

**TeVPA 2024, Summary Talk**  
**Gianfranco Bertone, GRAPPA - U. of Amsterdam**

# TevPA 2024

- 25 plenary talks
- 275 talks in parallel sessions
- $\mathcal{O}(10^4)$  slides
- 80 hours of presentations
- +15 hours of coffee/food/drinks
- ...cannot do justice to wonderful science discussed in these 5 days
- Apologies to this morning's speakers





# How it started..

## TeV Particle Astrophysics

Fermilab, Batavia, Illinois

July 13-15, 2005

### Organizing Committee

John Beacom Ohio State U.  
Gianfranco Bertone FNAL (chair)  
Elliott Bloom SLAC  
Marcela Carena FNAL  
Scott Dodelson FNAL  
Chris Hill FNAL  
Dan Hooper Oxford U.  
Rocky Kolb FNAL  
Olga Mena FNAL  
Angela Olinto U. of Chicago



Image courtesy of NASA



Image courtesy of A. Ashera

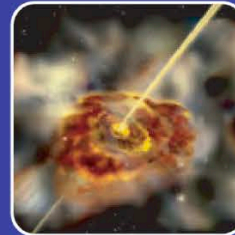


Image courtesy of NASA

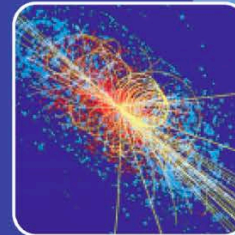


Image courtesy of CERN



Image courtesy of ANTARES

### TOPICS TeV Gamma-Rays Experiments

Air Cherenkov Telescopes  
HESS, CANGAROO,  
VERITAS  
Prospects for GLAST

### Dark Matter Detection

Update on Indirect detection  
Dark Matter Dynamics  
Profiles and Substructures  
Direct Detection

### Astrophysics & Cosmology

TeV Gamma-ray sources (BHs,  
AGNs, SNRs)  
The Galactic center  
Gamma-Rays from Clusters  
Gamma-Rays from Intergalactic  
Shocks

### Dark Matter Theory

SUSY candidates  
Extra-dimensions candidates  
TeV Particle Physics  
Accelerator searches

### Neutrinos

Astrophysical Sources  
High Energy Neutrino Experi-  
ments (Antares, Icecube)  
Constraints on Ultra-High  
Energy Neutrinos

# How it started..

## Fermilab Today

**TeV Particle Astrophysics Conference** The TeV Particle Astrophysics Conference will take place at Fermilab on July 13 through July 15. Registration is free.

[more information](#)

**Scottish Country Dancing** Scottish Country Dancing will meet Tuesday, July 12, in Ramsey Auditorium in Wilson Hall. Instruction begins at 7:30 p.m. and newcomers are always welcome. Most dances are fully taught and walked through, and you do not need to come with a partner. Dancing will continue in the auditorium through the summer. Info at 630-840-8194 or 630-584-0825 or [folkdance@fnal.gov](mailto:folkdance@fnal.gov).

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Fermilab, Batavia, Illinois

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INTERNET ARCHIVE  
**WayBackMachine**

### Detection

Direct detection  
Dynamics  
Structures

### Astrophysics & Cosmology

TeV Gamma-ray sources (BHs, AGNs, SNRs)  
The Galactic center  
Gamma-Rays from Clusters  
Gamma-Rays from Intergalactic Shocks

### Dark Matter Theory

SUSY candidates  
Extra-dimensions candidates  
TeV Particle Physics  
Accelerator searches

### Neutrinos

Astrophysical Sources  
High Energy Neutrino Experiments (Antares, IceCube)  
Constraints on Ultra-High Energy Neutrinos

# What hasn't changed





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- No clear answer yet to some big questions:
  - Nature of Dark Matter
  - Origin of CRs
  - Physics beyond the SM
  - ...

# What hasn't changed

- No clear answer yet to some big questions:
  - Nature of Dark Matter
  - Origin of CRs
  - Physics beyond the SM
  - ...
- Our unwavering trust that our problems can be solved with a bigger experiment!





# Progress in UHECRs

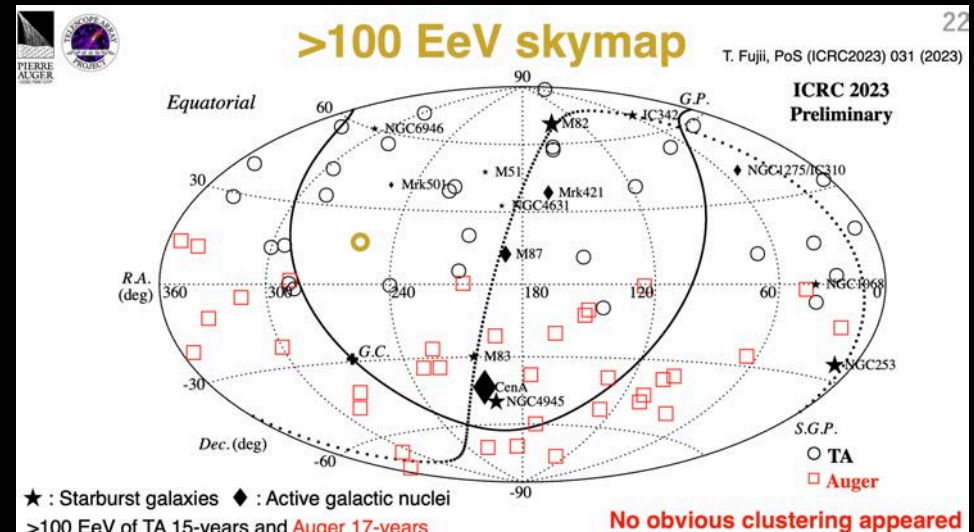
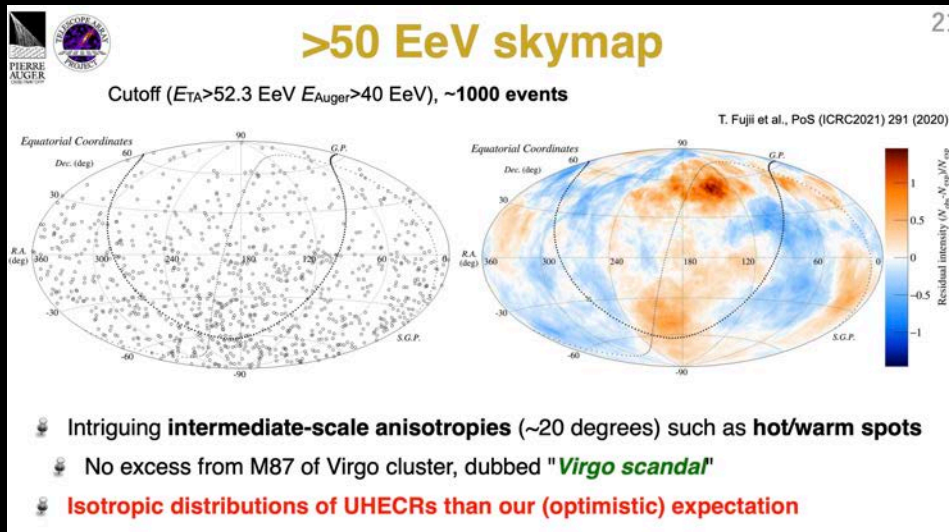
TeVPA 2005:

4pm *Joint Theoretical-Experimental Seminar, 1 West*  
**A. Chou (FNAL)**  
*First scientific Results of the Pierre Auger Observatory*

TeVPA 2024:

Toshihiro Fujii

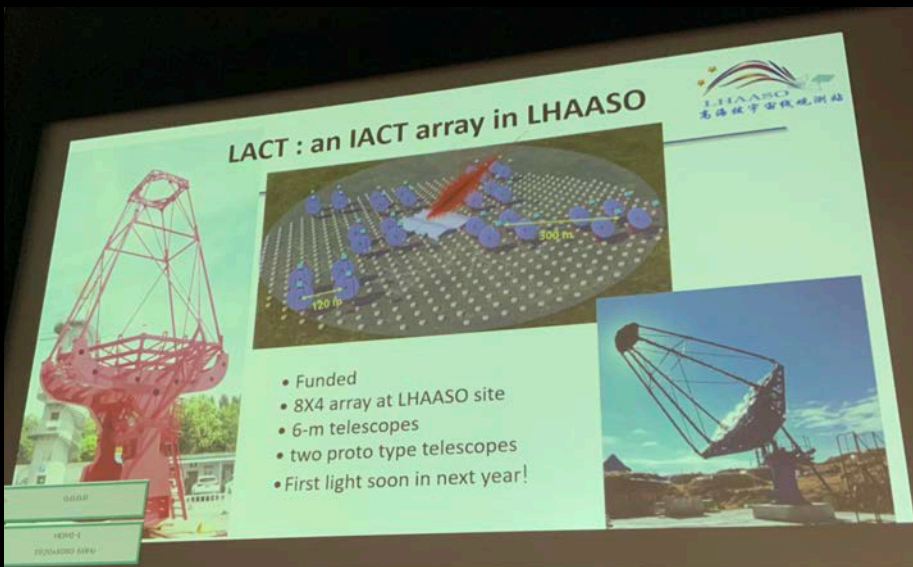
Toshihiro Fujii



# Progress in Gamma-ray Astronomy

- **LHAASO [Zhen Cao]:**

- > 100 TeV sources enable direct study of PeVatrons
- > PeV emission from stellar cluster Cygnus OB2 hints at super-PeVatron
- Coming soon: IACT array in LHAASO



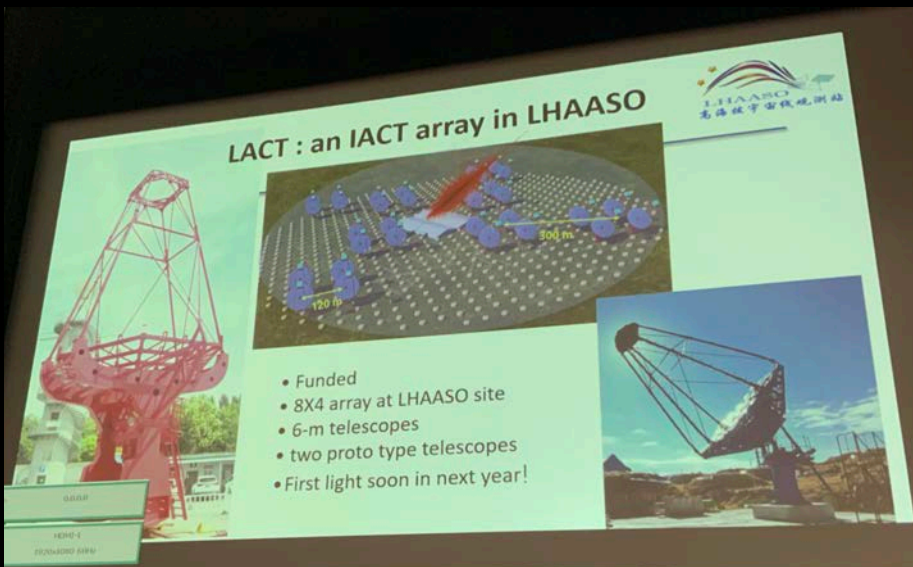
Zhen Cao



# Progress in Gamma-ray Astronomy

## • LHAASO [Zhen Cao]:

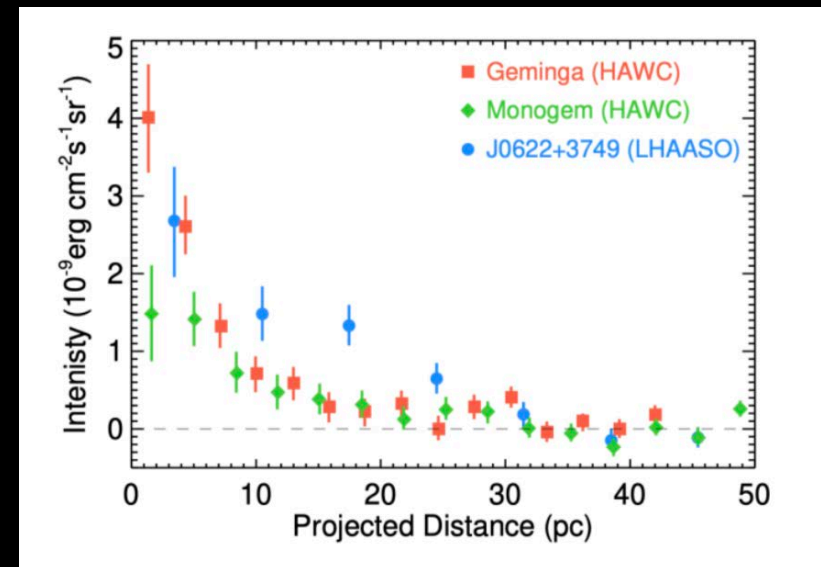
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Zhen Cao

## • TeV Halos [Carmelo Evoli]:

- What is the origin of the confinement?
- What implications for diffuse emission?
- For the positron and electron flux?

