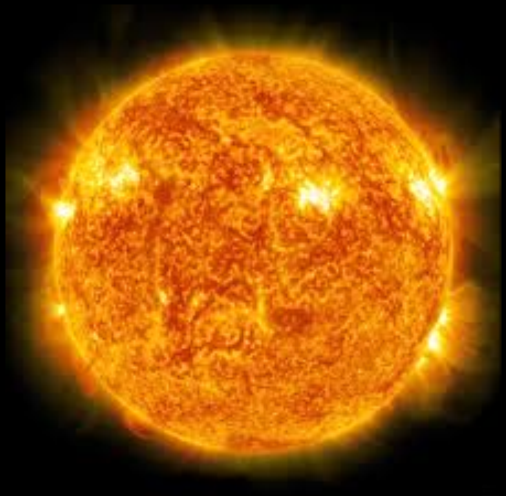
Solar Atmospheric Neutrinos: A HE Neutrino Source Another Neutrino Floor



Based on:
1508.06276
1612.02420
1703.04629
1703.10280

With John Beacom, Annika Peter, Carsten Rott

Kenny, Chun Yu Ng
Weizmann Institute of Science

מכון ויצמן למדע
WEIZMANN INSTITUTE OF SCIENCE

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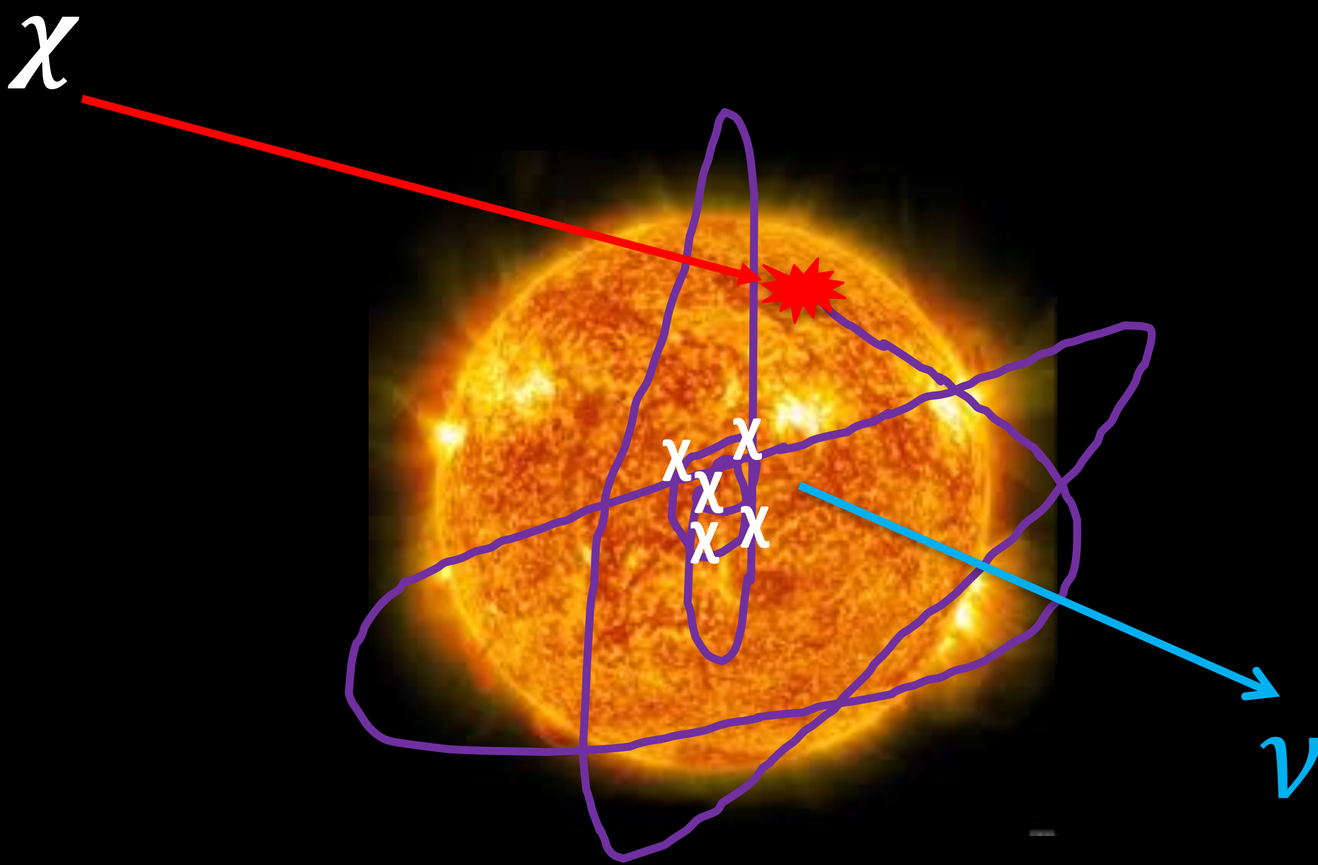
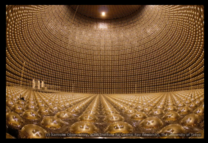
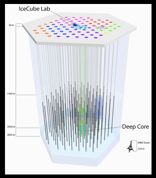
TeV PARTICLE ASTROPHYSICS
TeV PA
AUGUST 7-11 2017
COLUMBUS, OH

