The COHERENT Experiment at the Spallation Neutron Source

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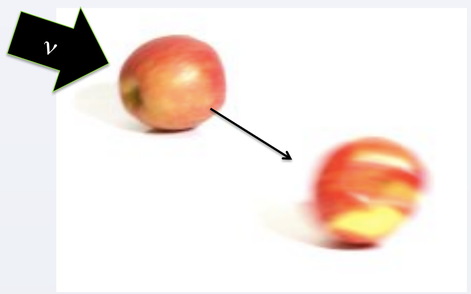
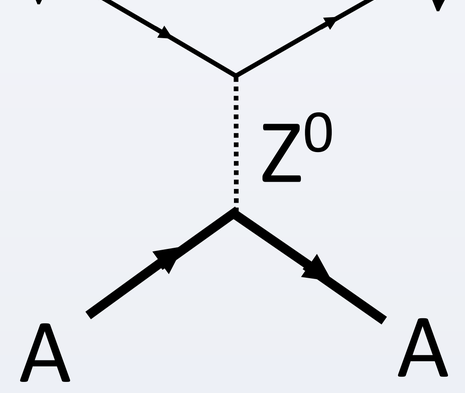
P2.038

COHERENT ELASTIC NEUTRINO-NUCLEUS SCATTERING (CEvNS)

A neutrino smacks a nucleus via exchange of a Z, and the nucleus recoils as a whole; **coherent** up to E_ν~ 50 MeV

$$\nu + A \rightarrow \nu + A$$



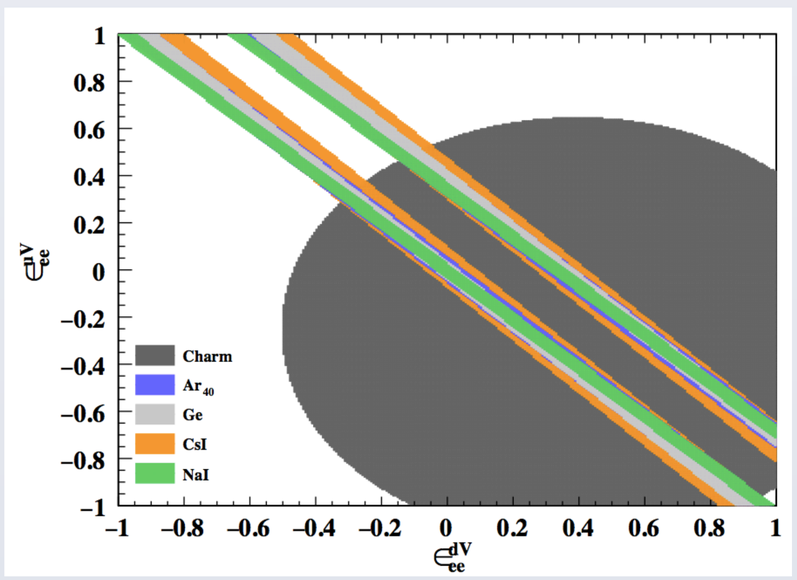


$$\frac{d\sigma}{d\Omega} = \frac{G^2}{4\pi^2}k^2(1+\cos\theta)\frac{(N-(1-4\sin^2\theta_W)Z)^2}{4}F^2(Q^2) \qquad \propto N^2$$

