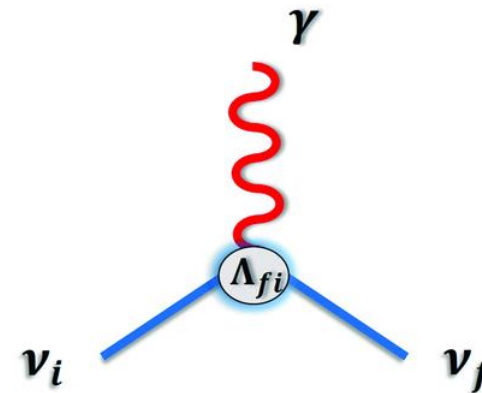
**+ Standard Model  $\nu$ -electromagnetic properties!**

# $\nu$ EM in the Standard Model

- Neutrinos are widely known to be **neutral particles: they cannot couple with a photon at tree level.**
- $\nu$ -electromagnetic property:  $\nu$  interaction mediated by a photon (**electromagnetic interaction**).

Do we have such electromagnetic interactions in the standard model?

What do we know about them?



**YES!**  
**Discover them the poster session!**

If you cannot wait, take a look at our study!  
**JHEP 09 (2022) 164 & JHEP 05 (2024) 271**



*Thanks for your  
attention and see you  
later!*