Sun – Dark Matter detector



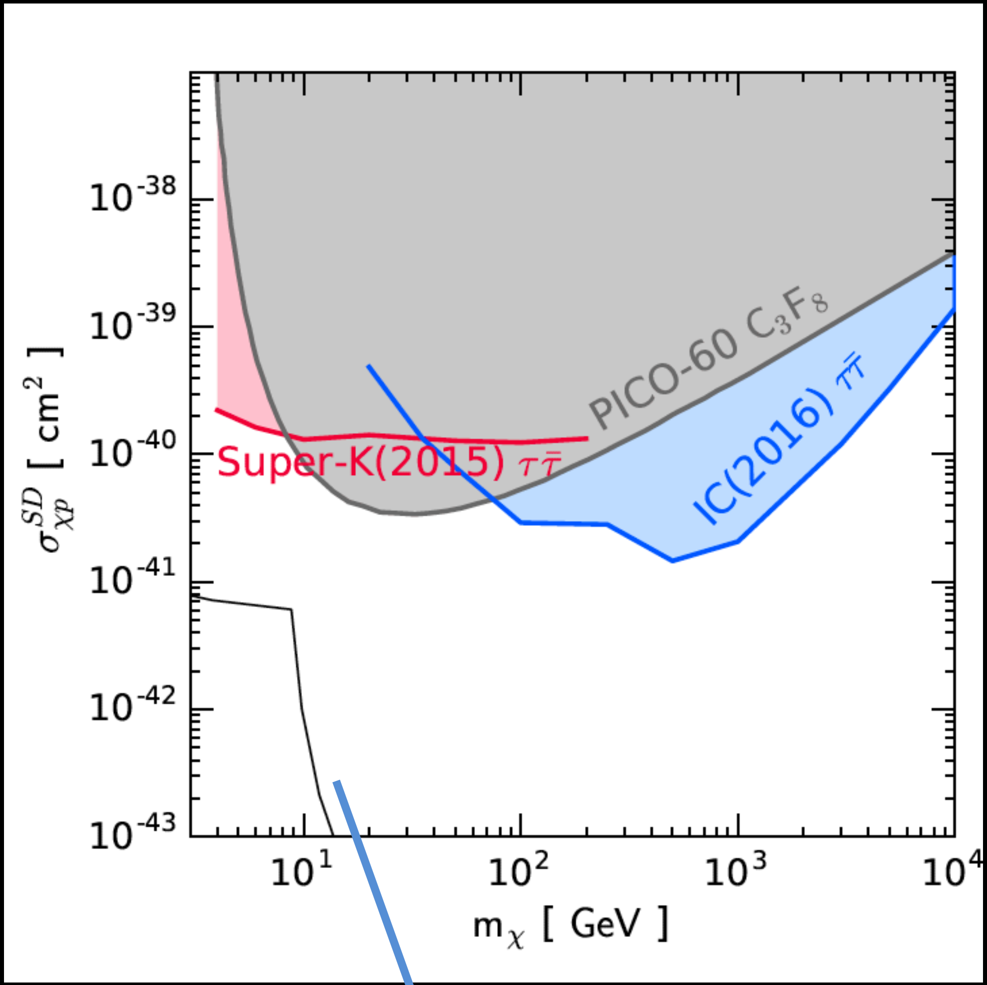




Press, Spergel (1985)
Krauss, Freese, Press, Spergel (1985)
Silk, Olive, Srednicki (1985)

Solar WIMP Search

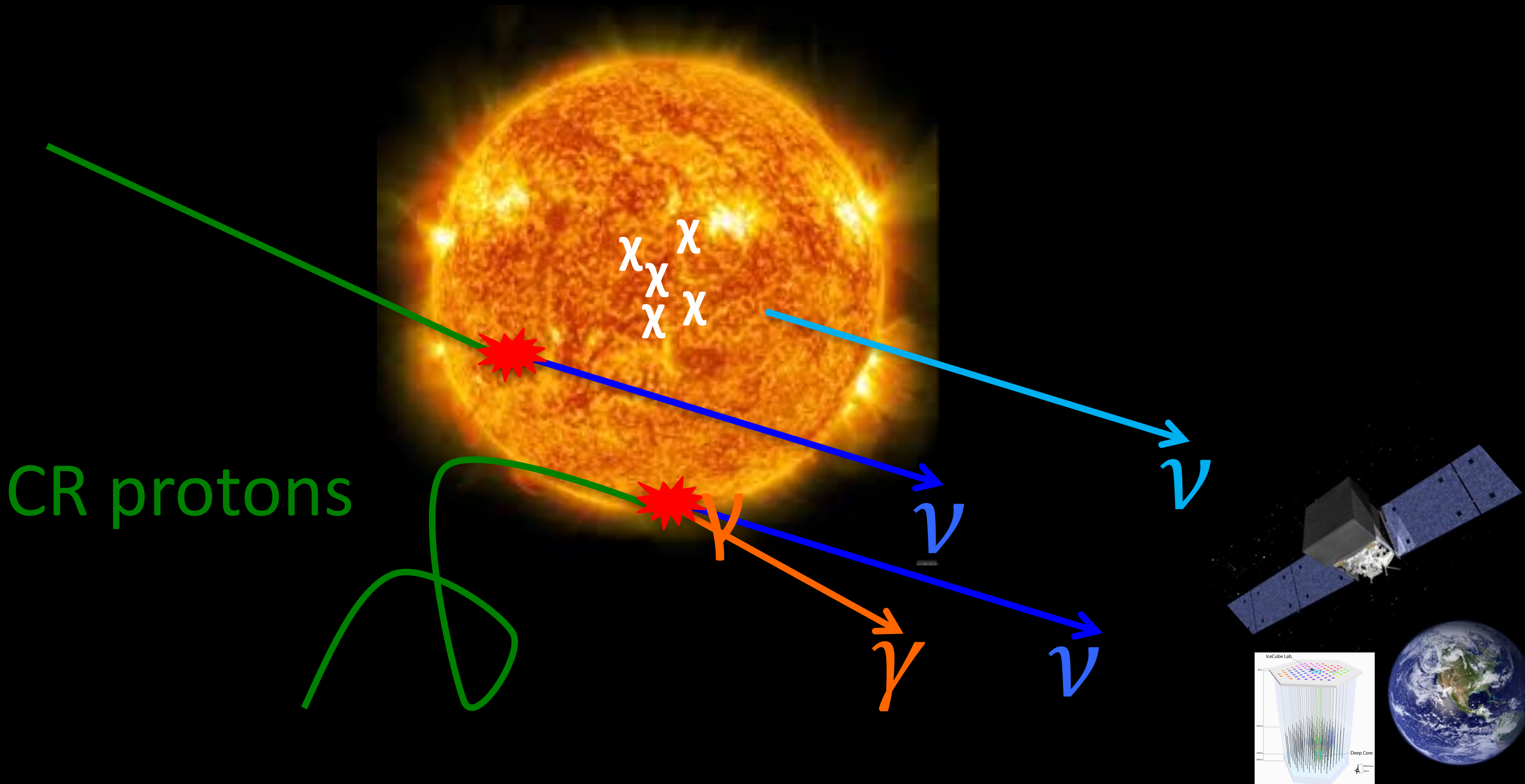
- Best limit on SD cross sections
  - Hard Channels
- Both scattering and Annihilation !
- How far can neutrino telescopes reach?



