Universidad Católica del Norte

DM HUNTERS

lawphysics
Latin American Webinars on Physics

Las partículas del Universo

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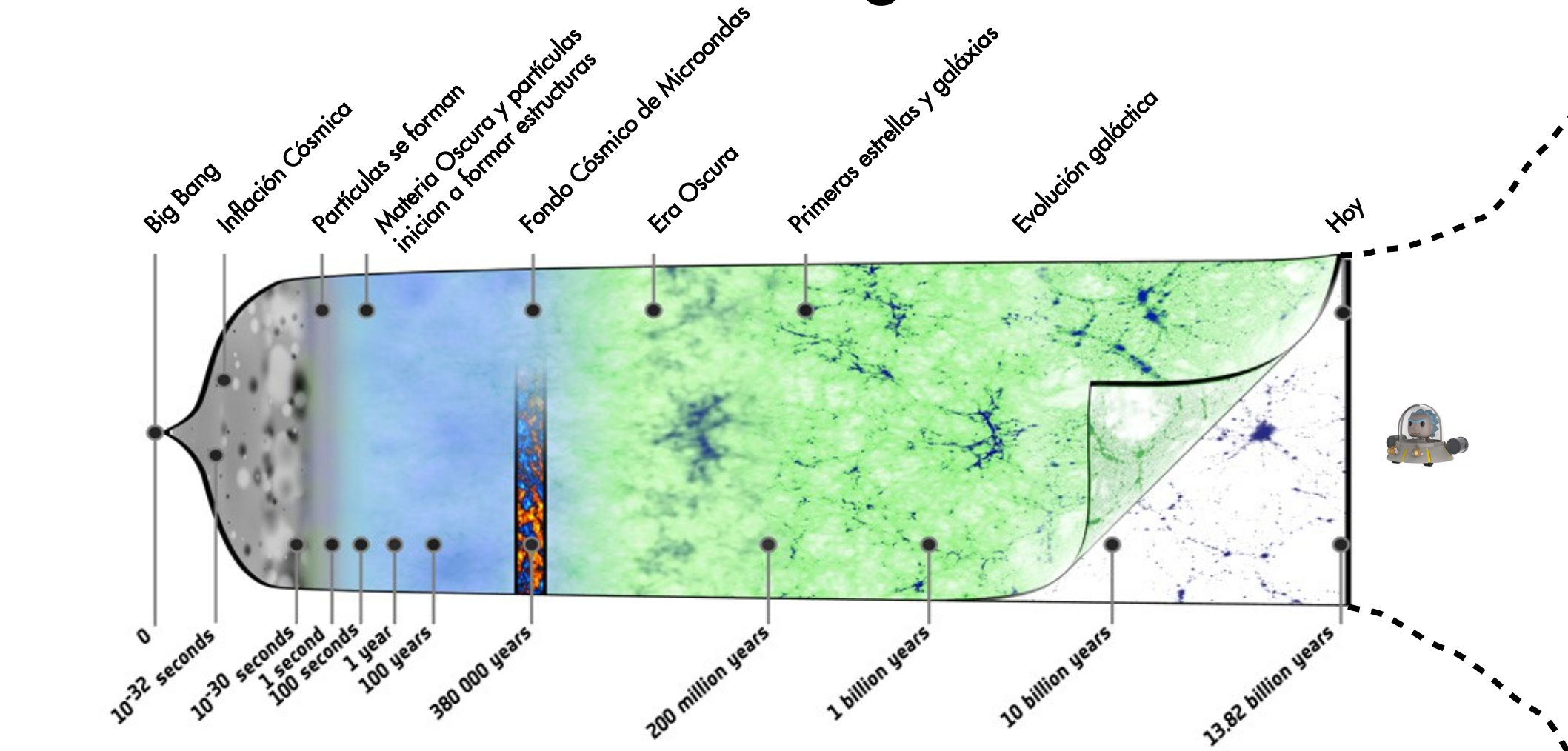
Departamento de Física, Universidad Católica del Norte

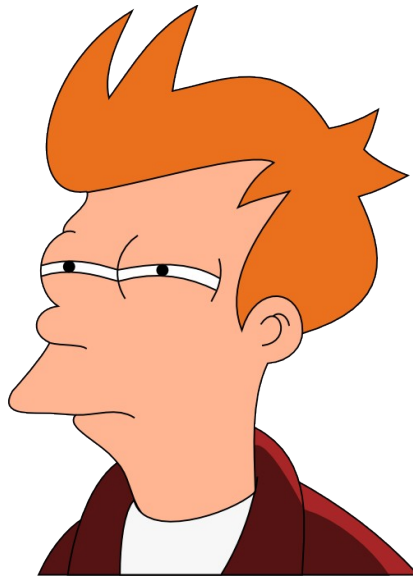
ASTRONOMICAL BEER

¿Por qué la noche es oscura?

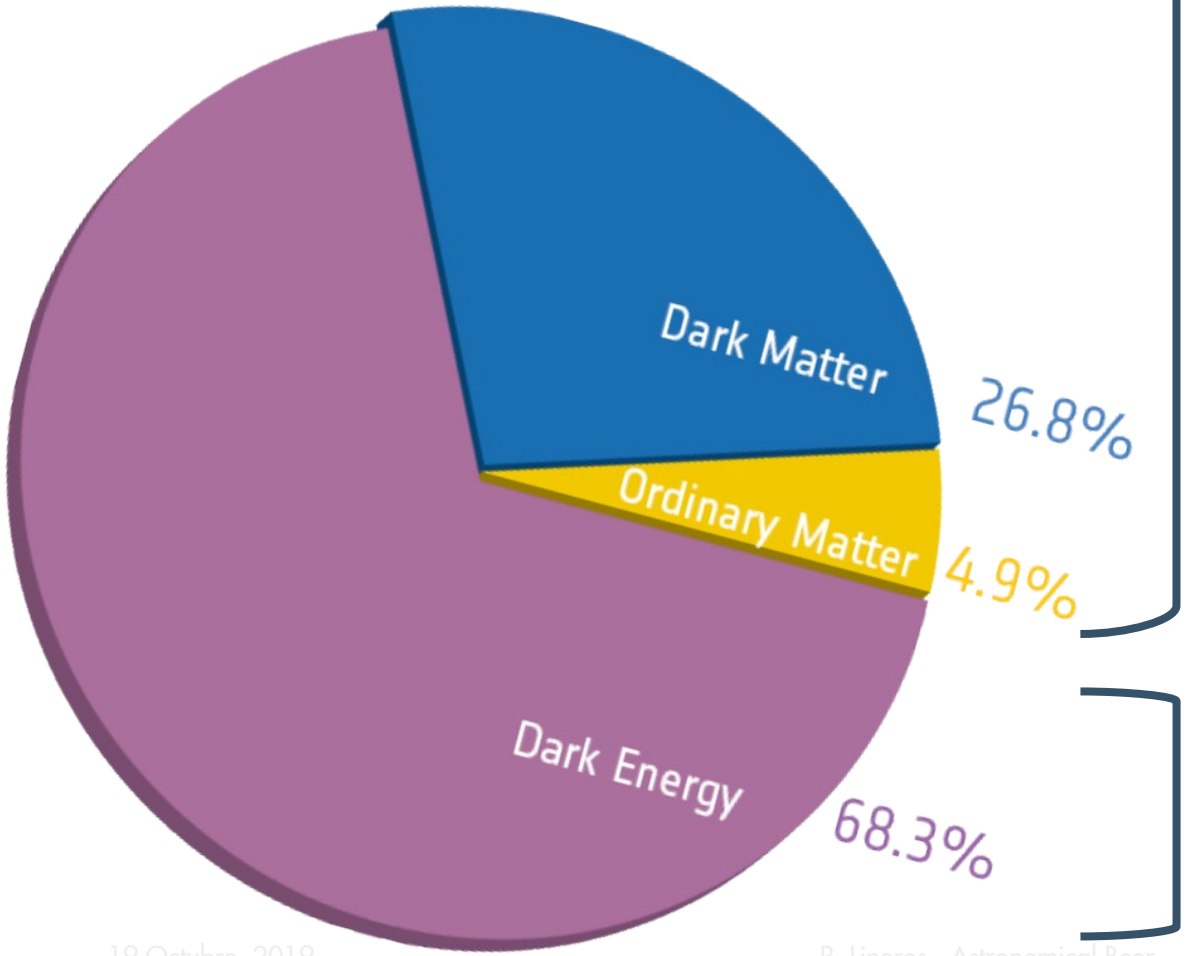
El Universo en un bang!



¿De que está hecho el Universo?



Tarta Cósmica



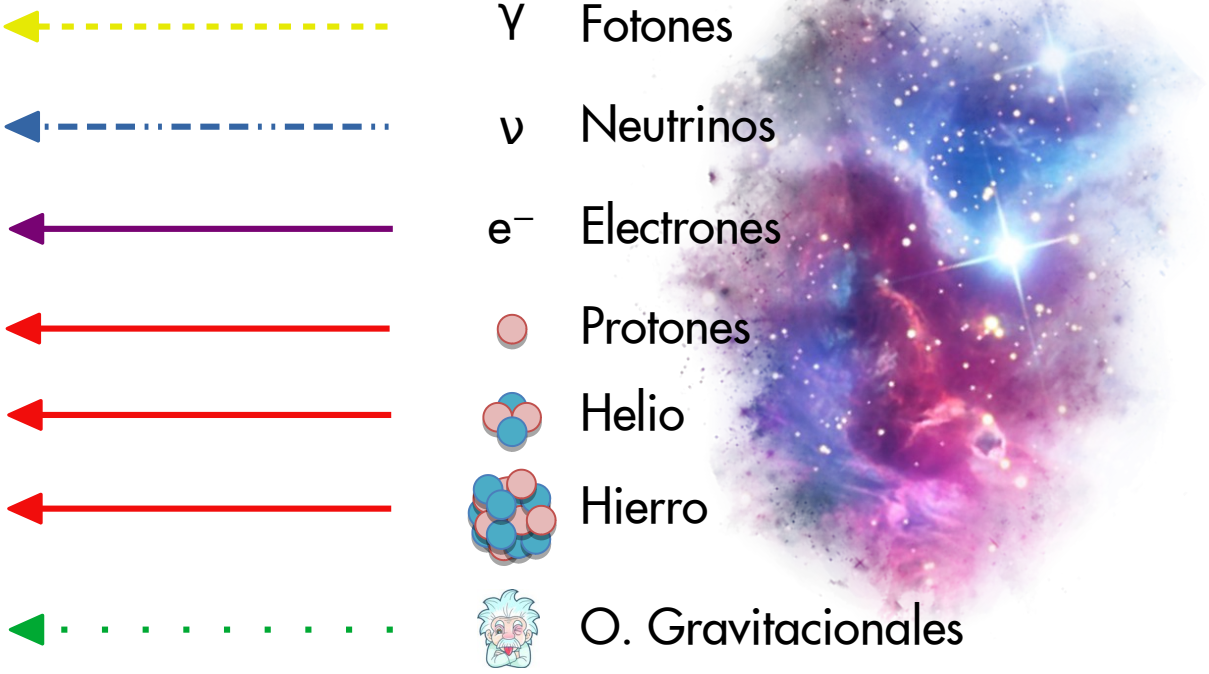
La materia en el Universo es

- 15.4% Materia Ordinaria
- 84.5% **Materia Oscura**

Energía Oscura

energía del mismo espacio-tiempo,
expansión acelerada del Universo

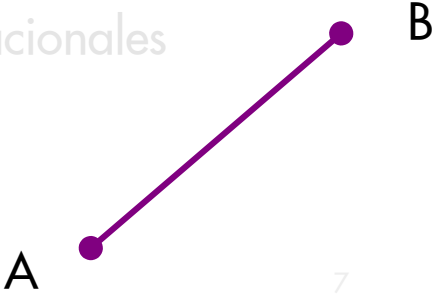
Mensajeros del espacio exterior



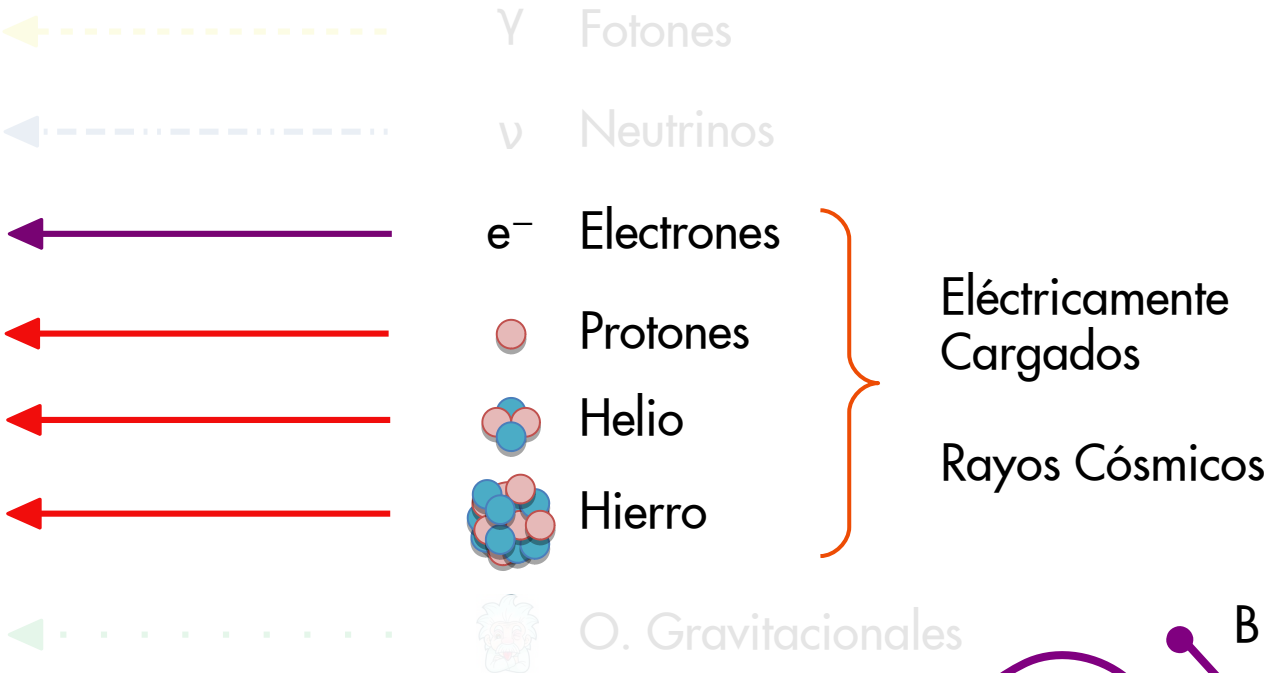
El planeta está constantemente bombardeado por partículas y ondas que son producto de la actividad del Universo

Mensajeros del espacio exterior

Viajan en linea recta.



