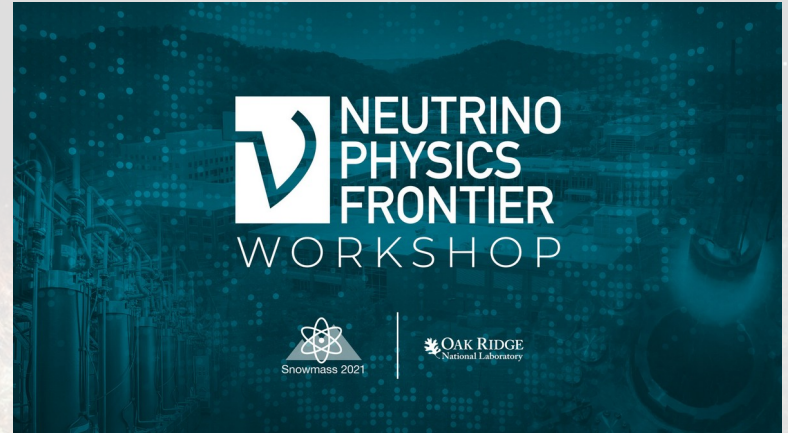


Connections: Cosmic Frontier

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Niels Bohr Institute, University of Copenhagen

Snowmass Neutrino Physics Frontier Workshop
March 16, 2022



UNIVERSITY OF
COPENHAGEN



VILLUM FONDEN



Cosmic Frontier: Topical groups

CF1. Dark matter: particle-like

CF2. Dark matter: wave-like

CF3. Dark matter: cosmic probes

CF4. Dark energy and cosmic acceleration:

The modern Universe

CF5. Dark energy and cosmic acceleration:

Cosmic dawn and before

CF6. Dark energy and cosmic acceleration:

Complementarity of probes and new facilities

CF7. Cosmic probes of fundamental physics

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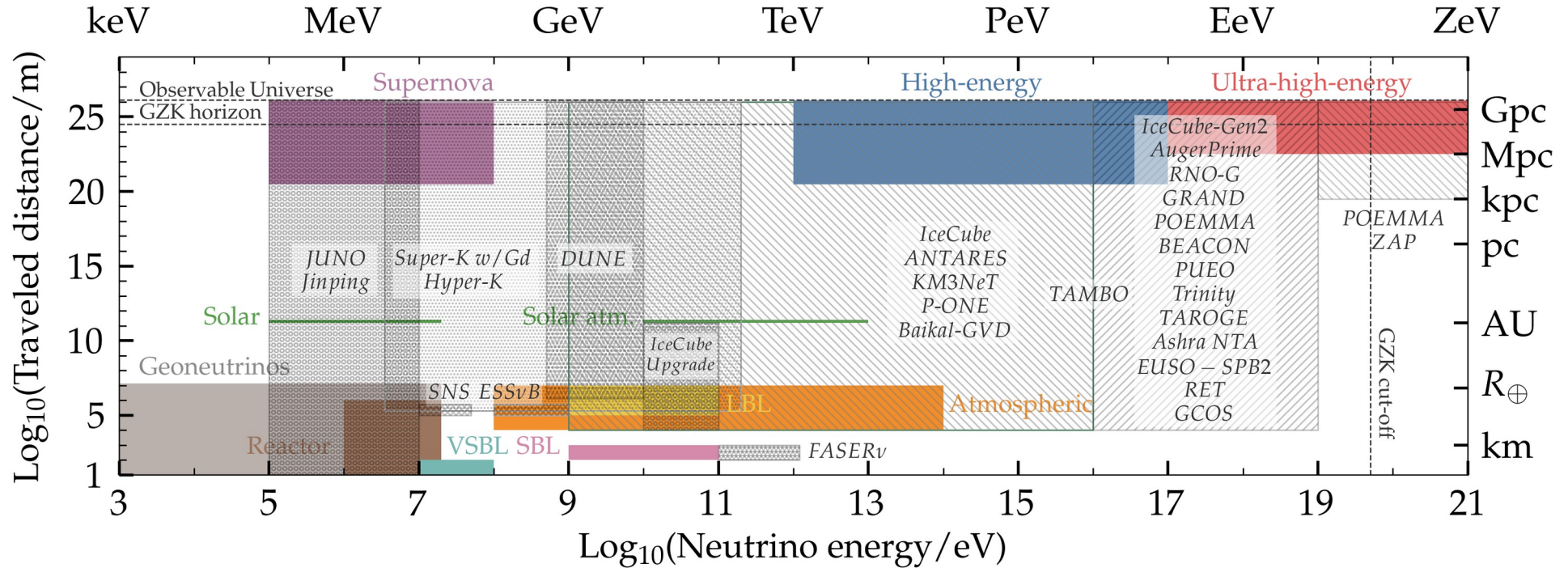
CF7. Cosmic probes of fundamental physics