C_3F_8 Direct Detection
Neutrino floor
Ruppin et al. 2014

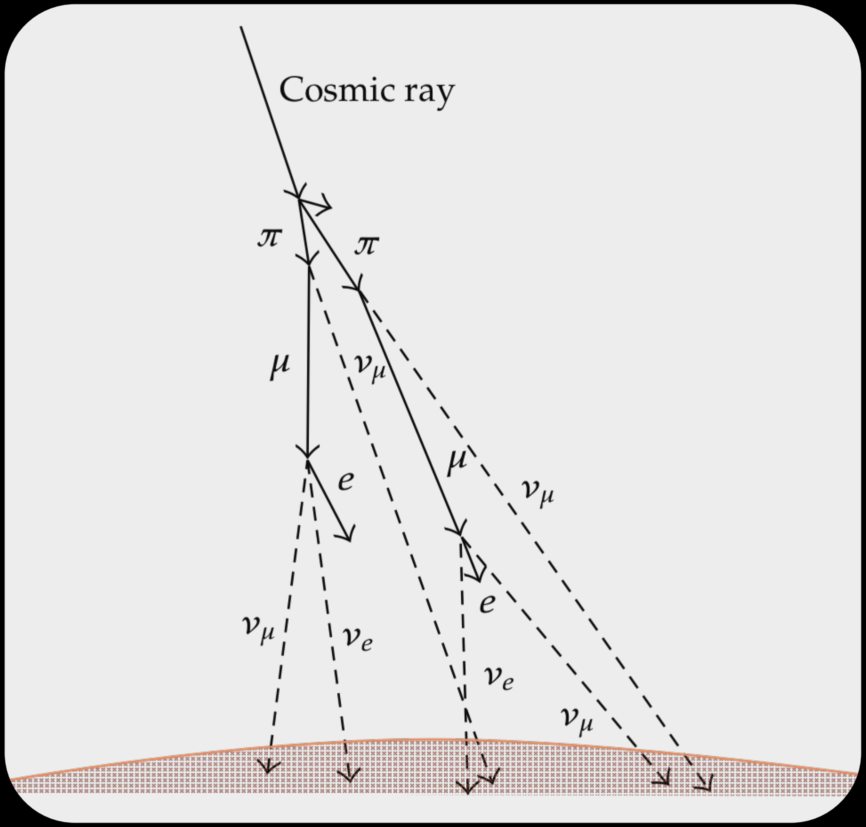
Sun – Cosmic-ray beam dump

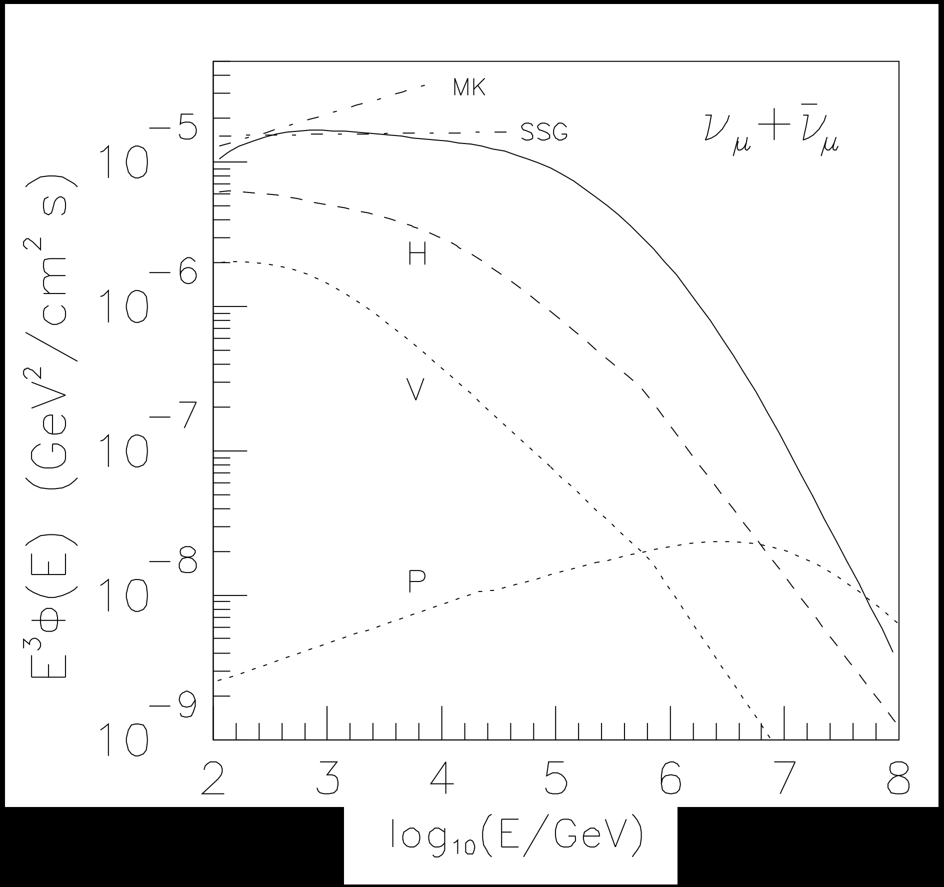
Seckel, Stanev, Gaisser (1991),
Moskalenko, Karakula (1993),
Ingelman, Thunman (1996), +



Solar Atmospheric Neutrinos

Ingelman & Thunman 1996





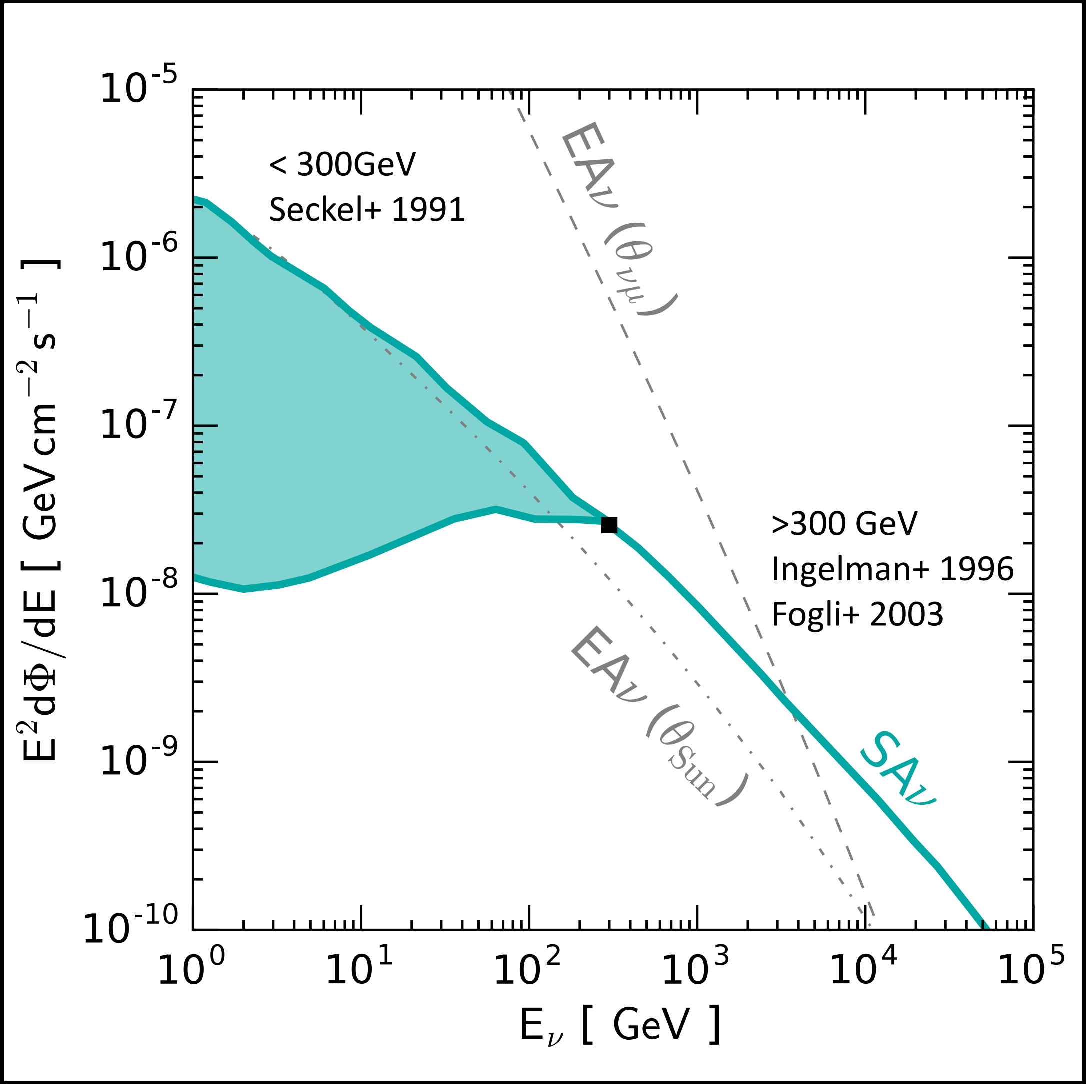
- Dilute atmosphere, larger neutrino flux

