



High-Energy Physics from the Sun

Problems and Prospects



Kenny, Chun Yu NG

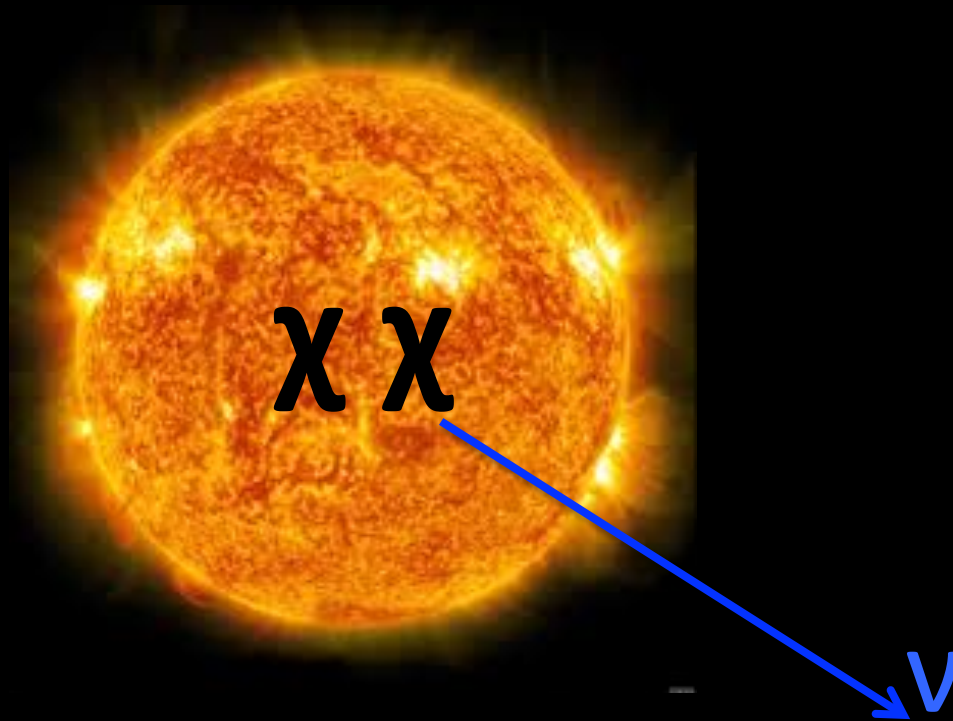
CCAPP, The Ohio State University

with John Beacom, Annika Peter, Carsten Rott



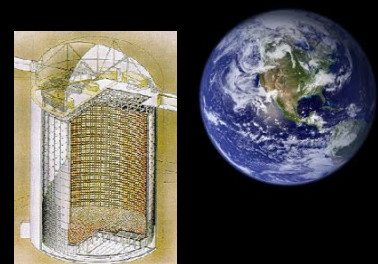
Sun – Dark Matter Detector

Gravitational Capture -> Annihilation

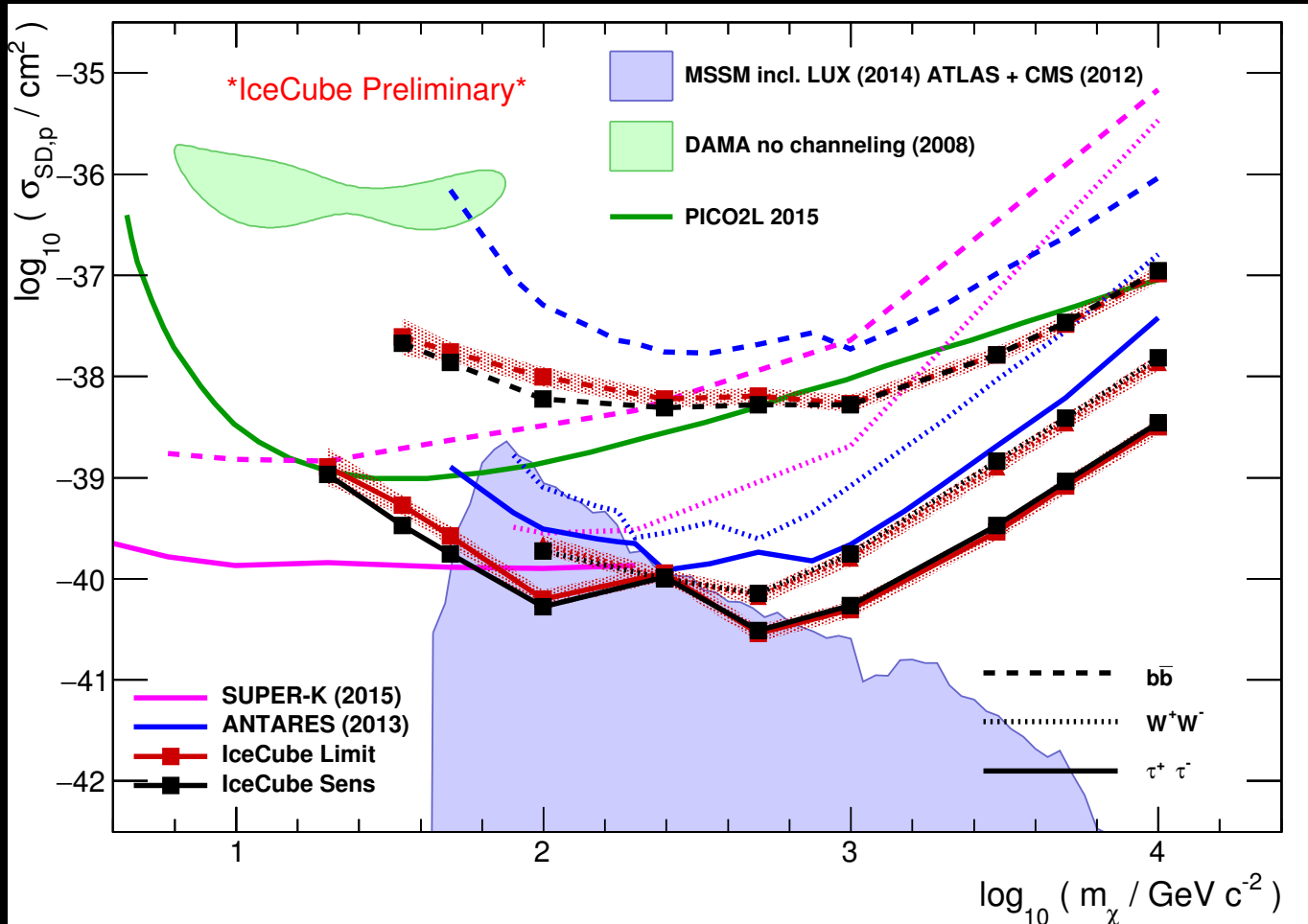


E.g. $\chi\chi \rightarrow WW \rightarrow \nu + X$