Mensajeros del espacio exterior

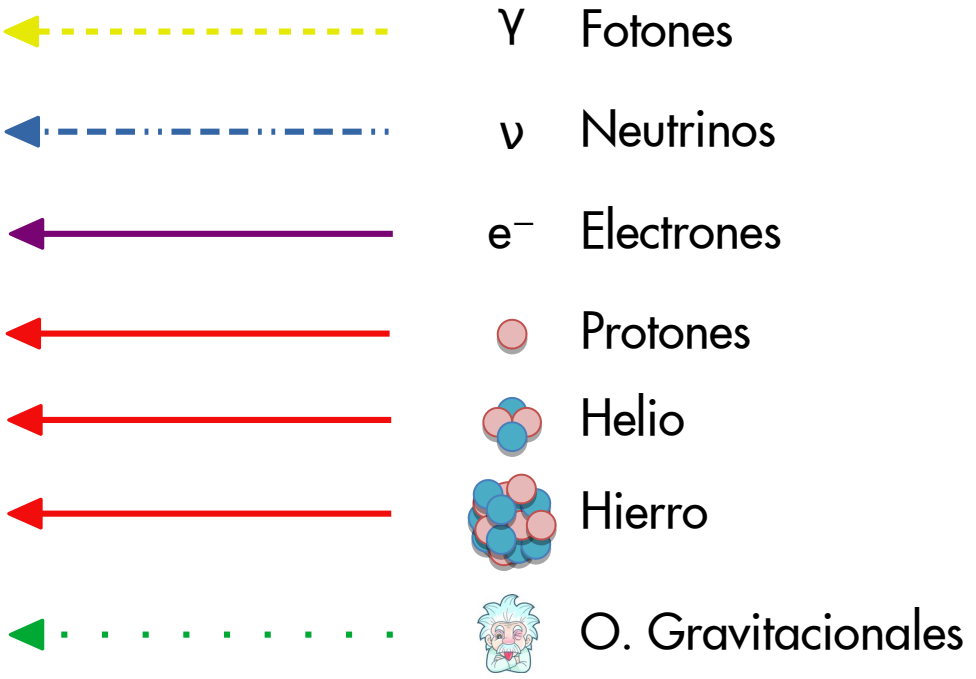


Se desvían debido a los campos magnéticos

Mensajeros del espacio exterior

Pequeñas perturbaciones del espacio producidas por objetos muy masivos.

Mensajeros del espacio exterior

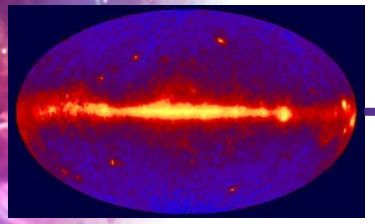


La información que se extrae desde ellos nos sirve para entender mejor:

Astrofísica, Física de Particulas, y Física Fundamental

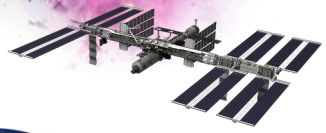
Astropartículas

Producción



Partículas fundamentales

Propagación



Observación

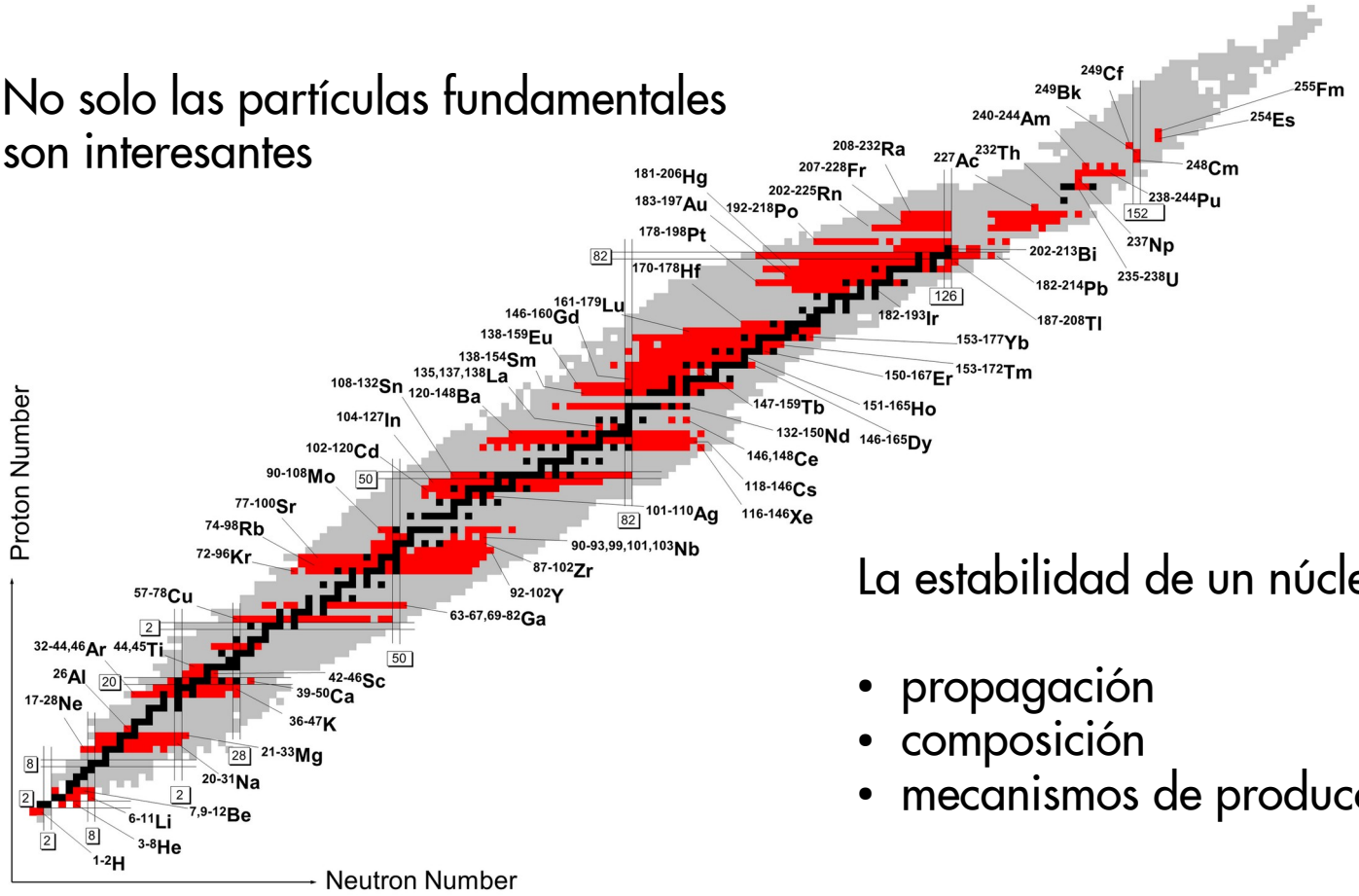
Rayos Cósmicos
Neutrinos
Fotones
O. Gravitacionales

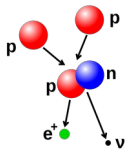
Un poquito de física del Universo

Ladrillos: Tabla periódica

Ladrillos: Física Nuclear

No solo las partículas fundamentales son interesantes



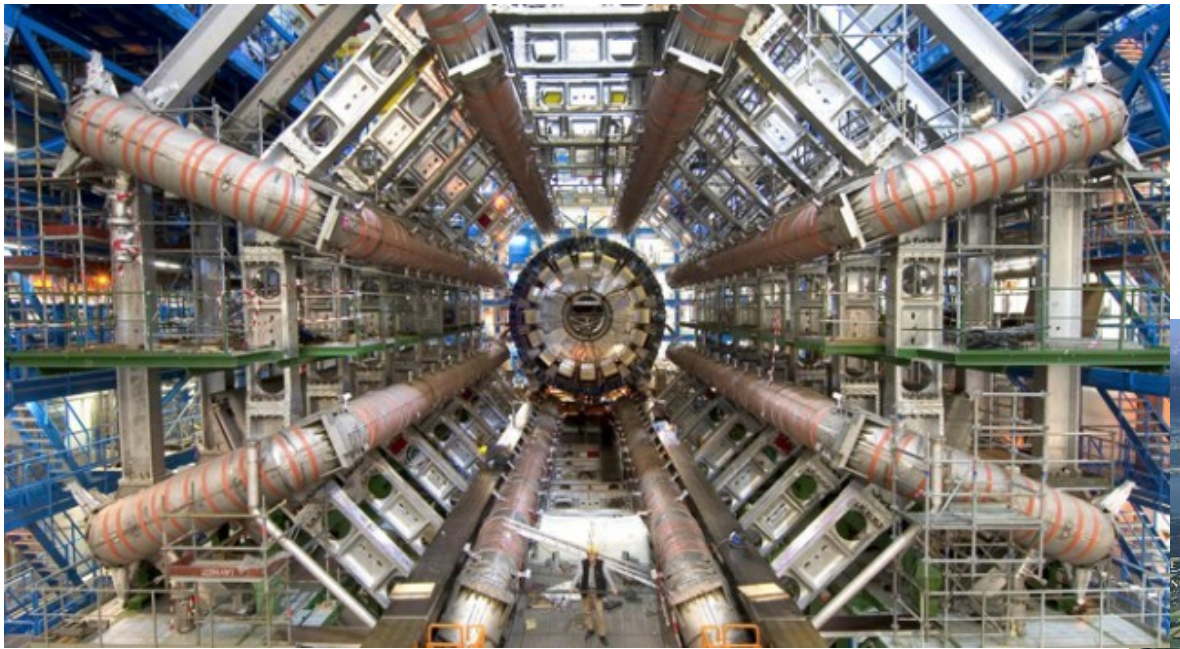


Nucleosíntesis

La estabilidad de un núcleo nos da información

- propagación
- composición
- mecanismos de producción

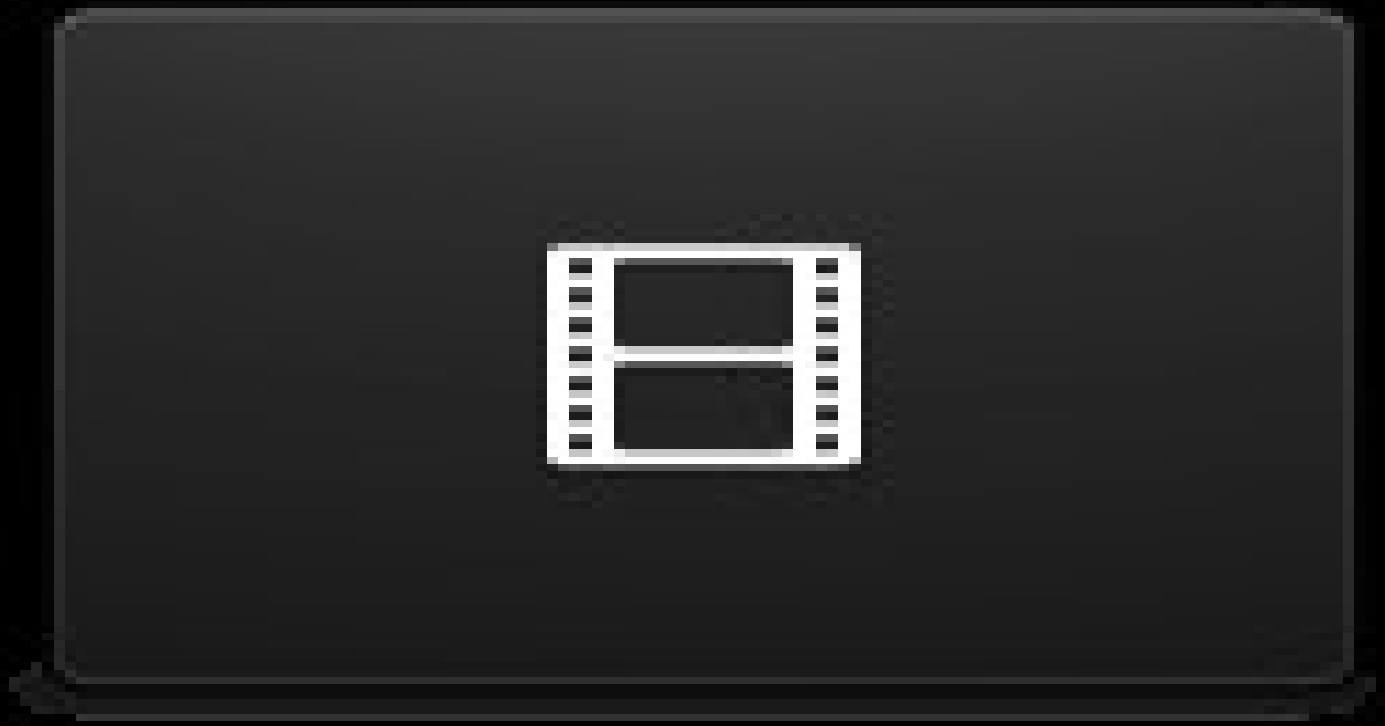
¿Cómo buscar lo fundamental?