Seckel+ 1991, Moskalenko+, 1993, Ingelman+ 1996, Hettlage+ 2000, Fogli+ 2003

C.A. Argüelles+ 1703.07798
- Tuesday Session
Joakim Edsjo+ 1704.02892

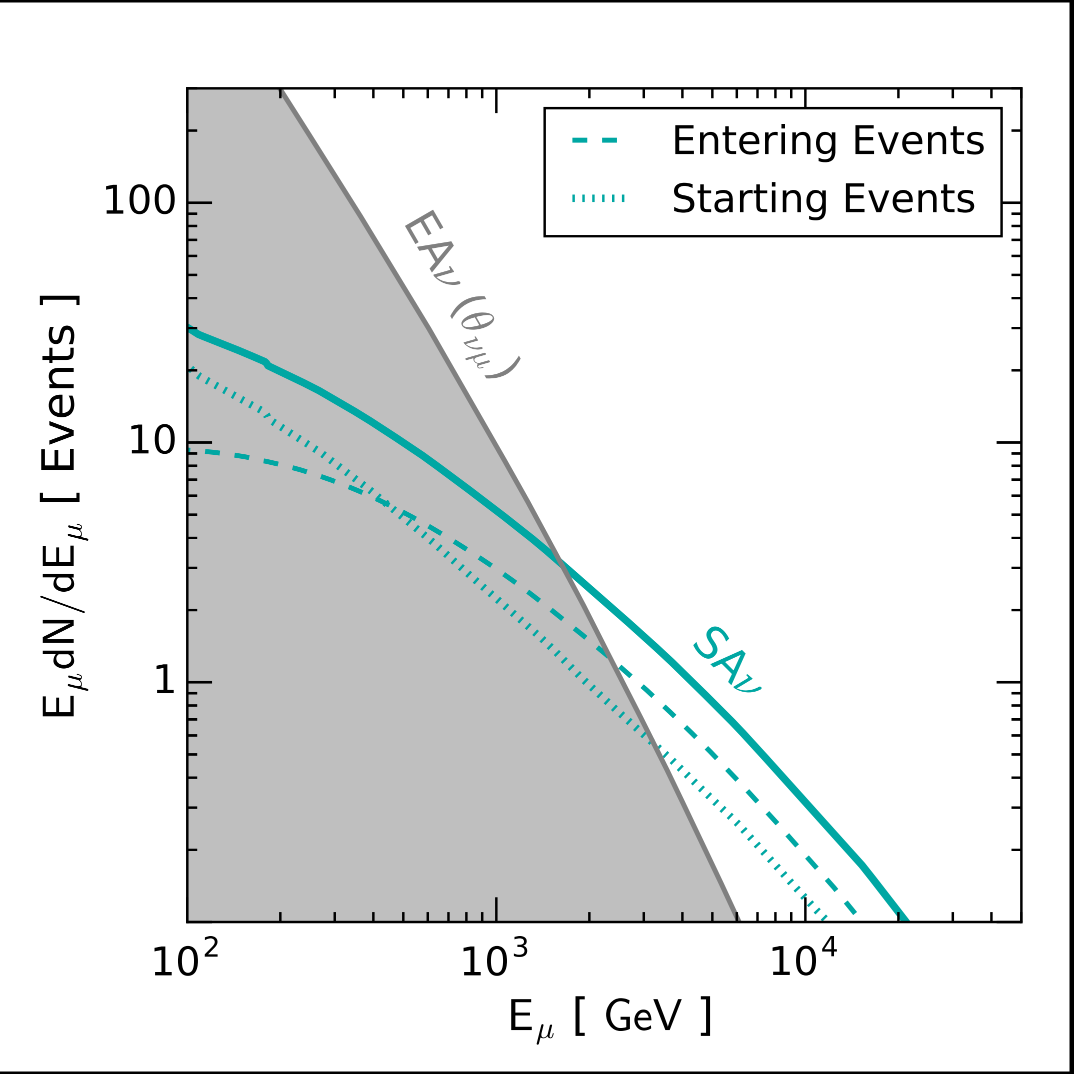
Neutrino Flux

- Muon neutrino for directionality
- Above ~3 TeV, greater than Earth ATM background