Press, Spergel 1985, +++



Sun – Dark Matter Detector

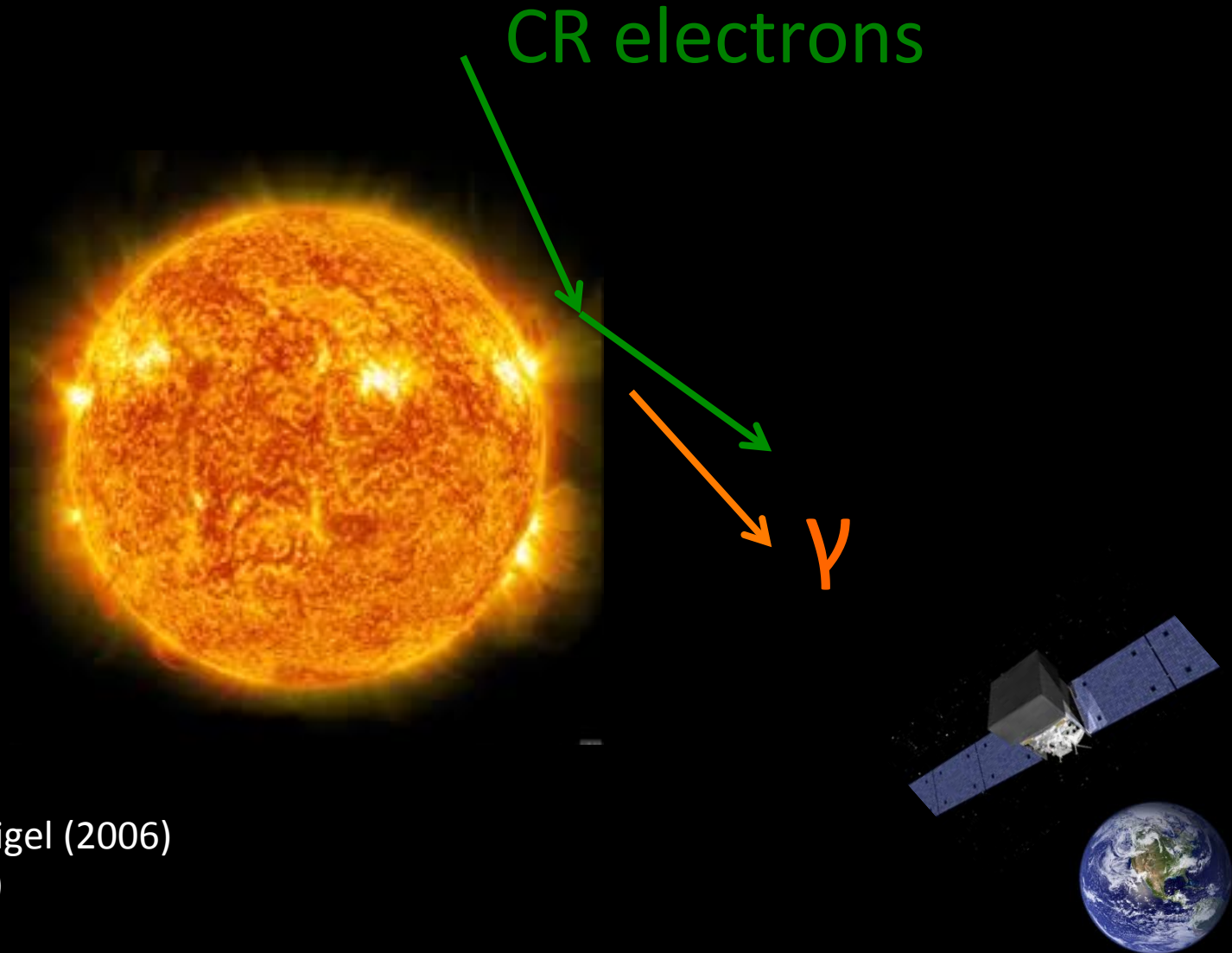


IceCube
ICRC 2015

The best SD - χN cross section limit!

Sun – Cosmic-Ray Beam Dump

- Leptonic



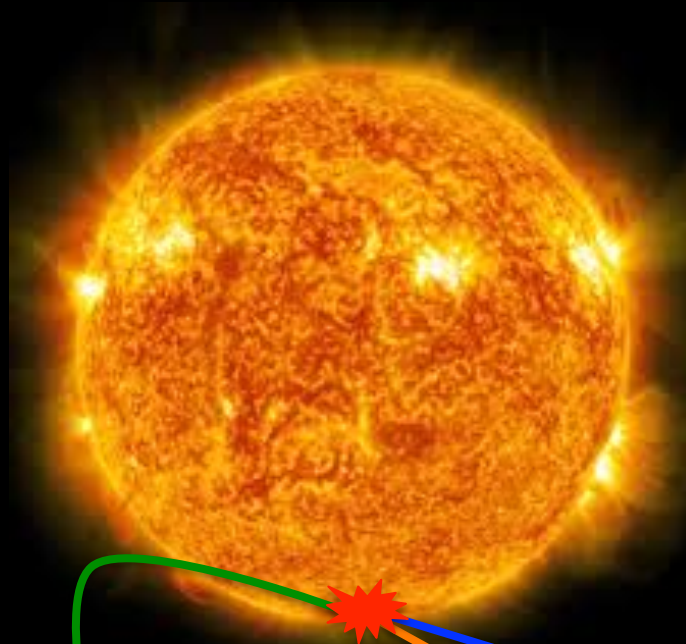
Moskalenko, Porter, Digel (2006)

Orlando, Strong (2007)

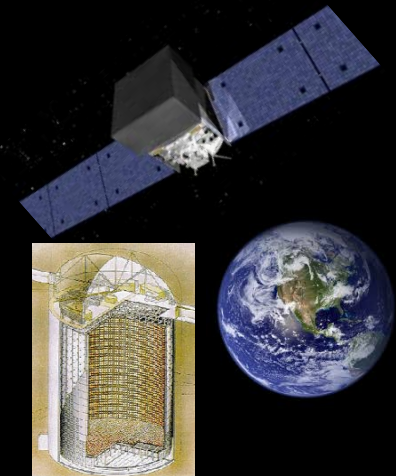
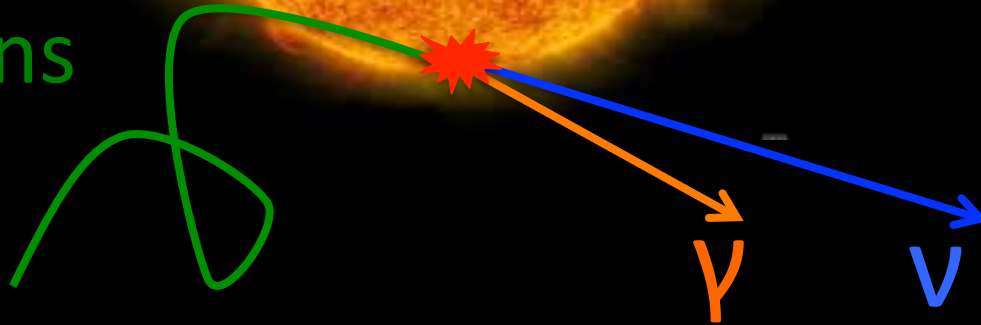
Sun – Cosmic-Ray Beam Dump