Detector ATLAS

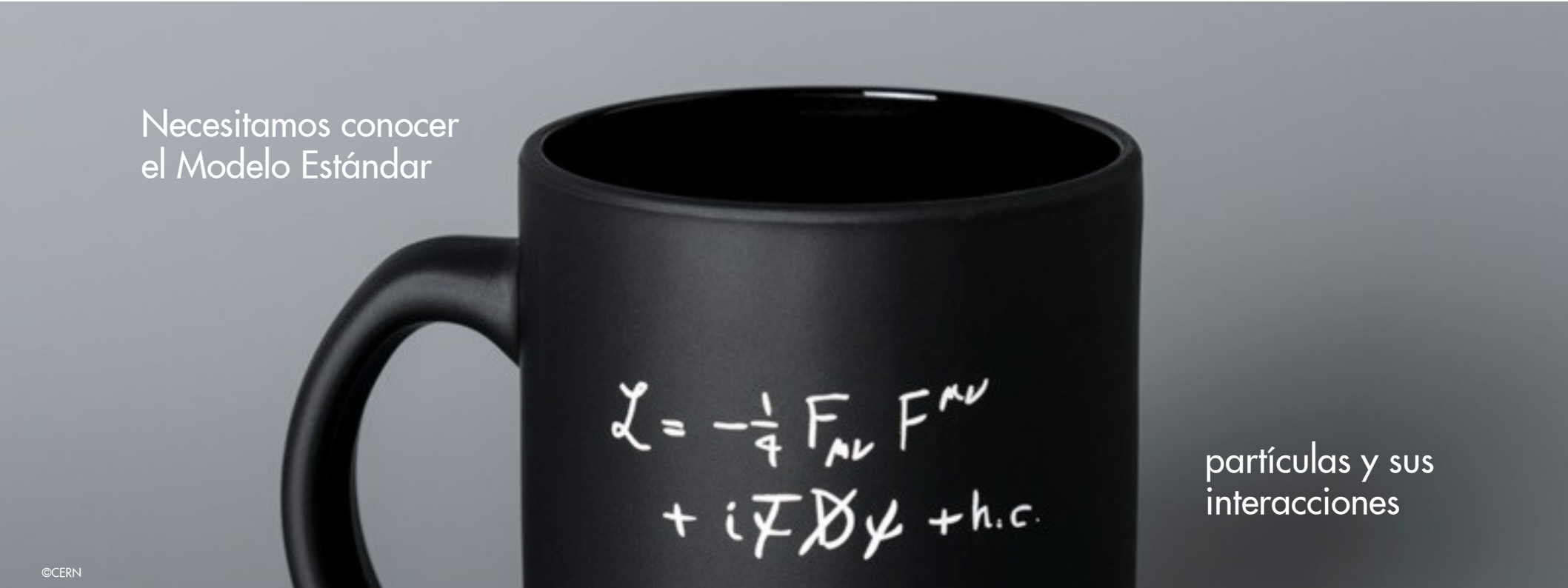
Gran colisionador de hadrones

¿Cómo buscar lo fundamental?



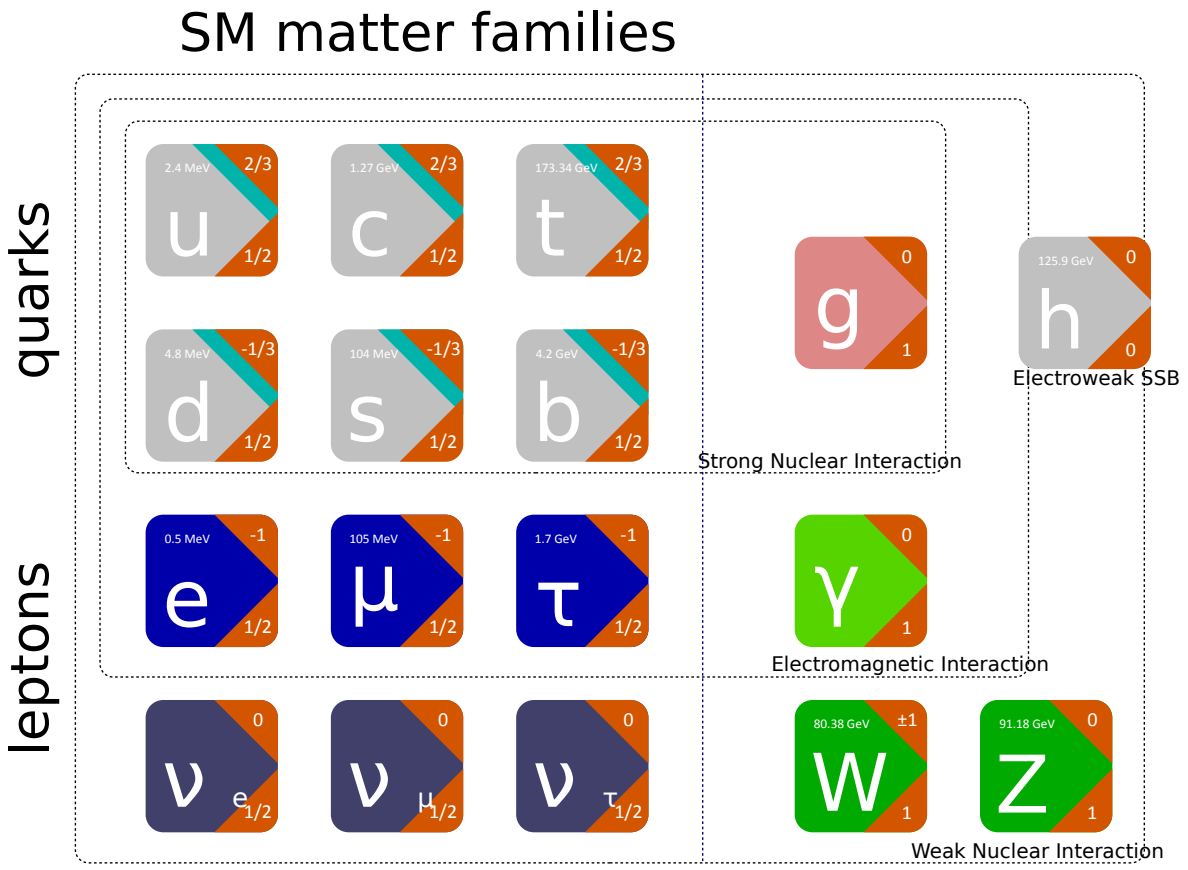
Ladrillos fundamentales

Para entender a las astropartículas necesitamos entender porque las partículas se comportan así.

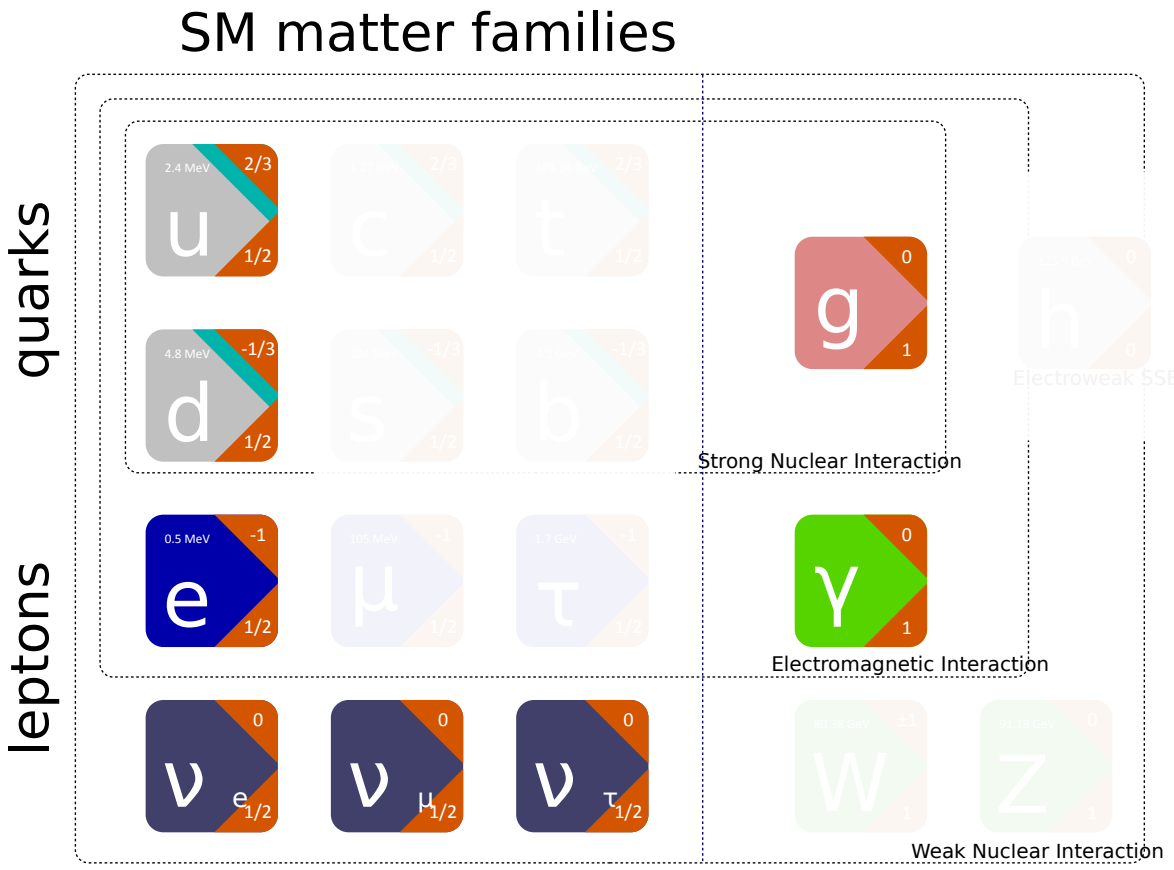


©CERN

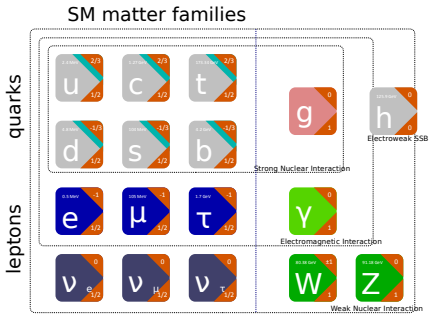
Modelo Estándar de física de partículas

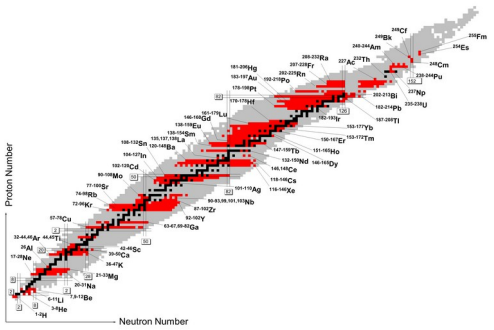


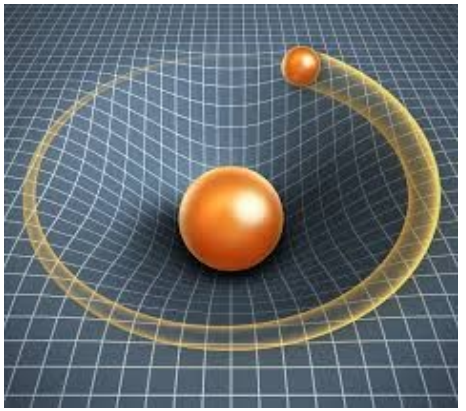
Modelo Estándar de física de partículas



Éxito total!