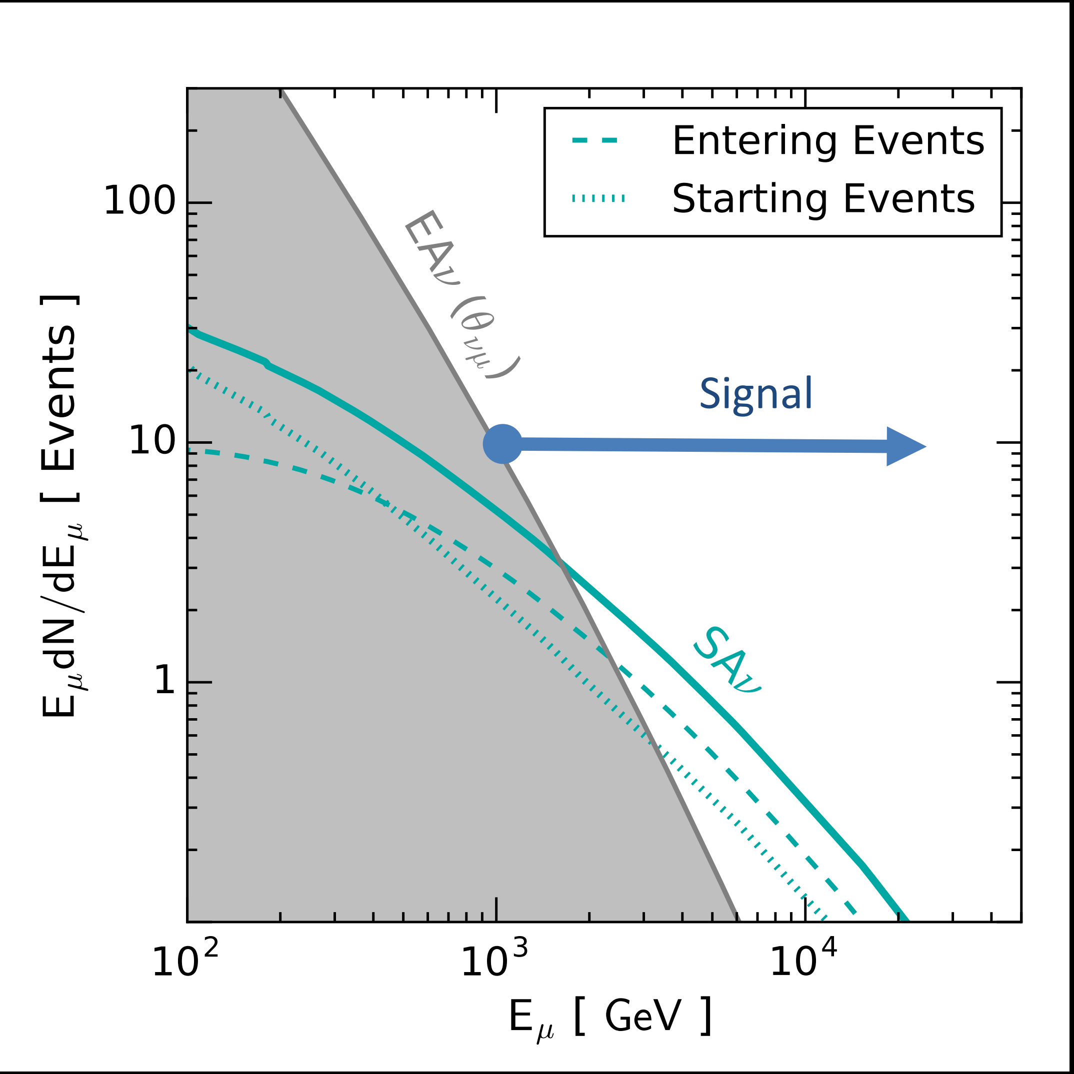
Muon spectrum

- 10 years of 1 Gton detector
  - IceCube
  - KM3NeT

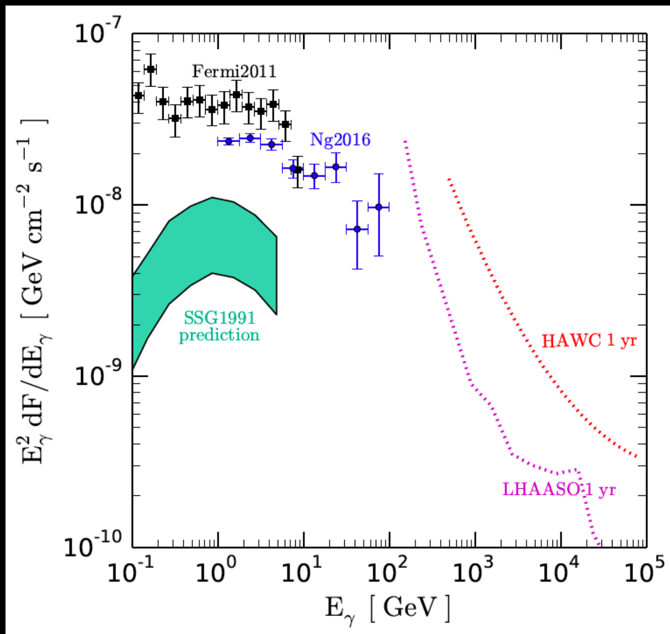


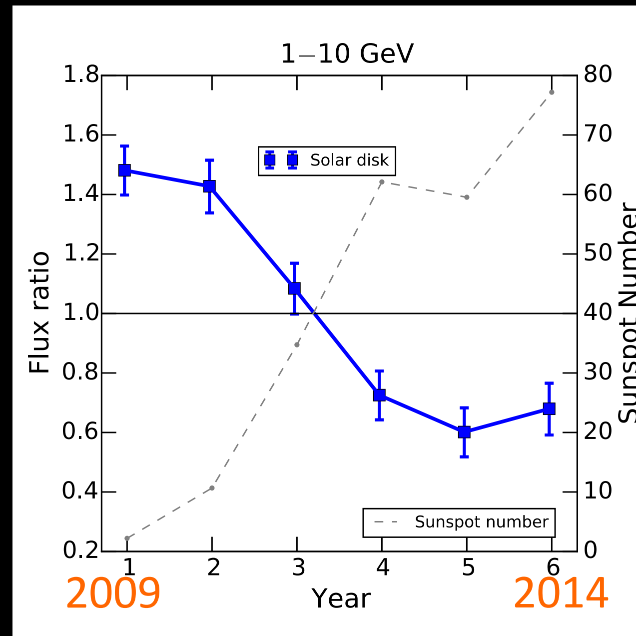
SAν as a Signal

- Muon (>1TeV) energy with energy loss
- ~ 4 signal events in 10 years (4 bkg)
- 1st high-energy neutrino source?
  Carsten Rott - Tuesday Session
- Common source for IceCube + KM3NeT