- Hadronic

Seckel, Stanev, Gaisser (1991),
Moskalenko, Karakula (1993),
Ingelman, Thunman (1996), +



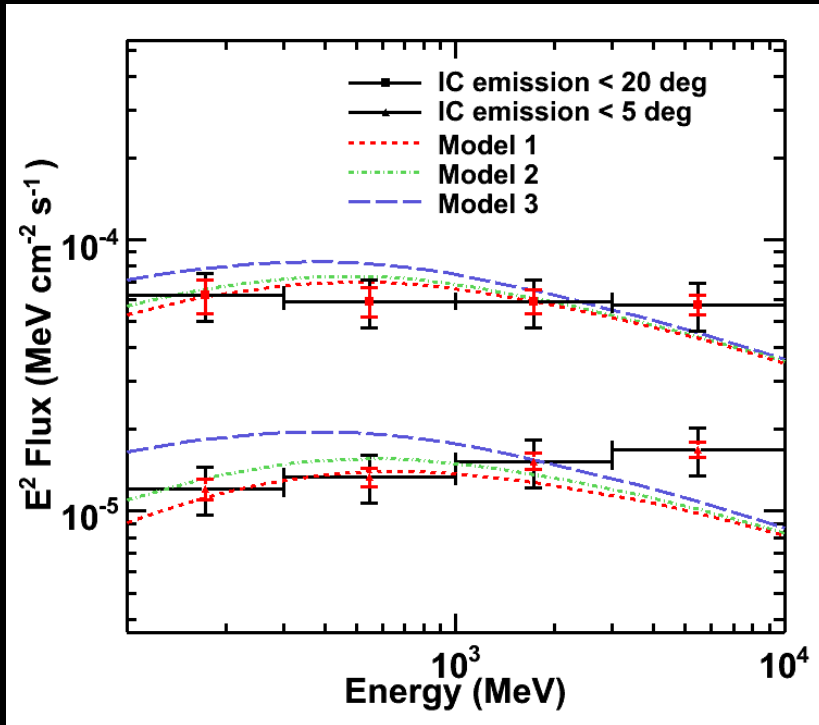
CR protons



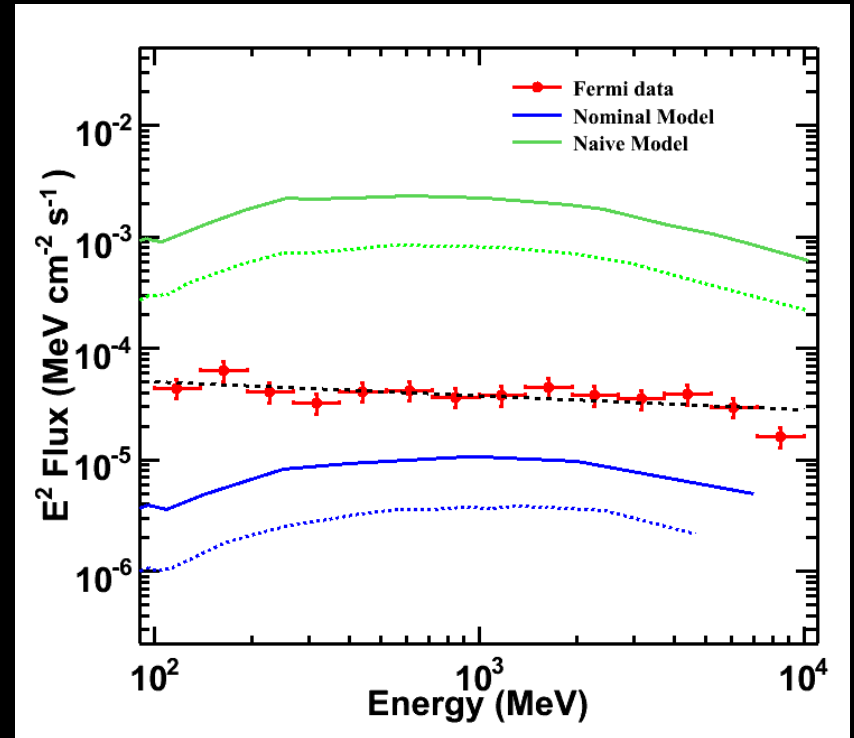
Fermi 2011

-> Nicola Giglietto 16B

Leptonic



Hadronic