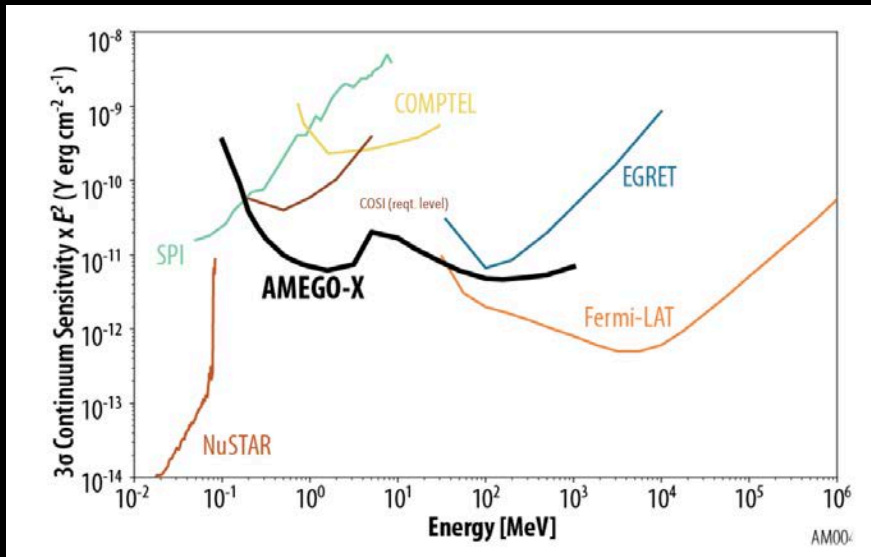


Carmelo Evoli

# Progress in Gamma-ray Astronomy

- @ NASA

- FIG SAG roadmap 
- Growing interest in MeV - GeV mission



Regina Caputo



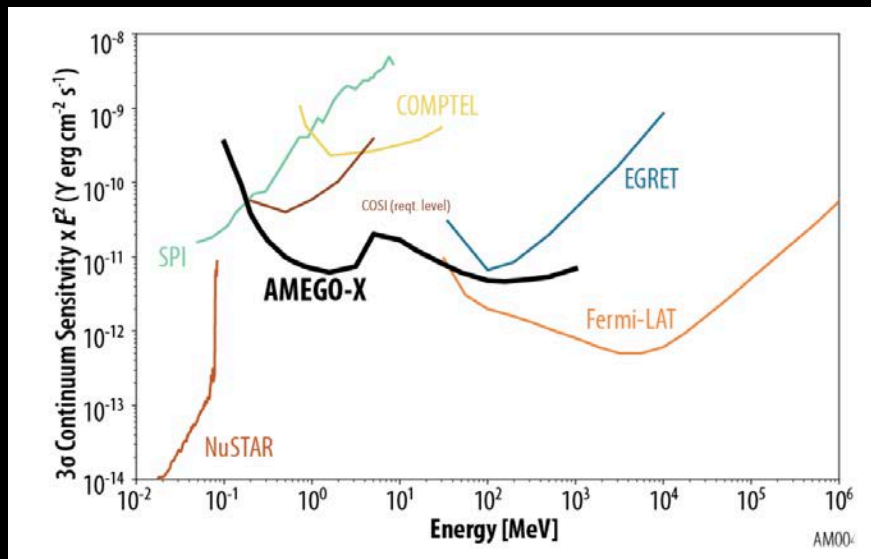
# Progress in Gamma-ray Astronomy

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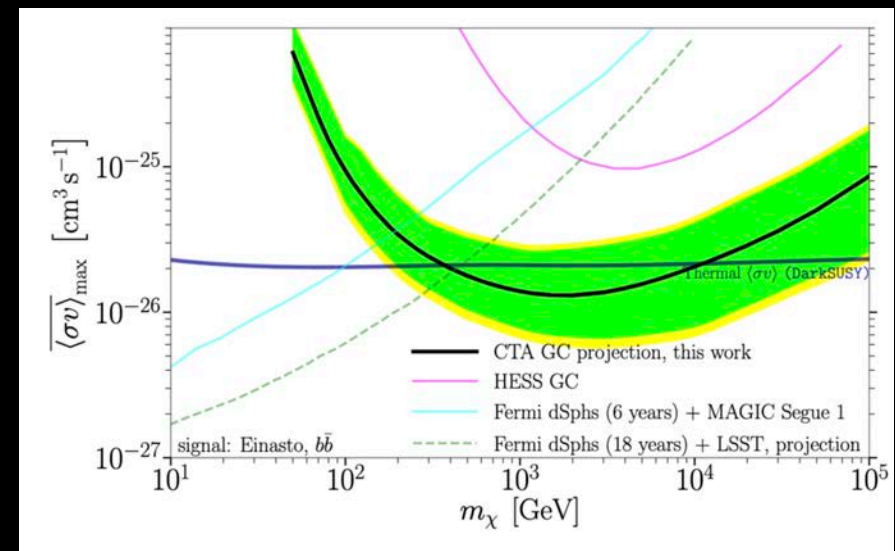
- FIG SAG roadmap 
- Growing interest in MeV - GeV mission

- > TeV

- CTA is happening!
- Astro: PeVatrons, Transients sources, AGNs, ...
- DM: testing WIMP paradigm