Astrophysical implications

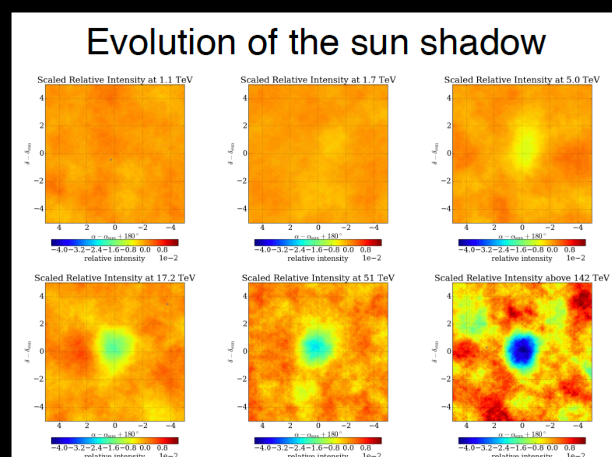


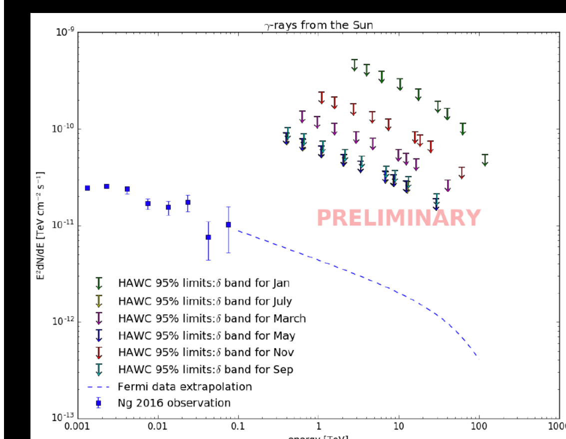


1508.06276

Bei Zhou
Tuesday Session

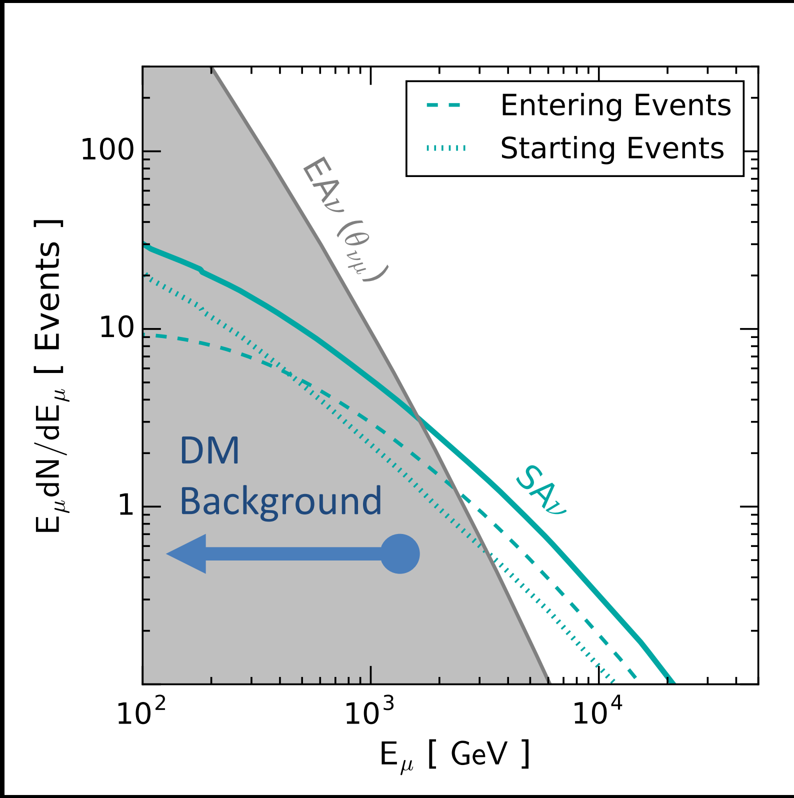
Solar Magnetic Fields ->

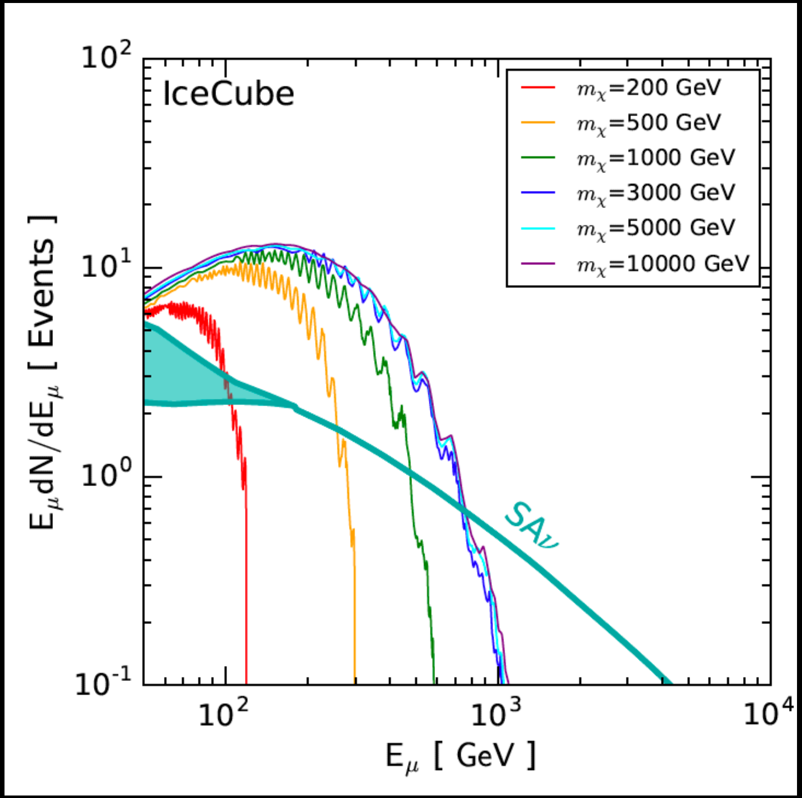




Mehr Un Nis, Monday Session

SAν as Dark Matter Background

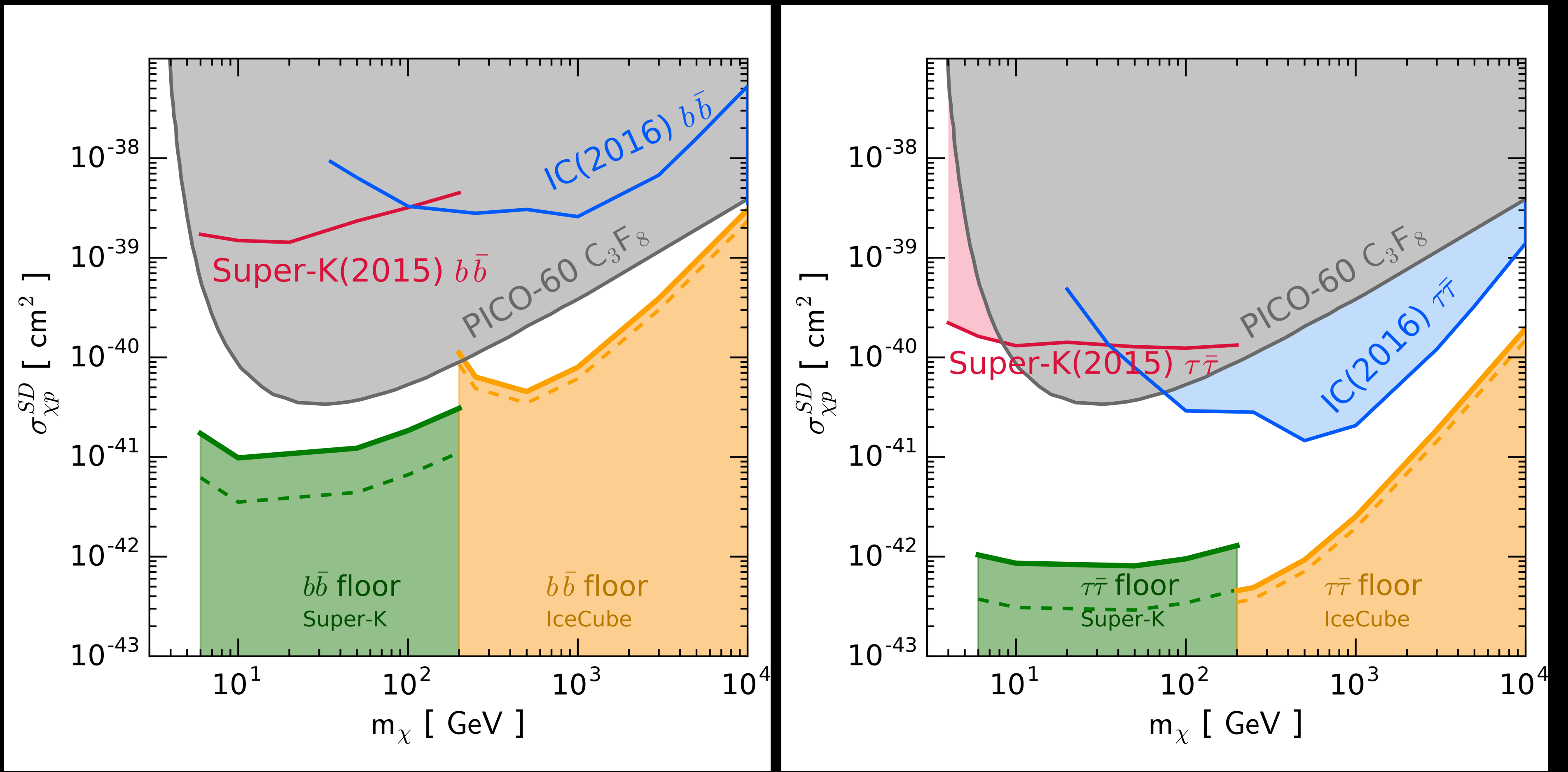




- < TeV muons
- Poor energy resolution

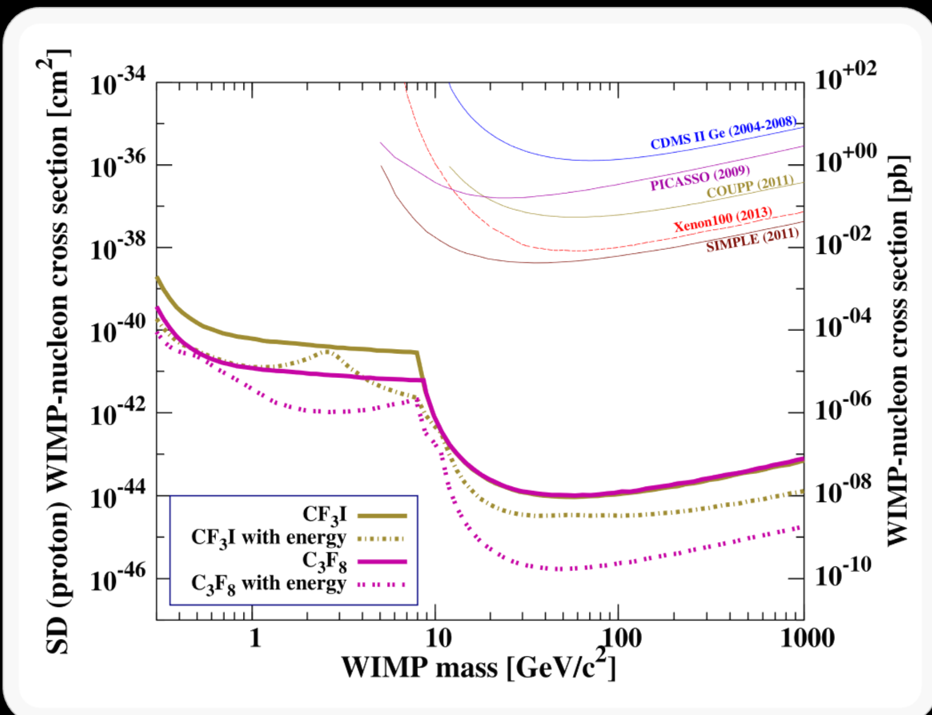
Solar Atmospheric Neutrino Floor

- SAν vs DMν , < TeV muons
- Large model uncertainties -> hard floor