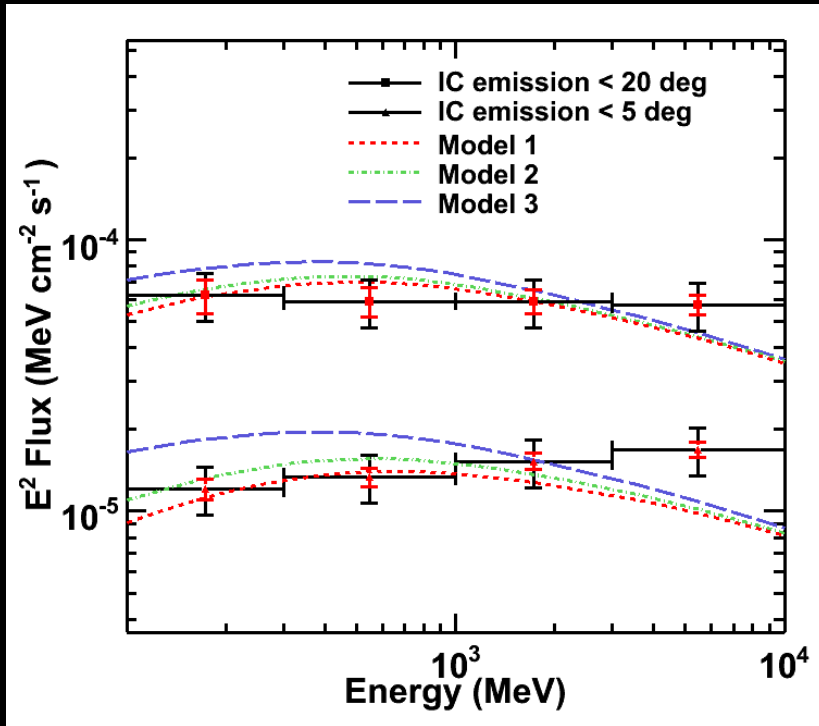


Abdo et al. 2011

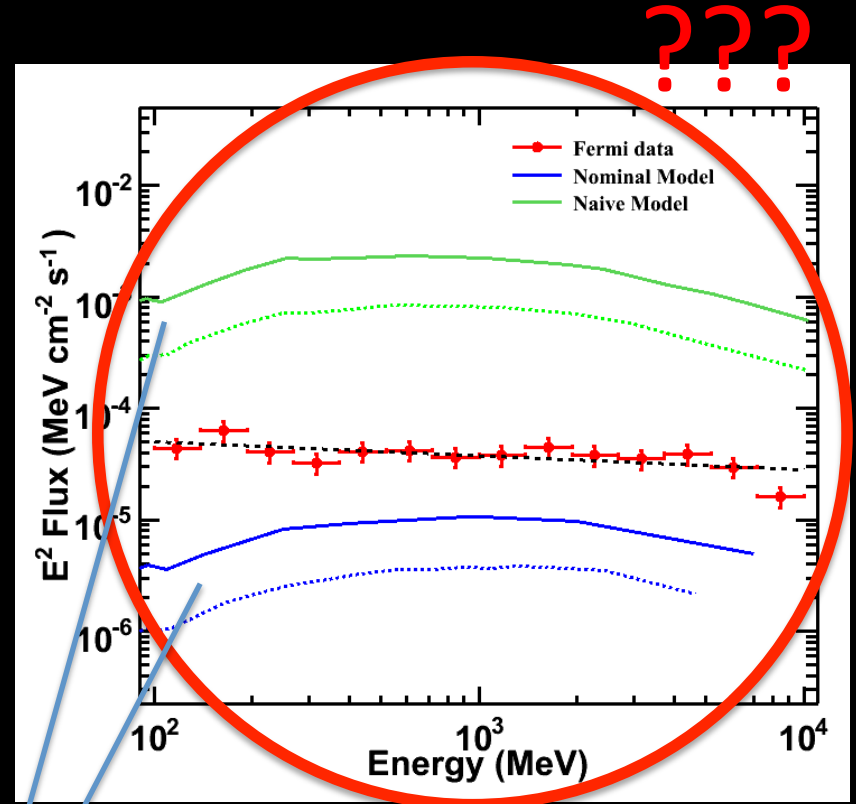
Fermi 2011

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Leptonic



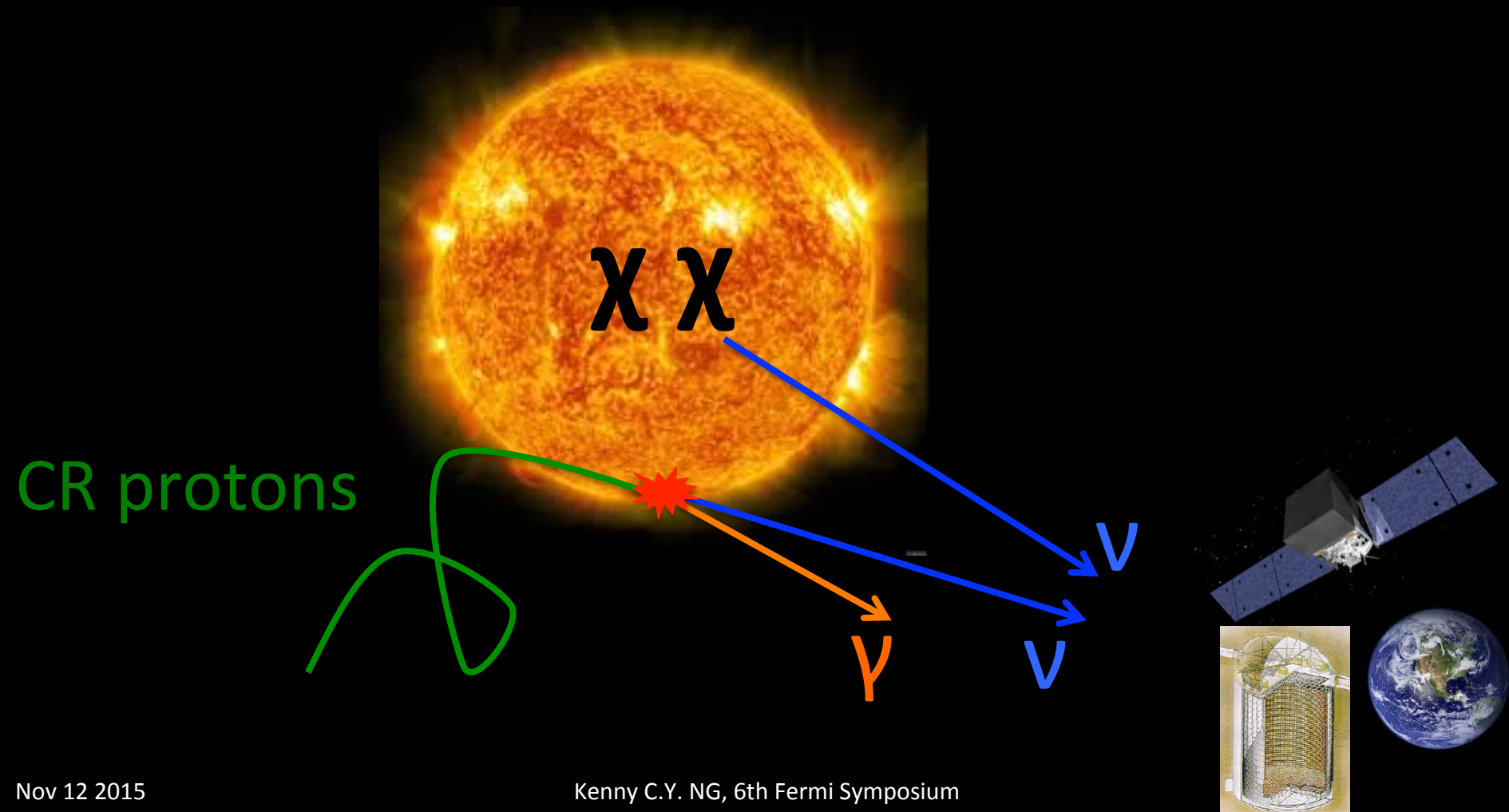
Hadronic



Seckel et al 1991

