

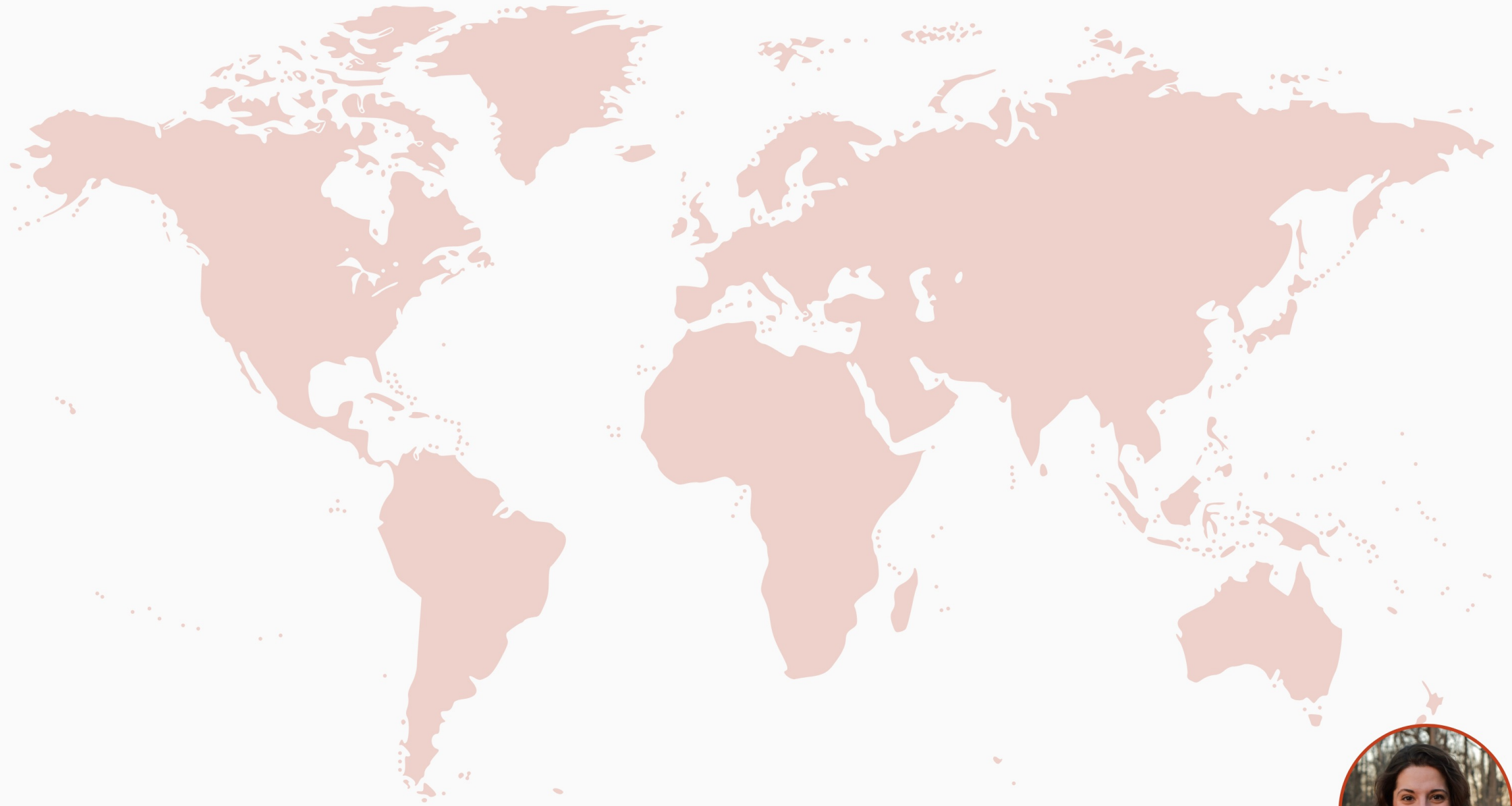
# My journey into astrophysics

Milena Crnogorčević (she/her)  
Postdoctoral Fellow @ Stockholm University

 [milena.crnogorcevic@fysik.su.se](mailto:milena.crnogorcevic@fysik.su.se)

 [mcrnogor.github.io](https://github.com/mcrnogor)







**BORN IN  
MONTENEGRO**



**1994**





*BORN IN  
MONTENEGRO*

*HIGH SCHOOL  
IN HONG KONG*



1994

2011





MIDDLEBURY COLLEGE

**First research experiences:**

- QFT in curved geometries
- Galaxy/SMBH coevolution

BORN IN  
MONTENEGRO

HIGH SCHOOL  
IN HONG KONG



1994

2011

2013

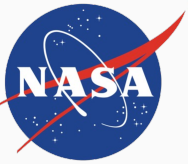


MIDDLEBURY COLLEGE

UNIVERSITY OF MARYLAND

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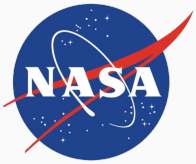
2013

2017



MIDDLEBU

UNIVERSITY OF MARYLAND



**PhD Advisors:**  
Dr. Regina Caputo  
Prof. Manuel Meyer

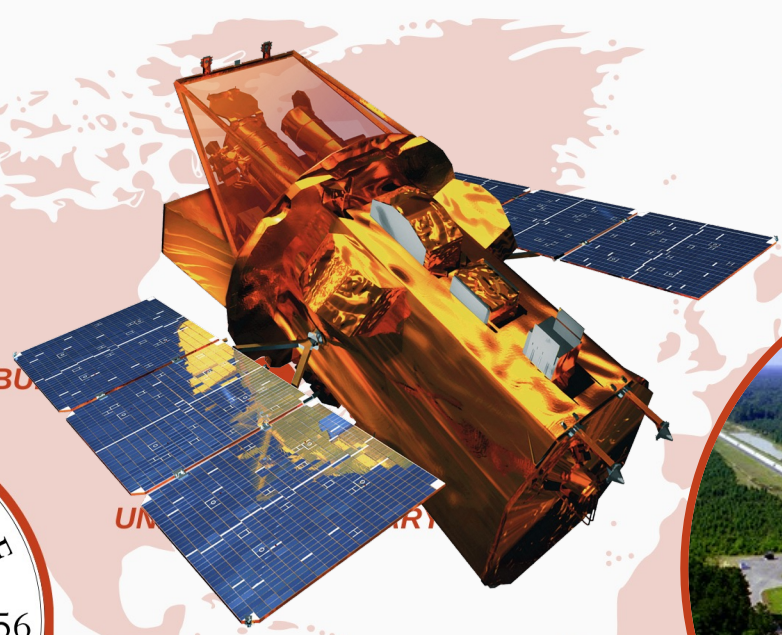


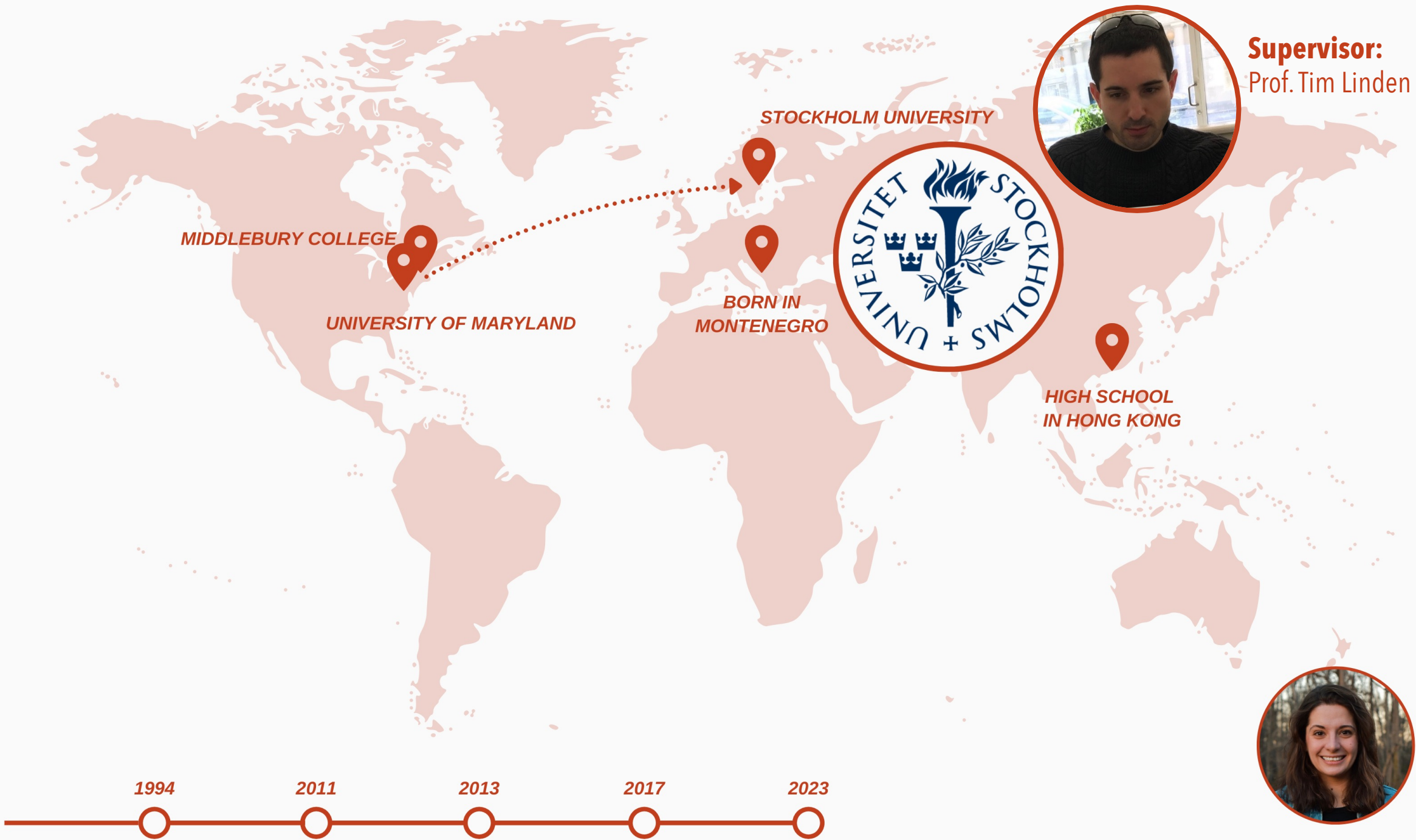
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**Supervisor:**  
Prof. Tim Linden



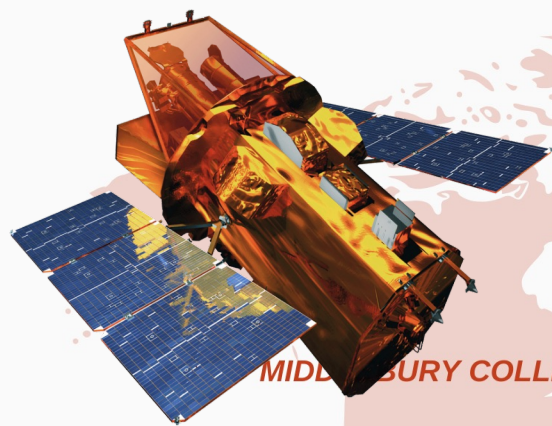
1994

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2013

2017

2023



MIDDLEBURY COLLEGE



UNIVERSITY

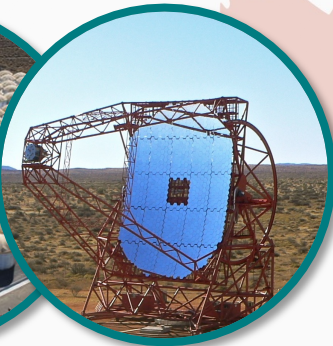
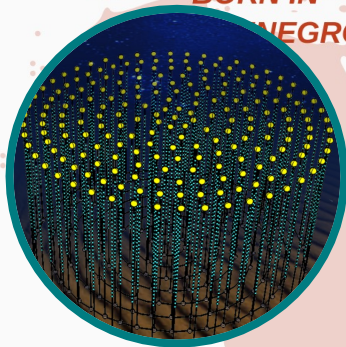
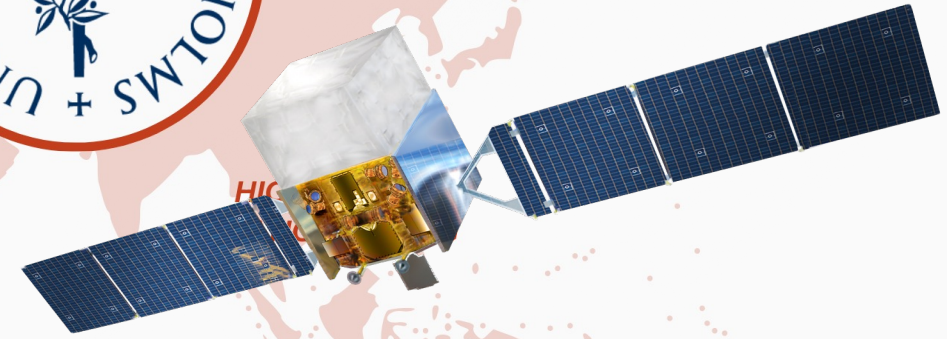
STOCKHOLM UNIVERSITY



