KM3NeT Paper Meeting

IceCube measurement of HE neutrino-nucleuon cross section

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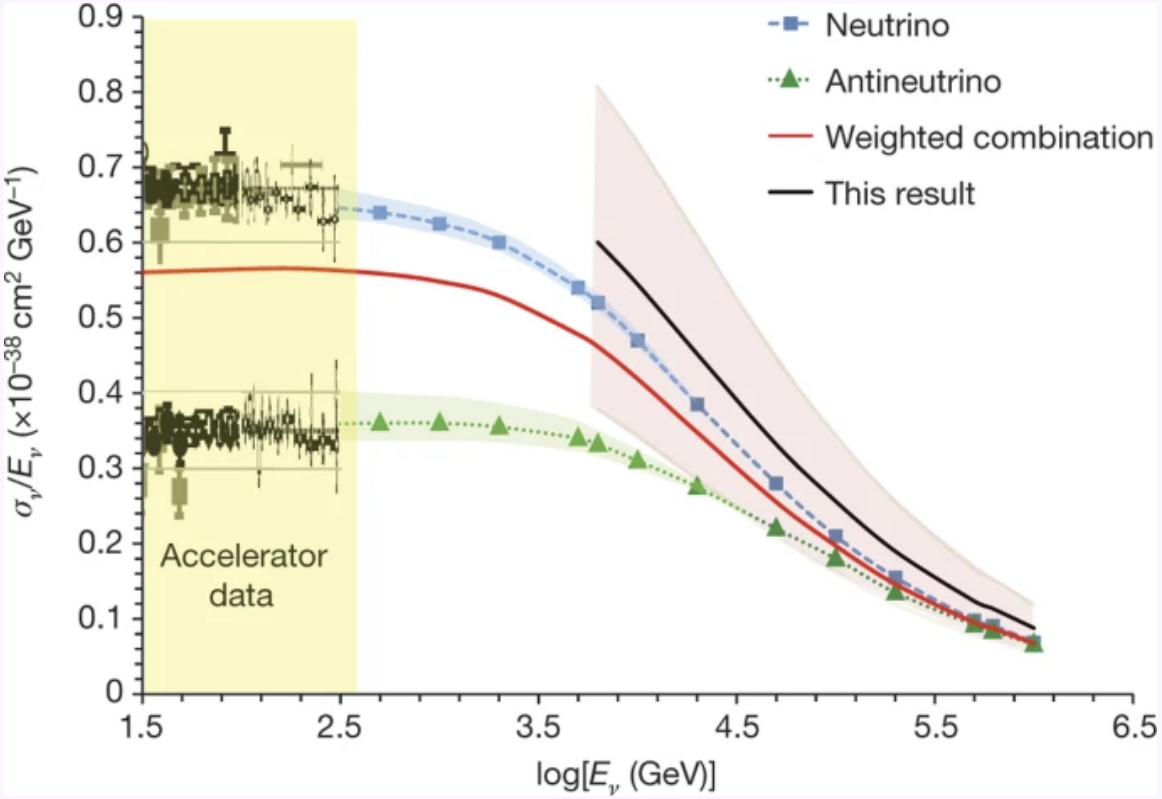
Some background

Neutrino cross-section measurements are scarce at energies above that of accelerators.

