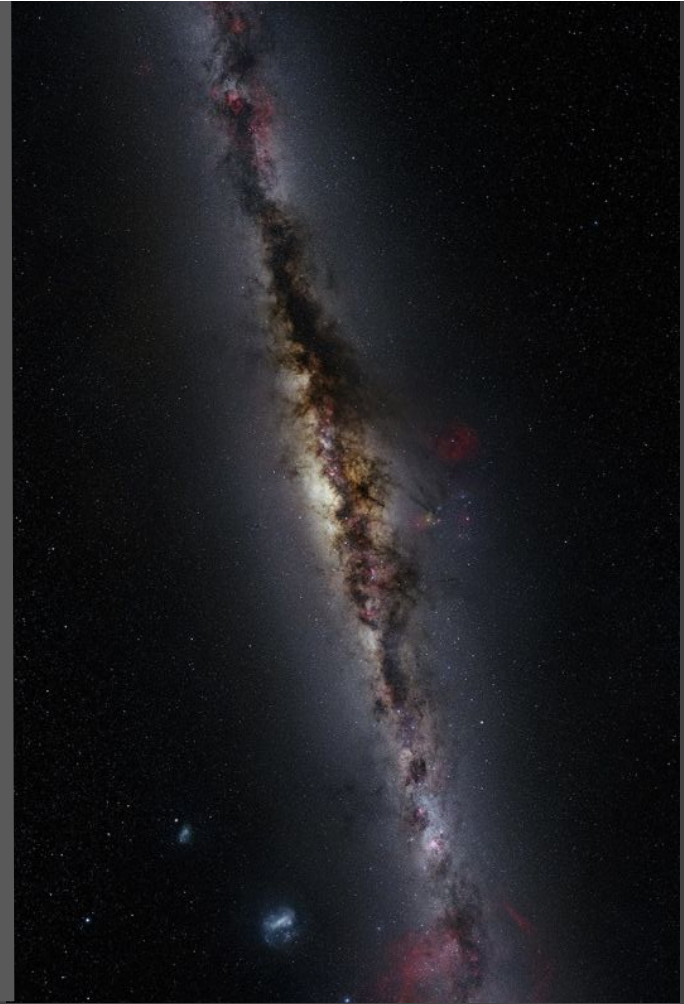




The Neutrino Floor for the Next Generation of Noble Liquid Dark Matter Detectors

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Pietro Giampa
and David Morrissey

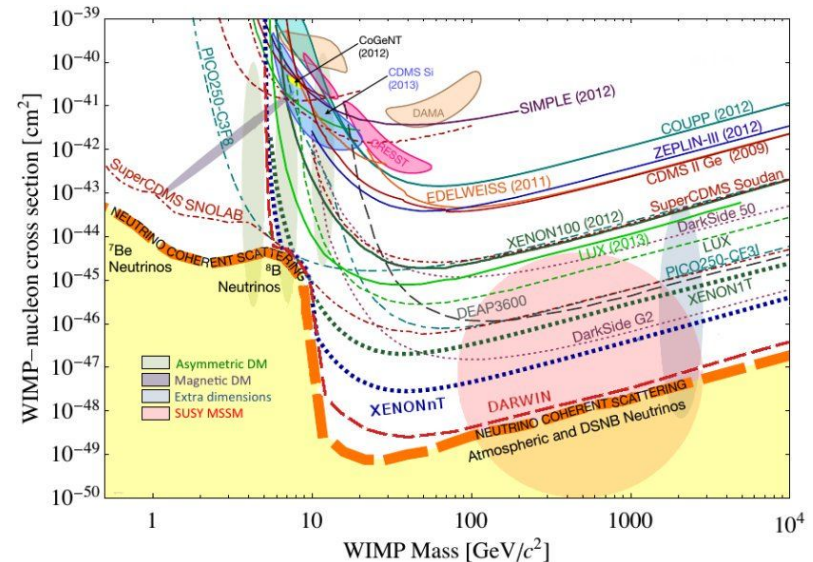
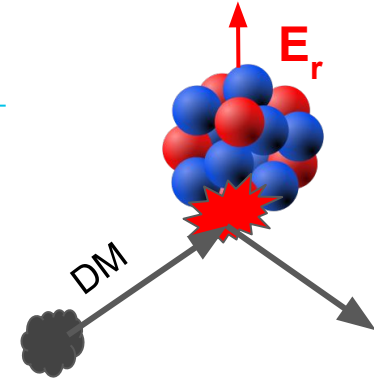