BORN IN NEGRO



Supervisor:  
Prof. Tim Linden



1994

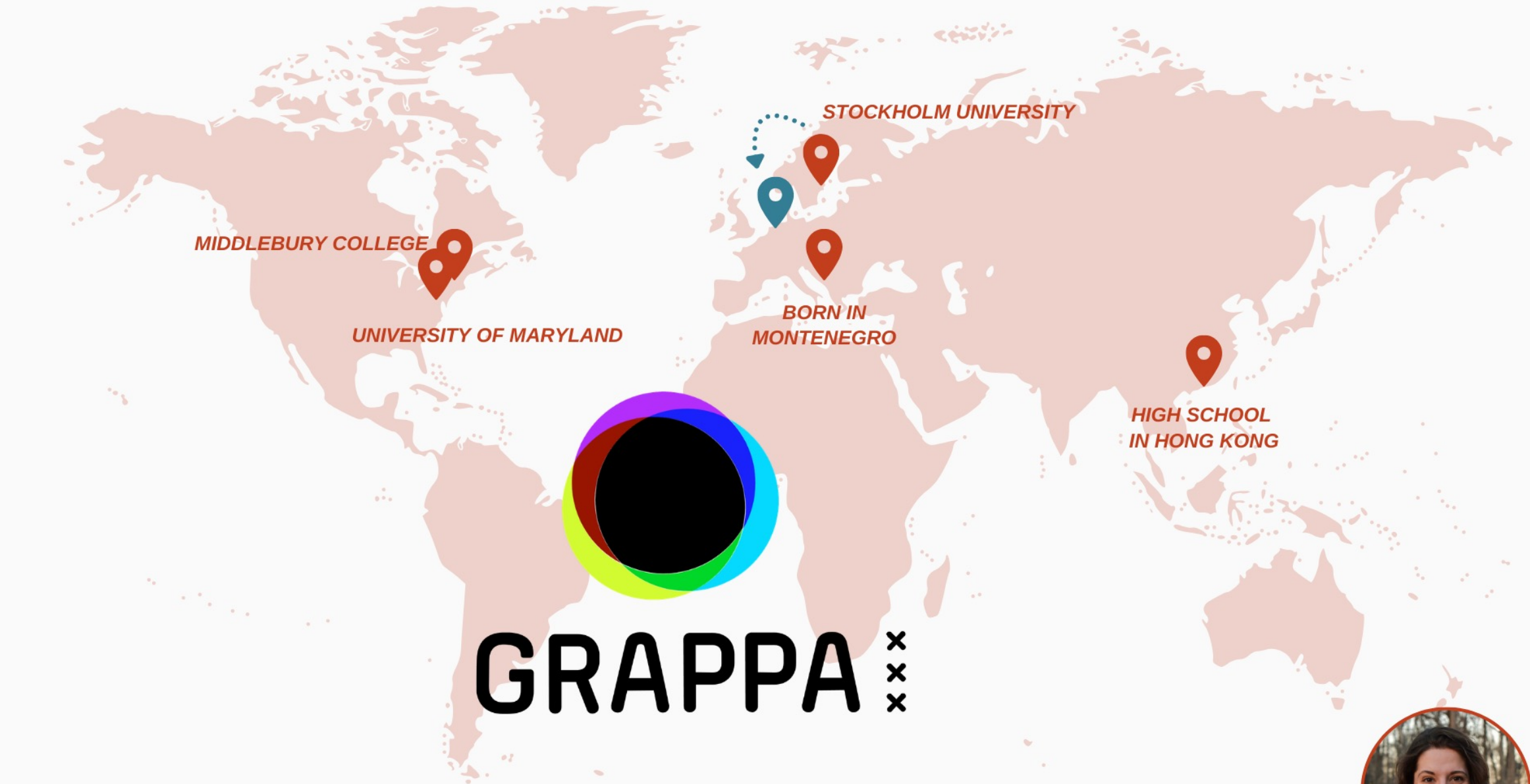
2011

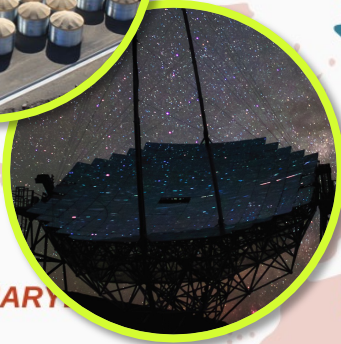
2013

2017

2023







**Prof. Shin'ichiro Ando**



**Prof. Christoph Weniger**



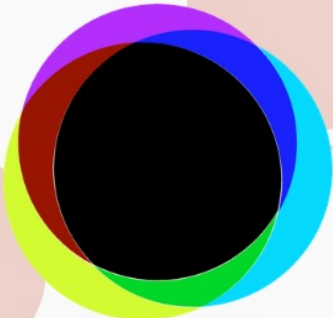
**Prof. Gianfranco Bertone**



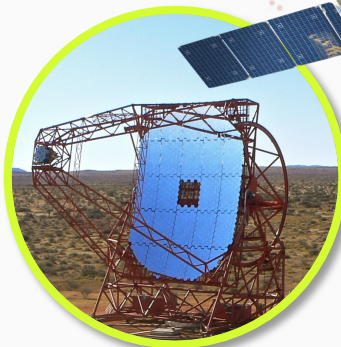
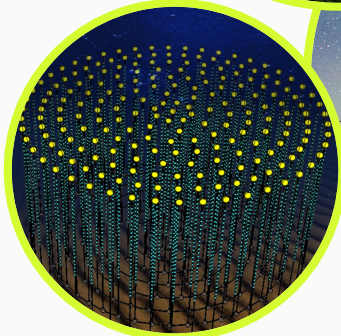
STOCKHOLM

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# GRAPPA $\times \times \times$



1994

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2013

2017

2023

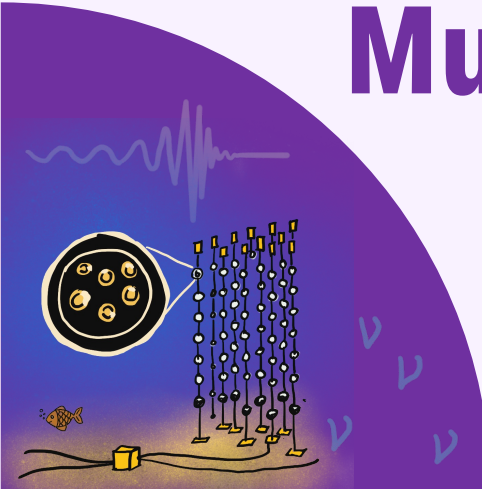
October 2026



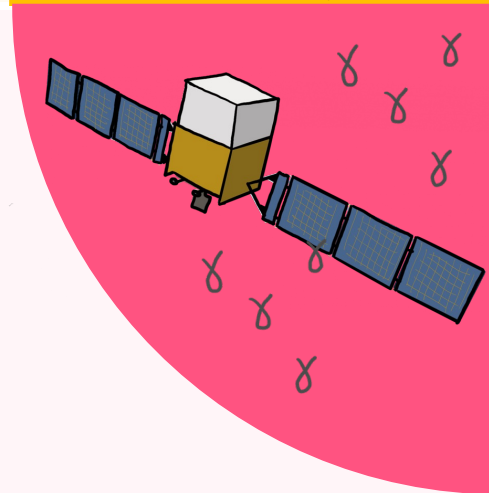
**Dark Matter  
& New Physics**



**Multimessenger  
astronomy**

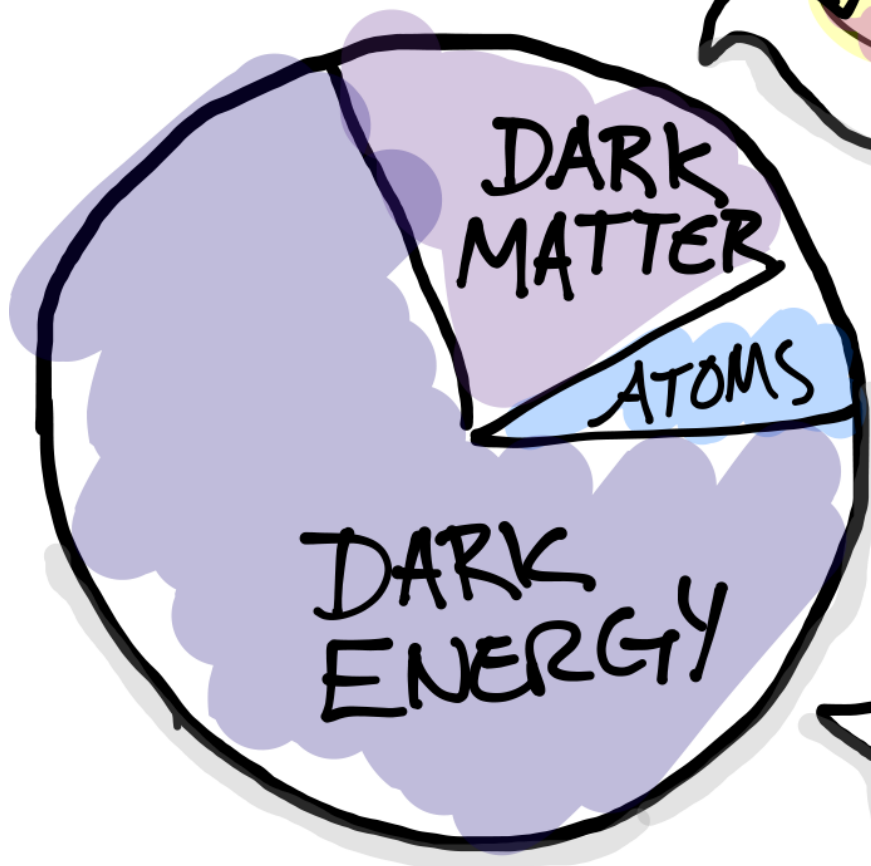


**Gamma-ray  
astronomy**



**Service  
& Outreach**





~25%, Interacts with gravity, but not light.  
Clumps into structures.

A hand-drawn diagram showing a spiral galaxy with yellow and purple colors and arrows indicating rotation. To its right is a cluster of several smaller galaxies, also in yellow and purple.