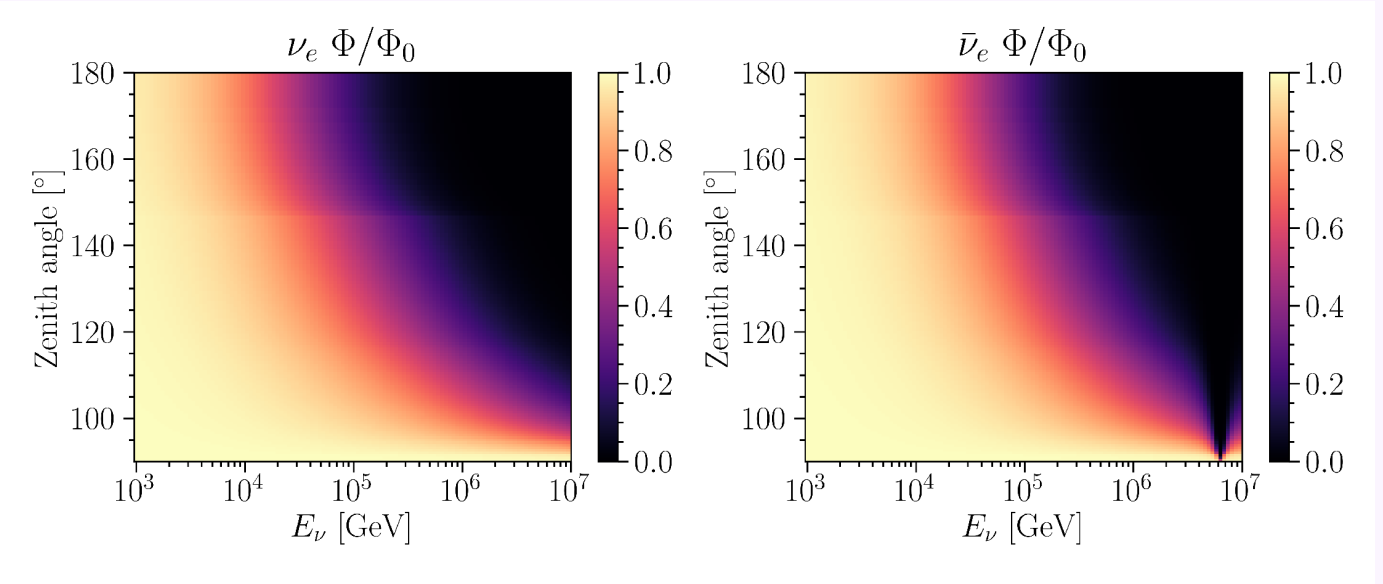
Previously only measured with single topologies with IceCube.

BSM hypotheses for deviations (of course), exotic massive spin-2 boson, extra dimensions, and more.