Abdo et al. 2011

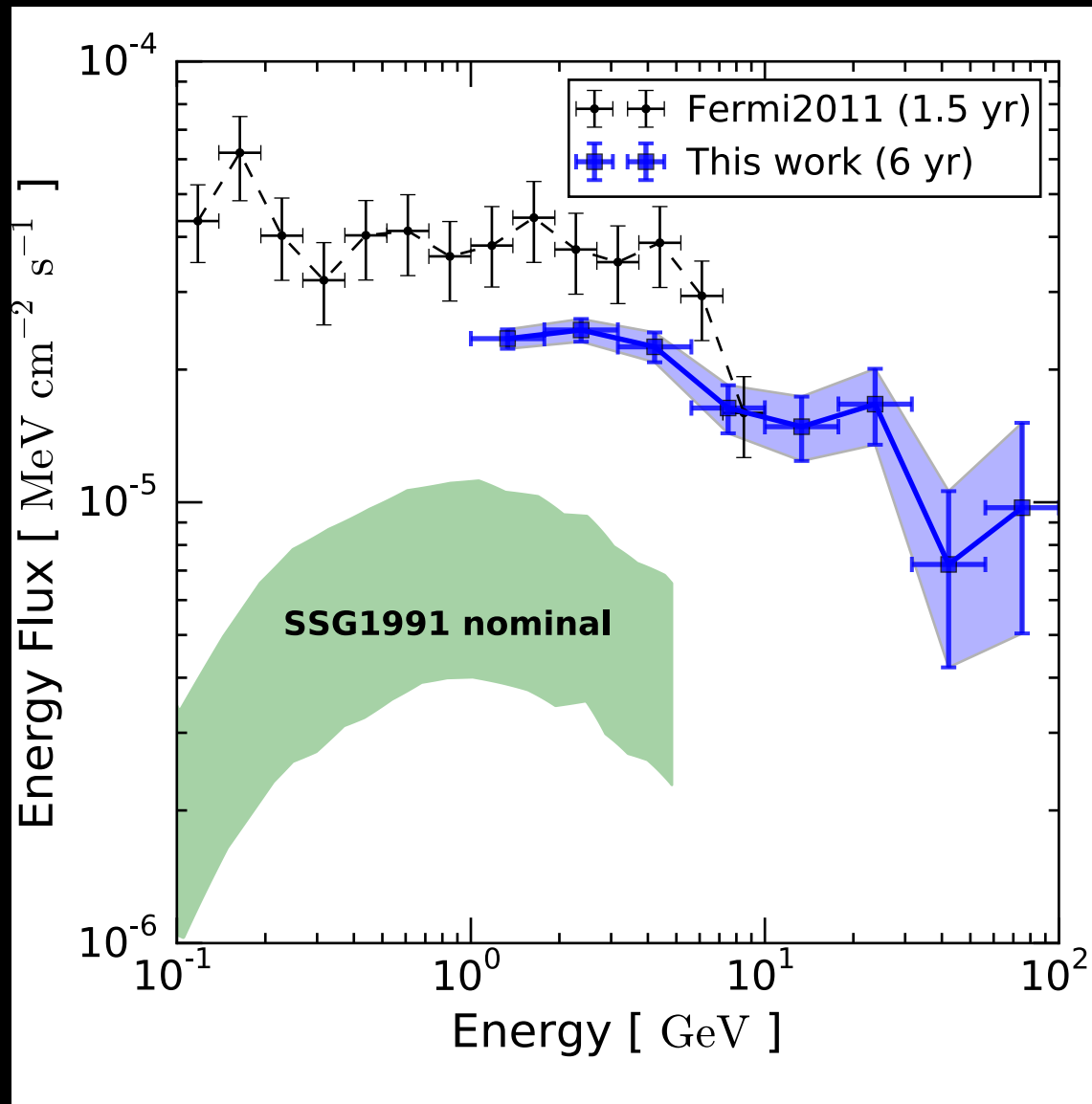
Cosmic Rays vs Dark Matter



6-yr Solar Disk Spectrum

Ng et al. (2015)

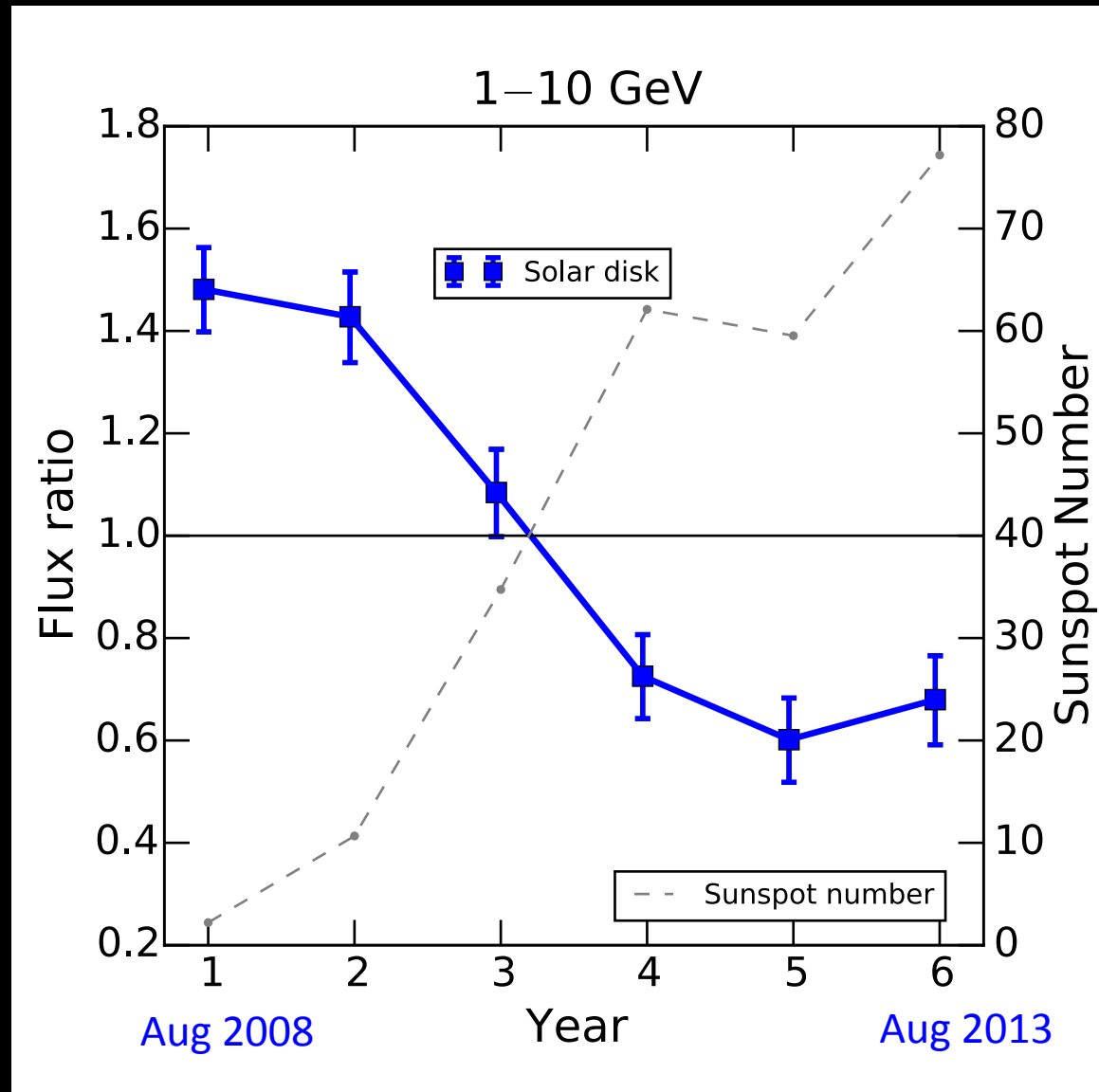
- $> 1\text{GeV}$
- Inconsistent with Model (Seckel et al. 1991)
- Lower flux!?