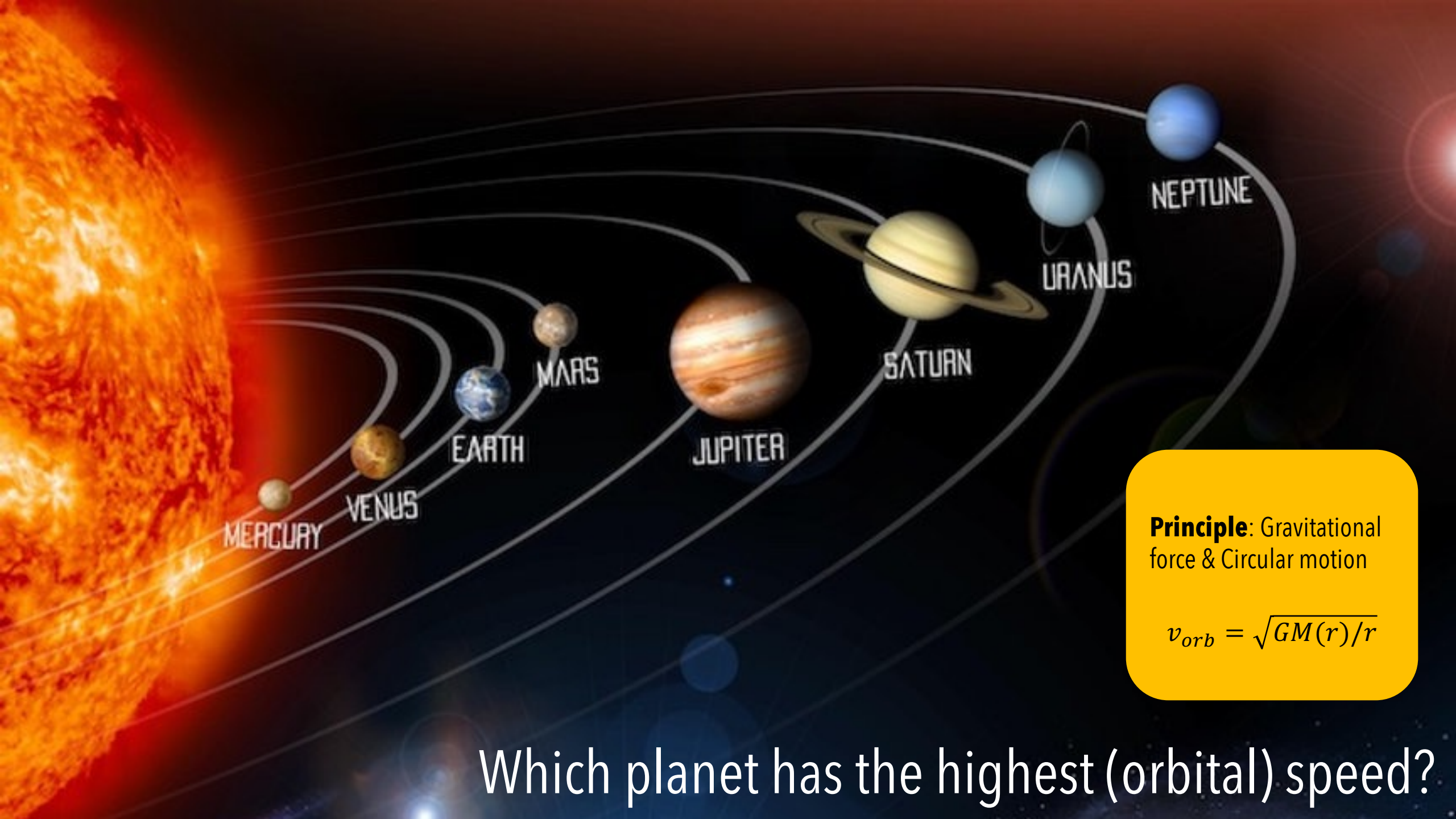
~5% Described by known physics.

A row of four hand-drawn icons: a stick figure, a globe of Earth, a sun with rays, and a spiral galaxy.

~70%, "Negative pressure" associated with the vacuum.  
Drives expansion of space.

A hand-drawn diagram showing a grid of lines with arrows pointing outwards from the center, representing the expansion of space.

**We have no idea what dark matter is,  
but we know it's there.**

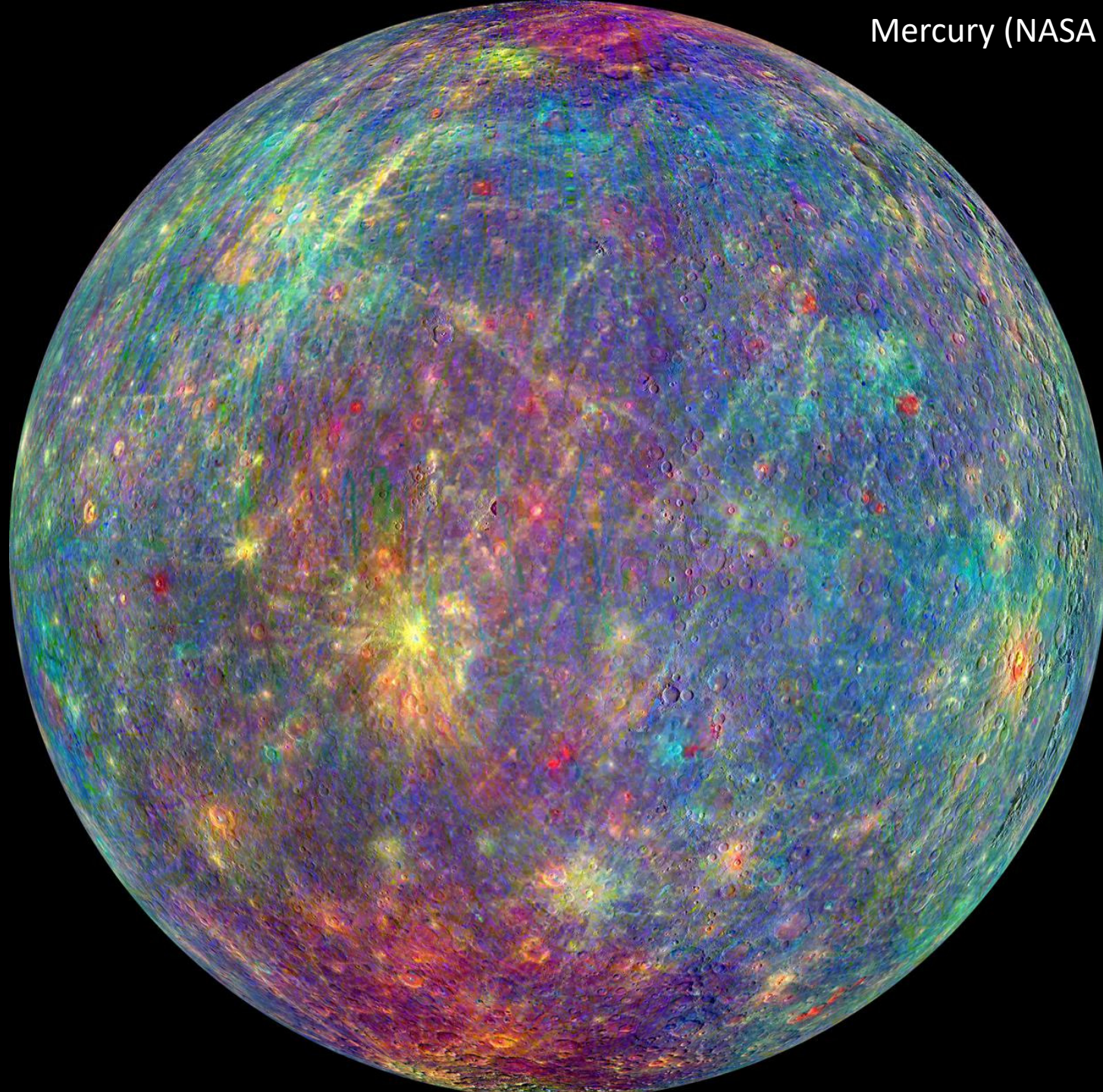


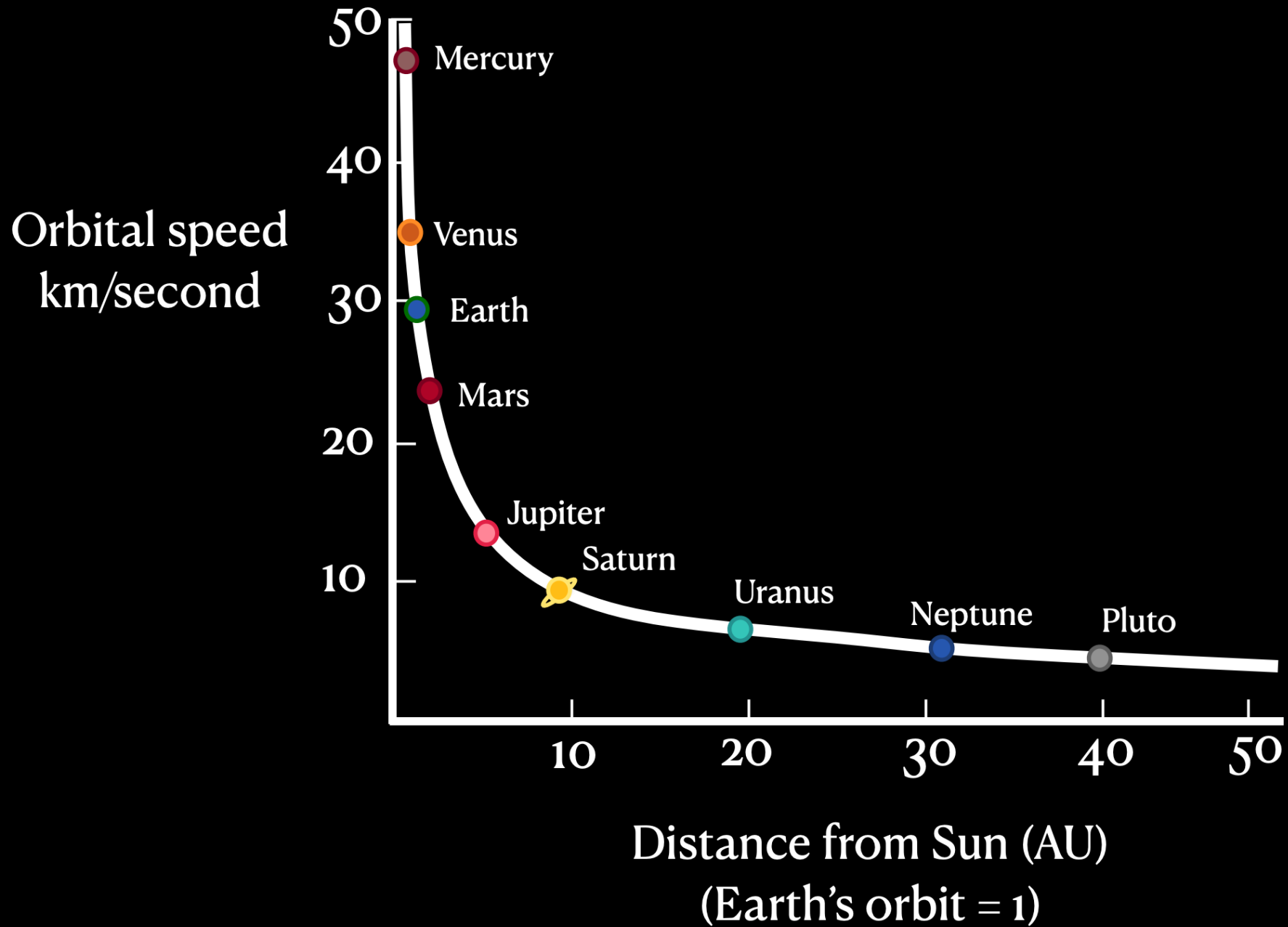
**Principle:** Gravitational force & Circular motion

$$v_{orb} = \sqrt{GM(r)/r}$$

Which planet has the highest (orbital) speed?

Mercury (NASA Science)