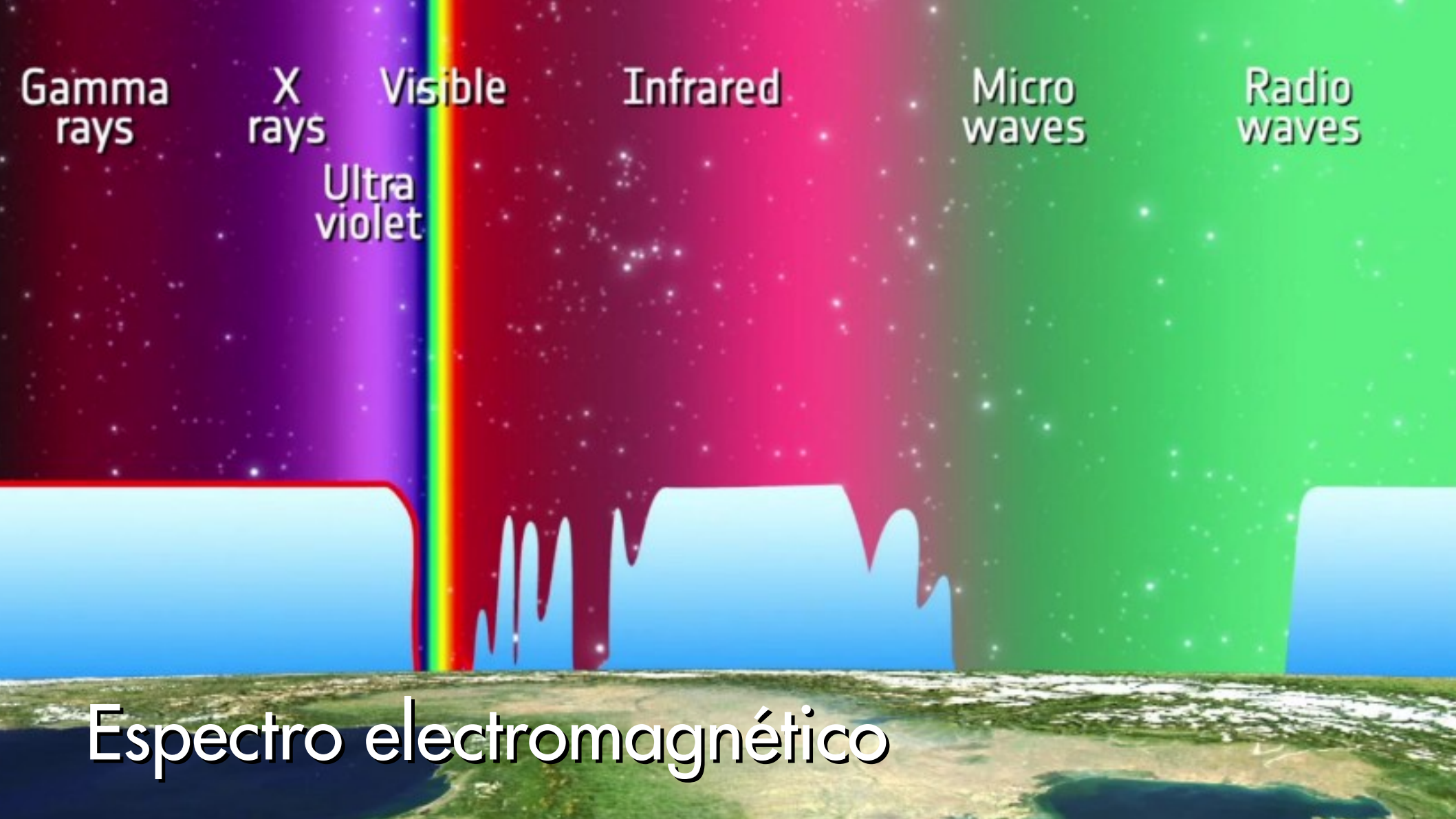
Física de partículas

Física nuclear

Gravedad

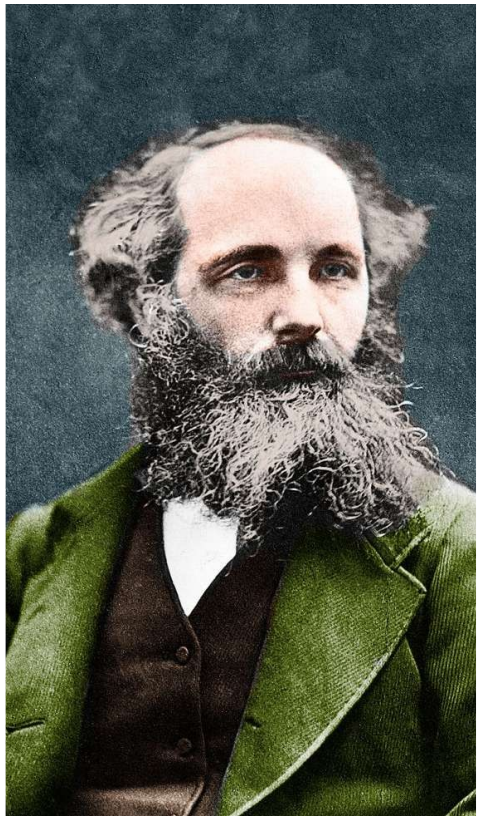
La mejor descripción de los objetos y sus interacciones que nos permiten describir el comportamiento del Universo

Luz y radiación electromagnética



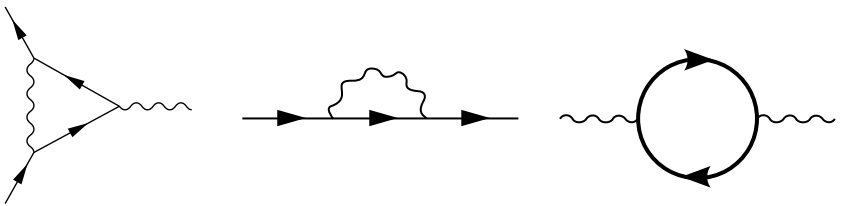
Espectro electromagnético

La luz, la electricidad, y el magnetismo



J. C. Maxwell (entre otros físicos)

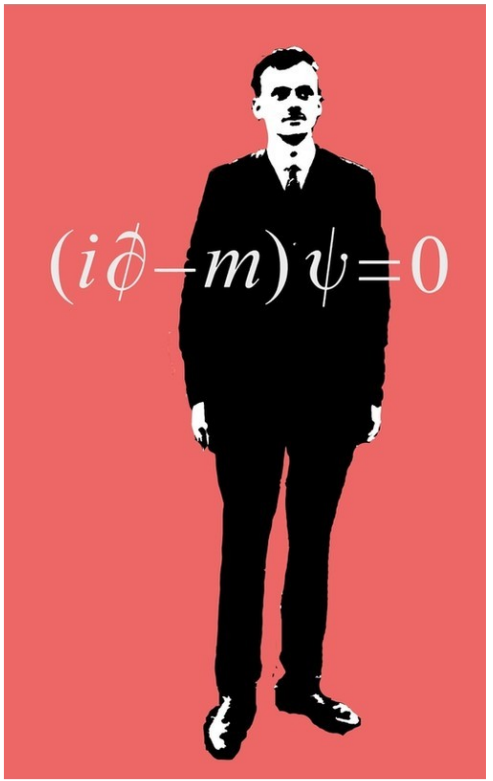
Unificación de la electricidad y el magnetismo.
Descripción de ondas electromagnéticas



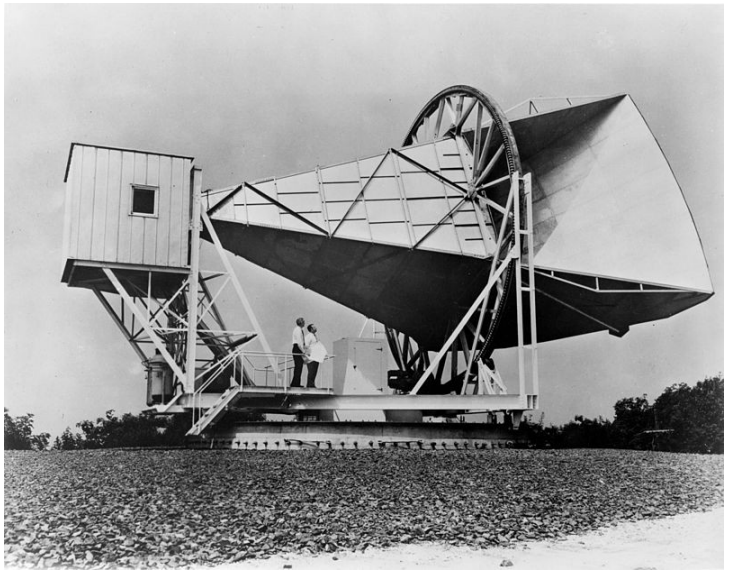
Paul Dirac (entre muchos otros)

Descripción cuántica entre partículas cargadas y el electromagnetismo.