Time Variation!

Ng et al. (2015)

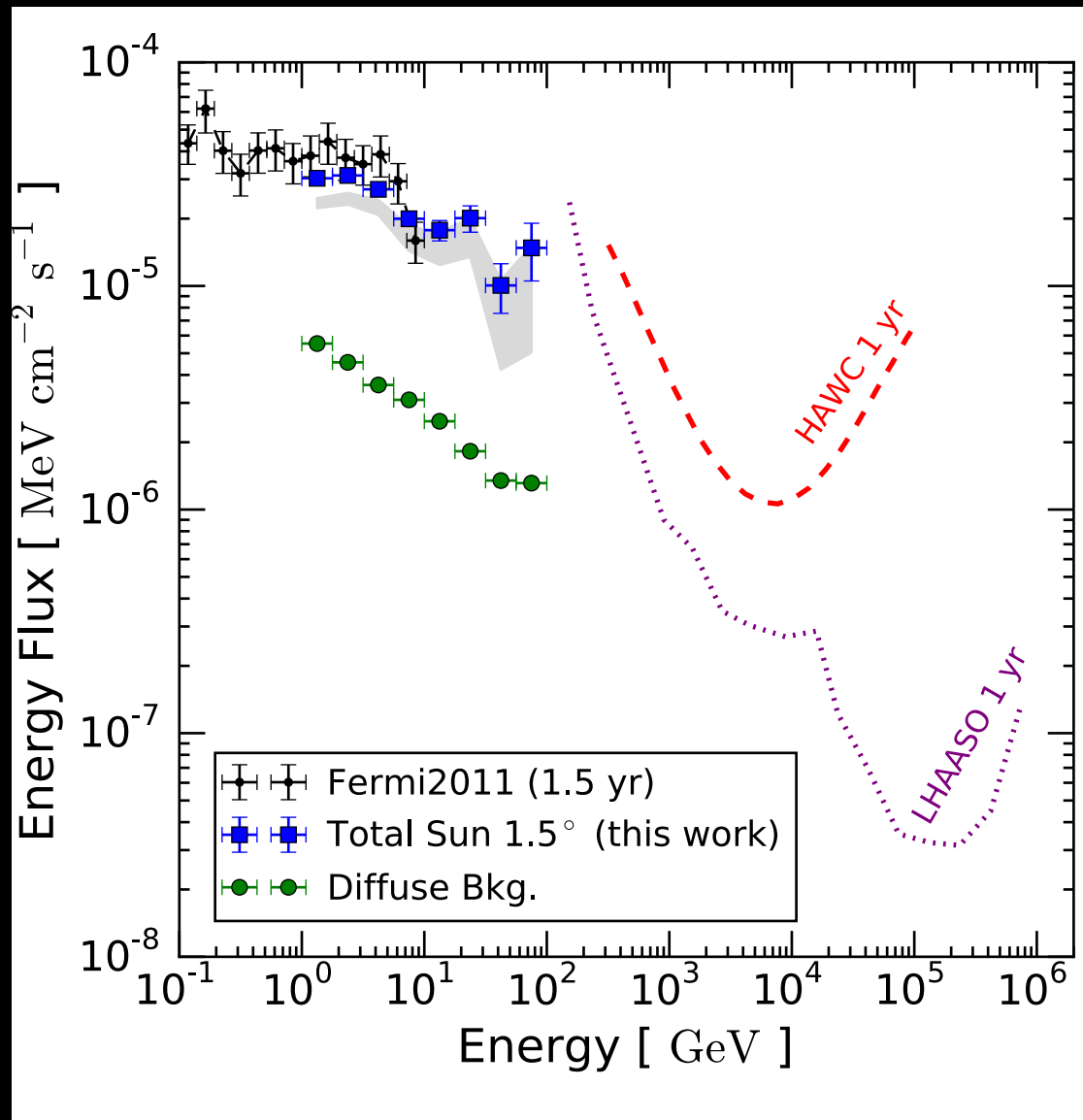
- Definitely looks like Cosmic Rays
- Magnetic fields
 - IMF
 - Corona
 - Photosphere



TeV Gamma-Ray Sun

Ng et al. (2015)