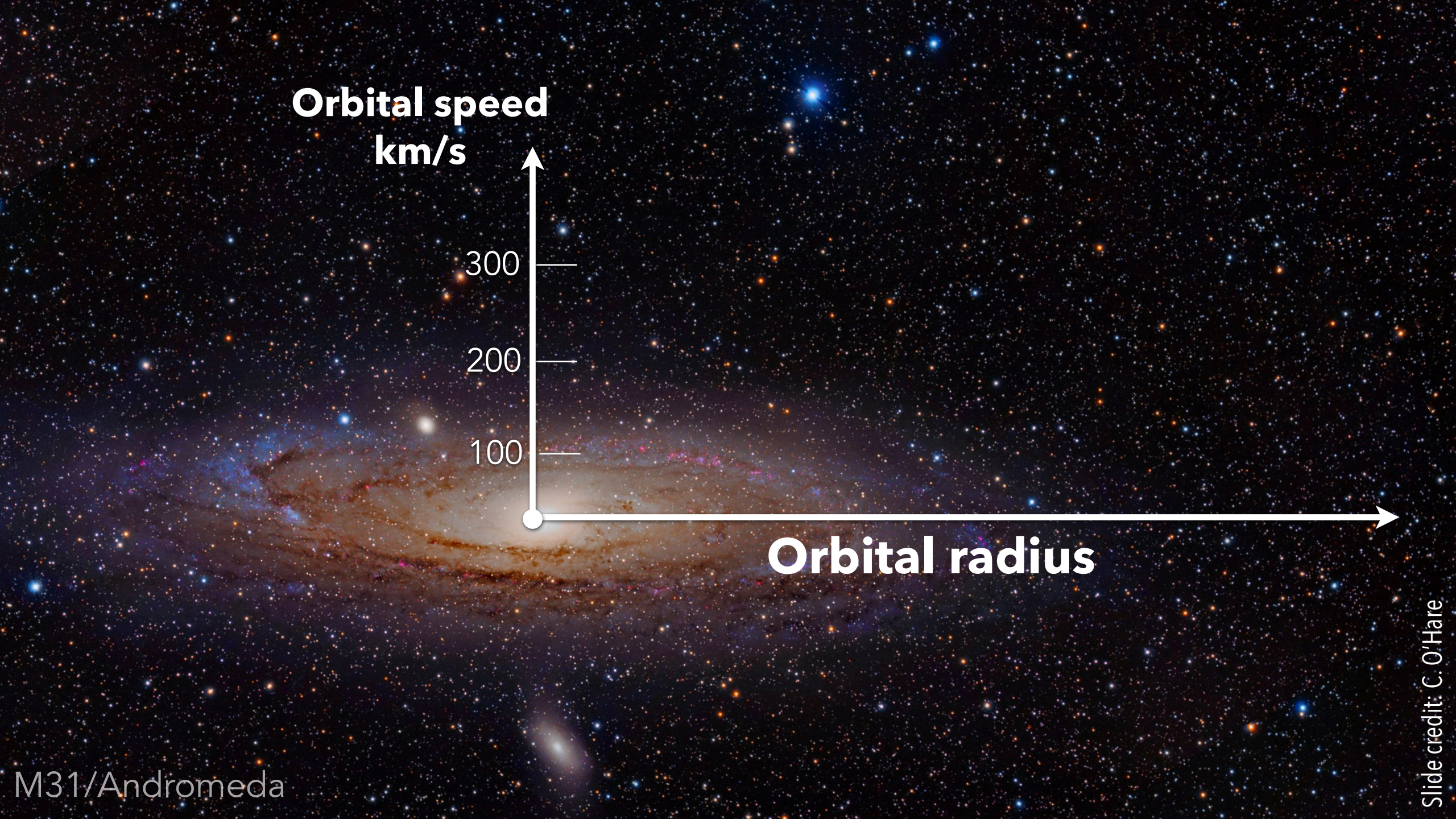
**Orbital speed  
km/s**

300  
200  
100

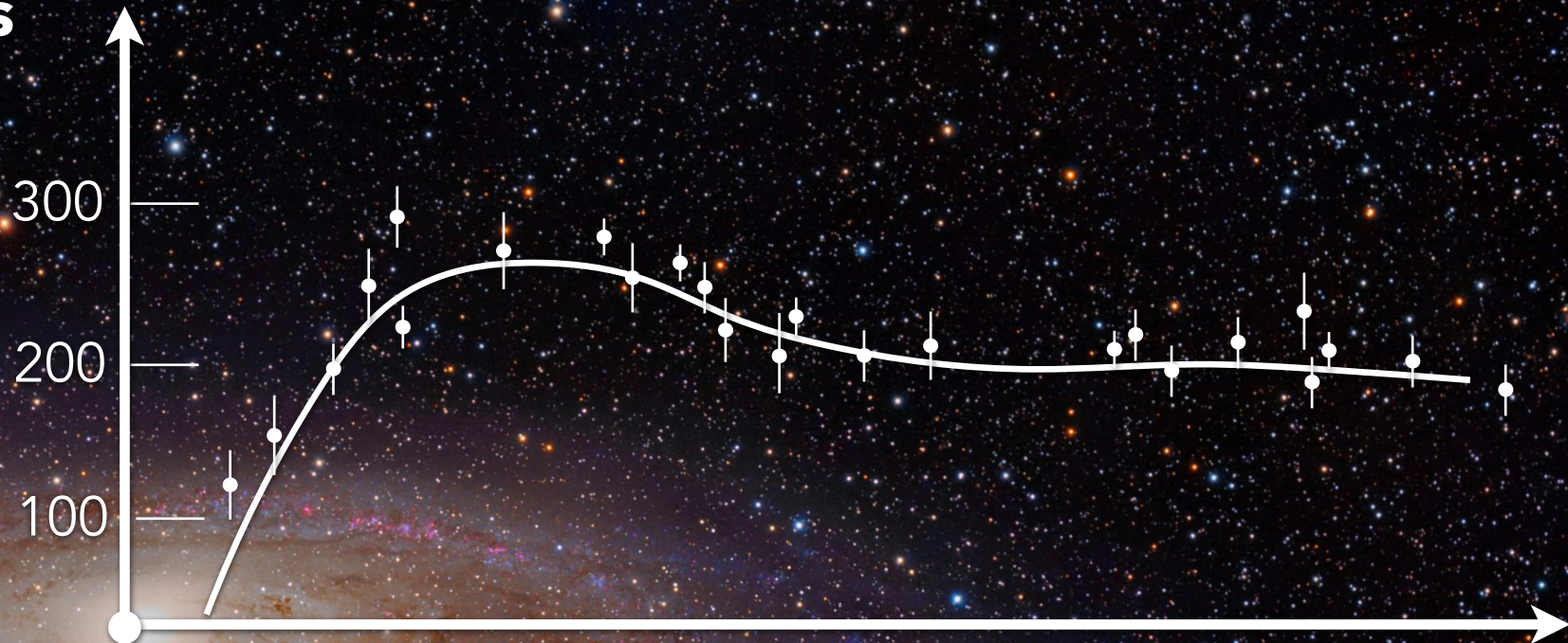
**Orbital radius**

M31/Andromeda

Slide credit: C. O'Hare



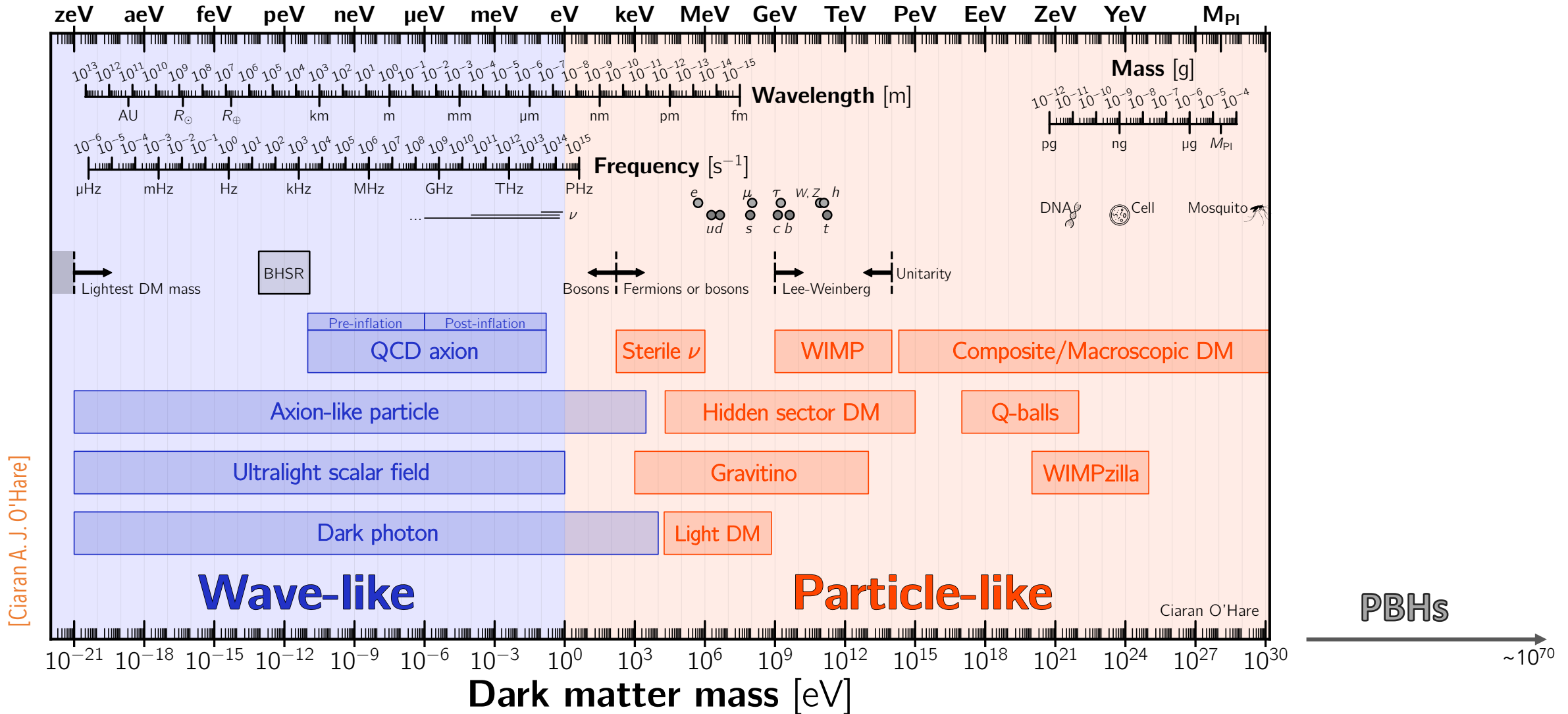
**Orbital speed  
km/s**



**Orbital radius**

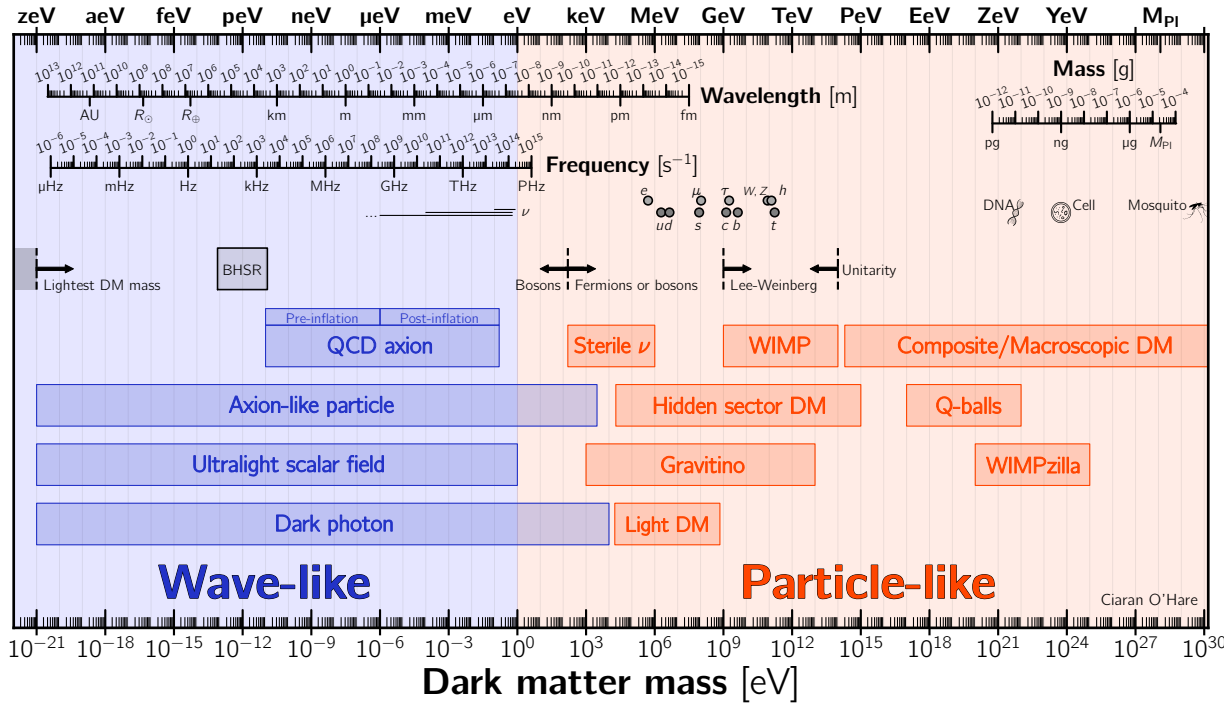
$$v_{orb} = \sqrt{GM(r)/r}$$

# Dark Matter Landscape: A Theorist's View



# Dark Matter Landscape: A Theorist's View

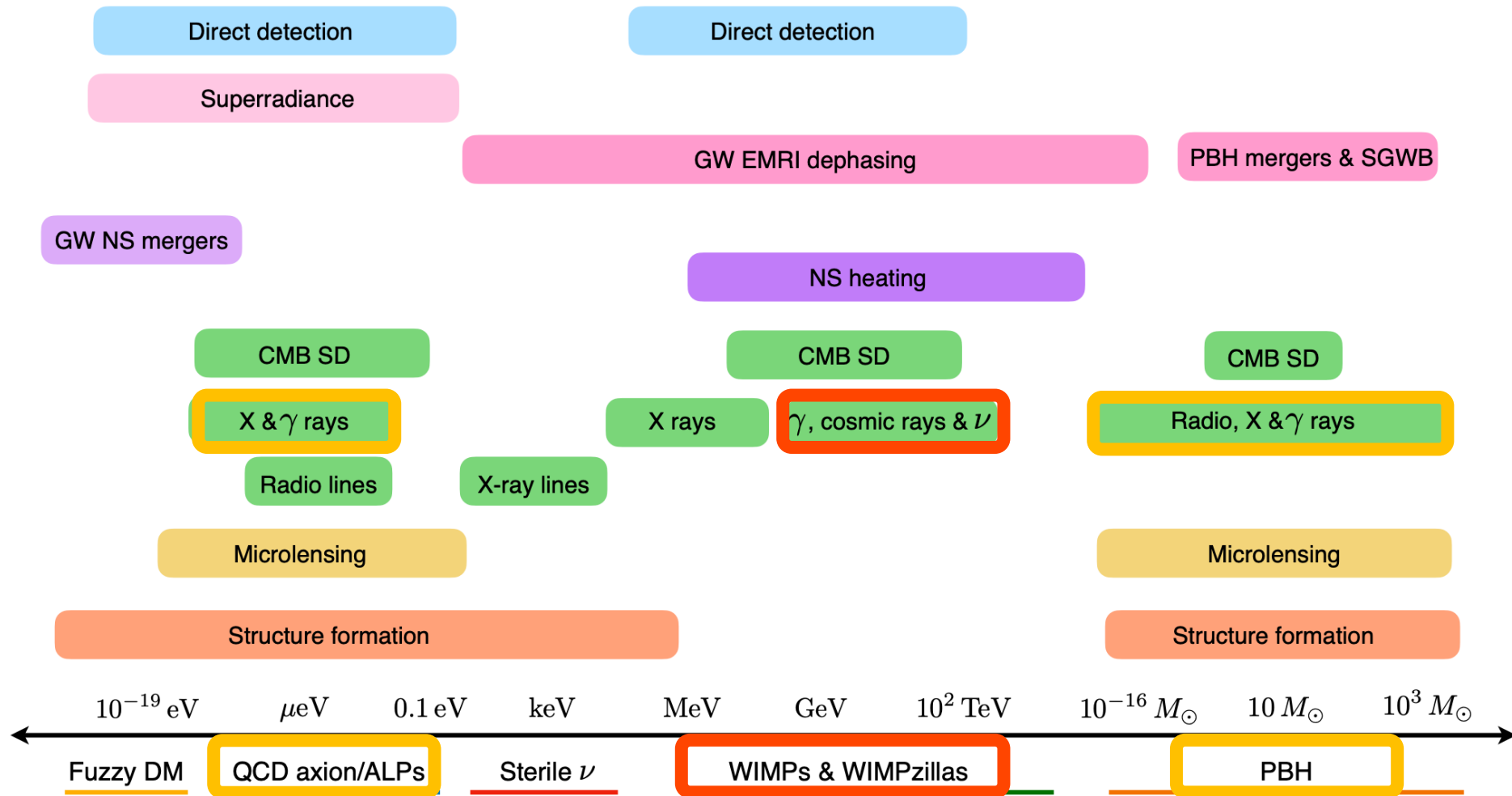
Dark matter spans over **80 orders** of magnitude in mass (+ interaction strength)



  
proton  
 $m \sim 10^{-27}$  kg



# Dark Matter Landscape: An Observer's View



# Dark Matter Landscape: An Observer's View



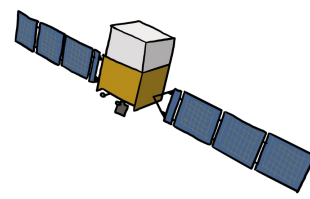
# Dark Matter & New Physics



# Dark Matter & New Physics

WIMPs

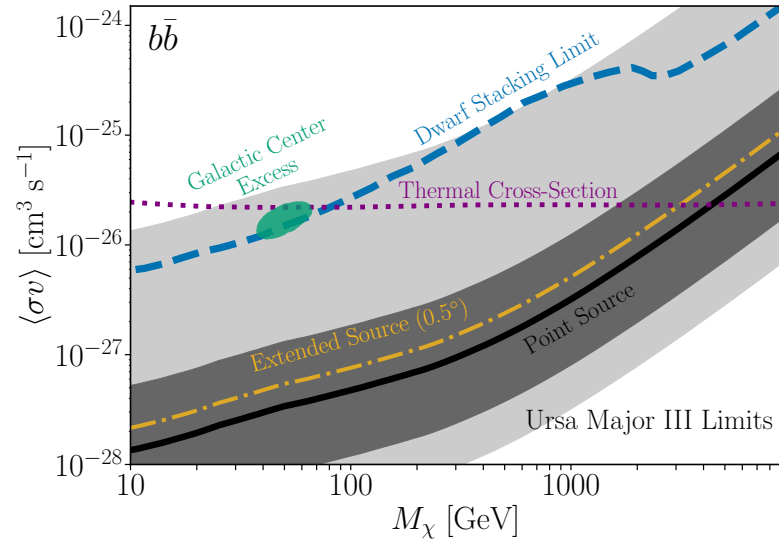
ALPs



## Ultra-faint dwarf galaxies

## Galaxy clusters

## Gamma-ray Bursts



- Ursa Major III: deepest LAT search of any dwarf to date
- No gamma-ray signal → strongest WIMP limits up to  $\sim 4$  TeV\*
- Framework scalable to large LSST/Rubin dwarf population

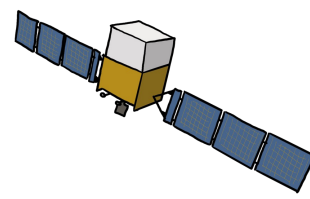
\*model dependent

[Crnogorčević & Linden, PRD '23]

