COHERENT Theory Workshop

January 11-12, 2015, Raleigh NC

coherent-theory.phy.duke.edu

Welcome!

Thanks to Gail, Wick, Jon, Phil

and to NCSU Physics Department
for coffee & snacks

COHERENT Theory Workshop

January 11-12, 2015, Raleigh NC

Small and informal...

motivated in large part by recent experimental developments and near-future prospects (COHERENT@ ORNL and CENNS@ FNAL)

need theory/experiment interaction!

Please give slides to Justin Raybern for posting

What this workshop is about

Two inter-connected topics:

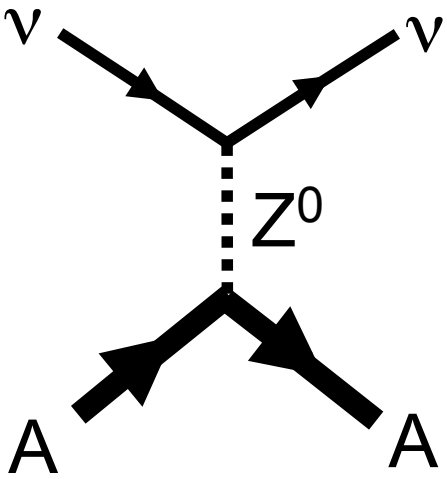
1. Coherent Elastic Neutrino-Nucleus Scattering (**CEvNS**)
   - physics motivations for measurements of coherent elastic neutrino-nucleus scattering (beyond-the-standard-model searches, nucleon distributions, neutrino magnetic moment, sterile oscillations...) and reach of near-term and farther future experiments.

2. Neutrino-Induced Neutrons (**NIN**s) and other inelastic neutrino-nucleus interactions
   - calculations of inelastic neutrino interactions on nuclei in the few tens of MeV regime, which may be non-negligible background for CEvNS (as well as being interesting in themselves)

Coherent elastic neutrino-nucleus scattering (CEvNS)

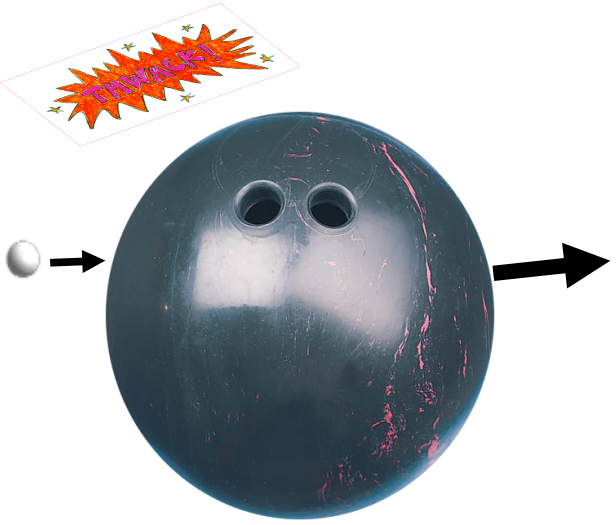
$\nu + A \rightarrow \nu + A$

A neutrino smacks a nucleus via exchange of a Z, and the nucleus recoils;
coherent up to $E_\nu \sim 50$ MeV



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

$$Q \lesssim \frac{1}{R}$$



Note on the process name:

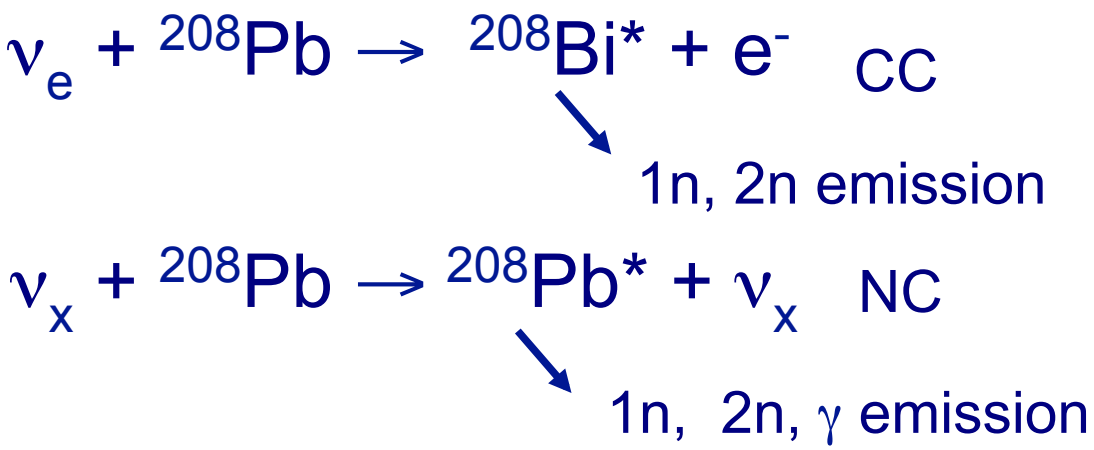
Literature has CNS, CNNS, CENNS, ...

- I prefer including “E” for “elastic”... otherwise HEP types constantly confuse it with coherent pion production at ~ GeV energies
- Gail tells me “NN” means “nucleon-nucleon” to nuclear types. Also CENNS is now a collaboration!
- CEνNS is a possibility but those internal Greek letters are annoying
- Phil’s idea: **CEvNS**, pronounced “sevens”...

spread the meme!

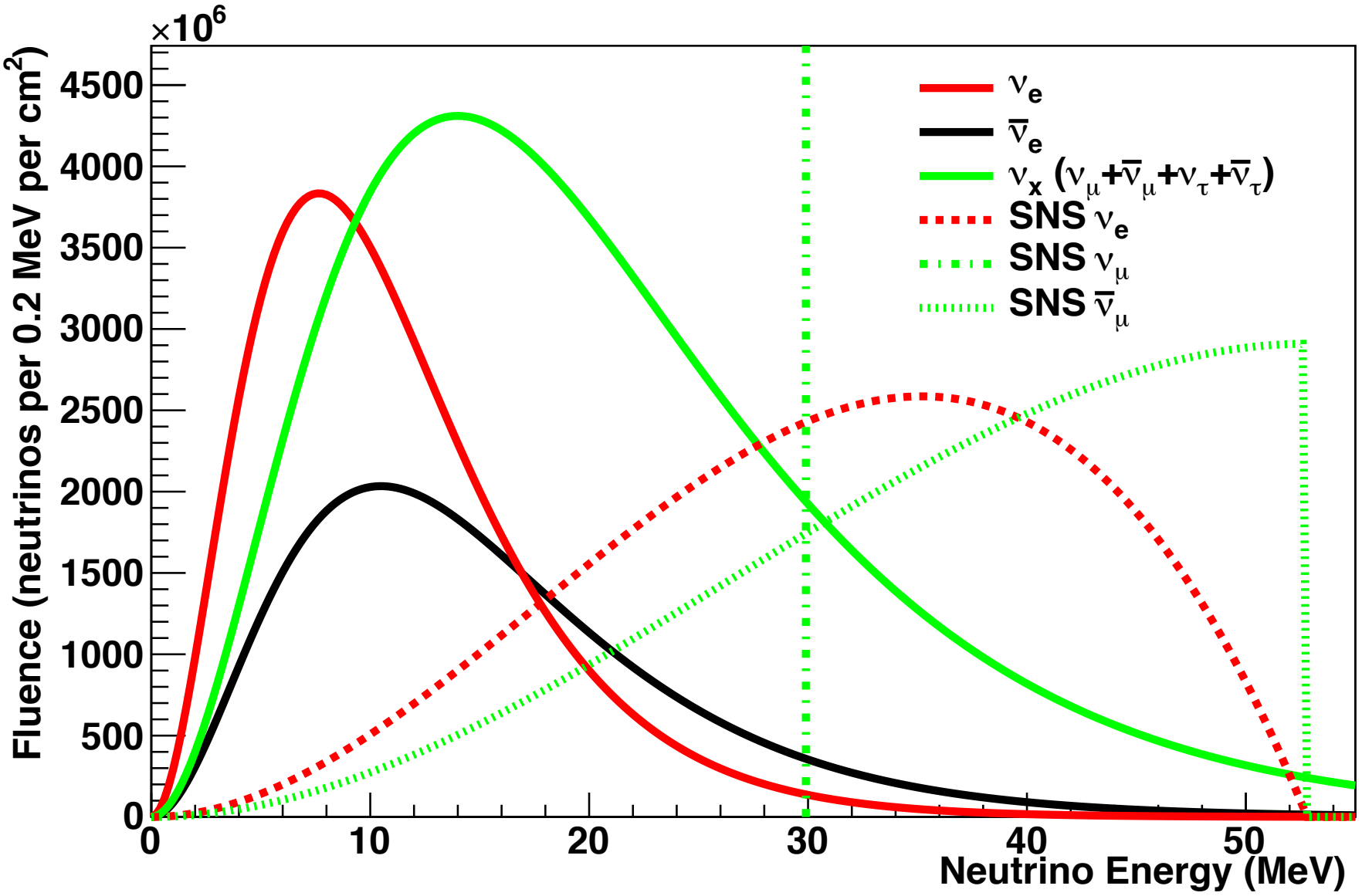
Neutrino-induced neutrons (NINs)