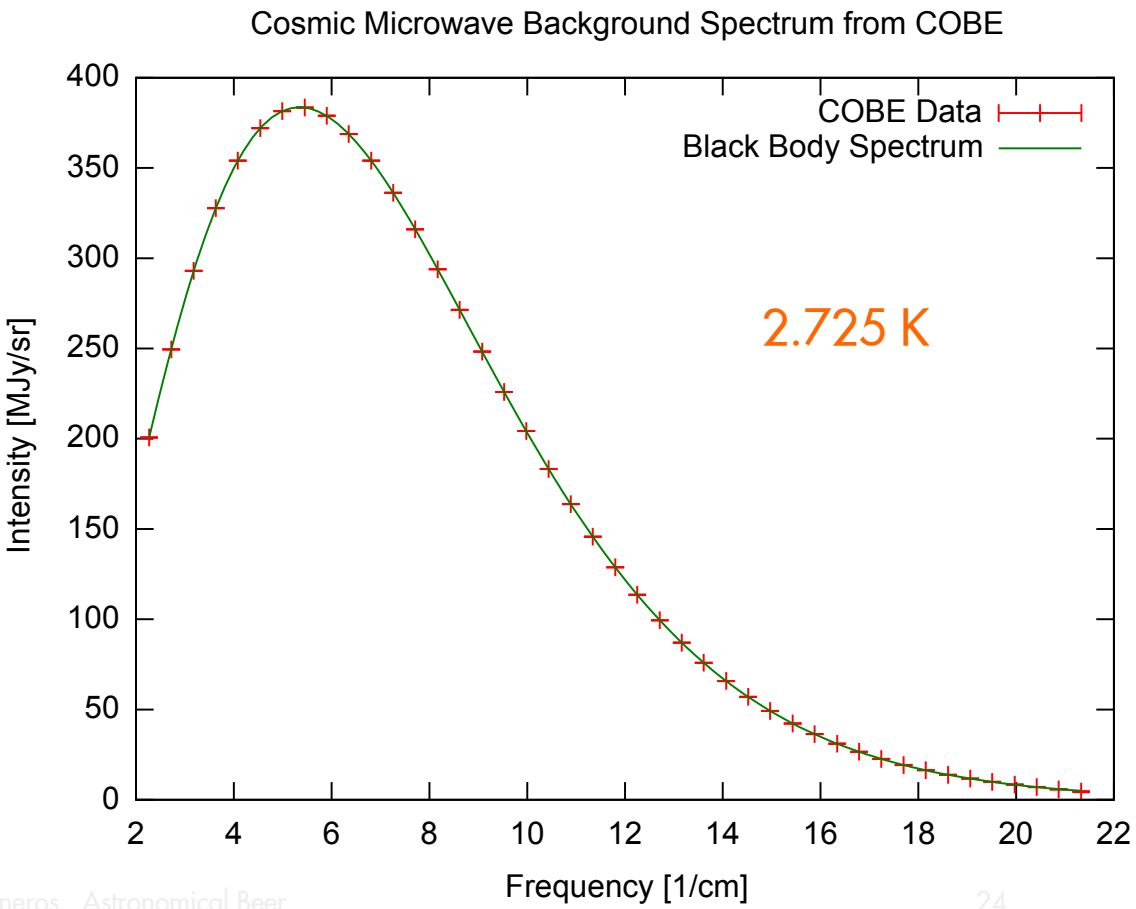
Pilar del Modelo Estándar

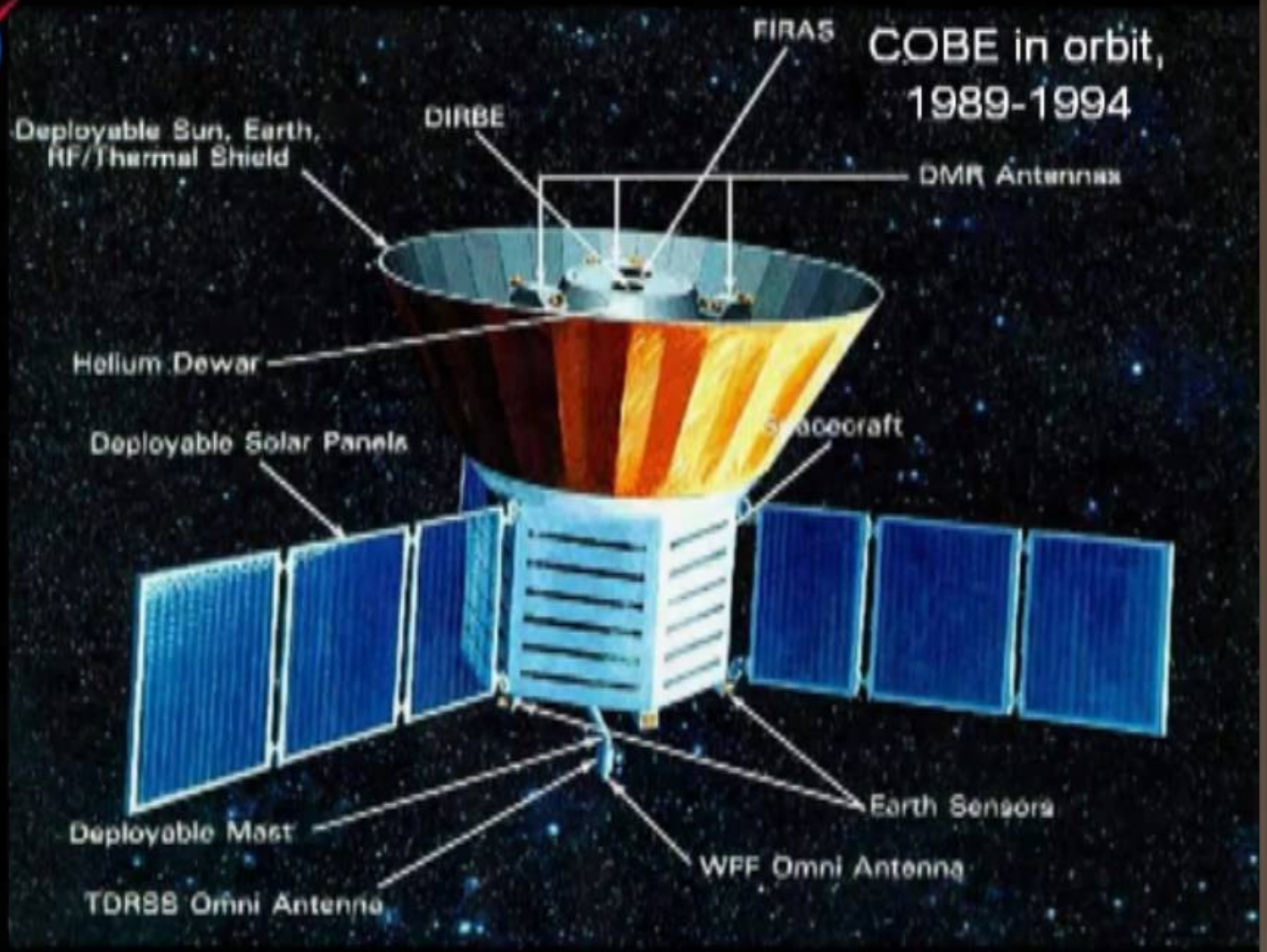


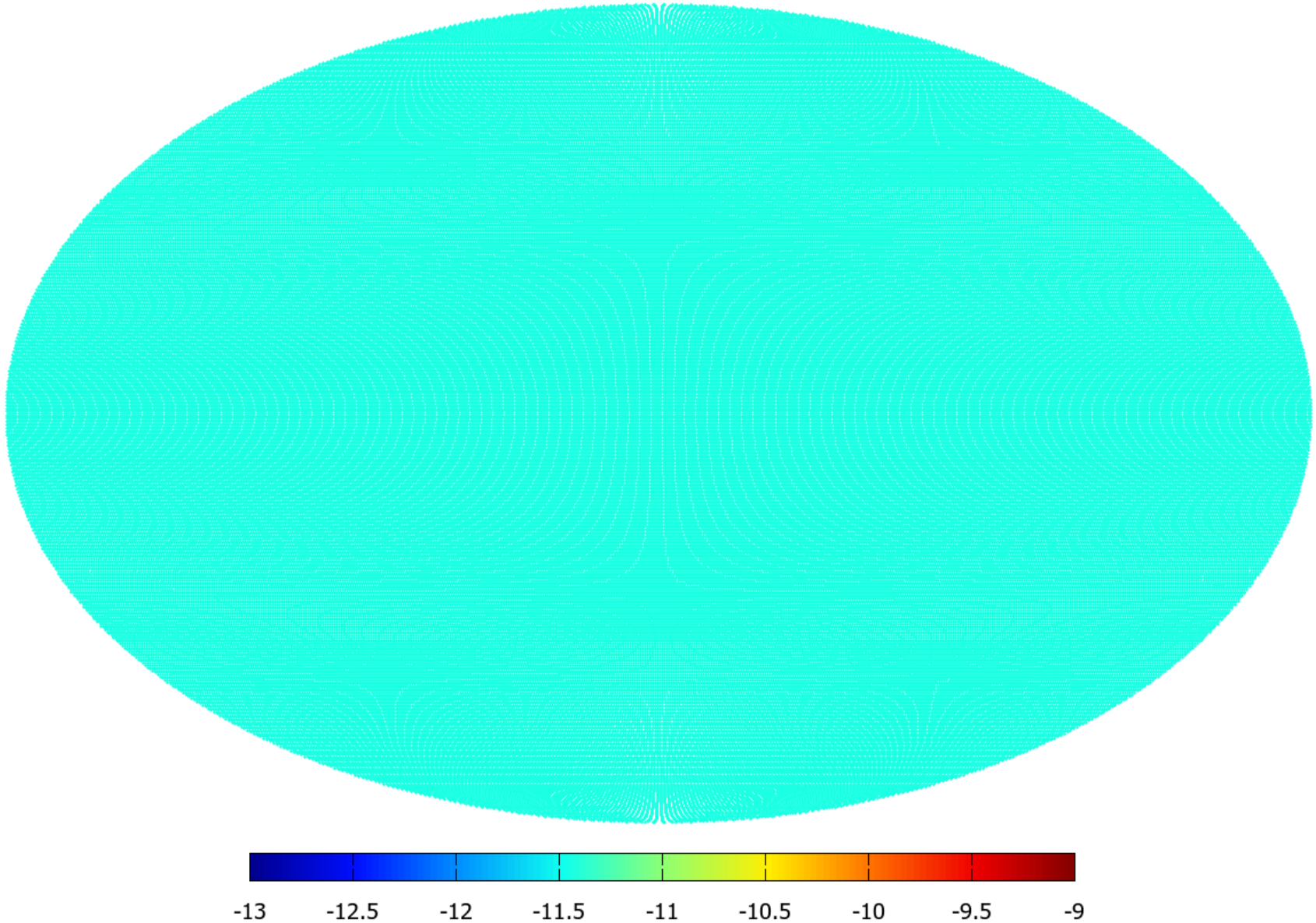
Fondo Cósmico de Microondas



Penzias y Wilson descubren este fondo usando una antena




COBE in orbit,
1989-1994
FIRAS
DIRBE
Deployable Sun, Earth, RF/Thermal Shield
DMR Antennas
Helium Dewar
Deployable Solar Panels
Spacecraft
Earth Sensors
Deployable Mast
WFF Omni Antenna