# Dark Matter & New Physics

WIMPs

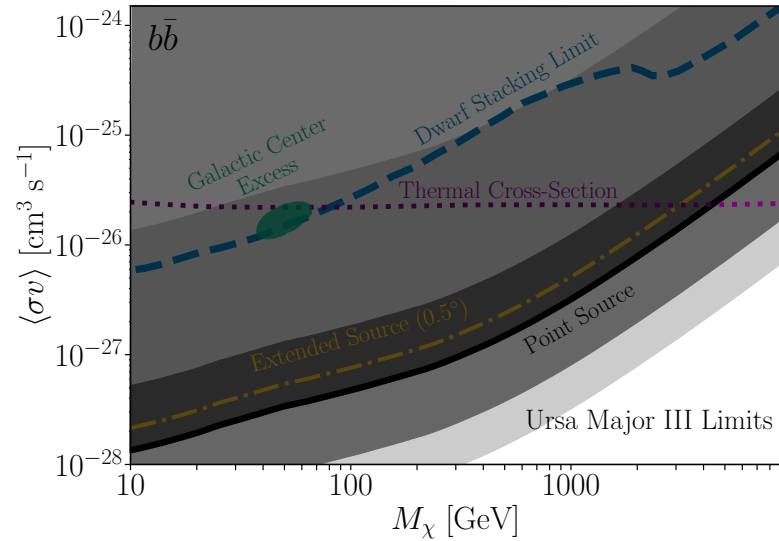
ALPs



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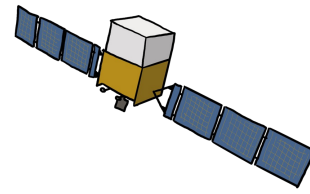
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[Crnogorčević & Linden, PRD '23]

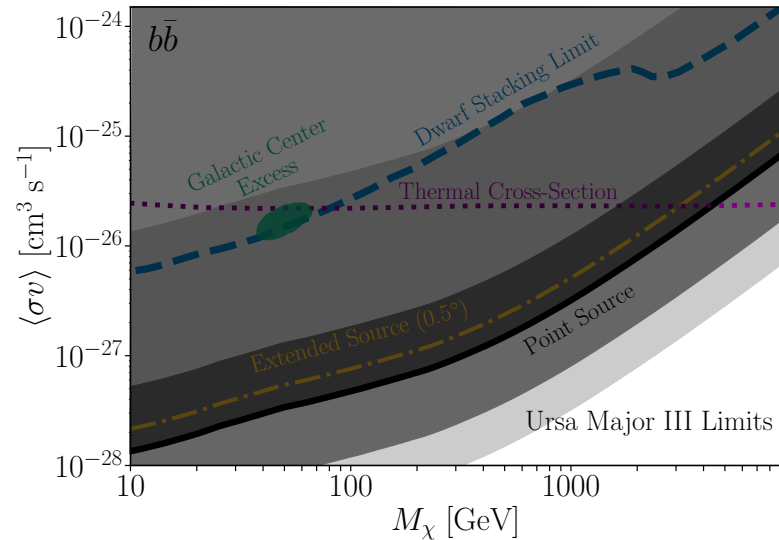
# Dark Matter & New Physics

WIMPs

ALPs



## Ultra-faint dwarf galaxies

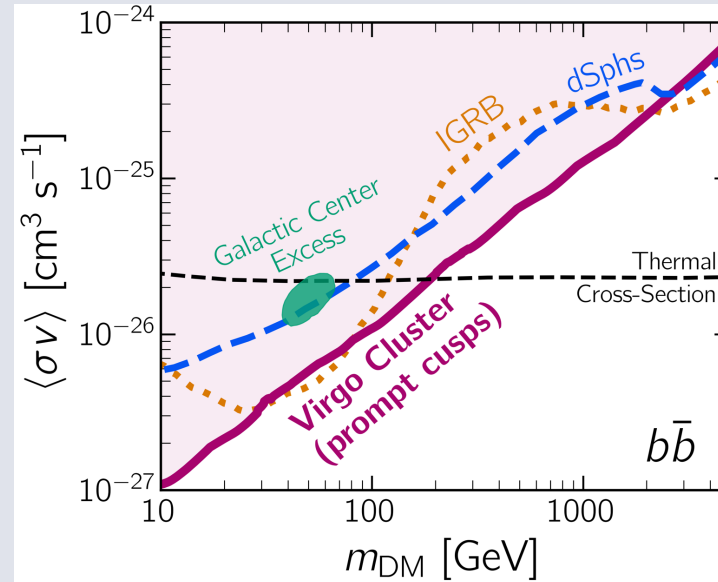


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\*model dependent

[Crnogorčević & Linden, PRD '23]

## Galaxy clusters



- Modeled annihilation signal from early-Universe "prompt cusps": cosmological relevance
- 15 years of LAT data on 7 clusters → cluster-based exclusion of thermal relic cross-section below  $\sim 400$  GeV
- Currently leading limits on cusp-enhanced annihilation\*

\*see Ando et al. 2601.19863

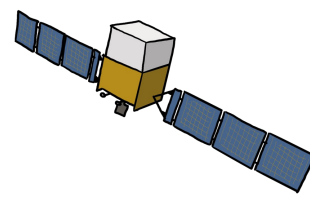
[Crnogorčević et al., PRD '25]

## Gamma-ray Bursts

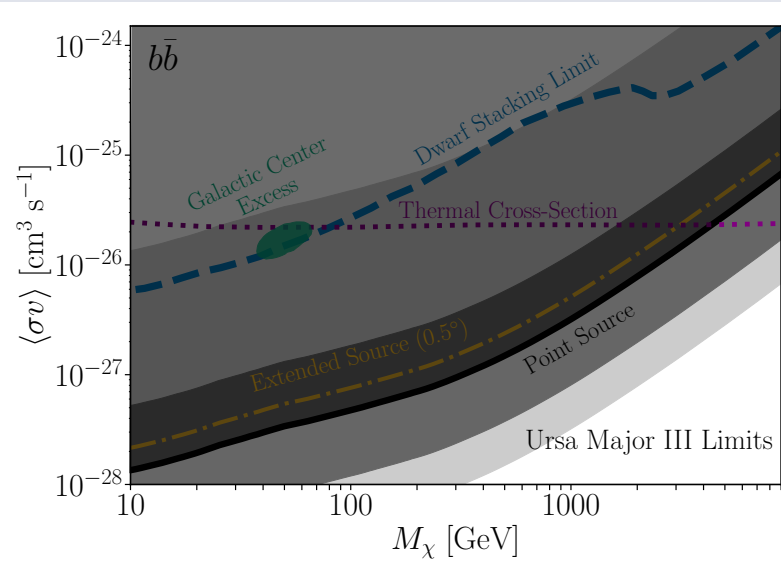
# Dark Matter & New Physics

WIMPs

ALPs



## Ultra-faint dwarf galaxies

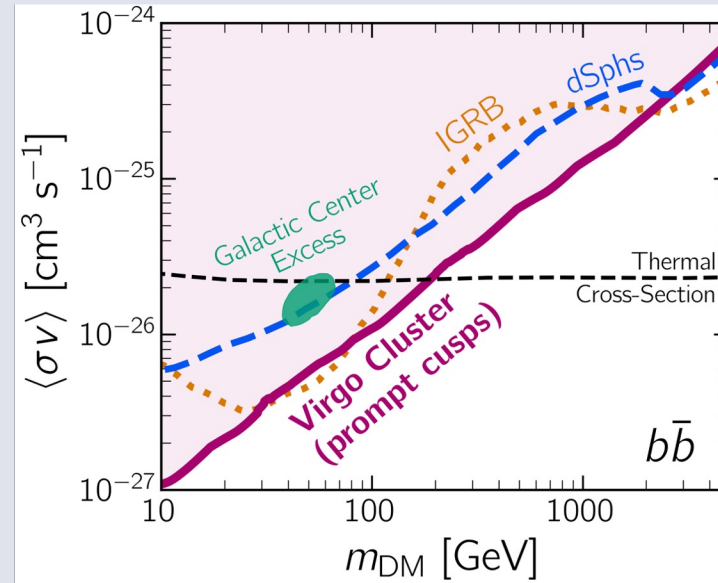


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[Crnogorčević & Linden, PRD '23]