Messages from the CF to the NF

1. Synergy between low-energy and high-energy ν experiments

High-Energy and Ultra-High-Energy Neutrinos WP, 2203.08096

Synergy between cosmological and laboratory searches in neutrino physics: a white paper, 2203.07377

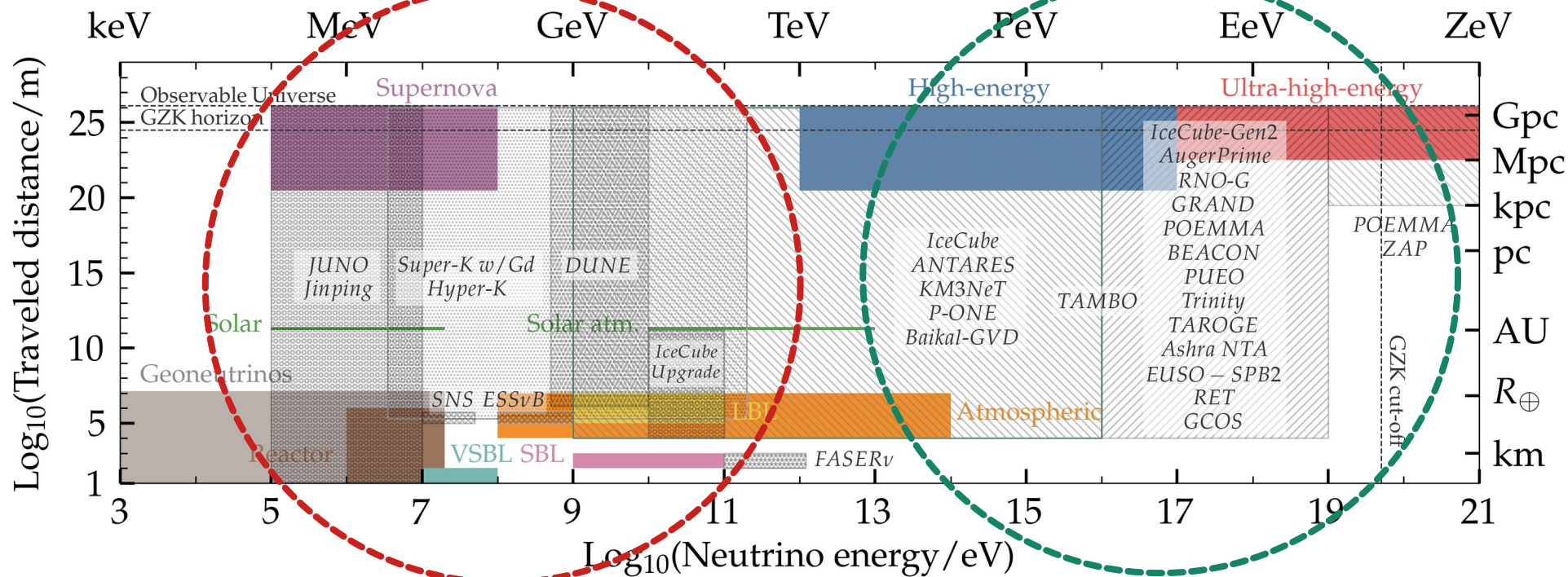


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What is measured here ...