Regina Caputo

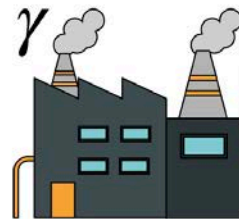


Manuel Meyer

# Neutrinos

- (Surprising) Facts about neutrino sources

- They exist!
- There are a lot of them
- They could be gamma-ray-opaque
- Some of them are Galactic
- Extragalactic sources are more powerful



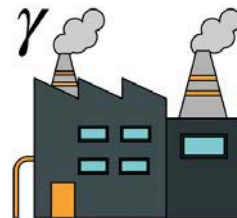
Ke Fang



# Neutrinos

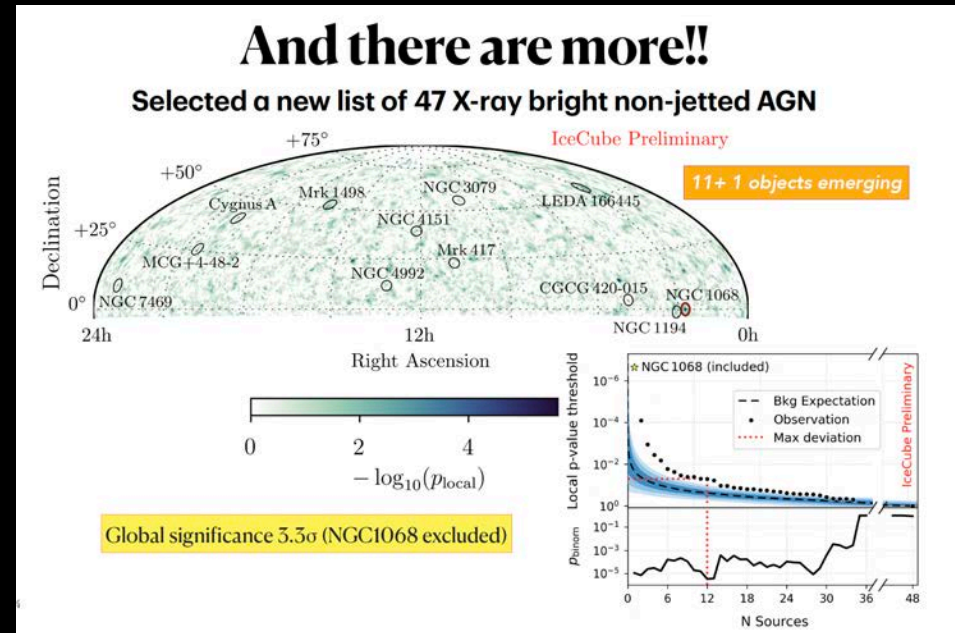
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Ke Fang

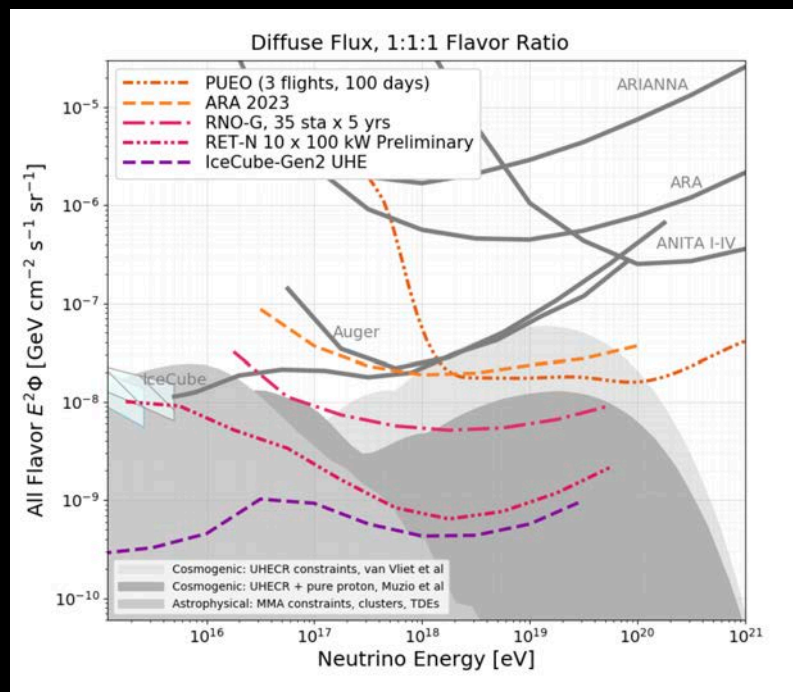
- Population of non-jetted AGNs at  $3.3\sigma$



Elisa Resconi

# Neutrinos

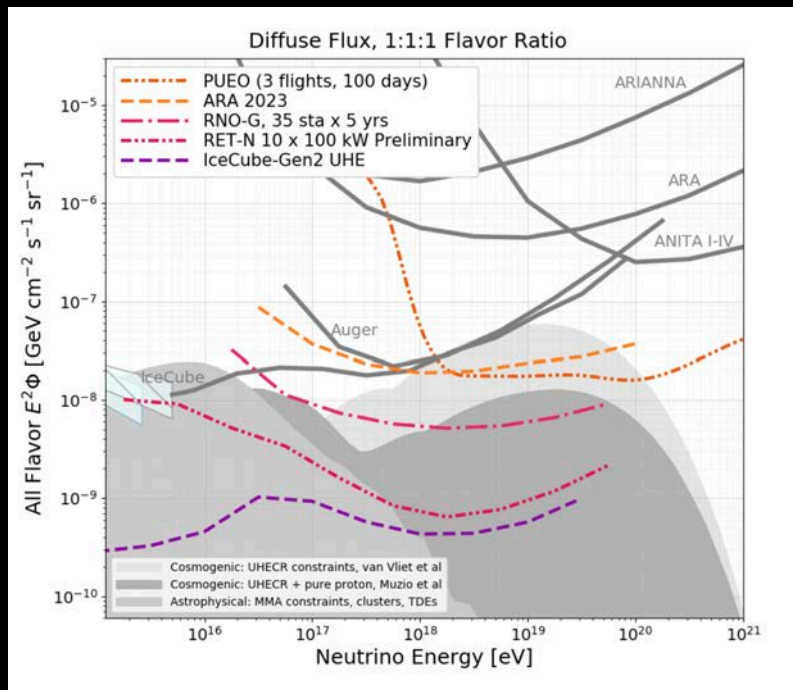
- Lots of ideas on how to reach  $\mathcal{O}(100)$  TeV to detect cosmogenic flux (ice, mountains, ...)