Previous cross-section measurements from IceCube using muon-neutrinos

https://www.nature.com/articles/nature24459

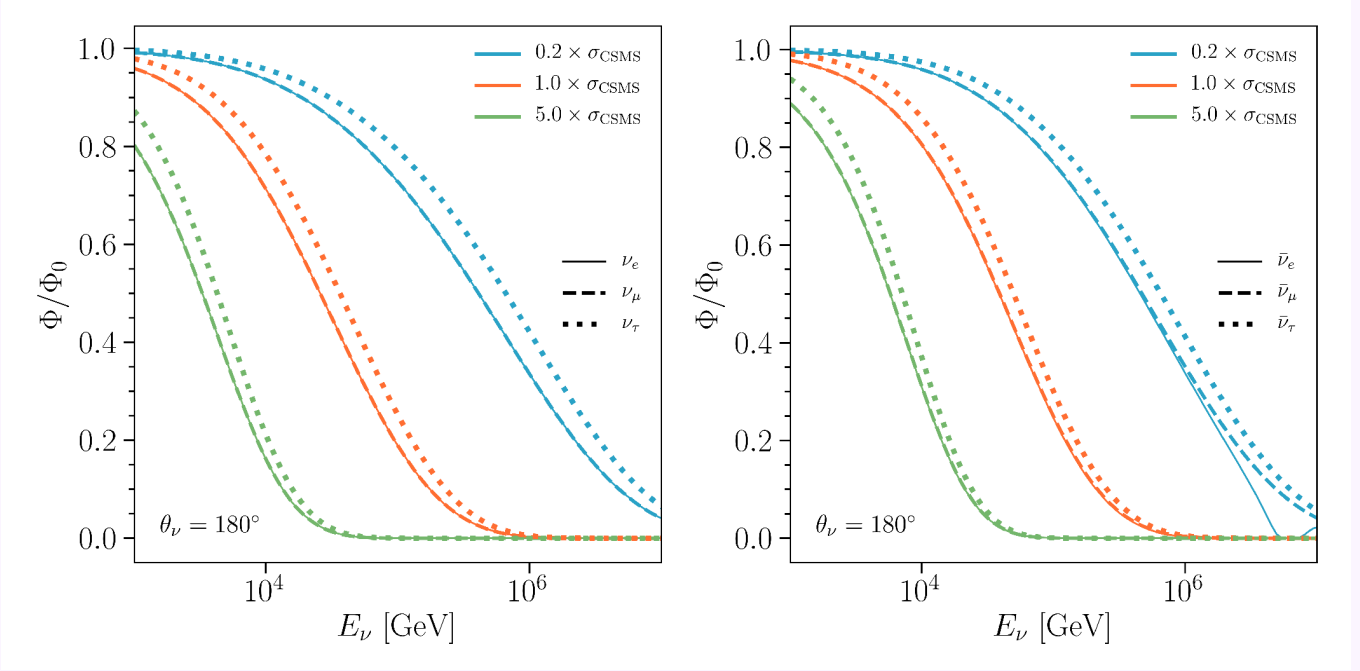


The expected electron-neutrino flux ratio. Note the core-mantle boundary and glashow resonance features.

Event selection

- High-Energy Starting Events (HESE). Events which interact within a fiducial region *across* a 4π solid angle
- NPE > 6000
- NPE < 3 in veto regions (surface of detector, and dusty ice region)
- Event classified according to topology, cascade-like, track-like, double cascade.

Comment: why the veto region around the dusty ice region?



Incoming/arrival flux ratio

- Large cross-section → suppression at lower E
- Tau regeneration
- Glashow resonnance

  These features help the flavor identification enhance the cross-section measurement!

Analysis

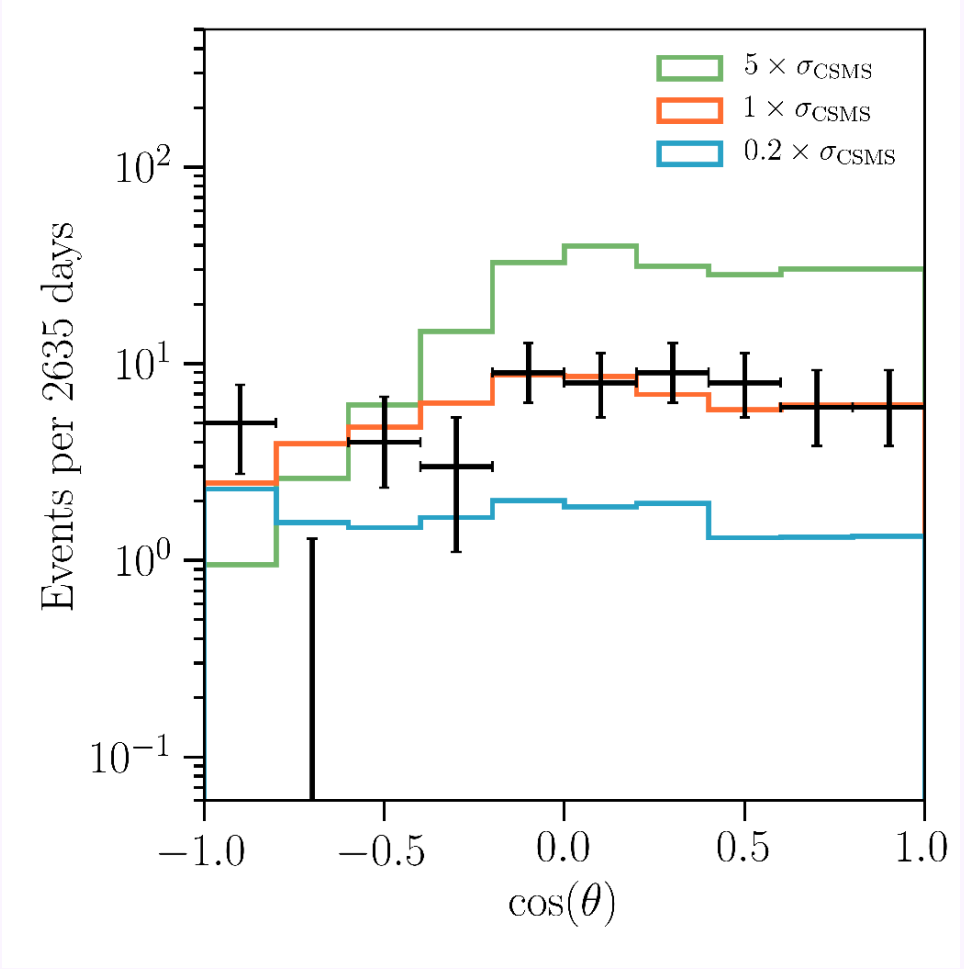
- Four energy bins are simultaneously fitted.
- CC-to-NC ratio fixed.
- Glashow resonance taken into account
- Earth propagator: nuSQuIDS
- Topologies correspond to flavors 57%, 73%, and 65% of the time for nu-e, nu-mu, nu-tau.