TDRSS Omni Antenna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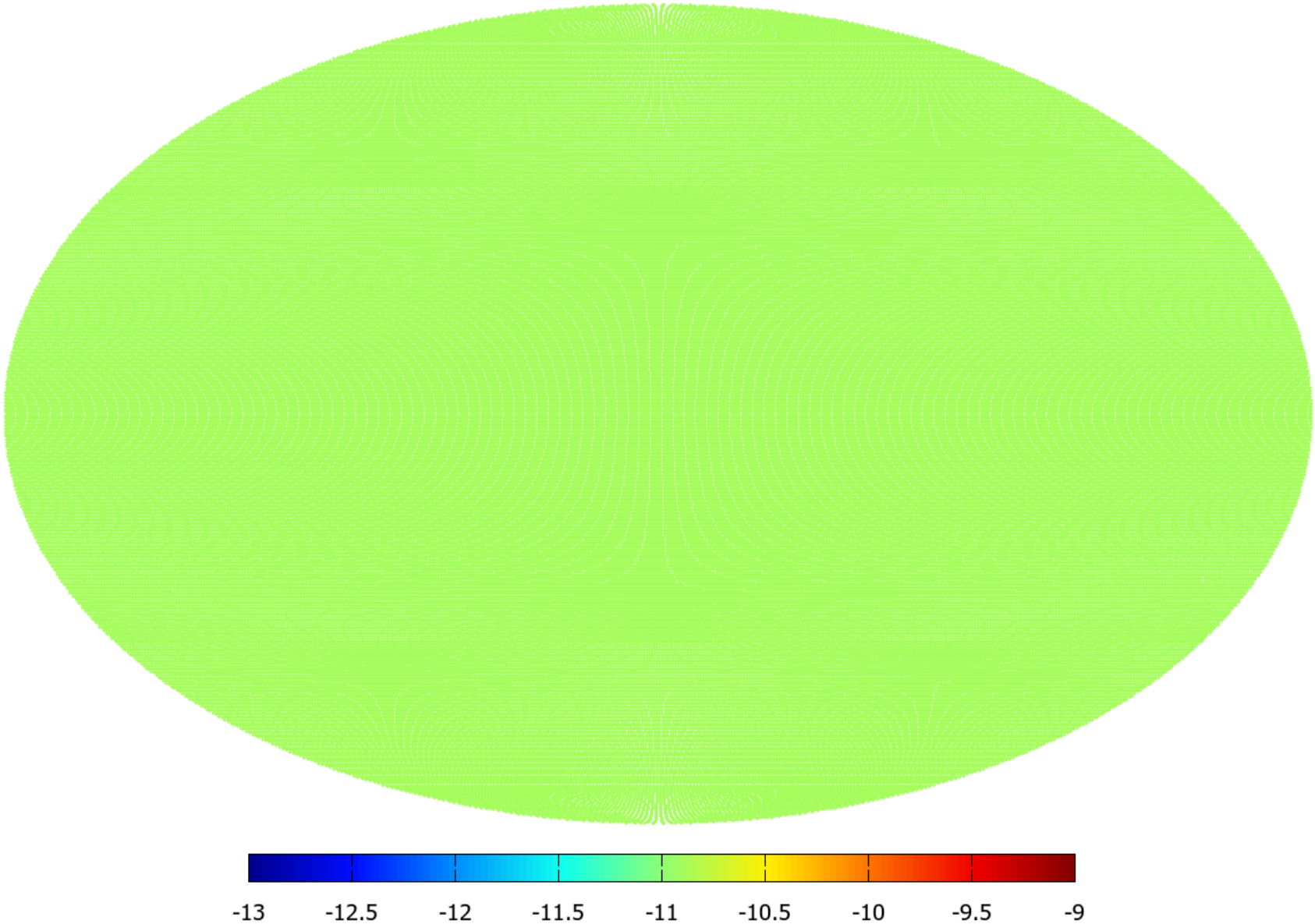
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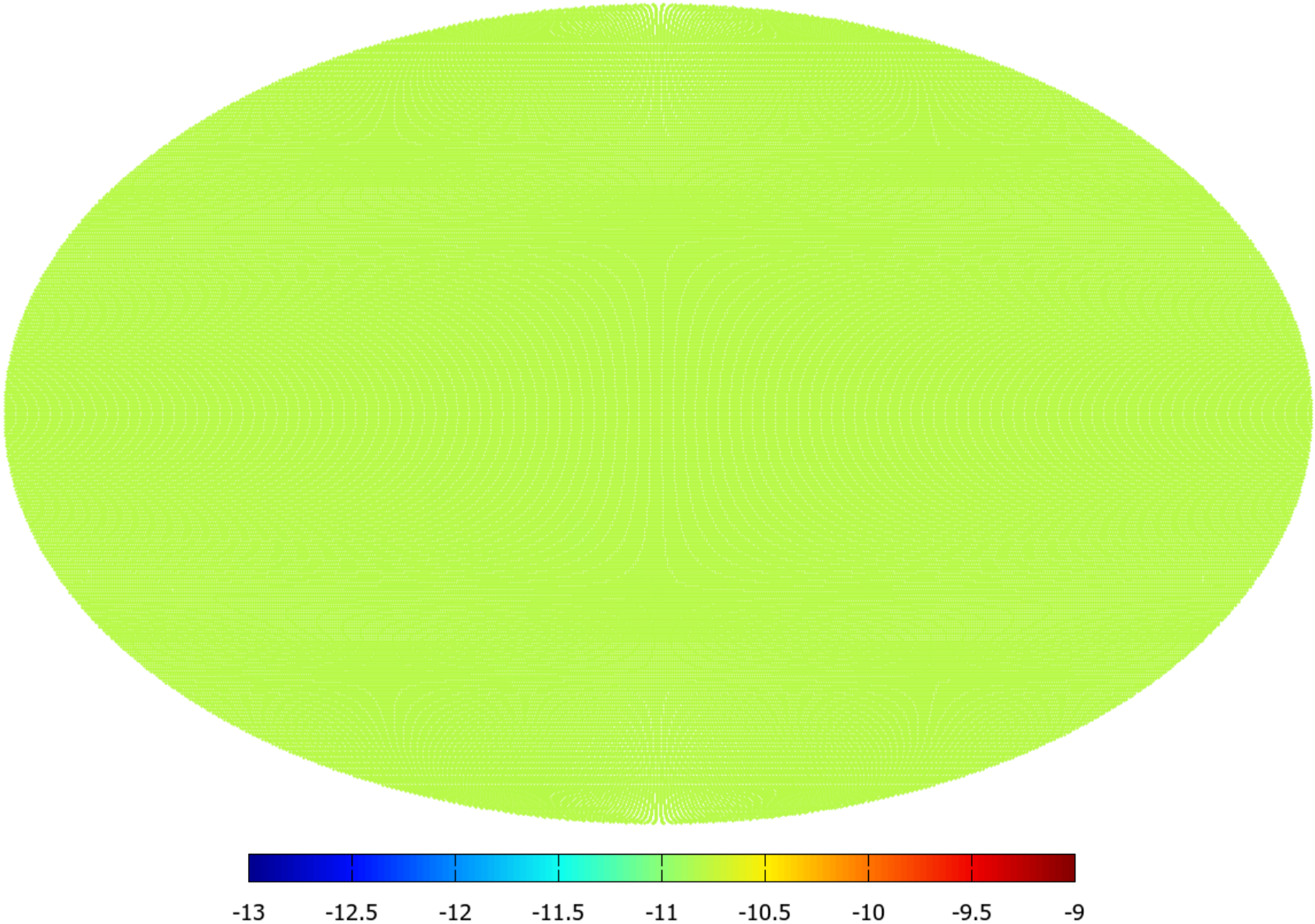
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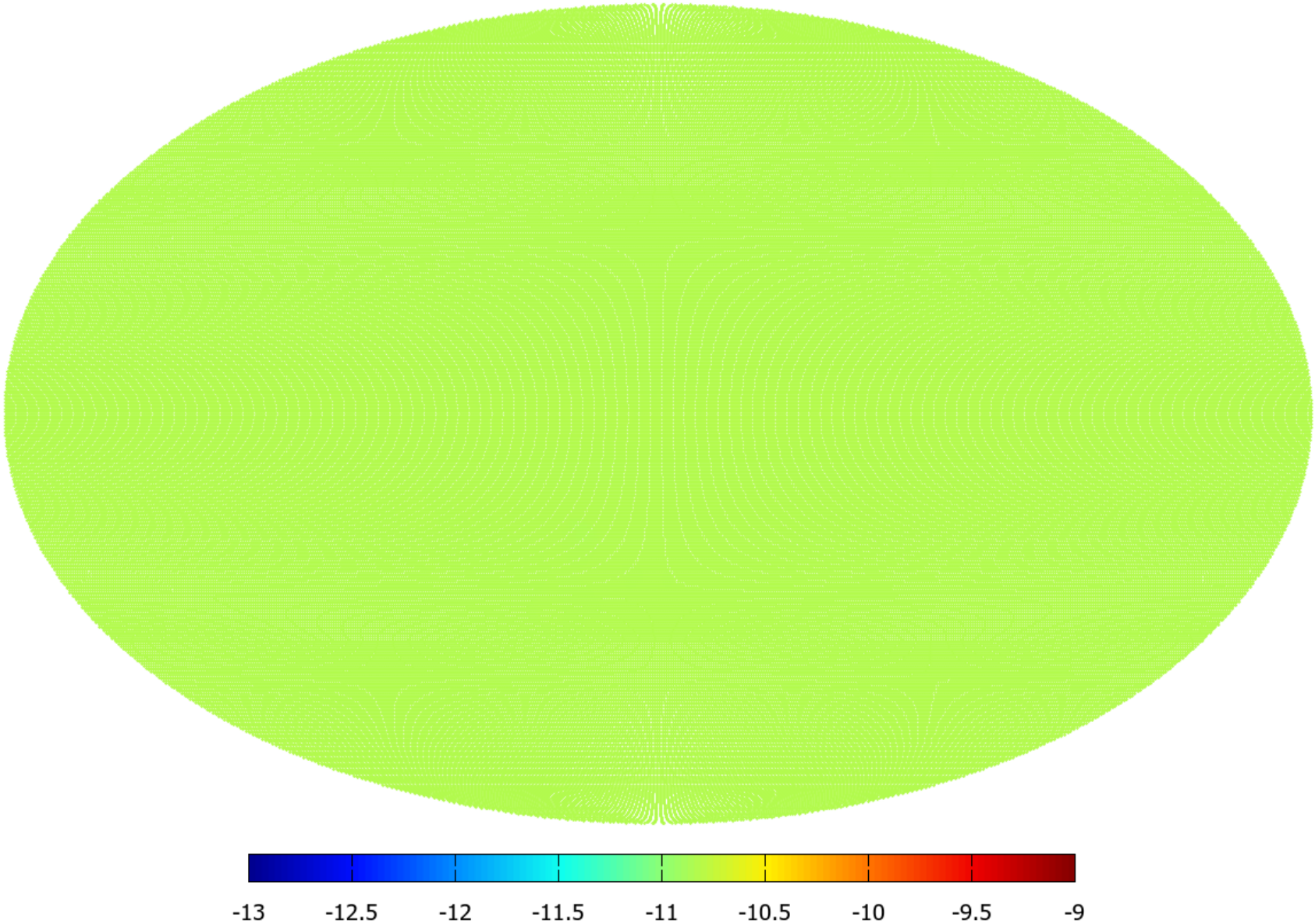
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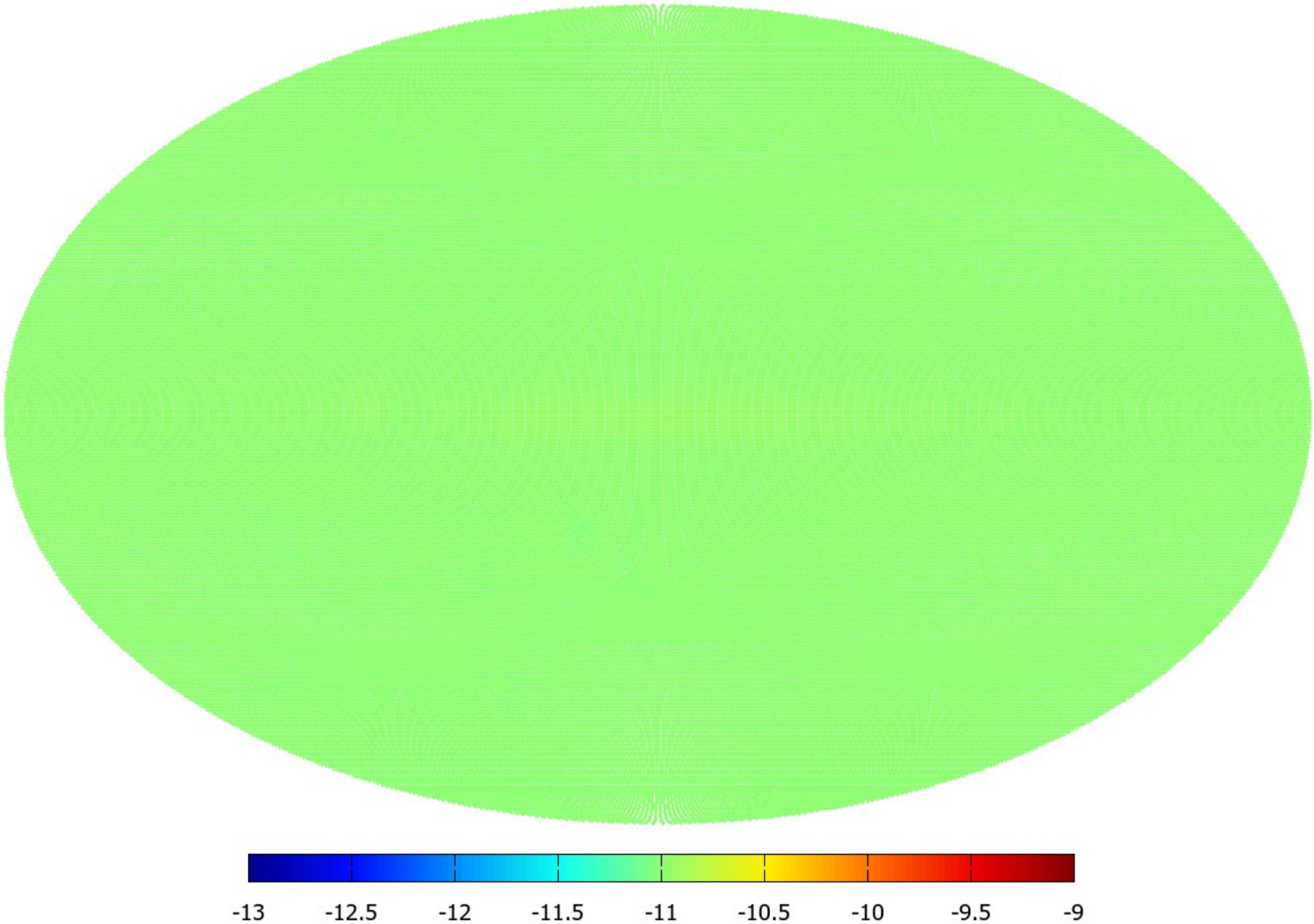
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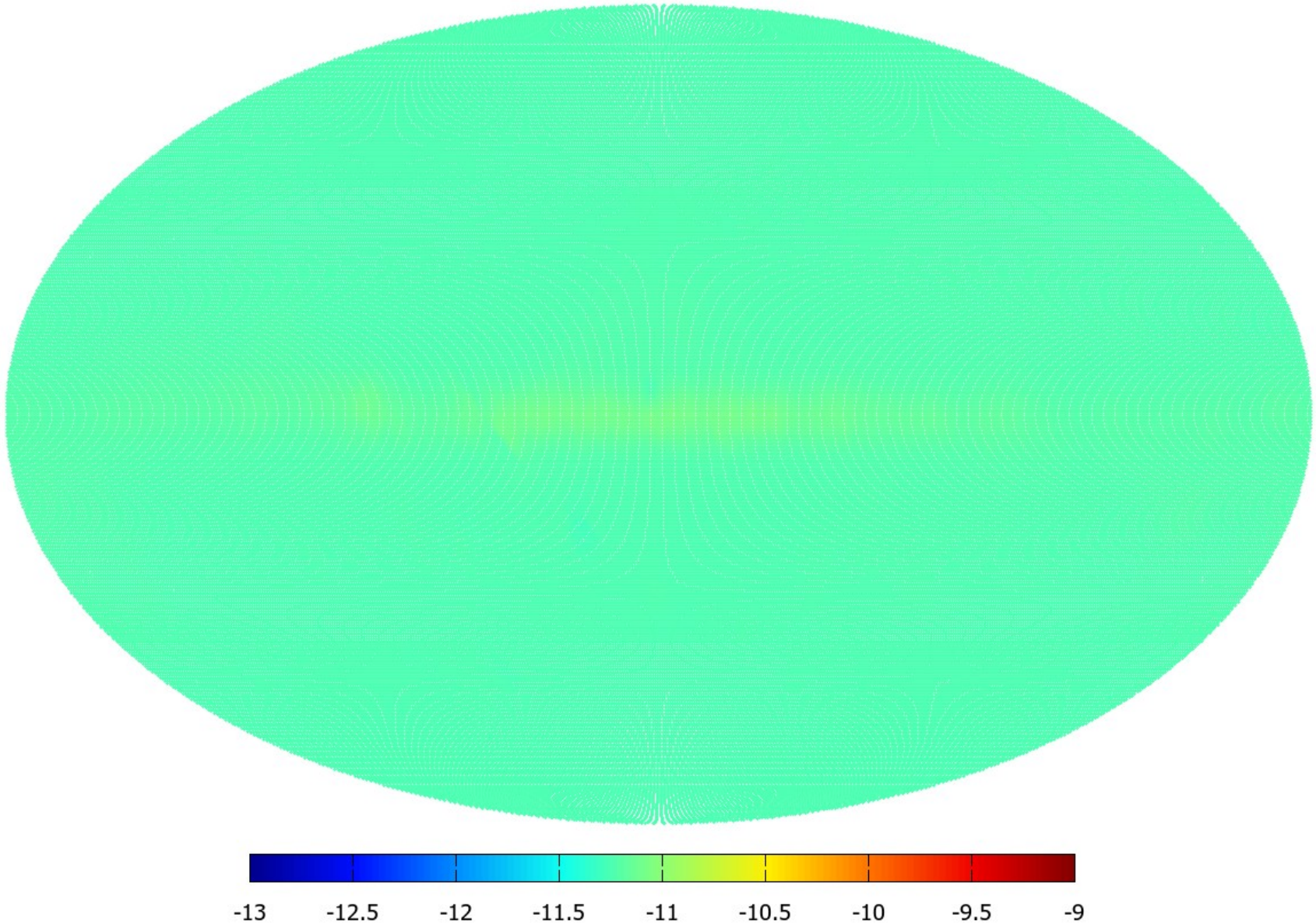