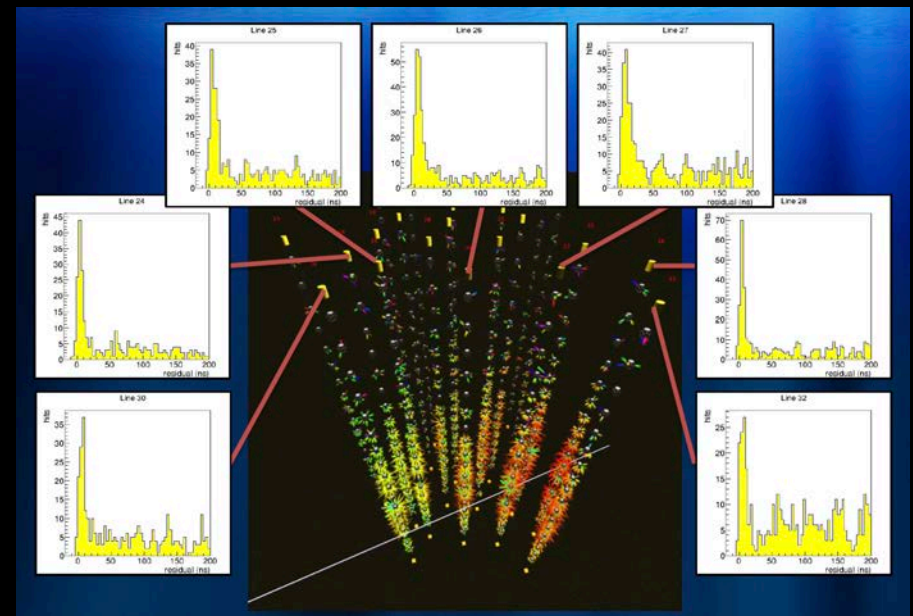
Brian Clark

# Neutrinos

- Lots of ideas on how to reach  $\mathcal{O}(100)$  TeV to detect cosmogenic flux (ice, mountains, ...)
- Km3Net (in construction) measured the first UHE neutrino!
- $>10$  PeV muon crossing ARCA21



Brian Clark

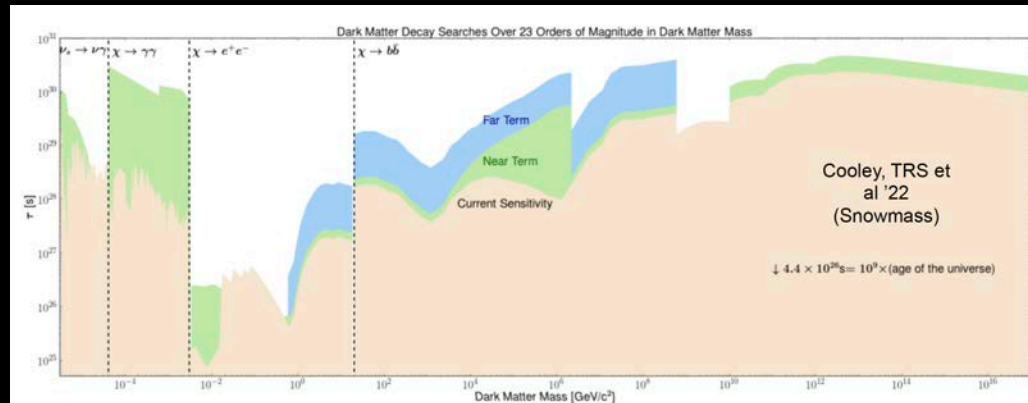


Marco Circella



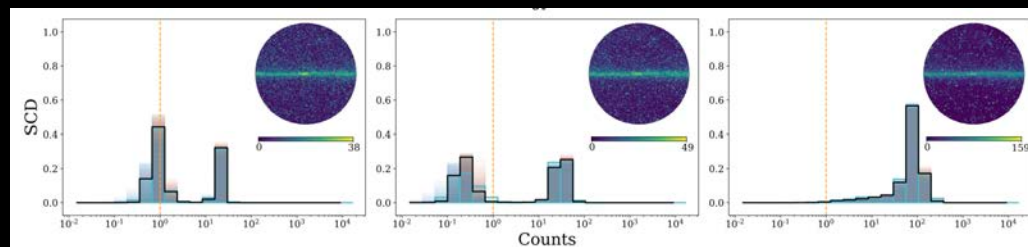
# Dark Matter indirect detection

- DM decay and annihilation rates constrained by  $\gamma$ -rays, neutrinos, anti-matter, 21cm etc.



Tracy Slatyer

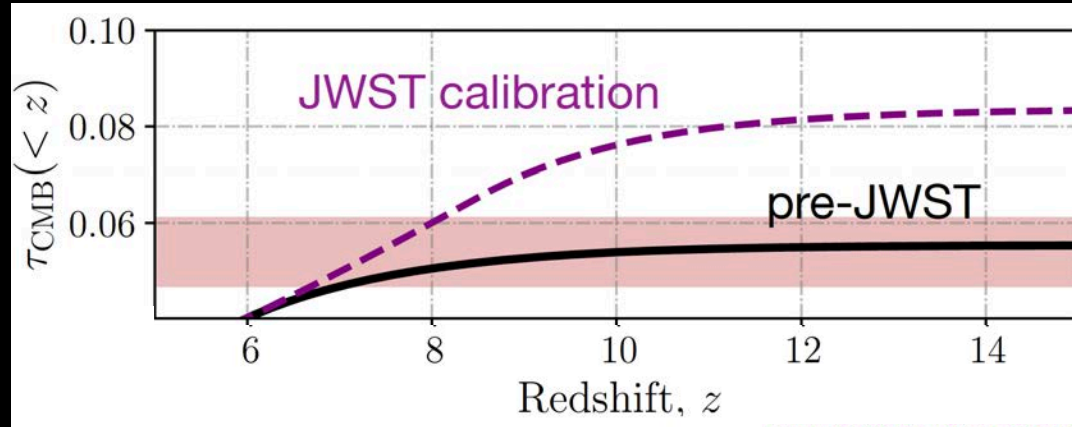
- A ML framework for jointly extracting spectra and source-count distributions