OUTLINE

- Demystifying the neutrino floor
- The next generation of noble liquid DM detectors
- A more realistic neutrino floor
- The impact of GAIA DR2

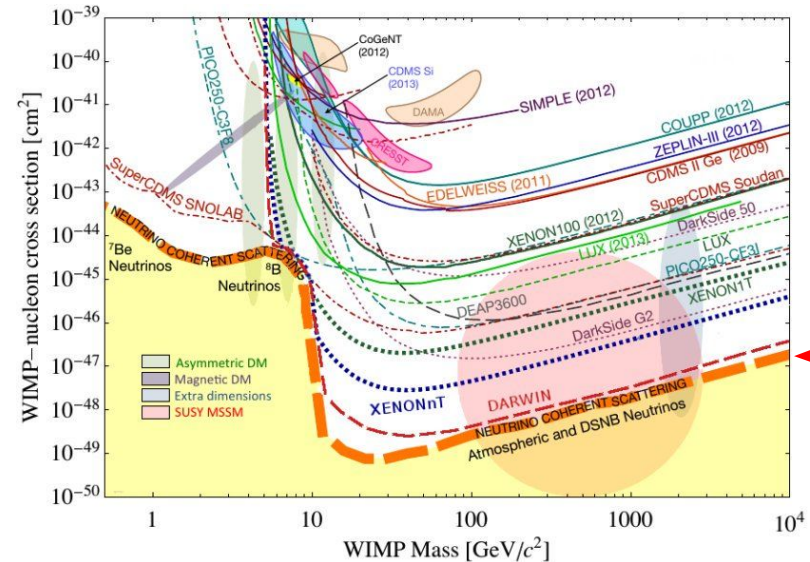
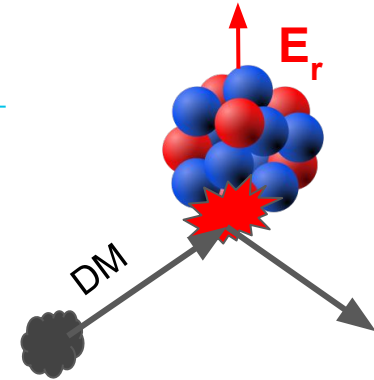
Demystifying the ν -floor

- Many experiments looking for scattering of a DM particle off of a nuclei on Earth
- Noble liquid detector technology has been leading the field
- As detectors becoming bigger and taking more data, also becoming sensitive to neutrinos!



Demystifying the ν -floor

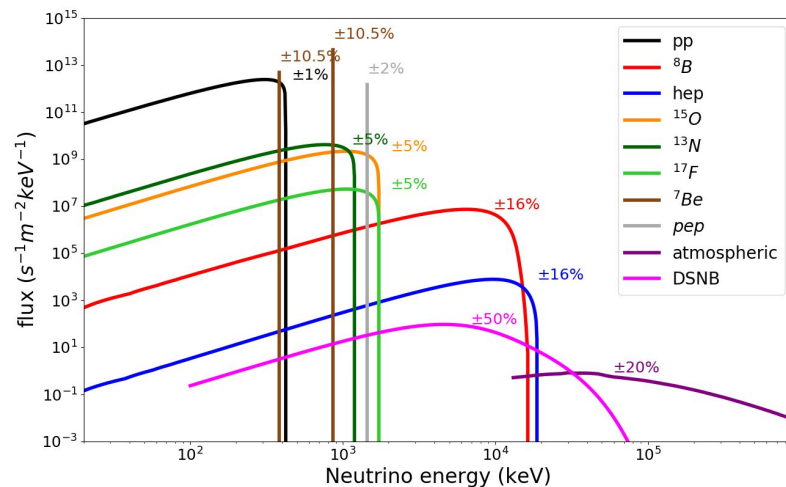
- Many experiments looking for scattering of a DM particle off of a nuclei on Earth
- Noble liquid detector technology has been leading the field
- As detectors becoming bigger and taking more data, also becoming sensitive to neutrinos!
- **Neutrino floor defined as a limit below which the neutrino events dominate over the dark matter signal in a detector**
- **Computed through a profile likelihood ratio test**