## Galaxy clusters

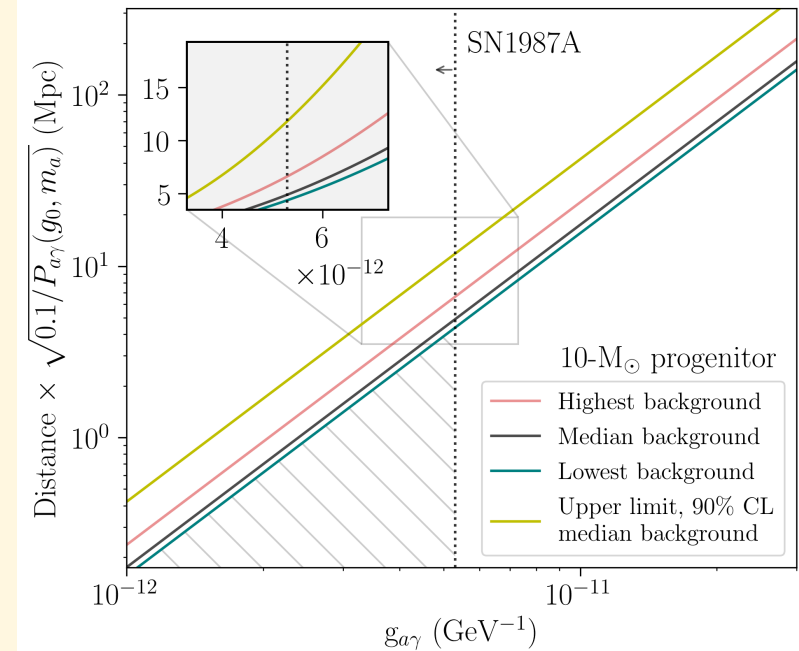


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\*see Ando et al. 2601.19863

[Crnogorčević et al., PRD '25]

## Gamma-ray Bursts



- Developed first ALP search using LAT's low-energy photons (down to 10 MeV)
- Independent channel relative to standard LAT analysis
- Limits competitive with conventional analyses
- Fermi GI Cycle 15 Grant (PI: Crnogorčević)

[Crnogorčević et al., PRD '21]

# Dark Matter & New Physics



# Dark Matter & New Physics

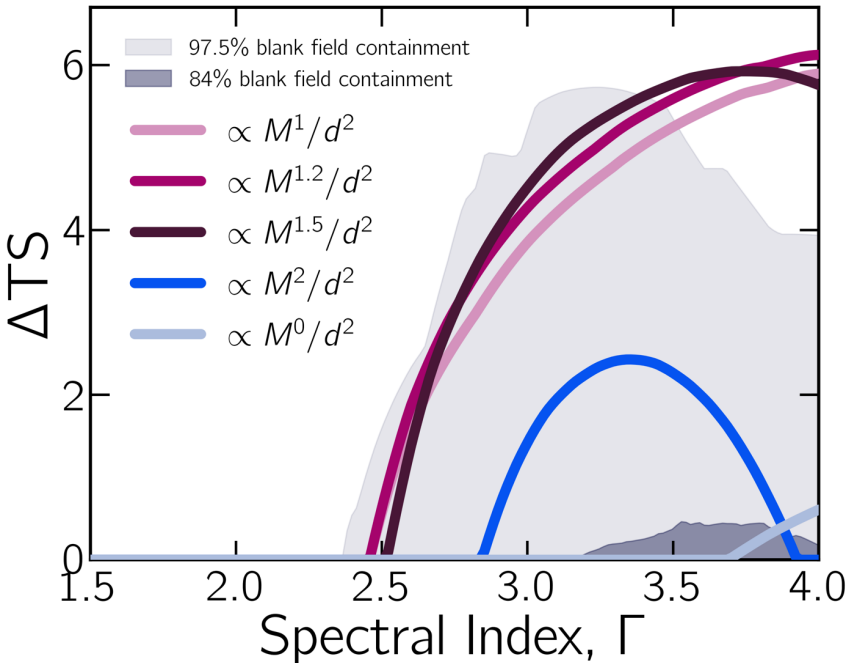


Gamma-ray  
astronomy

# Gamma-ray astronomy

## Dwarf AGN

[Crnogorčević et al., accepted to PRD '26]



## The Sun

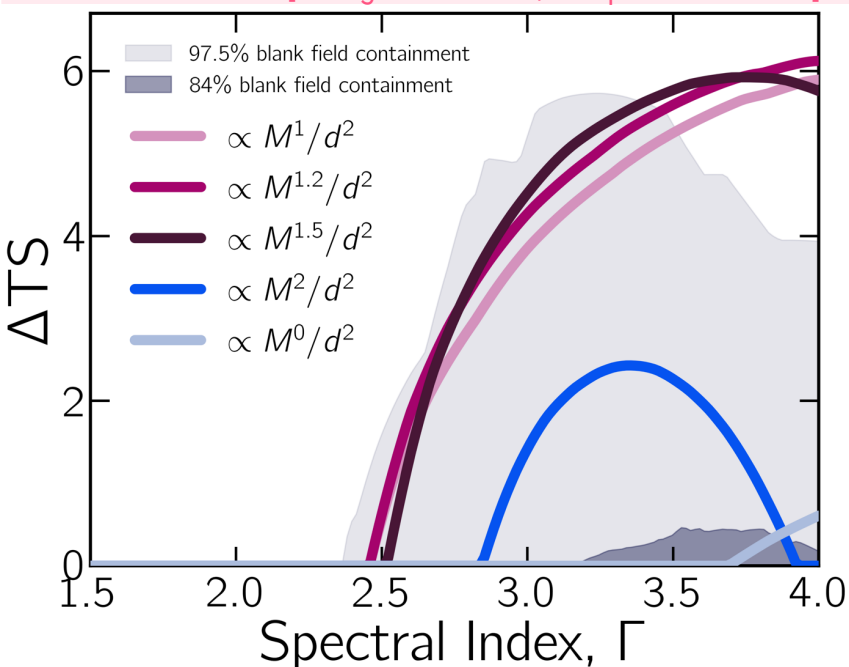
## KM3-230213A

- 74 eROSITA dwarf AGNs
- No individual detections, but  $\sim 2.2$  sigma soft excess in the JLA
- First gamma-ray constraints on intermediate-mass black holes
- Opens a new window for MeV/GeV studies of low-mass accretion

# Gamma-ray astronomy

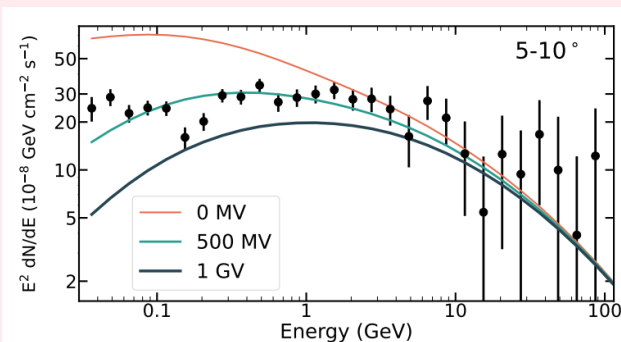
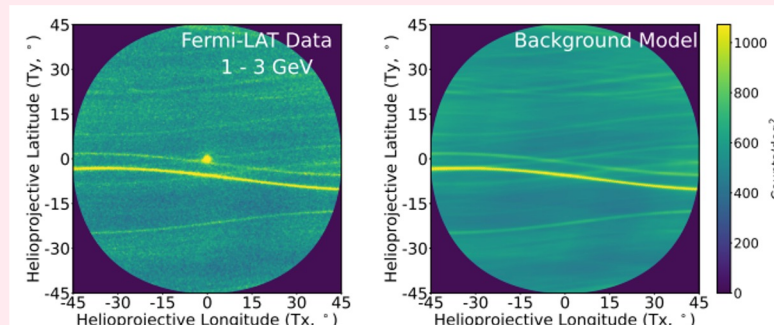
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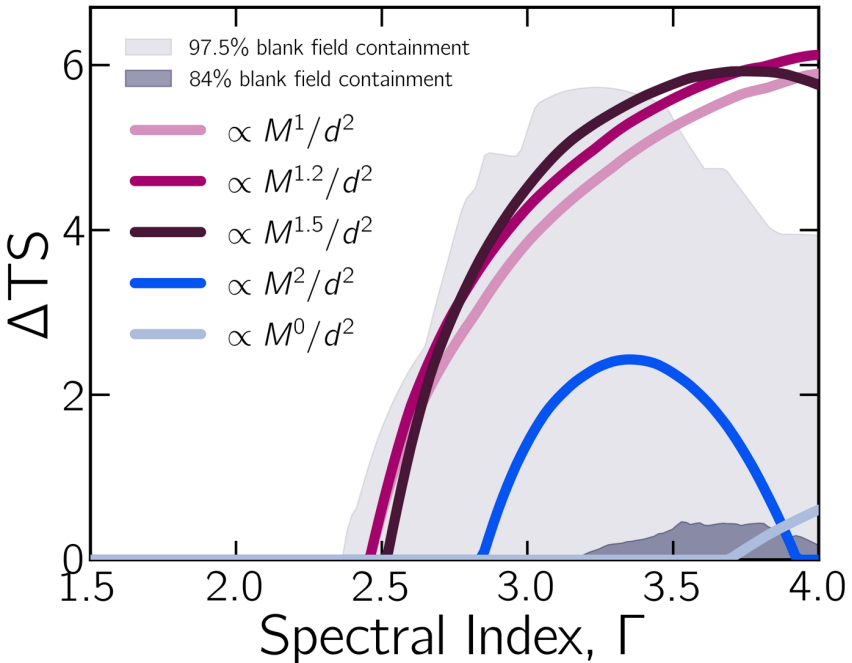
- Mapped the solar inverse-Compton halo out to  $45^\circ$  (requiring a new background modelling method)
  - Used 15 years of Fermi-LAT data  $\rightarrow$  first full solar-cycle measurement
  - Probes cosmic-ray modulation by solar magnetic fields
- [Linden et al. incl. Crnogorčević, PRD '25]