Nicholas Rodd

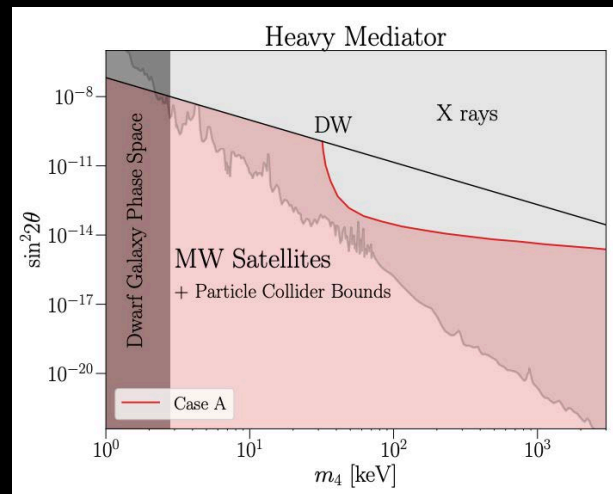
# Cosmological Probes

- JWST galaxies imply excess of ionizing photons, in tension with CMB and Ly $\alpha$



Julian Munoz (see also Philip Bull's talk on measuring the cosmological 21cm signal)

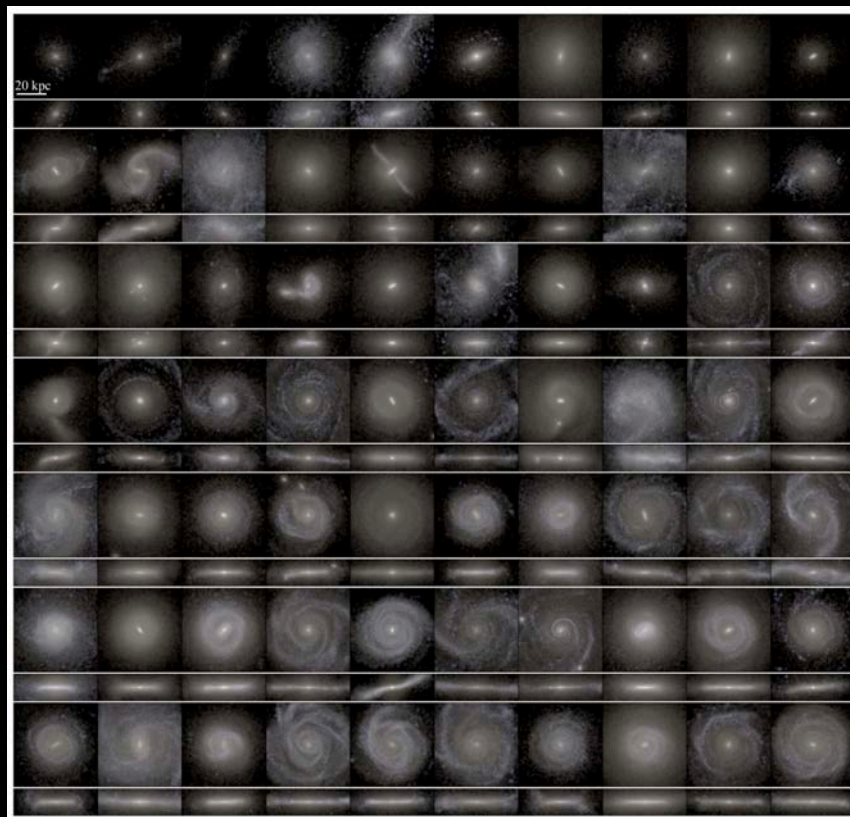
- MW satellite galaxy population combined with collider bounds rules out heavy mediators



Vera Gluscevic

# Dark Matter Simulations

- [Annika Peter]: 6 parts process “from Lagrangian to Likelihood and viceversa”
- [Mariangela Lisanti]: hydro simulations varying over astro and particle physics uncertainties