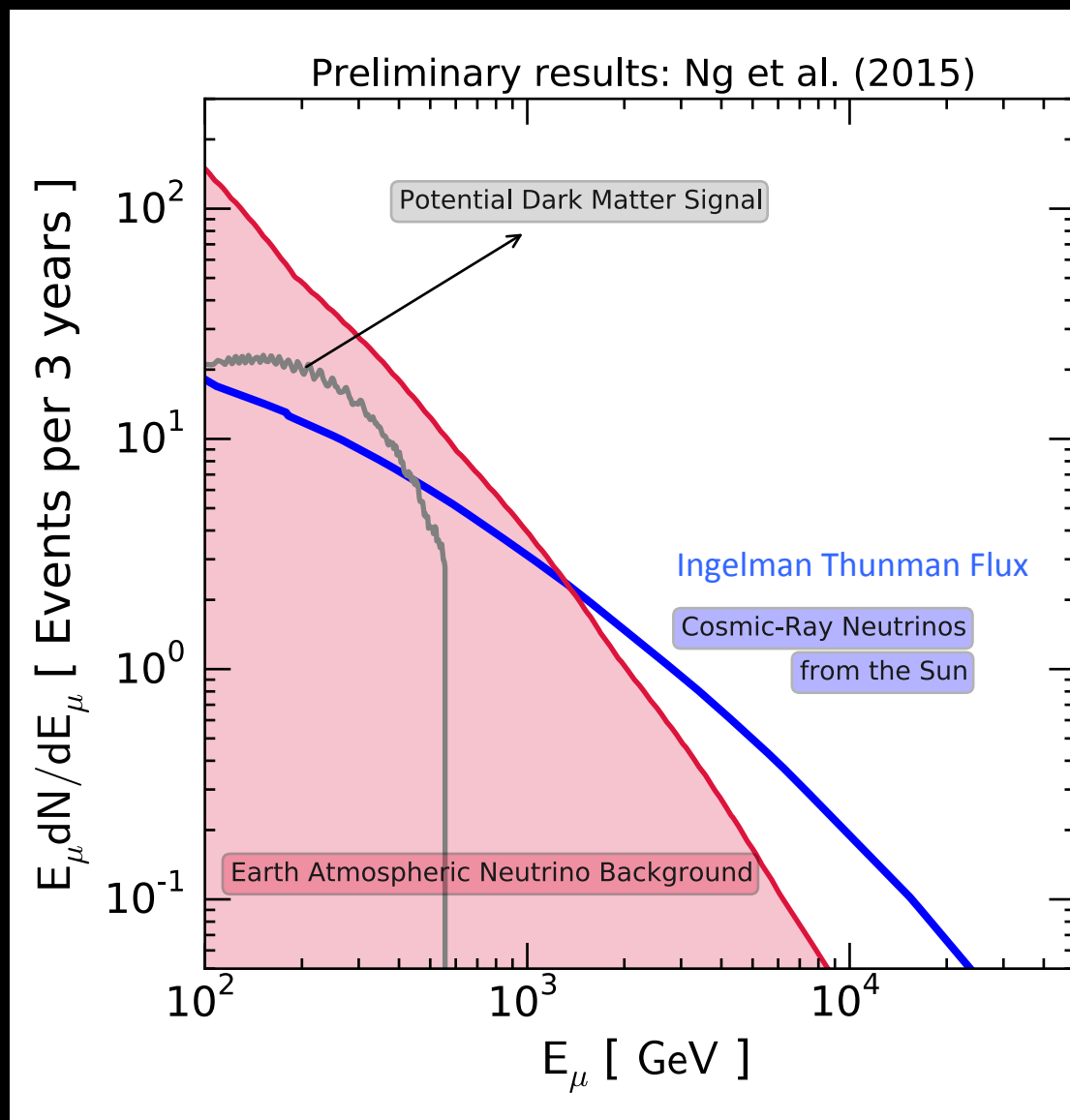
- Unique source for HAWC/ LHAASO
- Spectral break/ Cutoff?



TeV Neutrino Sun

Ng et al. (in prep.)

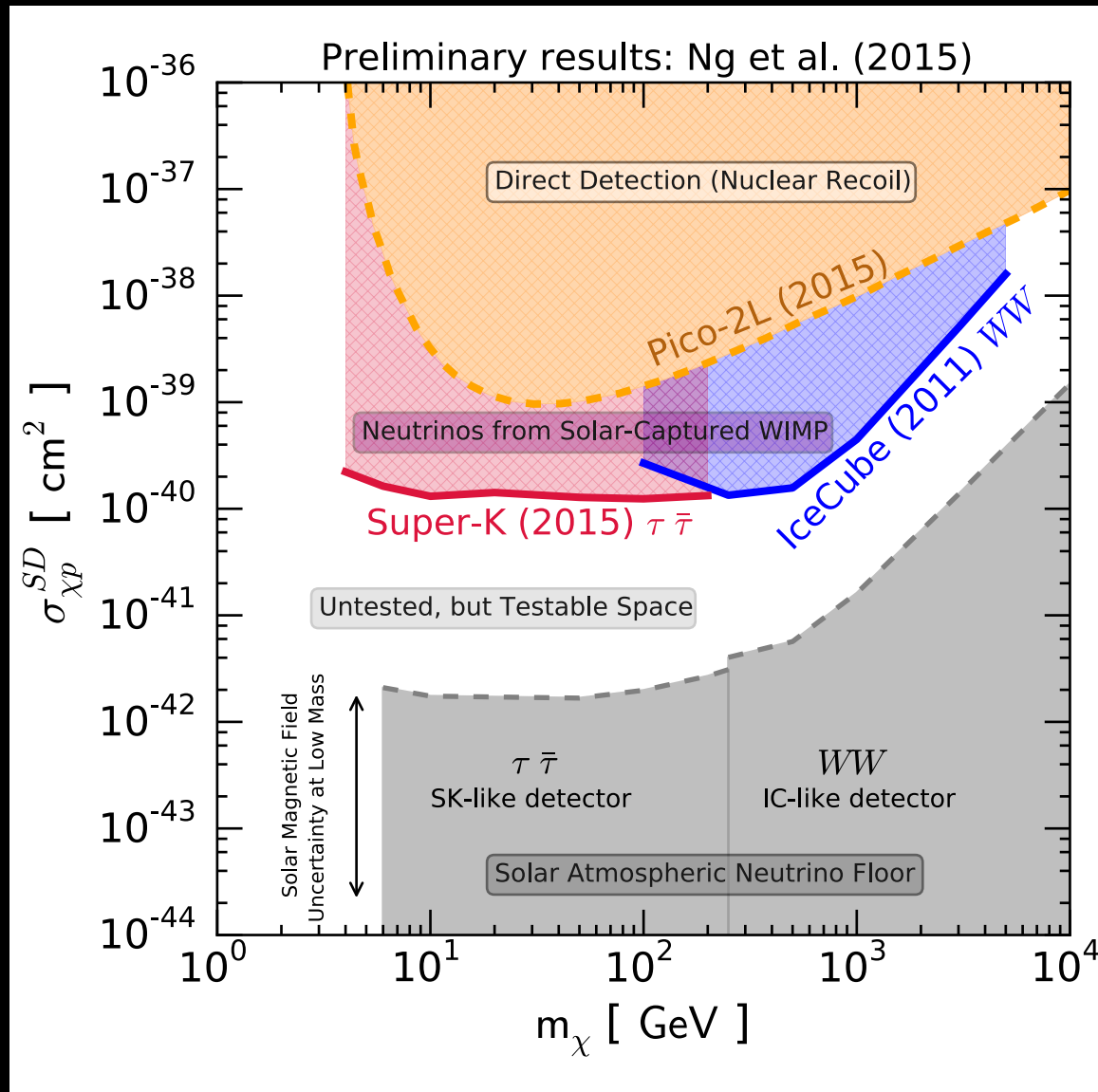
- Guaranteed, Identifiable Neutrino source!
- Standard candle
- Energy information?