Demystifying the ν -floor

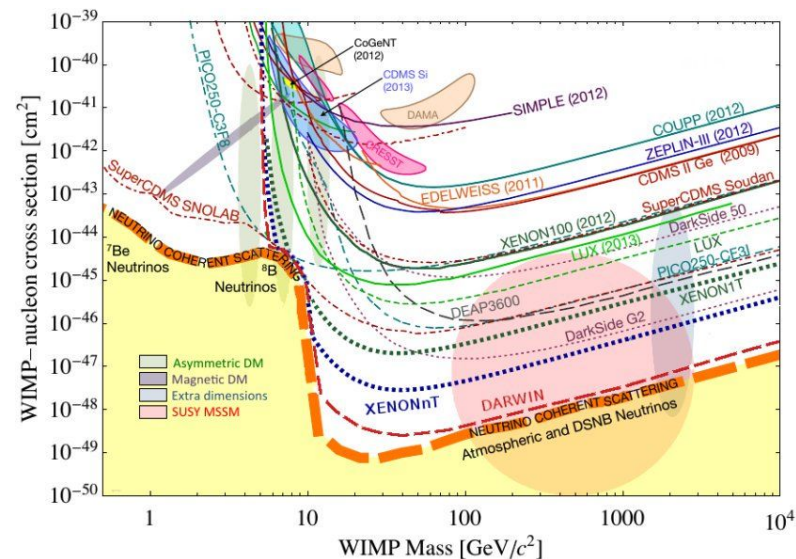
- Profile over different nuisance parameters and sources of uncertainties (neutrino fluxes, dark matter velocity and density distributions)

Param.	Canonical Value	Value Used (updated)
V_{esc} (km/s)	544 ± 70	528 ± 25
V_0 (km/s)	220 ± 30	233 ± 5
ρ_{DM} (GeV/cm^3)	0.3 ± 0.1	0.5 ± 0.2



Demystifying the ν -floor

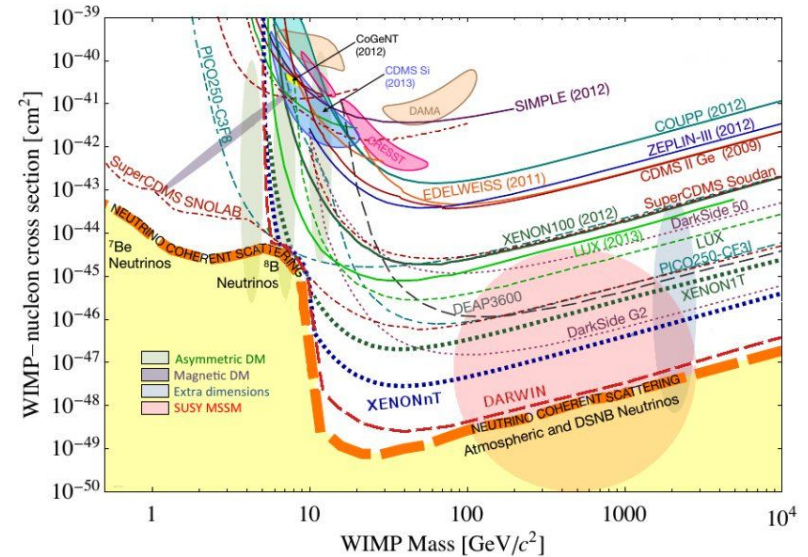
- Canonical neutrino floor computed for an ideal Xenon TPC with a 3 eV threshold
- Does not take neutrino-induced electron scattering into account