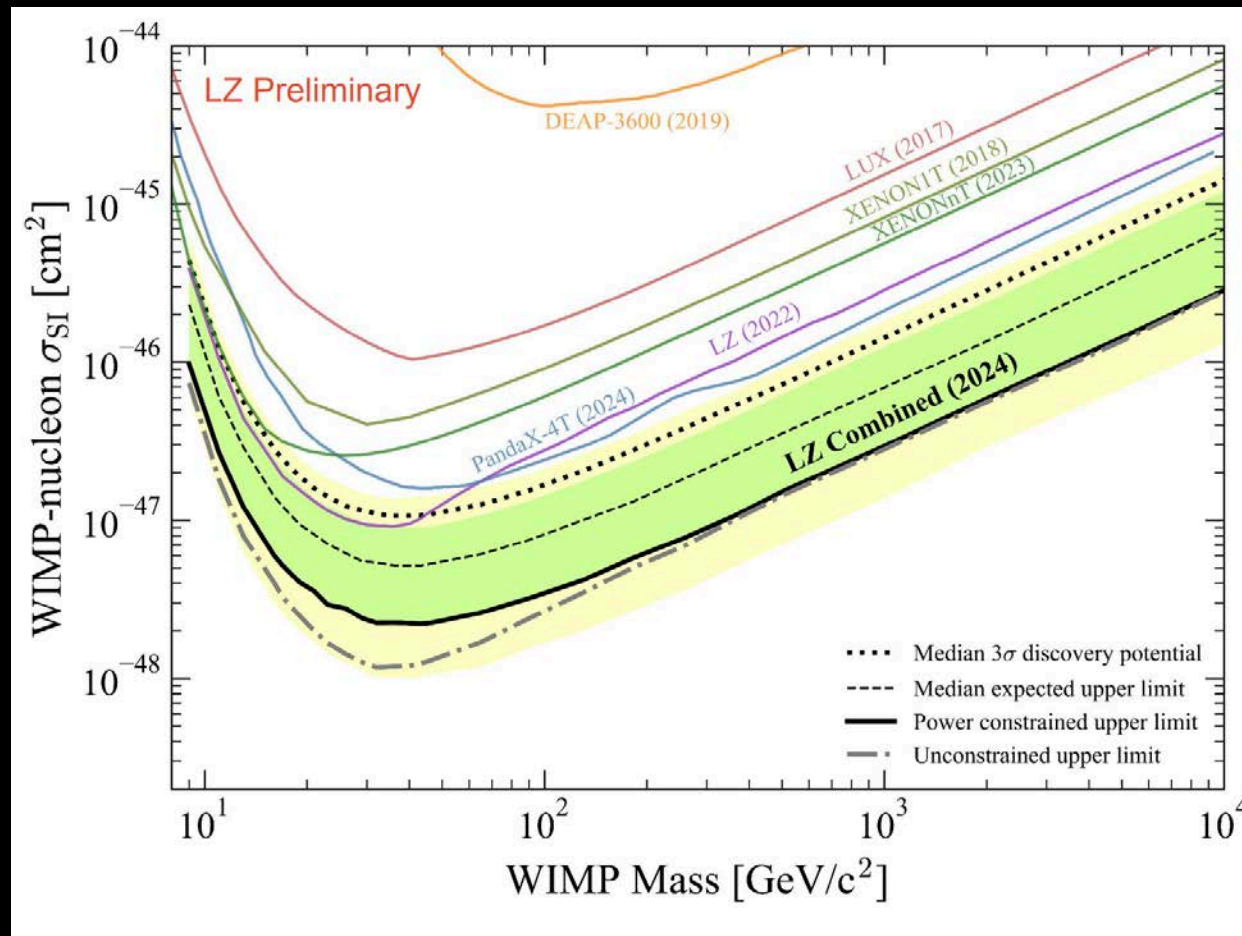
Dreams Project



# Dark Matter direct detection

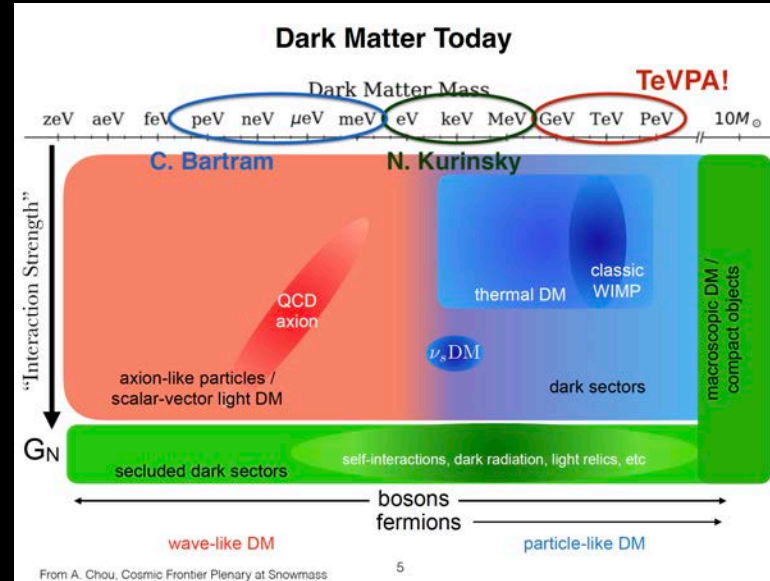
New Dark Matter Search Results from the LUX-ZEPLIN (LZ) Experiment

Combined min cross section:  $\sigma_{SI} = 2.2 \times 10^{-48} \text{ cm}^2 @ 43 \text{ GeV}/c^2$