## KM3-230213A

# Gamma-ray astronomy

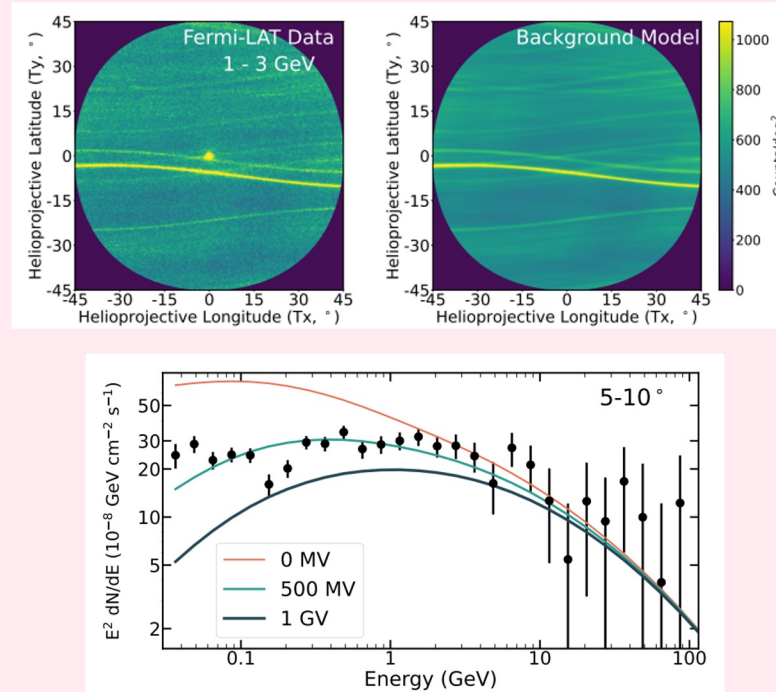
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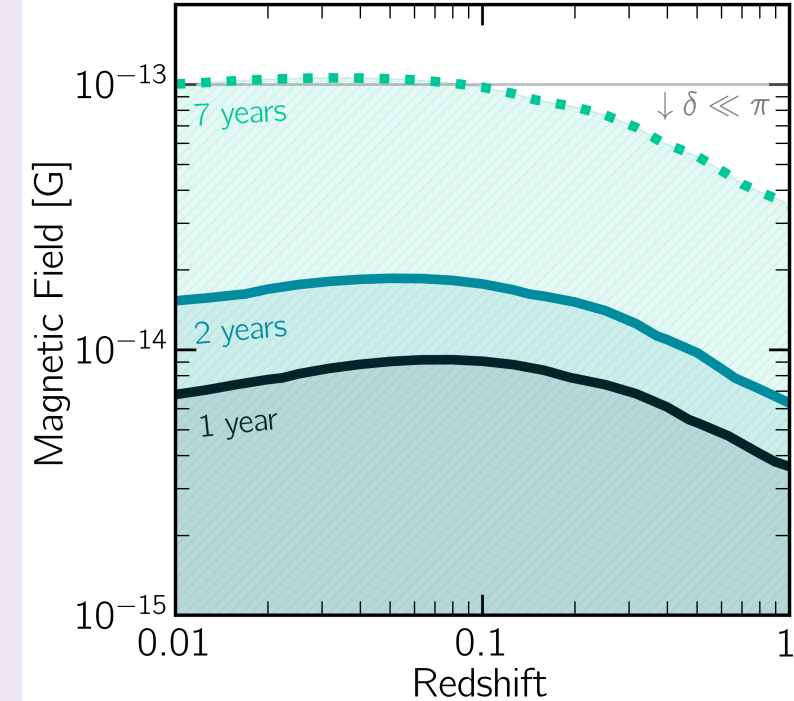
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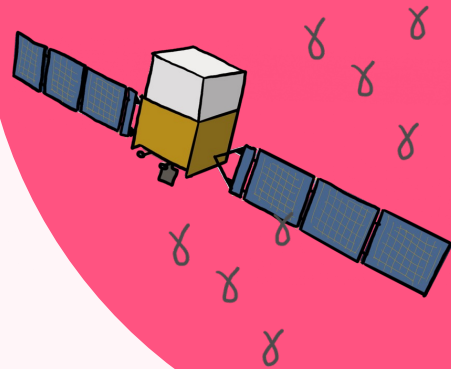
- Modeled expected gamma-ray cascades for hadronic origin
- Deep spatial + temporal Fermi-LAT follow-up
- No counterpart, but  $\rightarrow$  first constraints on redshift-IGMF plane
- Identified a new hard-spectrum gamma-ray source in the region

[Crnogorčević et al., JCAP '25]

# Dark Matter & New Physics



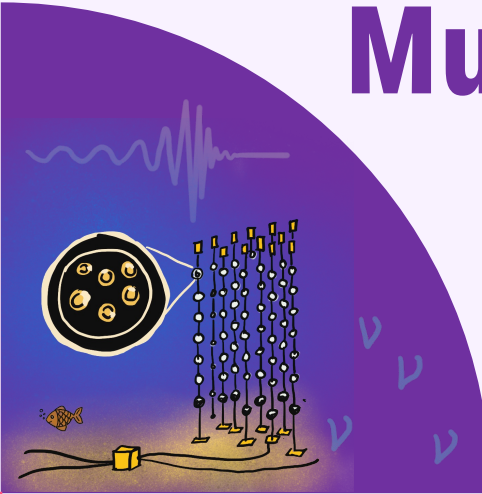
# Gamma-ray astronomy



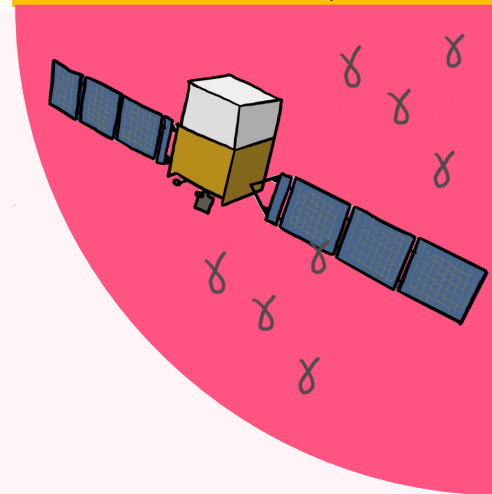
# Dark Matter & New Physics



# Multimessenger astronomy

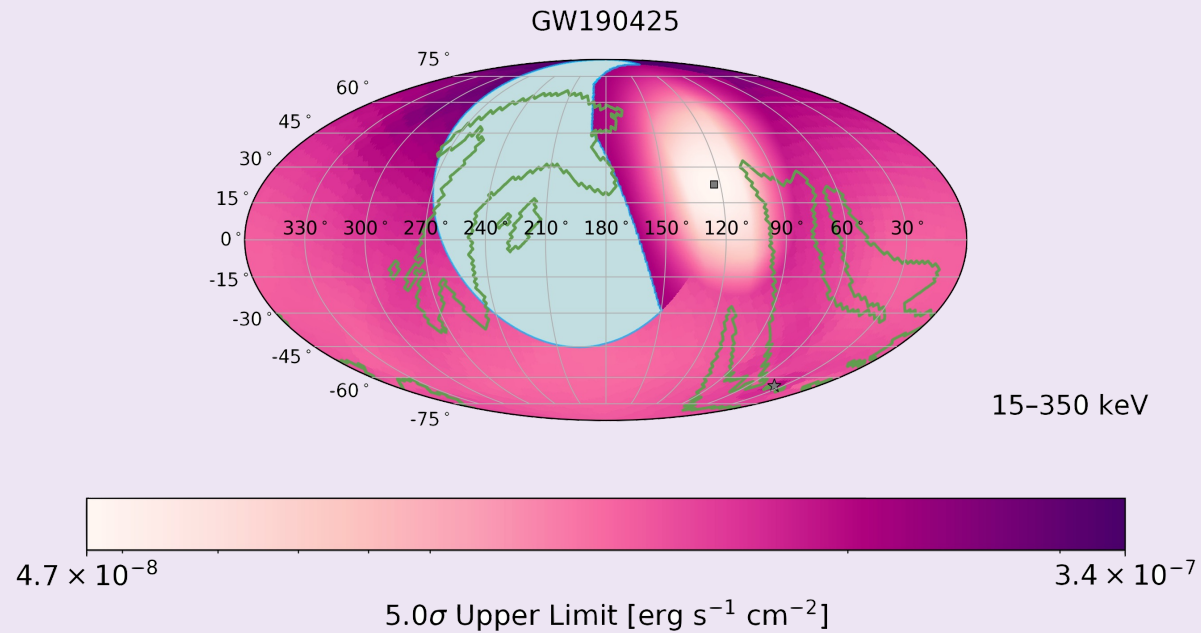


# Gamma-ray astronomy



# Multimessenger astronomy

## GW X gamma rays

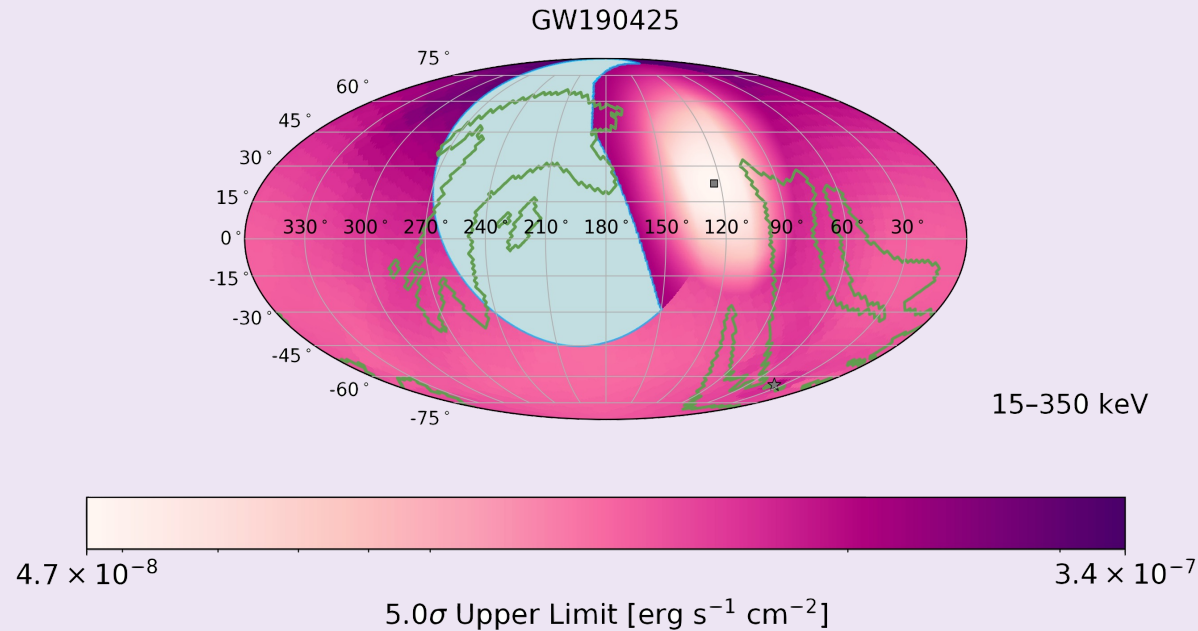


## neutrinos X gamma rays

- Offline *Fermi*-GBM + *Swift*-BAT search during LVK O3
- Looked for gamma-ray signals coincident with GW mergers
- No confirmed detections → limits on EM emission for BBH, NSBH, BNS
- Pipeline now informs real-time GCN notices

# Multimessenger astronomy

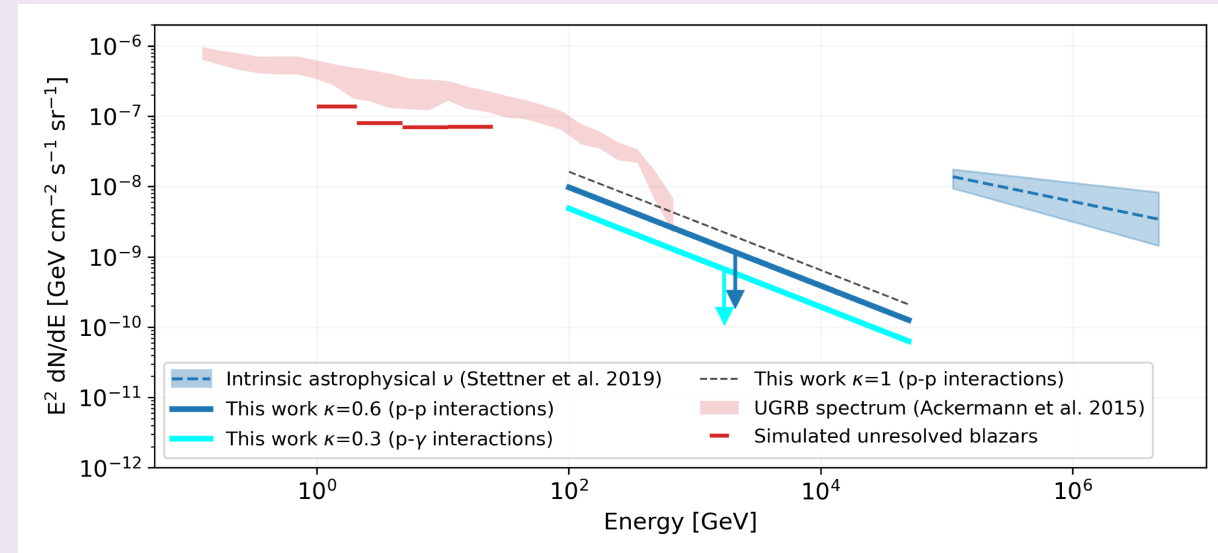
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[Fletcher et al. for *Fermi*-GBM, Crnogorčević et al. for *Swift*-BAT, LVK Collaboration, ApJ '24]

## neutrinos X gamma rays



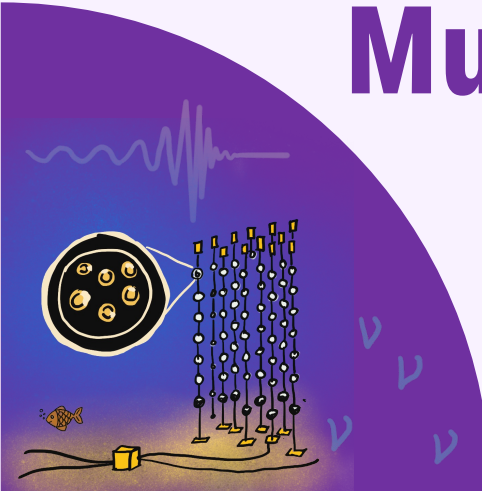
- First analysis linking IceCube neutrinos with *Fermi*'s unresolved gamma-ray background
- Includes emission below LAT detection threshold
- No correlation found → upper limits on neutrino flux from unresolved blazars
- Framework now a baseline for next-generation multimessenger studies