Demystifying the ν -floor

- Canonical neutrino floor computed for an ideal Xenon TPC with a 3 eV threshold
- Does not take neutrino-induced electron scattering into account

1. Compute accurate neutrino floors for realistic future noble liquid dark matter detectors
2. Evaluate how new information on the distribution of DM in our galaxy might affect predictions

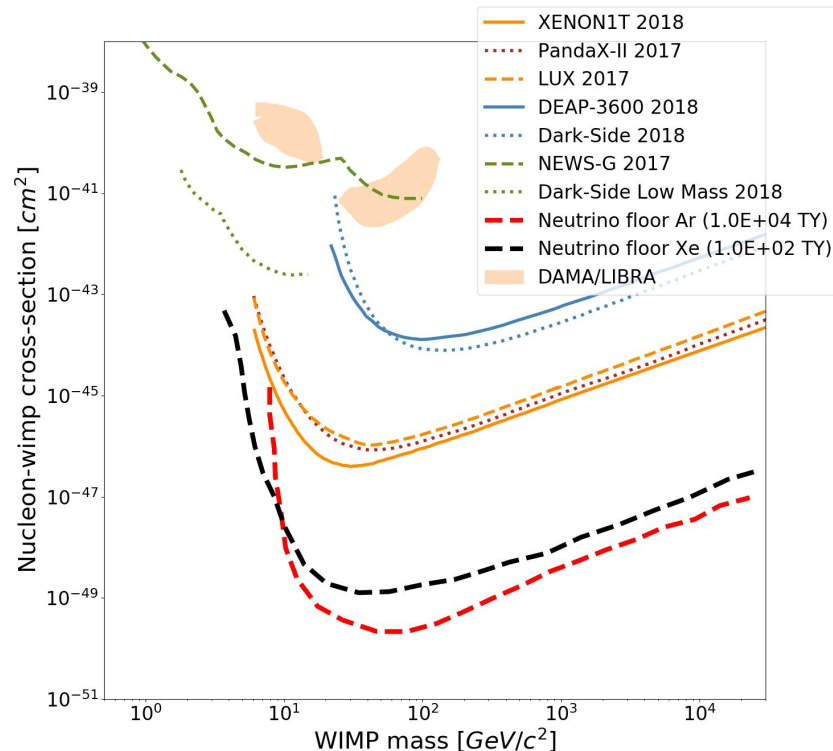


The Next Generation of Noble Liquid DM Detectors

- Focussed on the comparison between Argon single-phase and Xenon dual-phase detectors
- Included neutrino-induced electron recoils

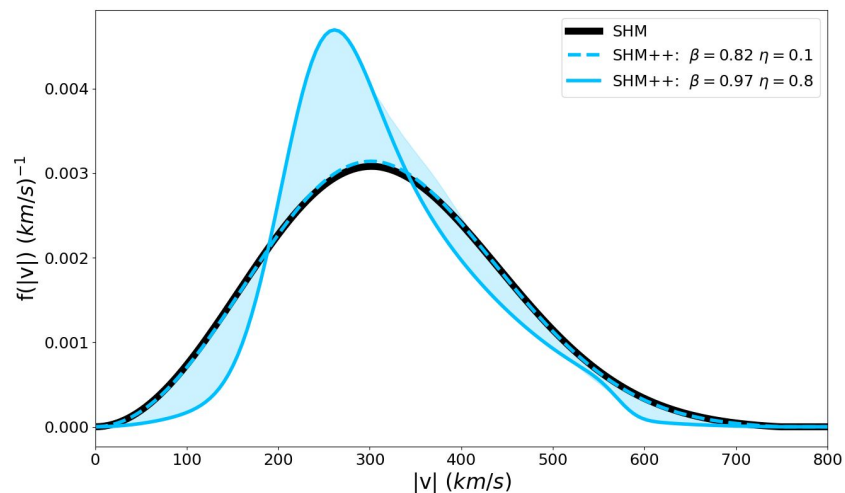
The Next Generation of Noble Liquid DM Detectors