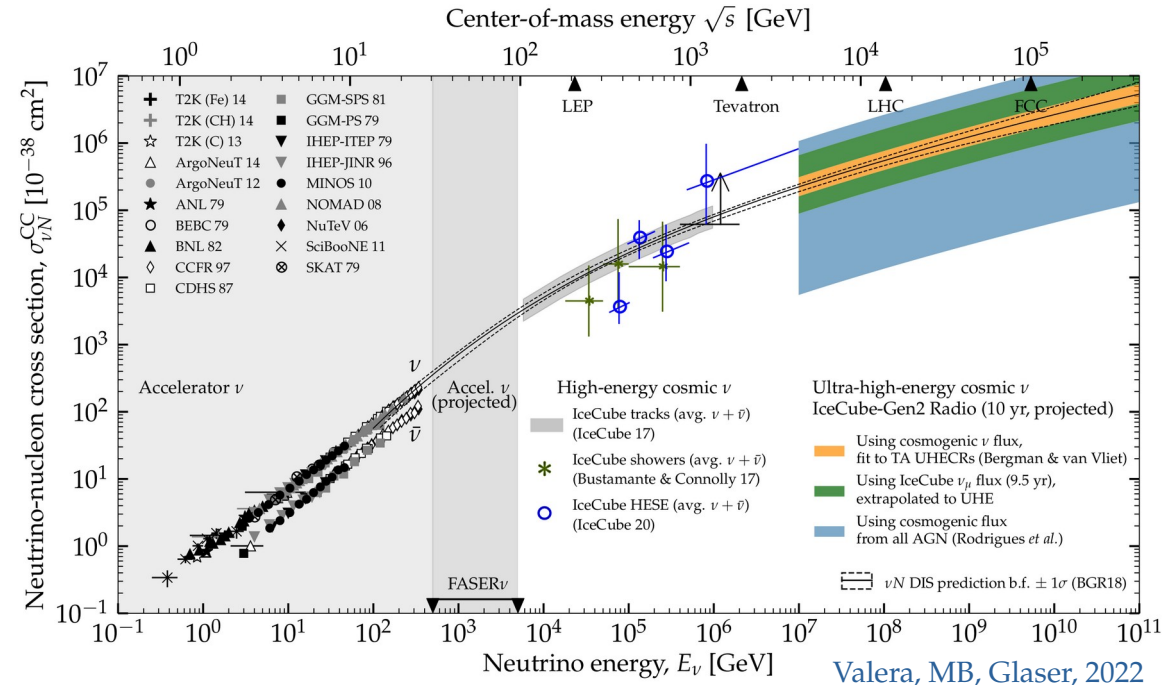
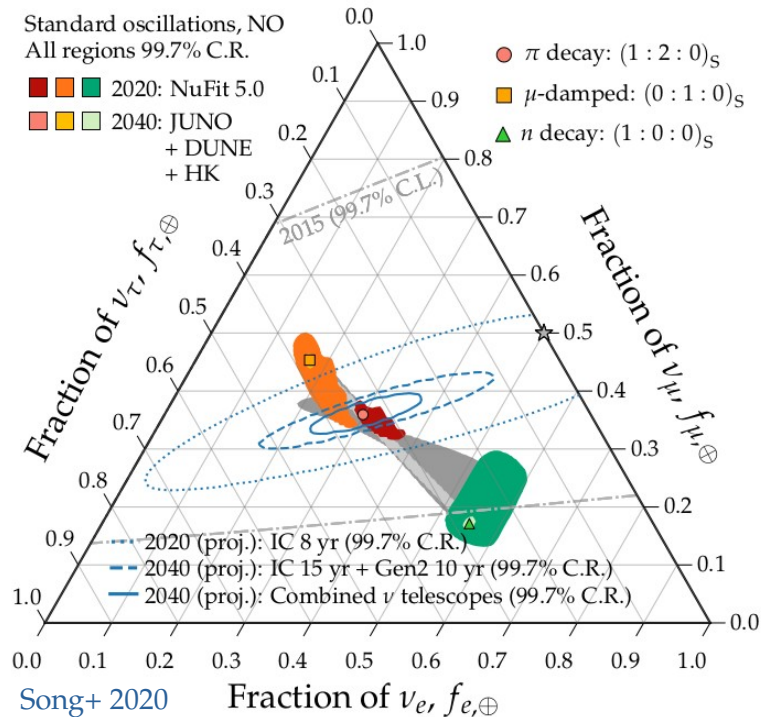
... informs searches here

Messages from the CF to the NF

Two examples:

Predicting flavor composition of the high-energy cosmic ν flux needs precise mixing parameters