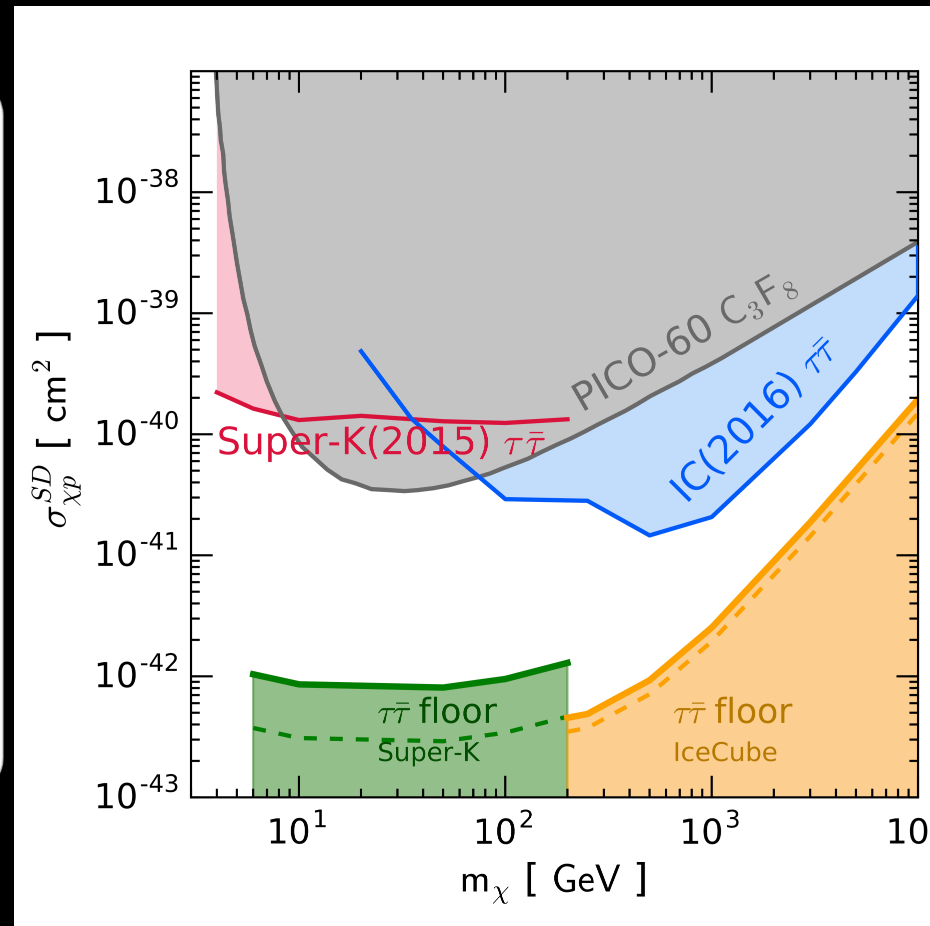


Solar Atmospheric Neutrino Floor

- Large direct detection experiments are needed to reach 10^{44} cm^2



Ruppin et al. 2014



Can Dark Matter give >TeV νs ?

- Long lived Mediators!
  - Unsuppressed neutrino

  Bell, Petraki: 1102.2958

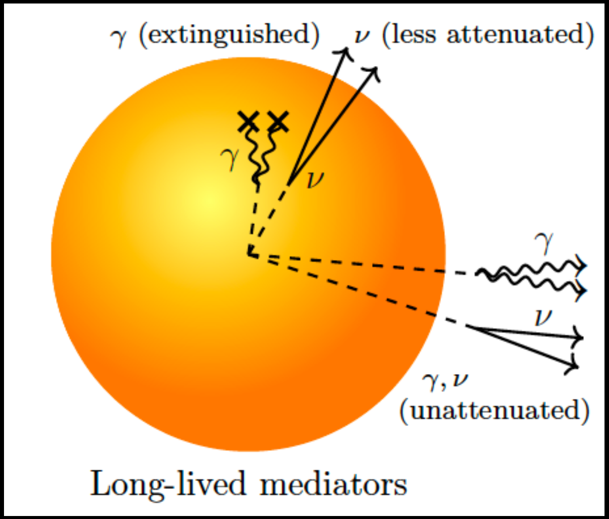
  +
- Also γ and $e^{\pm}$

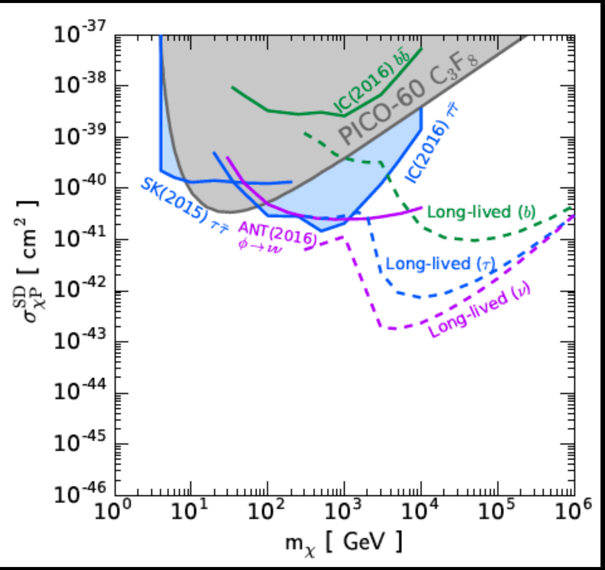
  Batell, Pospelov, Ritz, Shang: 0910.1567
  Feng, Smolinsky, Tanedo: 1602.01465
  Arina, Backović, Heisig, Lucente, 1703.08087

  +

  +
- Low background at high E ($\gamma, e^{\pm}$)