- Focussed on the comparison between Argon single-phase and Xenon dual-phase detectors
- Included neutrino-induced electron recoils
- **Argon floor slightly lower for higher DM masses for these detector properties**
- **Mostly due to higher ER-rejection efficiency**



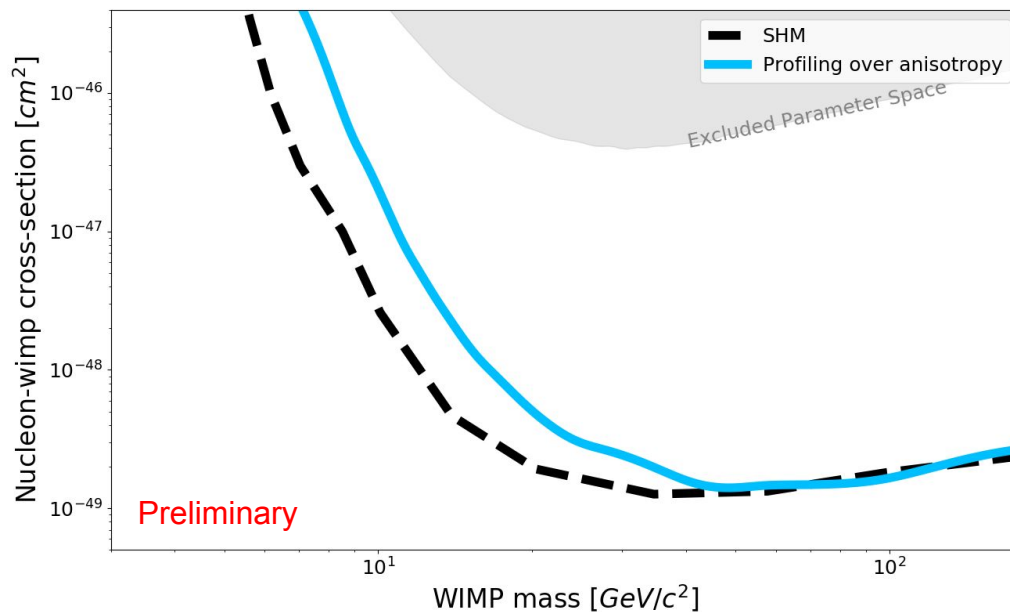
The impact of Gaia DR2

- Velocity distribution of stars in the MW bulk is significantly anisotropic
- Velocity Distribution of DM in Milky Way can be separated in two components:
 - Old pre-collision stars with SHM distribution
 - Newer stars from collision with anisotropic velocity distribution
- Two parameters:
 - fraction of dark matter in anisotropic “sausage” η
 - Anisotropy of “sausage” β



The impact of Gaia DR2

- We computed the neutrino floor while also profiling over values of η and β
- Mostly affects low DM-mass portion of the floor



$$0.8 < \beta < 0.98$$

$$0.1 < \eta < 0.8$$

Conclusions

- Argon-based detectors have a lower neutrino floor at higher WIMP masses, when including neutrino-induced electron recoils and considering detector properties.
- Although the potential anisotropy of the dark matter velocity distribution has only a small impact on the neutrino floor, this impact is most important for lower dark matter masses.
- The neutrino floor can still be pushed down:
 - Better measurements of the neutrino fluxes
 - directional DM detection
 -

Thank you!
Merci!