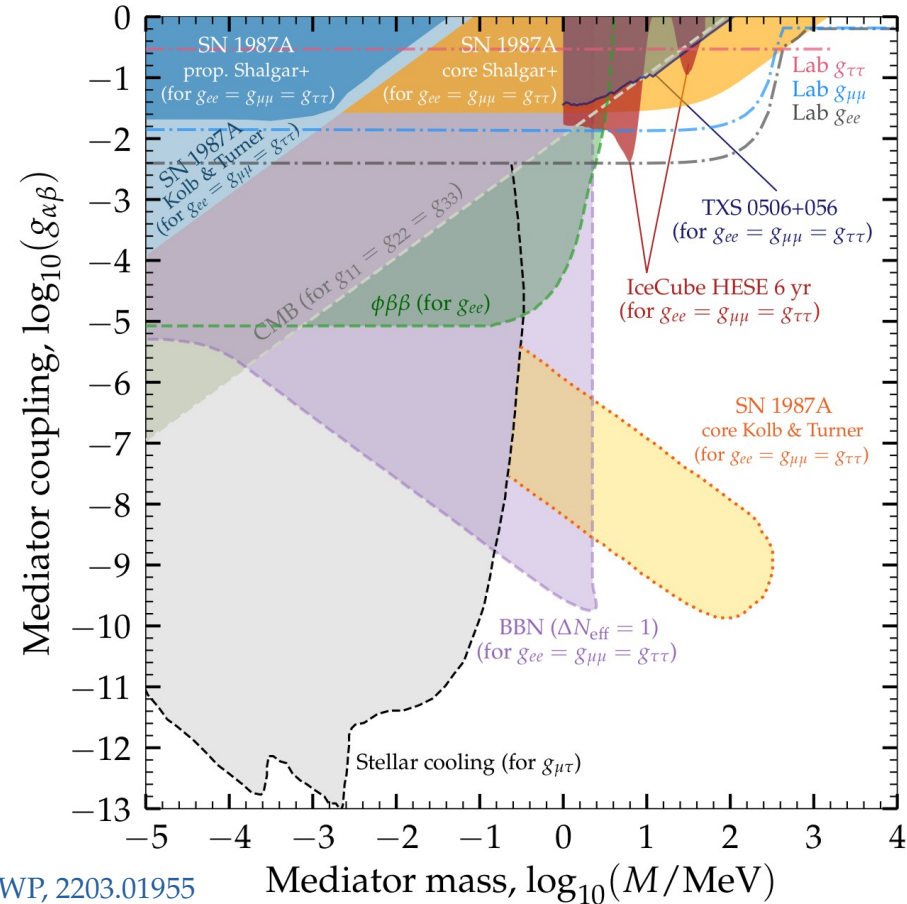
Neutrino-nucleon deep-inelastic-scattering cross section determines high-energy ν absorption in Earth