  Zhou, KCYN, Beacom, Peter, 1612.02420

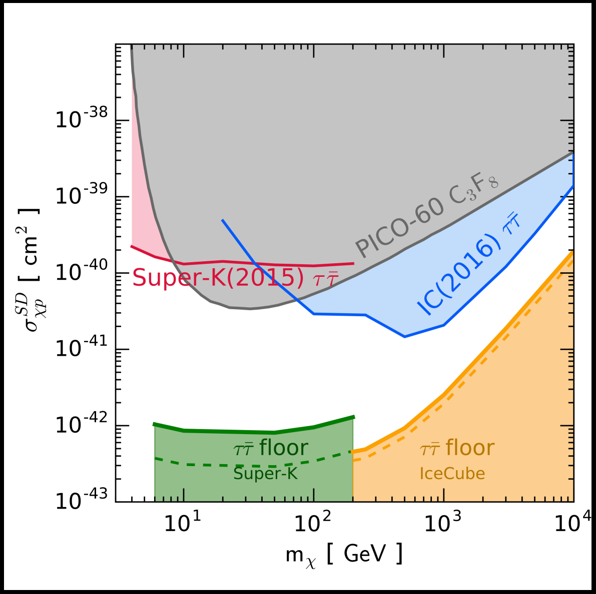




Leane, KCYN, Beacom, 1703.04629

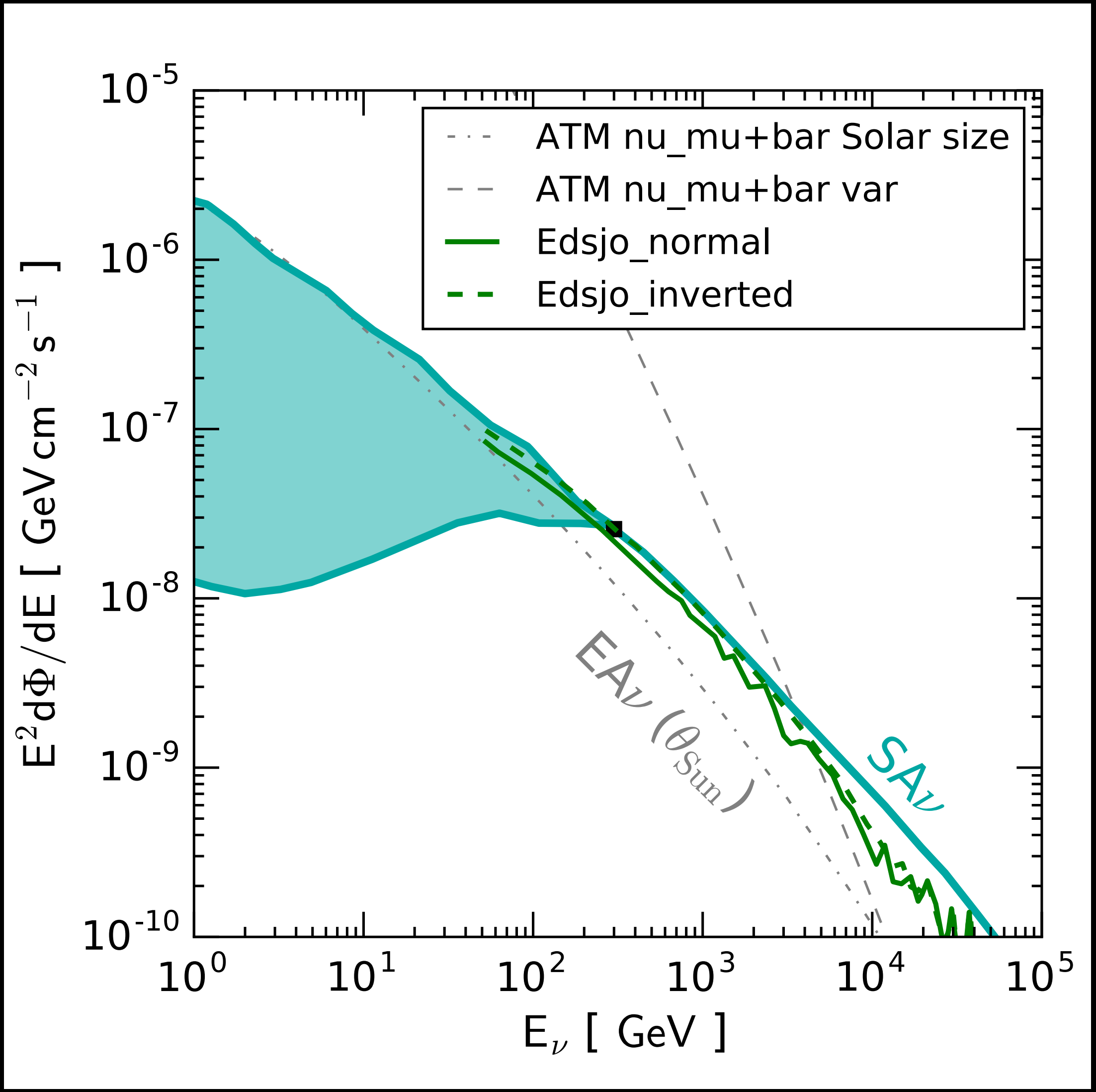
Summary

- SAν as a dark matter background (< TeV μ)
  - Background to solar WIMP search
  - Large model uncertainty -> Hard sensitivity floor
- SAν as a astrophysical signal (> TeV μ)
  - Cosmic-ray interactions in the Sun
  - Reduce the SAν untertinaty
- SAν as a dark matter signal (> TeV μ)
  - Hidden mediator models
  - Multi-messenger constraints

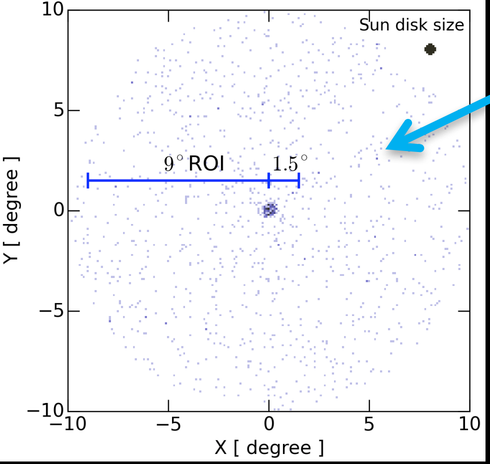


Thanks!

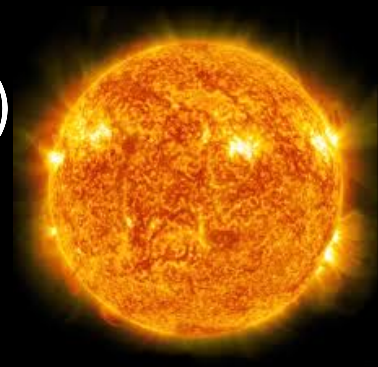
Back up



10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
10^0
10^1
10^2
10^3
10^4
10^5
E^2dΦ/dE [GeV cm^-2 s^-1]
E_ν [GeV]
ATM nu_mu+bar Solar size
ATM nu_mu+bar var
Edsjo_normal
Edsjo_inverted
EA_ν (θ_Sun)
SA_ν

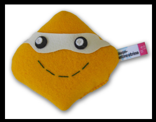


This is a picture of the Sun (> 10 GeV!) in gamma rays, from Hadronic interactions of cosmic rays



Can we also see the Sun in *HE Neutrinos*?

Maybe?



Do they look like ***Dark Matter*** signals?

Yes…… mostly…..

So what do we do???

*Find out in the **Tuesday 2pm Neutrino** Sec.!*