Systematic uncertainty estimation: found to have little effect on study.

Parameter	Constr./Prior	Range	Shape	Best fit
Astro. ν:				
Φ_{astro}	-	$[0, \infty)$	Uniform	6.94
γ_{astro}	2.0 ± 1.0	$(-\infty, \infty)$	Gaussian	3.15
Atmos. ν:				
Φ_{conv}	1.0 ± 0.4	$[0, \infty)$	Truncated	0.96
Φ_{prompt}	1.0 ± 3.0	$[0, \infty)$	Truncated	0.00
π/K	1.0 ± 0.1	$[0, \infty)$	Truncated	1.00
$2\nu/(\nu + \bar{\nu})_{atm}$	1.0 ± 0.1	$[0, 2]$	Truncated	1.00
Cosmic-ray:				
$\Delta\gamma_{CR}$	-0.05 ± 0.05	$(-\infty, \infty)$	Gaussian	-0.05
Φ_{μ}	1.0 ± 0.5	$[0, \infty)$	Truncated	1.22

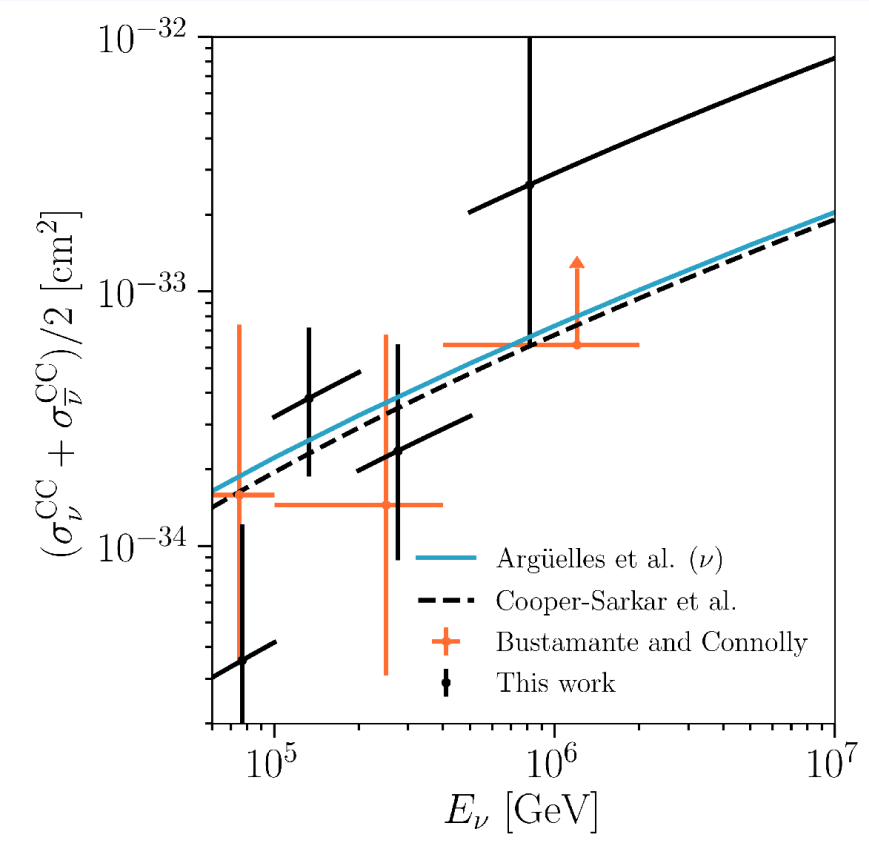
Comment: what is meant by "regularization"?
Comment: what is meant by "Poisson-like likelihood"?
Comment: seems like nuisance parameter fits failed most of the time?
Comment: best fit spectral index very soft!