Messages from the CF to the NF

2. Astrophysical tests complement, extend laboratory / accelerator tests

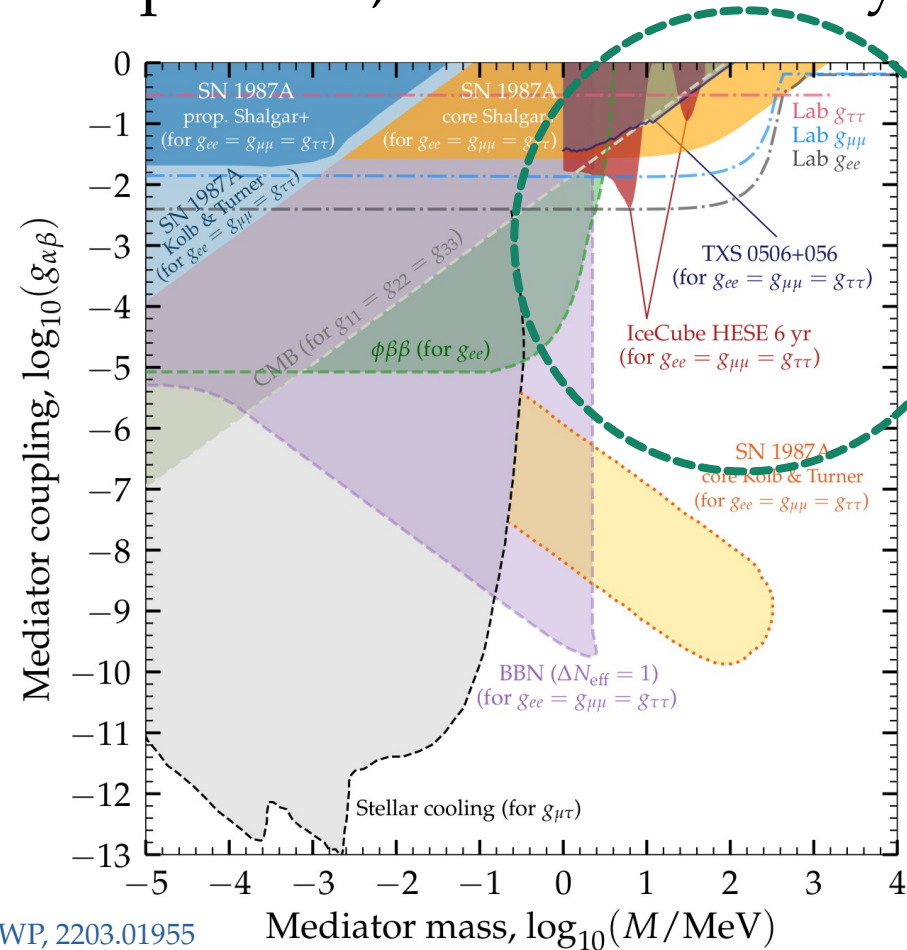
Example:
 ν self-interactions



Messages from the CF to the NF

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Example:
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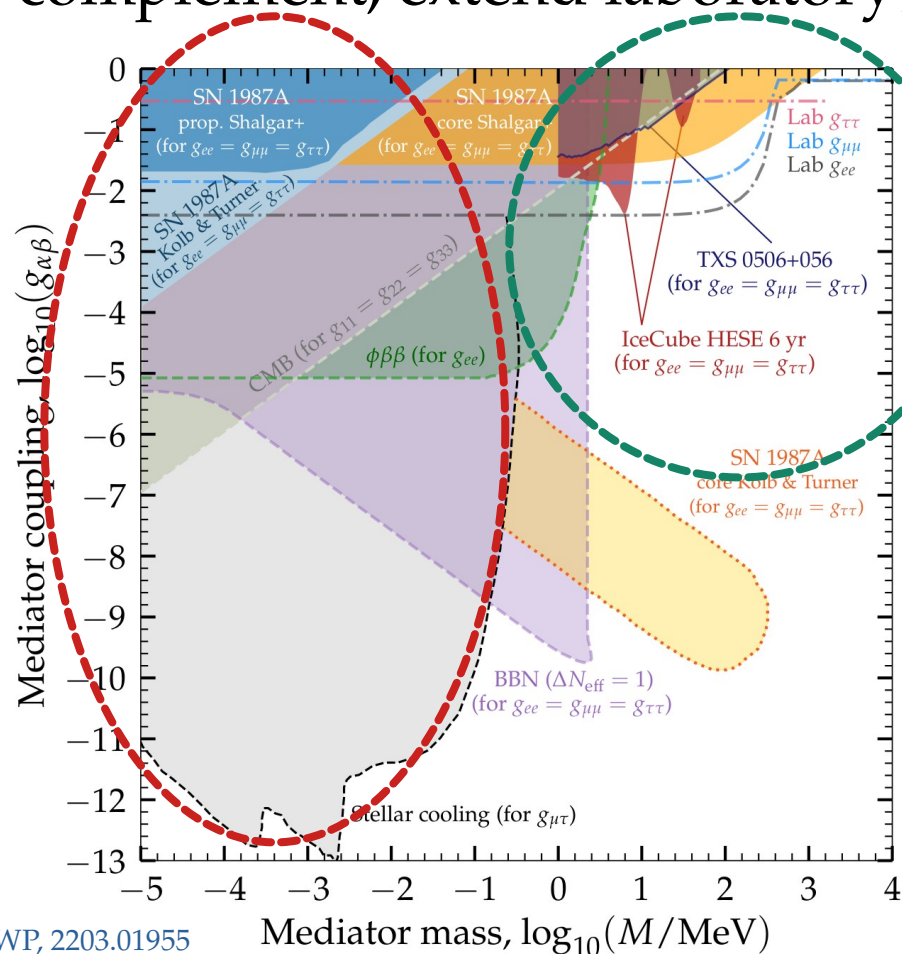
Higher ν energies,
long baselines test
larger new
mediator masses

Messages from the CF to the NF

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Example:
 ν self-interactions