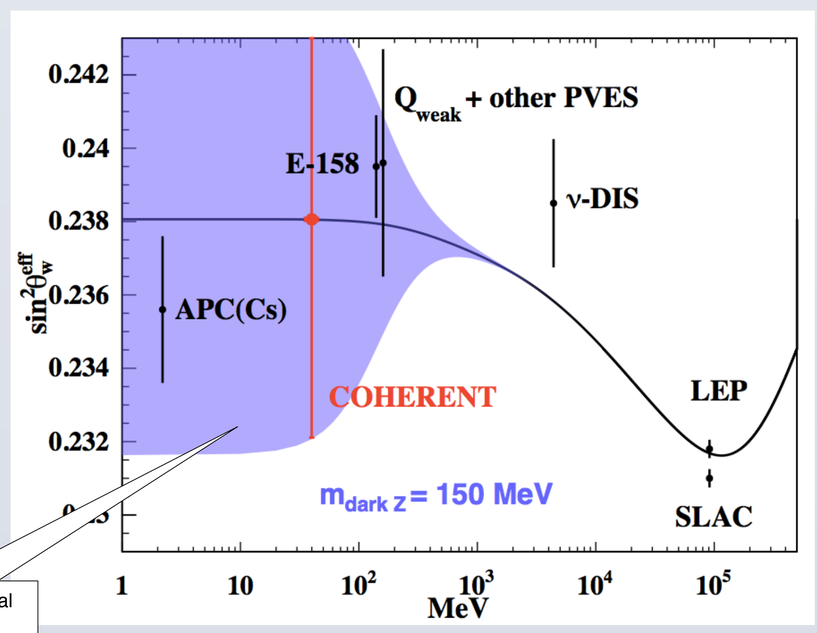
The COHERENT collaboration aims to unambiguously measure the CEvNS cross section (and its N^2 dependence), and then use it as a tool to search for new physics

PHYSICS MOTIVATIONS

CEvNS is cleanly predicted in the SM, so any deviation could represent new physics



Example: sensitivity to Non-Standard Interactions (NSI) of neutrinos and quarks; can get ~factor of 10 beyond existing limits with current-generation CEvNS experiment

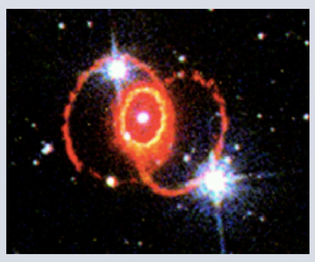


CEvNS sensitivity is @ low Q; need sub-percent precision to compete w/ electron scattering & APV, but **new channel**

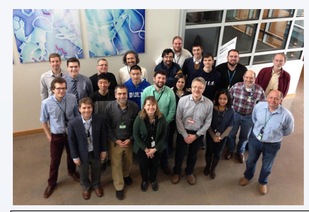
Example: hypothetical dark Z mediator (explanation for g-2 anomaly)

And more motivations:

- understanding of dark matter background, detector response
- core-collapse supernova processes and detection
- sterile neutrino oscillations
- neutrino magnetic moment
- neutron form factors
- reactor monitoring

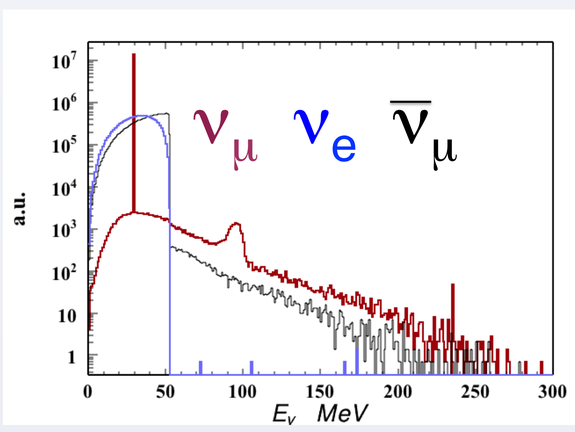


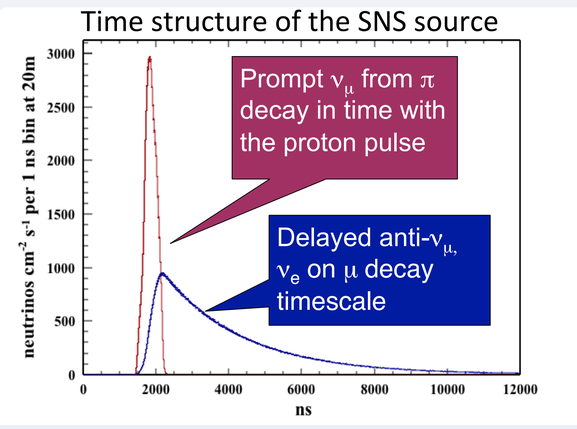
COHERENT at the SPALLATION NEUTRON SOURCE