[Negro, Crnogorčević, et al., ApJ '23]

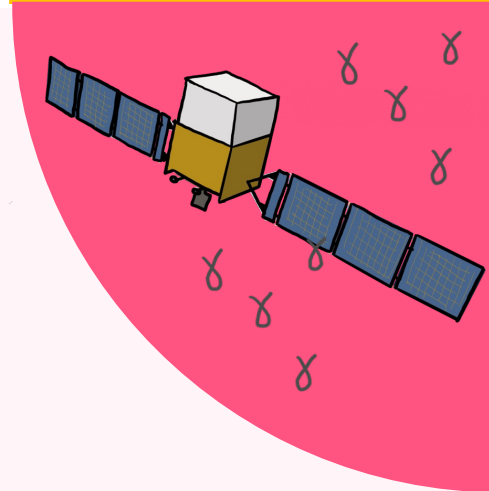
# Dark Matter & New Physics



# Multimessenger astronomy



# Gamma-ray astronomy



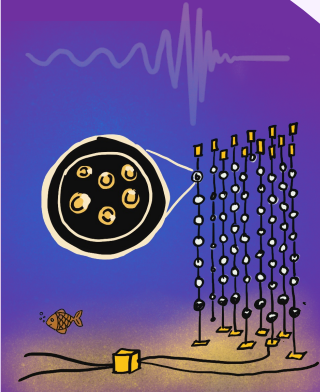
# Dark Matter & New Physics

- DM capture in rotating neutron stars in GC
- DM spikes around IMBHs + gamma rays

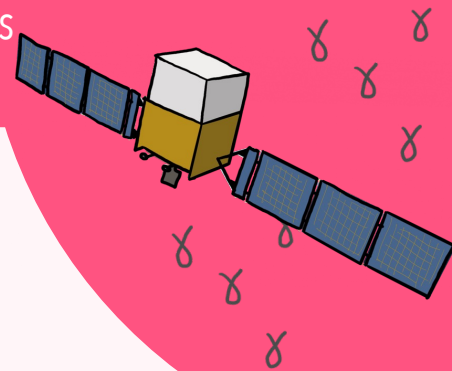
- superluminous supernovae in gamma rays
- voids and blazars



# Multimessenger astronomy



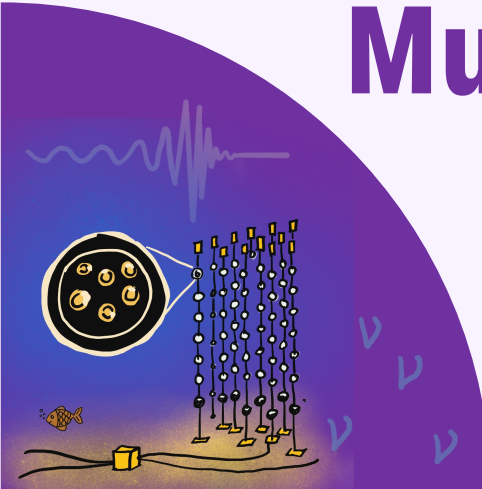
# Gamma-ray astronomy



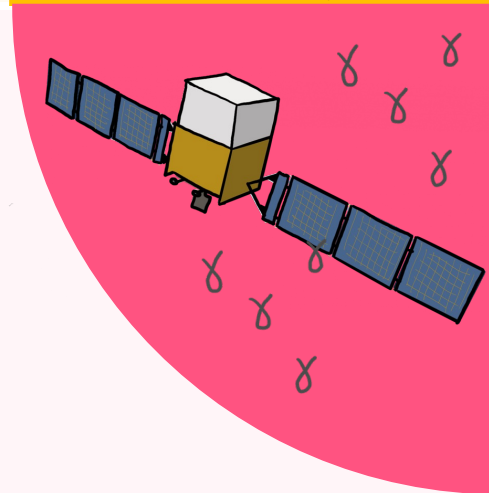
**Dark Matter  
& New Physics**



**Multimessenger  
astronomy**



**Gamma-ray  
astronomy**



**Service  
& Outreach**



**Service  
& Outreach**

# Service & Outreach

*ScientiFika*



<https://scientifika.se/>

# Service & Outreach

ScientiFika



<https://scientifika.se/>



# Service & Outreach

<https://science.nasa.gov/astrophysics/programs/physics-of-the-cosmos/community/fig-sag/>

RECOMMENDED PRIORITIES FOR NASA'S GAMMA RAY ASTRONOMY PROGRAM 1996-2010

RECOMMENDED PRIORITIES FOR NASA'S GAMMA RAY ASTRONOMY PROGRAM 2025 - 2040

## ScientiFika

<https://scientifika.se/>

arXiv roast

[astro-ph]

# GRAD MAP

Graduate Resources Advancing Diversity with Maryland Astronomy and Physics

A Graduate Student-led Diversity Initiative

**Milena Crnogorčević** - Co-lead (ASTR)  
**Andrew Guo** - Co-lead (PHYS)  
**Amy Steele** - Advisor (ASTR)



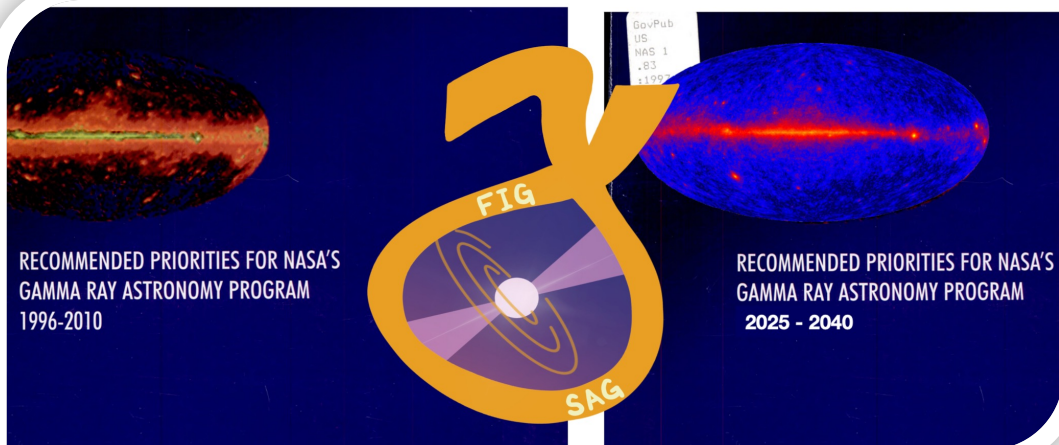
UNIVERSITY OF MARYLAND

GR0WTH  
Global Relay of Observatories Watching Transients Happen

<https://www.umdgradmap.org/>

## Service & Outreach

<https://science.nasa.gov/astrophysics/programs/physics-of-the-cosmos/community/fig-sag/>



## ScientiFika



<https://scientifika.se/>



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UNIVERSITY OF MARYLAND

GR0WTH  
Global Relay of Observatories Watching Transients Happen

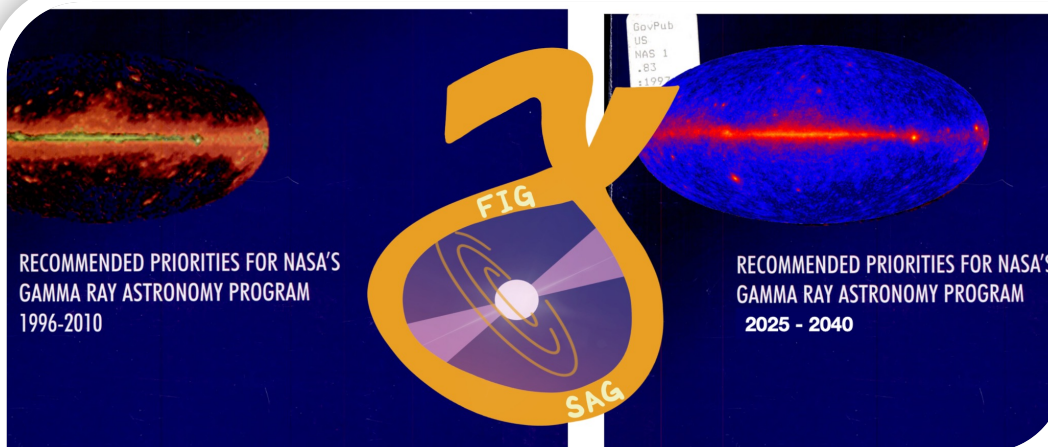
# ScientiFika



<https://scientifika.se/>

# Service & Outreach

<https://science.nasa.gov/astrophysics/programs/physics-of-the-cosmos/community/fig-sag/>



Better  
Astronomy  
for  
Next  
Generation!



<https://pages.astro.umd.edu/events/past/bang/>

# GRAD MAP

Graduate Resources Advancing Diversity with Maryland Astronomy and Physics

A Graduate Student-led Diversity Initiative

Milena Crnogorčević - Co-lead (ASTR)  
Andrew Guo - Co-lead (PHYS)  
Amy Steele - Advisor (ASTR)



UNIVERSITY OF MARYLAND

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Global Relay of Observatories Watching Transients Happen



<https://glast.sites.stanford.edu/fermi-mentoring-program-mp>

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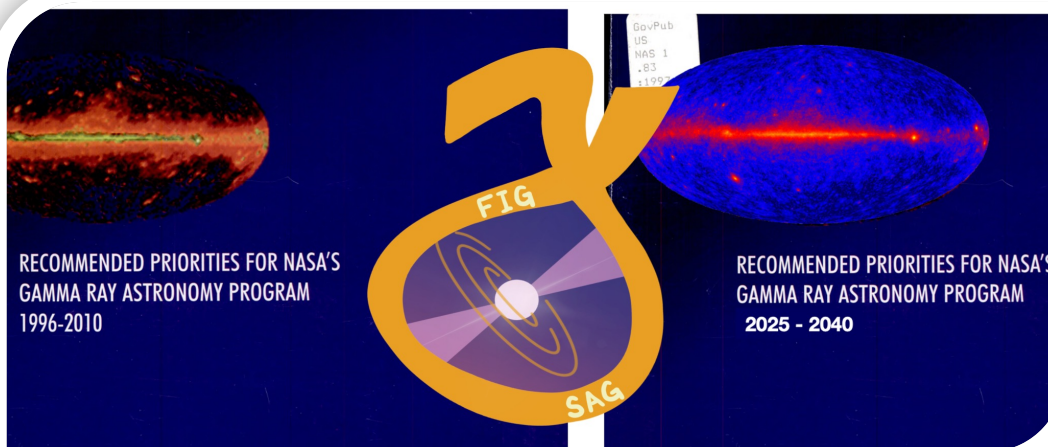


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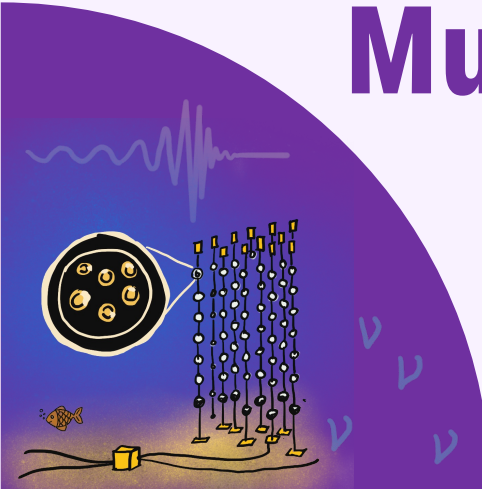


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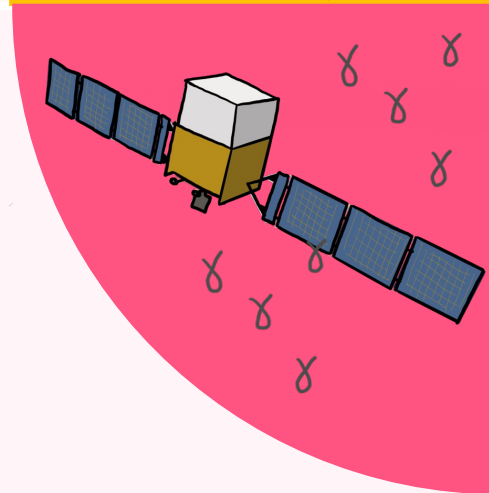
**Dark Matter  
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**Multimessenger  
astronomy**



**Gamma-ray  
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