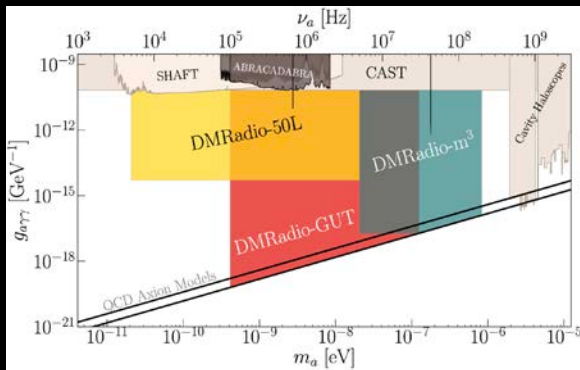


Scott Haselschwardt

# Dark Matter direct detection

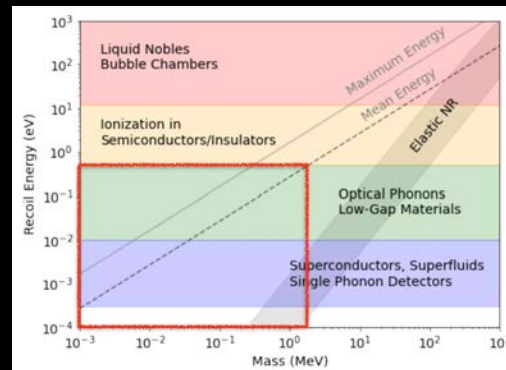


## New approaches to axion searches



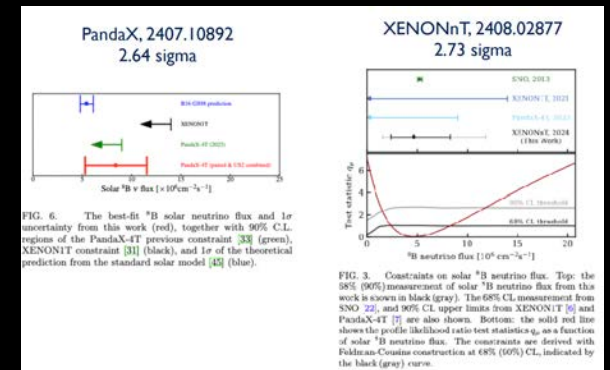
Chelsea Bartram

## meV single photons measurements



Noah Kurinsky

## "Into the Fog"

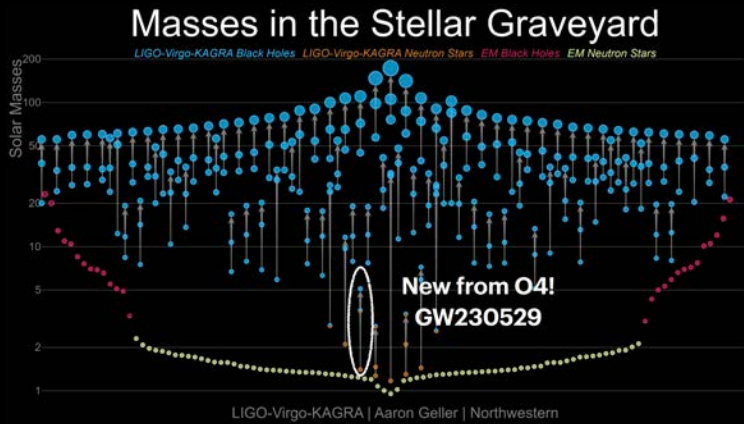


Hugh Lippincott Matthew Szydagis

# The Gravity Files

Over 200 gravitational-wave observations

PBHs implications for Cosmological observables

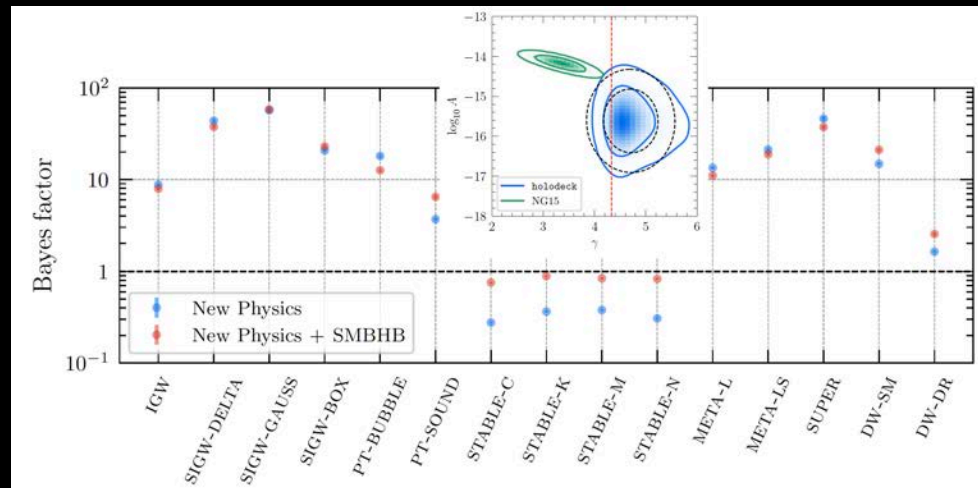


Maya Fishbach



Jessica Turner

NanoGrav: searching for new physics with PTAs



Kim Boddy

# Highlights from parallel sessions:

- **[Rebecca Diesing]:** William Luszcak, presented a novel means of studying tornadoes with atmospheric Muons
- **[Gordon Krnjaic]:** David Cyncynates showed that ultralight, feebly coupled scalar "remember the big bang"
- **[Weishuang Xu]:** Energy injection from DM can impact the observable stellar content of our universe
- **[Nick Camp]:** Itamar J. Allali showed  $\nu$  mass bounds from DESI 2024 are relaxed by Planck and SNe
- **[Tianlu Yuan]:** Jose Carpio's talk with a joint model of the gamma ray and neutrino flux from NGC 1068
- **[Mahmoud Alawashra]:** Paaarmita Pandey reported detection of  $\gamma$ -rays from star-forming region RCW 38
- **[Will Luszcak]:** Nataliia Borodai showed AugerPrime CRs and MM potential with  $\sim 40\,000\text{ km}^2\text{ sr yr}$  exposure
- **[Pouya Asadi]:** Sania Heeba presented a new mechanism - dubbed ROMP- for calculating the relic abundance
- **[Deheng Song]:** ML tools may discriminate point-source and diffuse origins of the Galactic center excess
- **[Donglian Xu, Bei Zhou]:** IceCube test of X-ray bright AGNs found global significance of  $3.3\sigma$  from 11 sources
- **[Huangyu Xiao]:** A heavy QCD axion can make inflation warm
- **[Chris Eckner]:** LHAASO Galactic plane diffuse is consistent with current understanding of cosmic-ray propagation
- **[Elena Pinetti]:** Nicolao Fornengo showed 8.9 sigma cross-correlation Fermi - DES cosmic shear maps
- **[Ariane Dekker]:** IceCube data consistent with Galactic diffuse emission of LHAASO if of hadronic origin
- **[Sanyia heeba]:** New materials, search strategies and modelling of the astrophysics for DM
- **[Aurora Ireland]:** Harikrishnan Ramani limits on primordial power spectrum from DM clumps in ultrafaint dwarfs
- **[Amy Furniss]:** OP 313 gamma-ray detection by LST-I is huge leap forward in our path toward CTAO
- **[Manuel Meyer]:** Reshmi's talk on the prototype for the CTA Schwarzschild Couder Mid Sized telescope
- **[Milena Crnogorcevic]:** a flare of (friendly) controversy in their last talk, "The Road to Higgsino DM"
- **[Luca Orusa, Benedikt Schroer]:** AMS-02 deuteron flux has different rigidity dependence with respect to  $^3\text{He}$  (discussion)
- **[Vikram Dwarkadas]** Many ground-based gamma-ray collaborations are now willing to work together
- [Kathryn Plant] J. de Mello Neto discussed discrepancy in UHECR maps by TA and Auger.



# Summary of the Summary

- We came a long way since the first TeVPA in Chicago
- We built extraordinary experiments, made incredible discoveries
- We also struggled to find an answer to our biggest questions
- Will we ever find an answer?

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- Will we ever find an answer?

*“We did not come here to fear the future.  
We came here to shape it”*

*Barack Obama*



Please join me in  
thanking Dan Hooper  
and the rest of LOC  
for a wonderfully  
organised conference!



**Local Organizing Committee:**

Dan Hooper (chair)  
Galen Tsongas (event manager)  
Abigail Vieregg  
Paolo Privatera  
Gordan Krnjaic  
Dan Baxter  
Anastasia Sokolenko  
Elena Pinetti  
Huangyu Xiao  
Ariane Decker  
Cosmin Deaconu  
Leah Jenks  
Rocky Kolb  
Damiano Caprioli  
Luca Grandi  
Alex Drlica-Wagner  
Benedikt Schroer  
Bei Zhou