- Collaboration: ~65 members, 16 institutions (USA+ Russia)
- Spokesperson: K. Scholberg ORNL PI: J. Newby
- Technical coordinator/PM: D. Reyna

The primary goal of COHERENT is detection of CEvNS using the extremely clean, pulsed stopped-pion flux at SNS





SNS flux (1.4 MW): 430 x 10^5 ν/cm²/s @ 20 m;
~400 ns proton pulses @ 60 Hz ➔~10^{-4} bg rejection

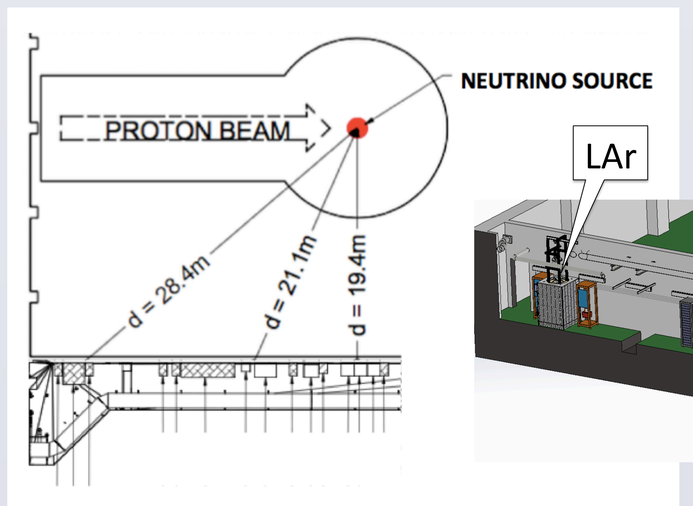
60 Hz *pulsed* source

Background rejection factor ~few x 10^{-4}

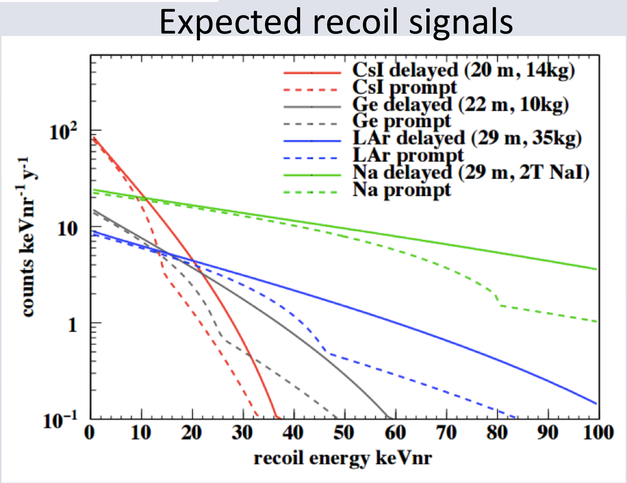
COHERENT DETECTORS AND STATUS

Nuclear Target	Technology	Mass (kg)	Distance from source (m)	Recoil threshold (keVr)	Data-taking start date; CEvNS detection goal
CsI[Na]	Scintillating crystal	14	20	6.5	9/2015; 3σ in 2 yr
Ge	HPGe PPC	10	22	5	Fall 2016
LAr	Single-phase	35	29	20	Fall 2016
NaI	Scintillating crystal	185*/ 2000	22	13	*Summer 2016

- Background measurements indicate SNS basement is neutron-quiet
- CsI installed July 2015
- Three more detectors to be deployed summer/fall 2016



Expected recoil signals



REFERENCES

K. Scholberg, PRD73, 033005 (2006)

COHERENT collaboration, arXiv:1509.08702

See also posters: 2.037, 2.039, 3.002

ACKNOWLEDGEMENTS

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