in lead, (iron, copper), ...

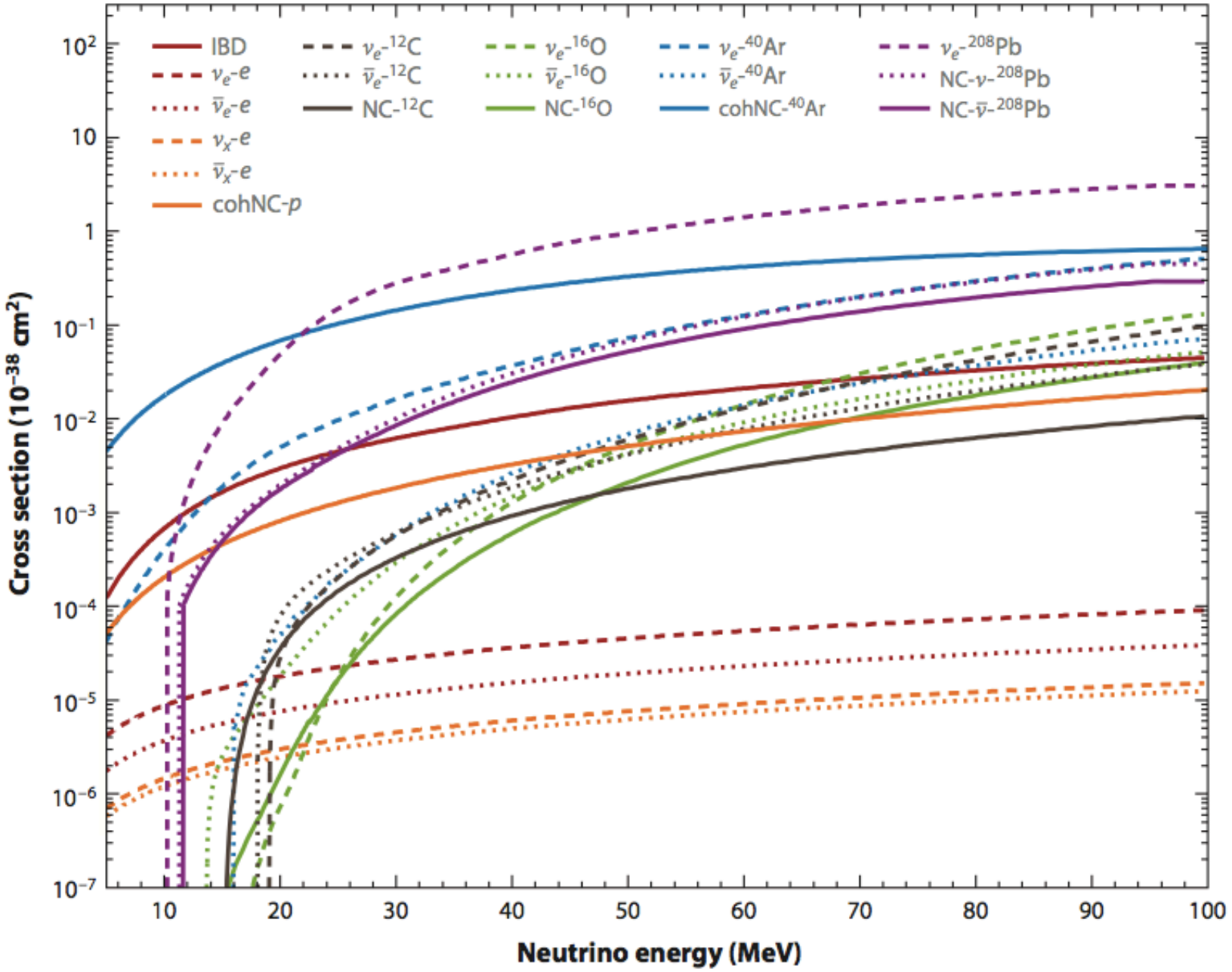


- likely a non-negligible background to CEvNS
  we must understand, especially in lead shield
- valuable in itself, e.g. HALO supernova detector
  at SNOLAB
- short-term physics output

This is the energy range we're talking about:



Other CC&NC interactions in this energy range are relevant as well...



Questions to address

- What are the opportunities for physics with measurements of CEvNS and NINs? What physics is most interesting to probe? Are we missing anything? What connections are there to other broader areas?
- What is known theoretically already? *What do we need to know? What can be done in the near term?*
- What are the experimental requirements? What are the capabilities? What is realistically achievable on a short timescale? On a long timescale? How can we optimize?

Output: - short term to-do list
- White paper/ “Science Book”

Agenda

Sunday, January 11

9:45-10:00	Introduction/Overview	K. Scholberg
	CEvNS Theory	
10:00-10:30	Historical Overview	W. Haxton
10:30-11:00	CEvNS and PV Electron Scattering	W. Donnelly
Break		
11:30-12:00	Neutrino Event Rates in DM Detectors	L. Strigari
12:00-12:30	Sensitivity to Light DM Scenarios	P. deNiverville