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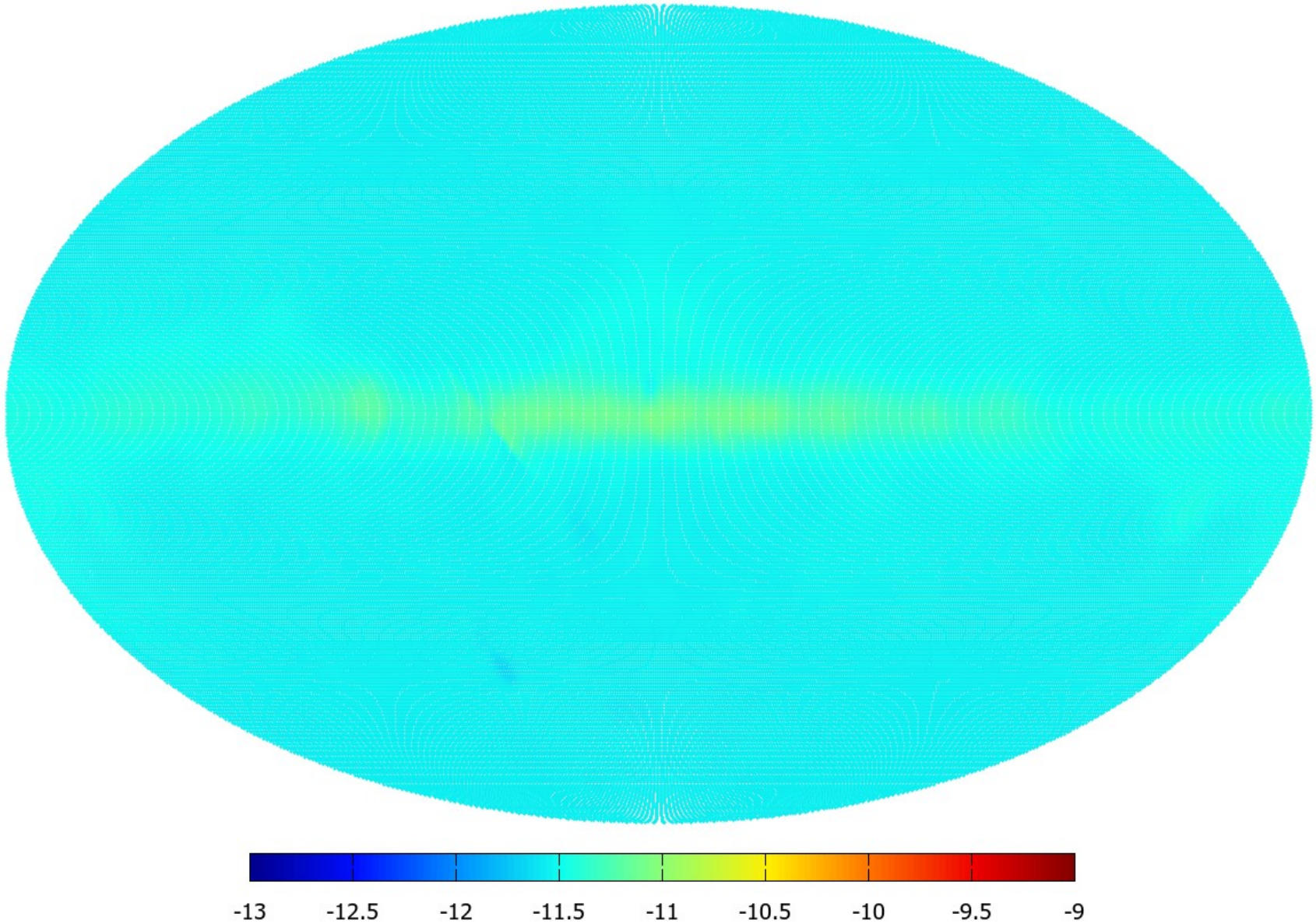
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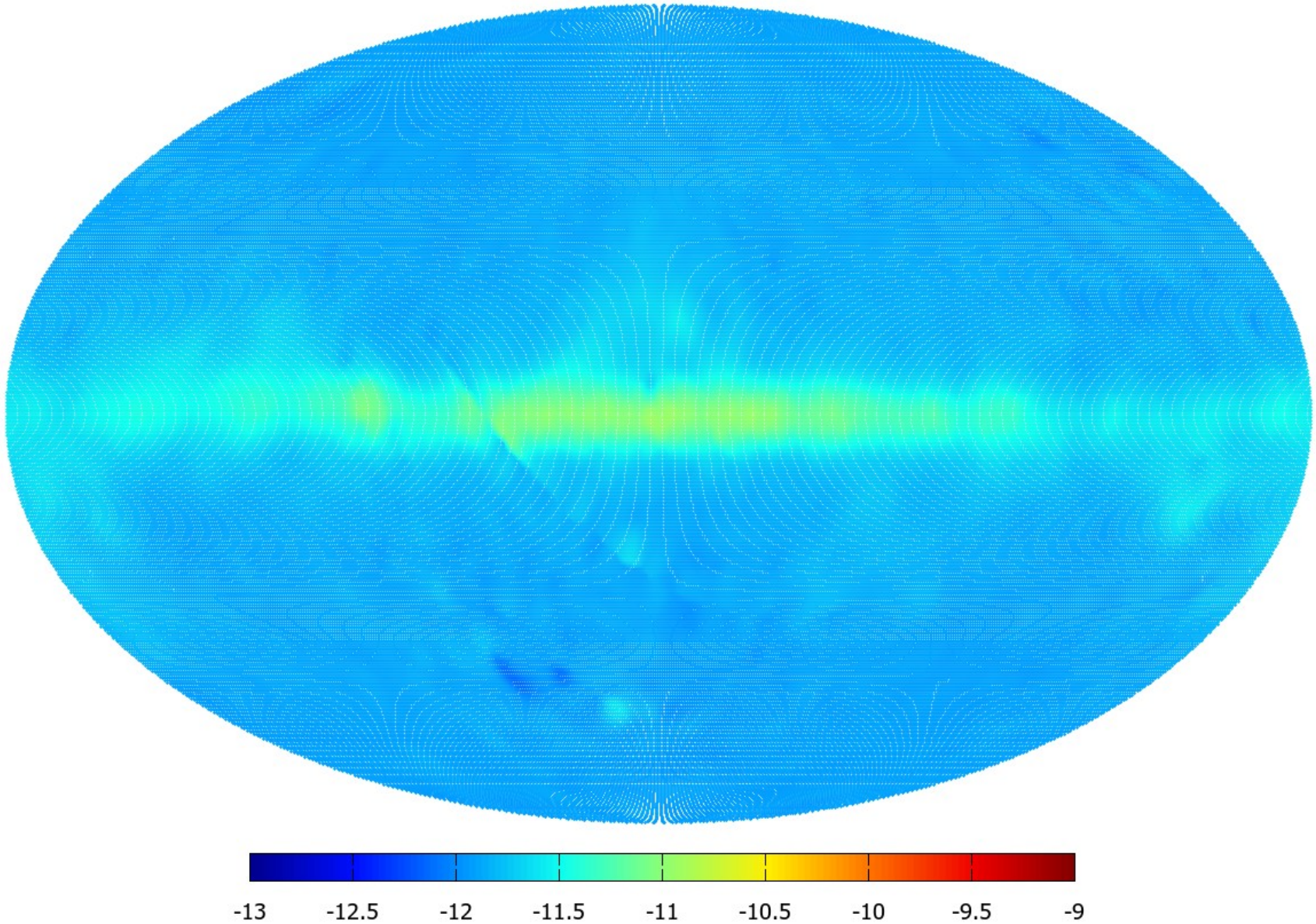
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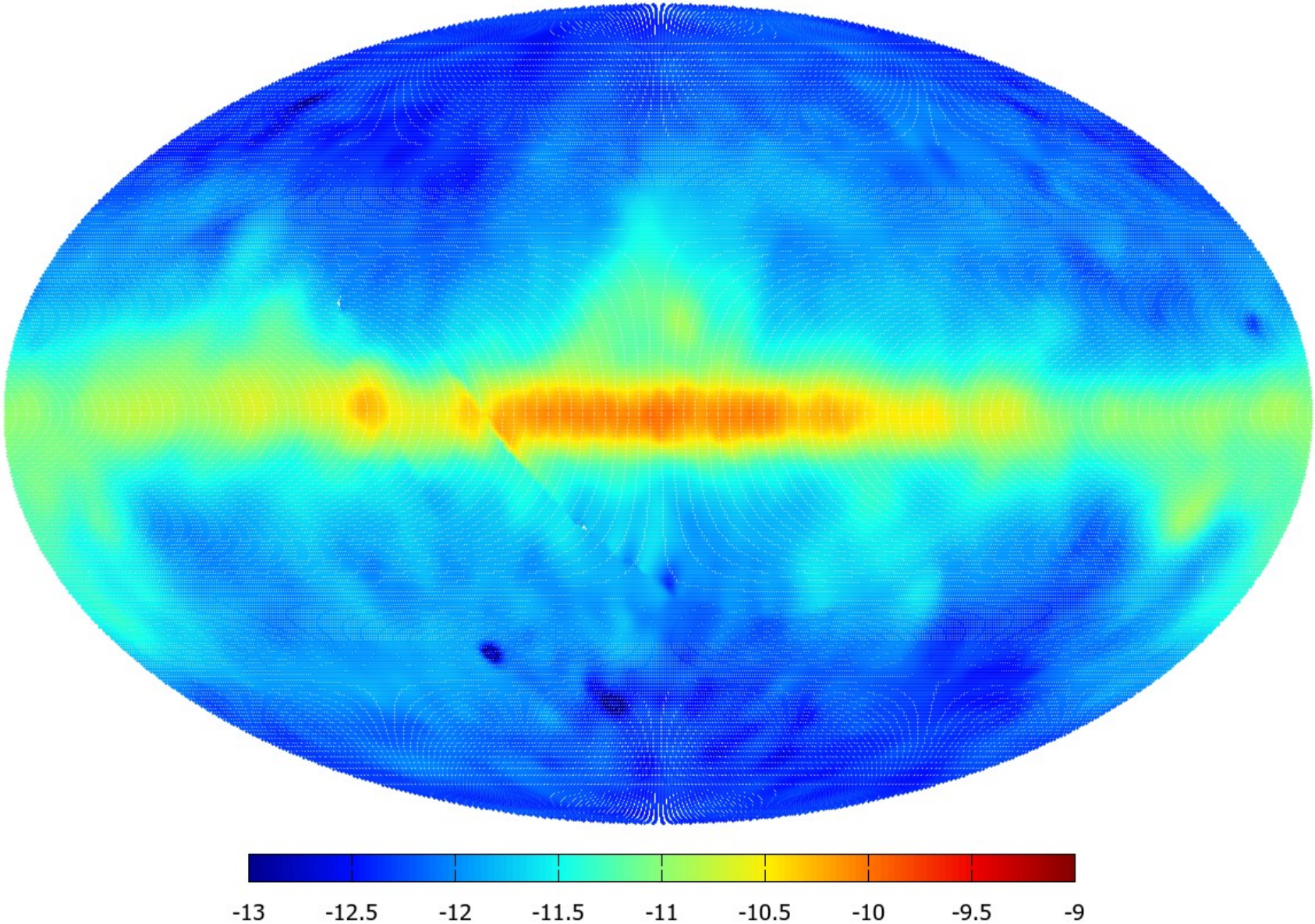
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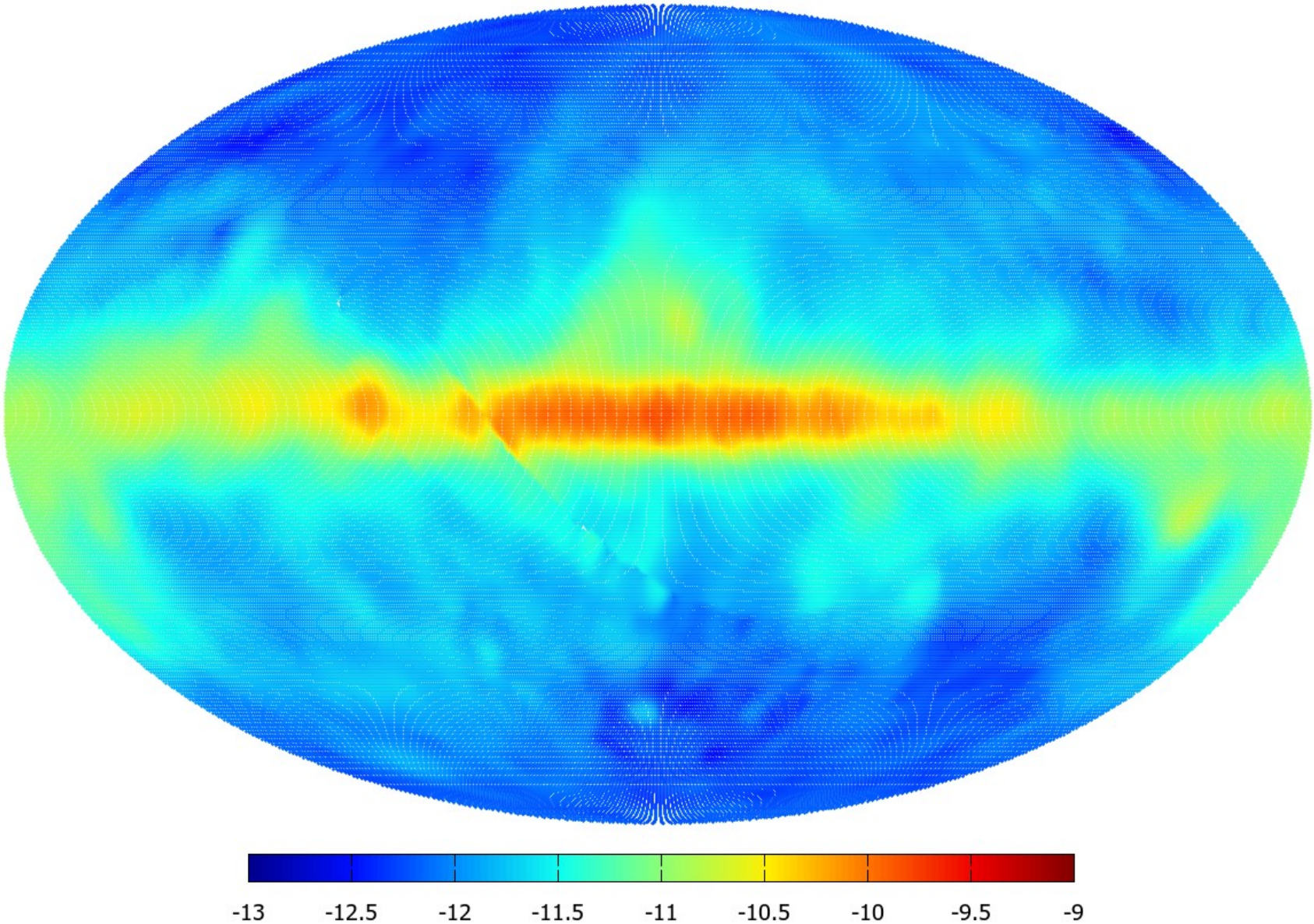
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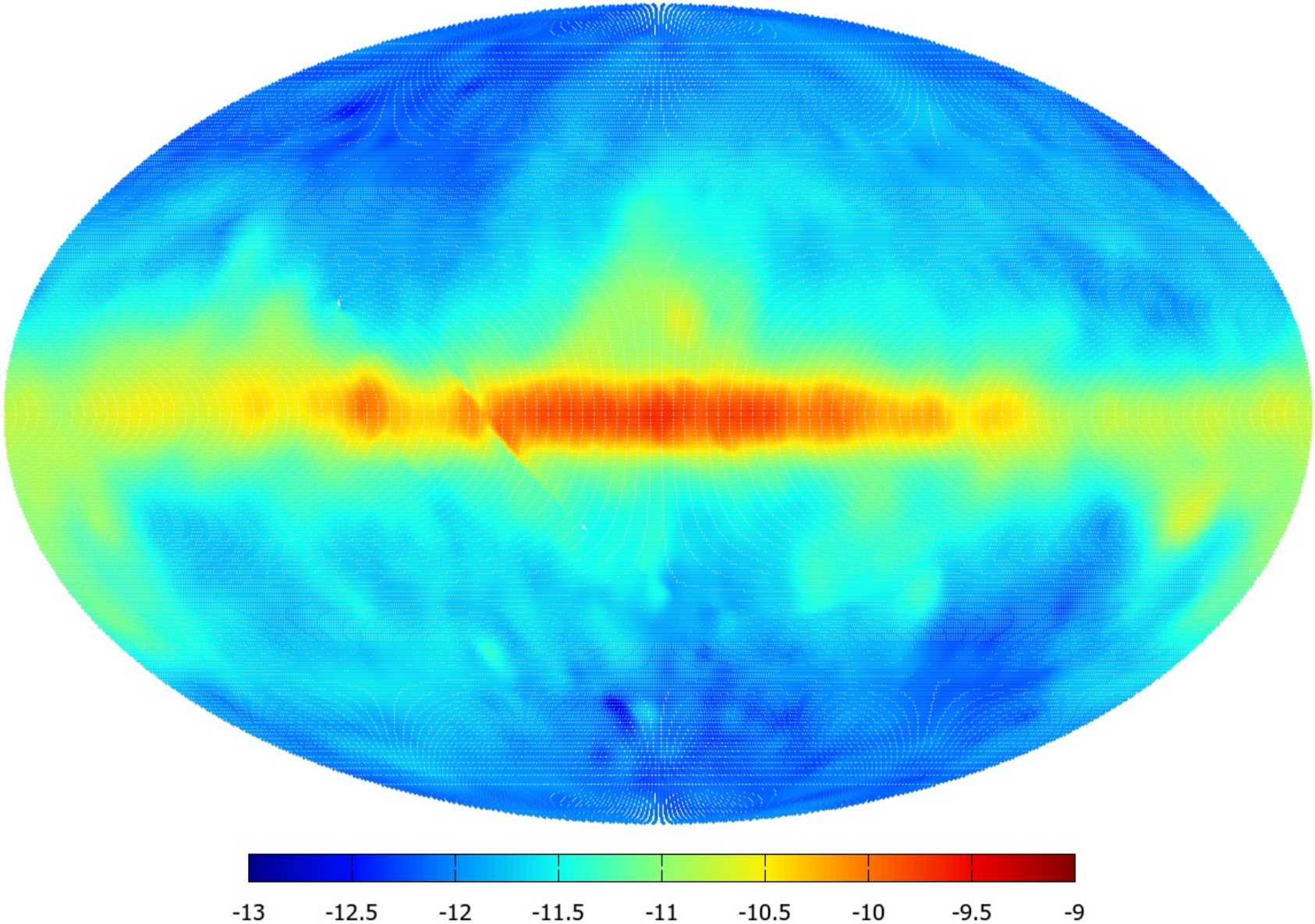