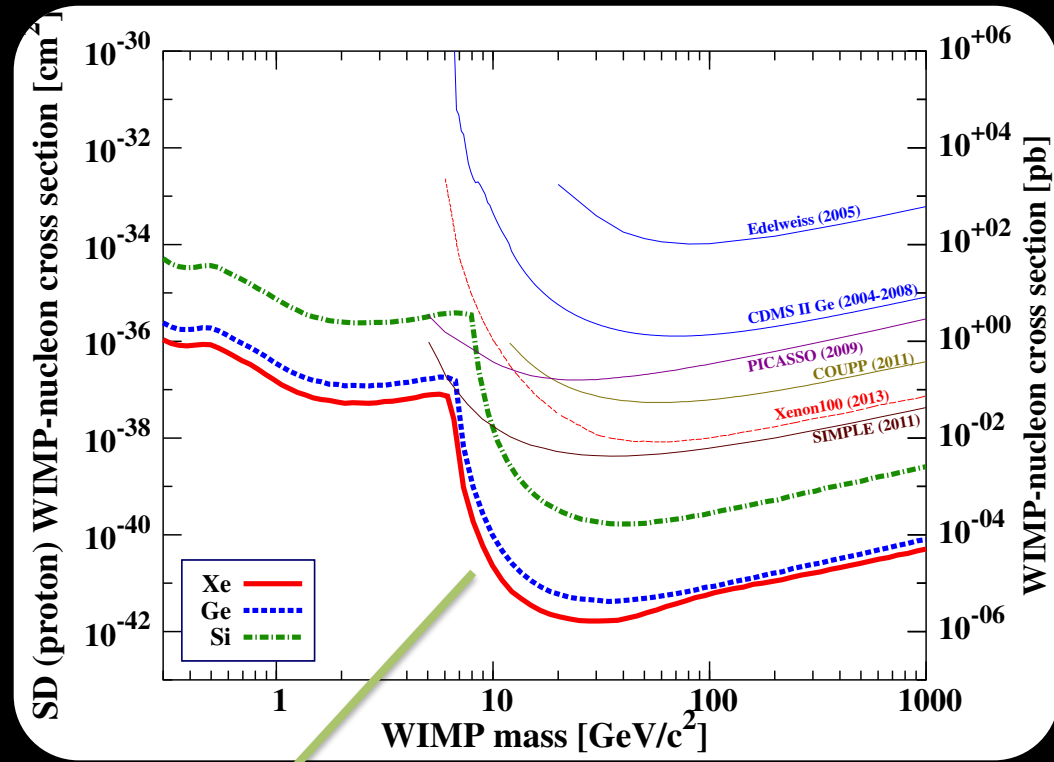
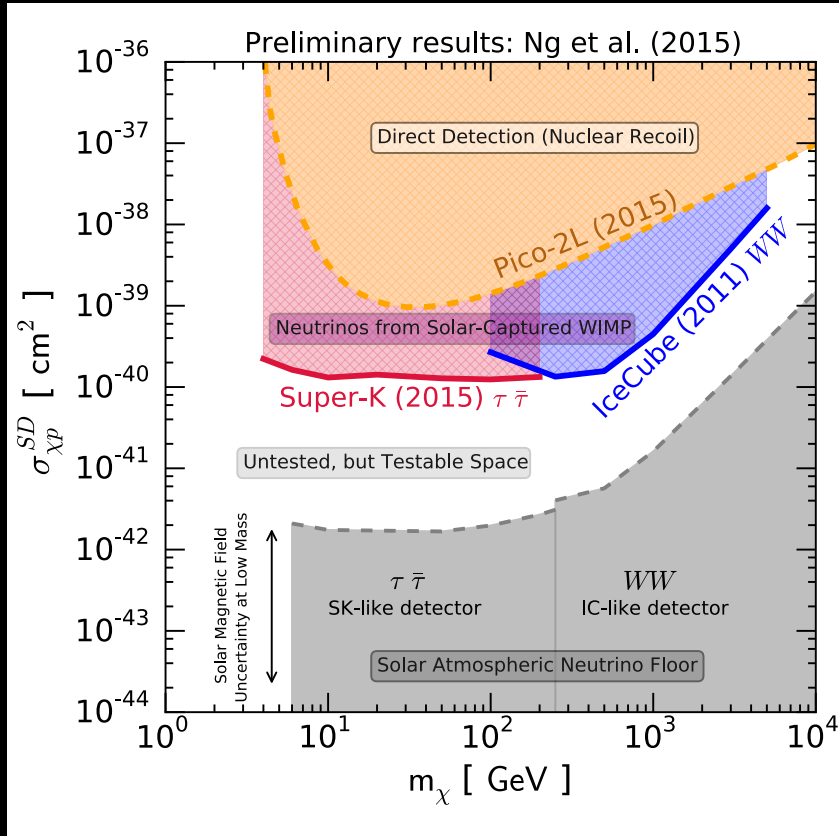
Sensitivity floor

Ng et al. (in prep.)

- 1.5 – 2 orders of magnitude away
- Rate comparison



Neutrinos floors

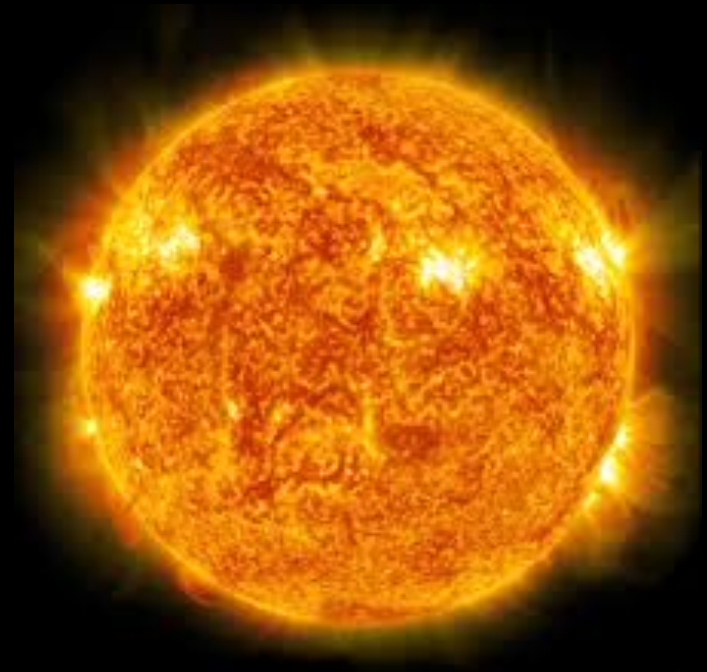


Ruppin et al. 2014

Coherent neutrino scattering

Summary

- The Sun is a bright gamma-ray and neutrino source
- Cosmic rays
 - Propagation
 - Interaction
- Solar atmospheric physics
- Neutrino astronomy
 - Standard Source
- Dark matter
 - Neutrino floor
- More studies, more results to come



Thanks!