Intermezzo:
North-sky (cos(θ) < 0) measurements break degeneracy between incoming flux and cross-section!

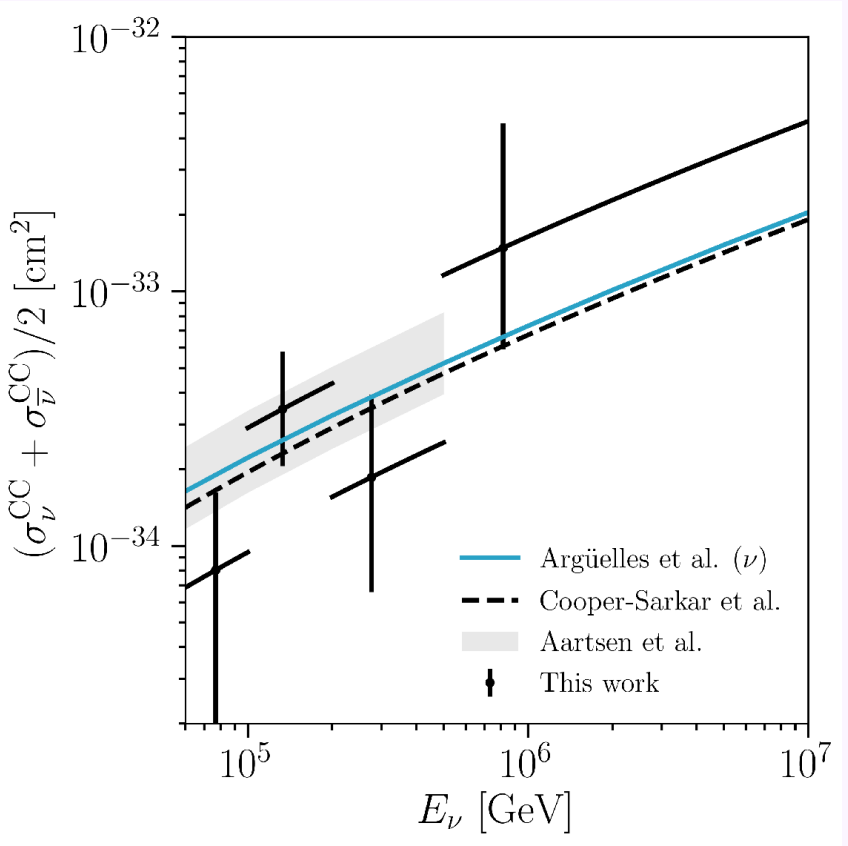


Best-fit yield expectations for various assumed cross-sections

Comment: 0.2 x CSMS does not look like a best fit…
Comment: The scaling does not seem linear to me in the low cross-section, first bin above horizon… Atmospheric effect?



Bayesian analysis



Frequentist analysis

Cross-section measurements are consistent with SM

Largest deviations found at the lowest and highest energies

Comment: it seems like the frequentist analysis is slightly less deviating. Coincidence?

More comments?