12:30-12:45	Neutrino Magnetic Moment Searches (may remove)	TBD
Lunch		
	Supernova-related	
2:00-2:30	Halo-generating Neutrino-Nucleus Coherent Scattering couples nuclear composition into the supernova neutrino flavor transformation problem in a new way	G. Fuller (remote)
2:30-3:00	CEvNS in core-collapse supernovae	E. O'Connor
3:00-3:30	Detection of supernova neutrinos with CEvNS	C. Horowitz
Break		
	CEvNS Experiment	
4:00-4:20	SNS prospects/COHERENT	P. Barbeau
4:20-4:40	CsI	J. Collar
4:40-5:00	Germanium	M. Green
5:00-5:30	CENNS @ FNAL	A. Hime
5:30-5:50	RICOCHET (this may go to Monday if a conflict)	T. Figueroa-Feliciano or J. Formaggio

Monday, January 12

	Low-Energy Cross-Sections/Neutrino-Induced Neutrons	
8:30-9:00	NIN rates, theory	J. Engel
9:00-9:30	Neutrino-nucleus scattering : from very low energies to the quasi-elastic peak	N. Jachowicz
9:30-10:00	NIN measurements at the SNS	G. Rich
10:00-10:15	NINs for supernova detection/HALO	K. Scholberg
Break		
	Nuclear Physics	
10:45-11:30	Inelastic Neutrino Interactions and Neutron Distributions for Neutron Stars	J. Piekarewicz
11:30-12:00	Form factors	G. McLaughlin
Lunch		
1:30-2:00	Reserve for conflicts/overflow	
2:00-3:00	Discussion/Summary/Moving Forward/Science Book	All