High ν densities
(e.g., SNe)
test small couplings



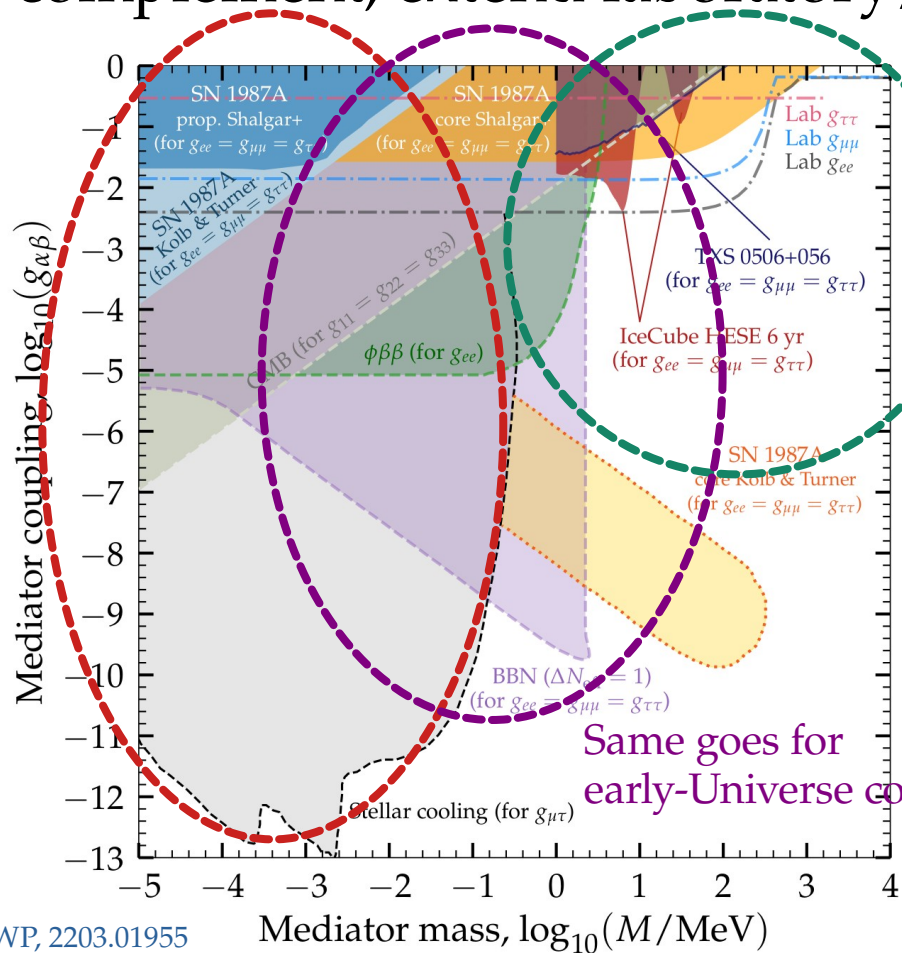
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Same goes for early-Universe constraints

Messages from the CF to the NF

3. Many new opportunities in cosmic tau neutrinos
 - It's the least-known flavor, so there is more open space to explore
 - Many UHE ν telescopes are only or mainly sensitive to them

Tau Neutrinos in the Next Decade: from GeV to EeV WP, 2203.05591

4. At high energies (TeV–PeV), we finally have data to test against
E.g., non-unitarity, BSM oscillations, decay, connections to DM, etc.

High-Energy and Ultra-High-Energy Neutrinos WP, 2203.08096

Dark Matter in Extreme Astrophysical Environments WP, 2203.07984

Snowmass2021 Cosmic Frontier White Paper: Puzzling Excesses in Dark Matter Searches and How to Resolve Them, 2203.06589

5. Instruments:

- TeV–PeV: Several upgrades & new detectors being built *now*
- EeV: New detector technologies being explored;
realistic chances of discovery in 10–20 years

High-Energy and Ultra-High-Energy Neutrinos WP, 2203.08096

Food for thought / From the CF to NF

At high energies, how do we do better and move forward:

- Higher statistics, higher energies → In progress
- Move beyond low-hanging fruit
- For **particle-physics** searches, bring in the **astrophysical** nuisances
- For **astrophysics** searches, bring in the **particle-physics** nuisances
- Lots of open theory parameter space: machine learning?

What would the NF like from the CF?

Questions and suggestions are welcome!