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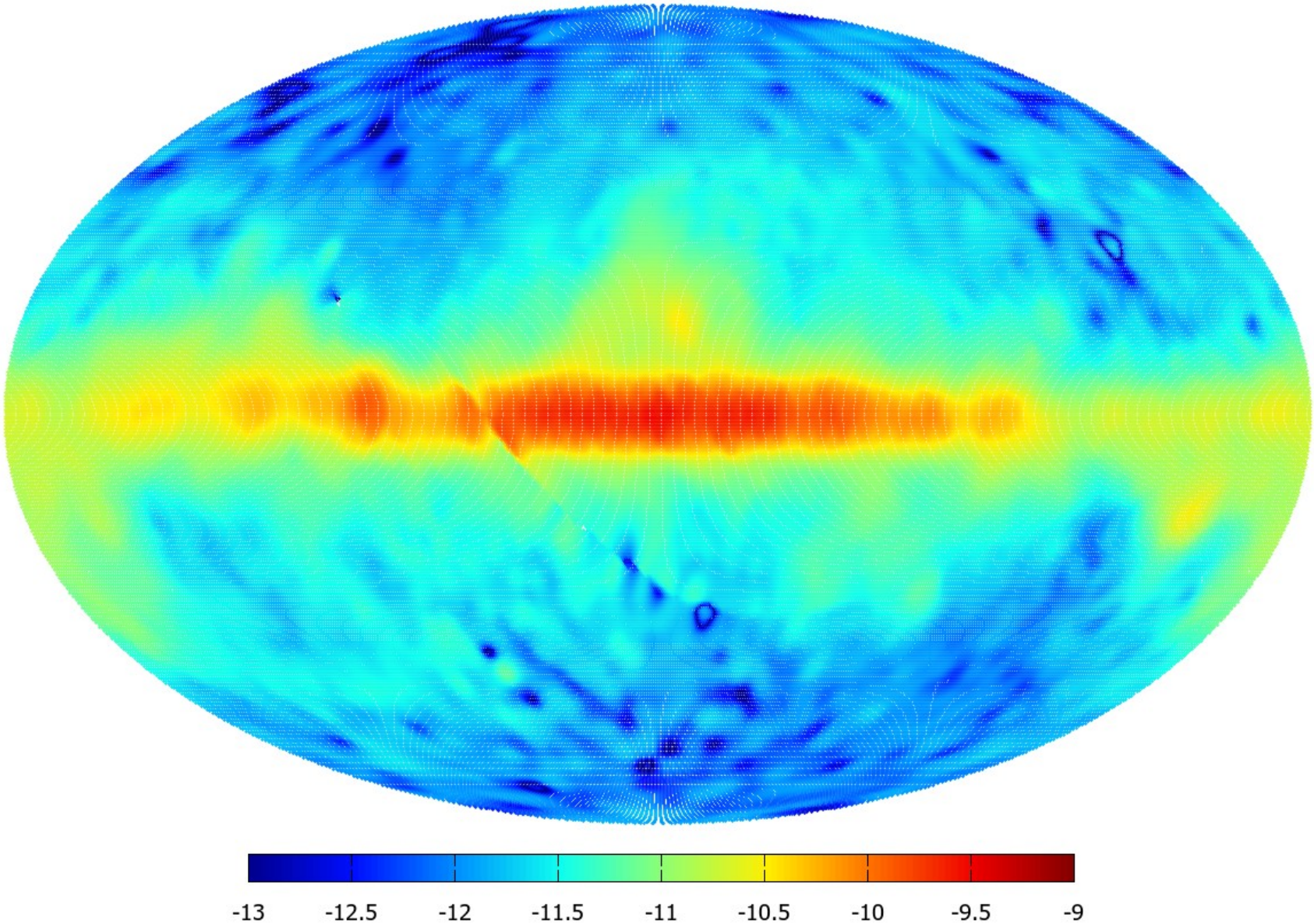
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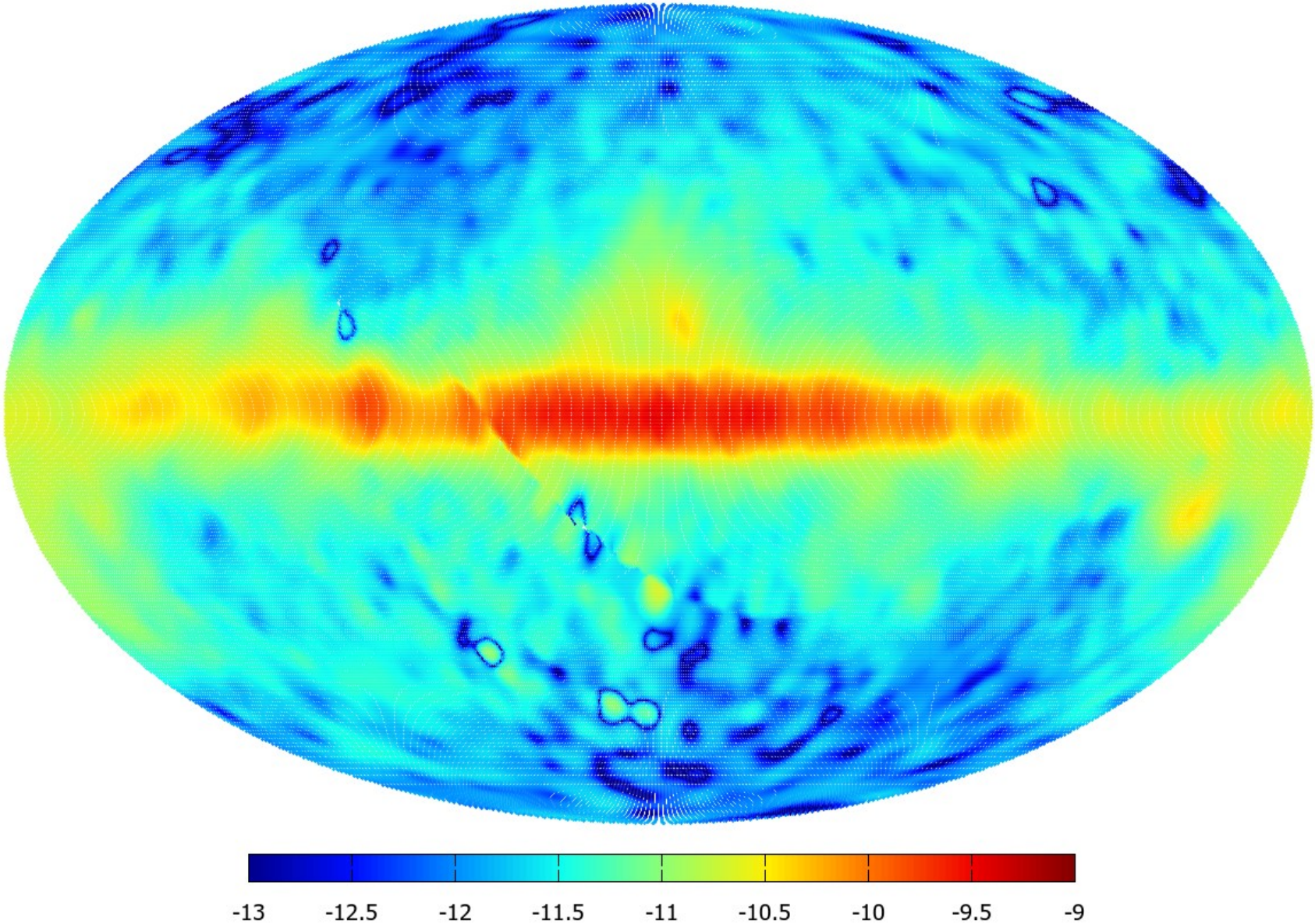
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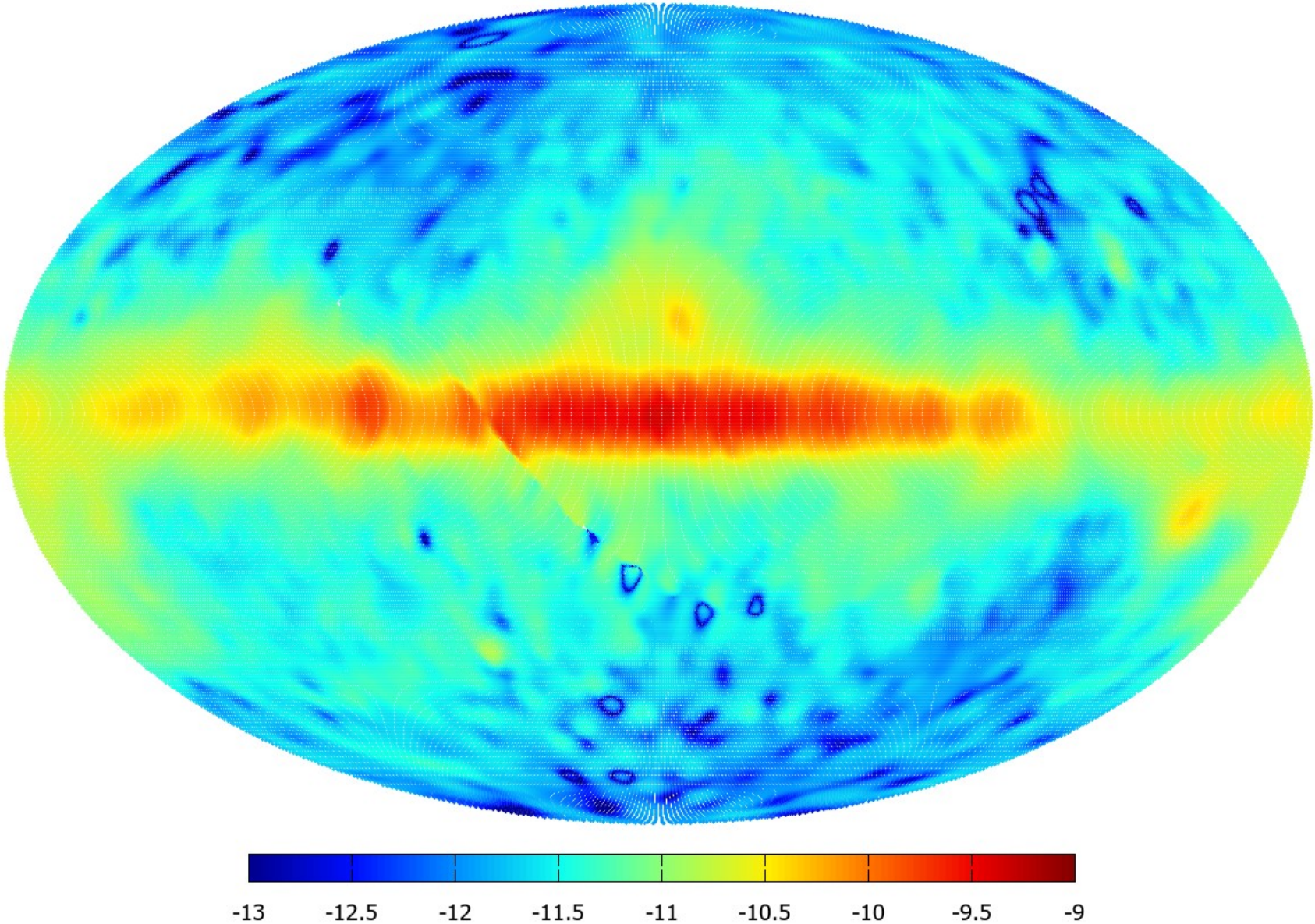
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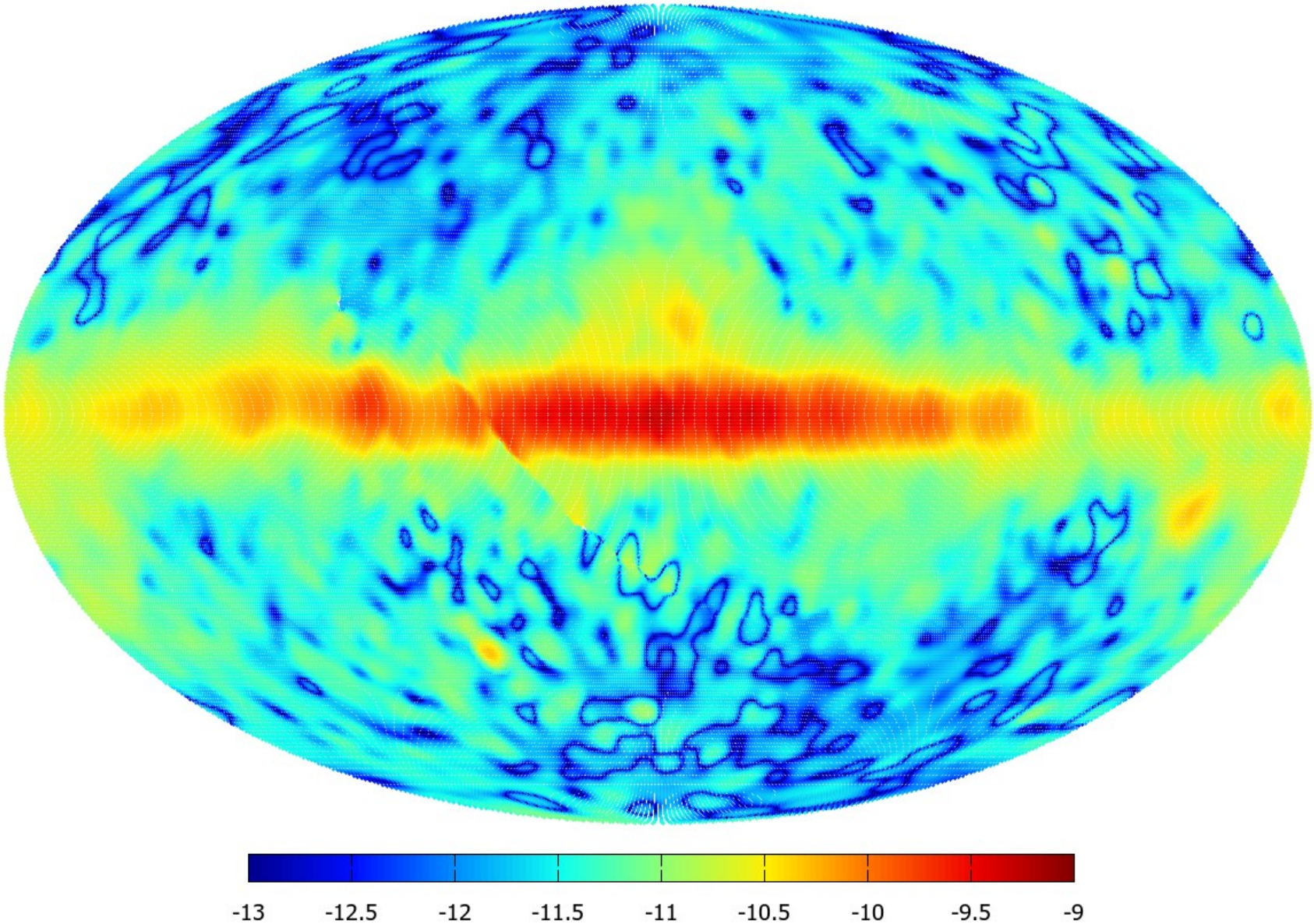
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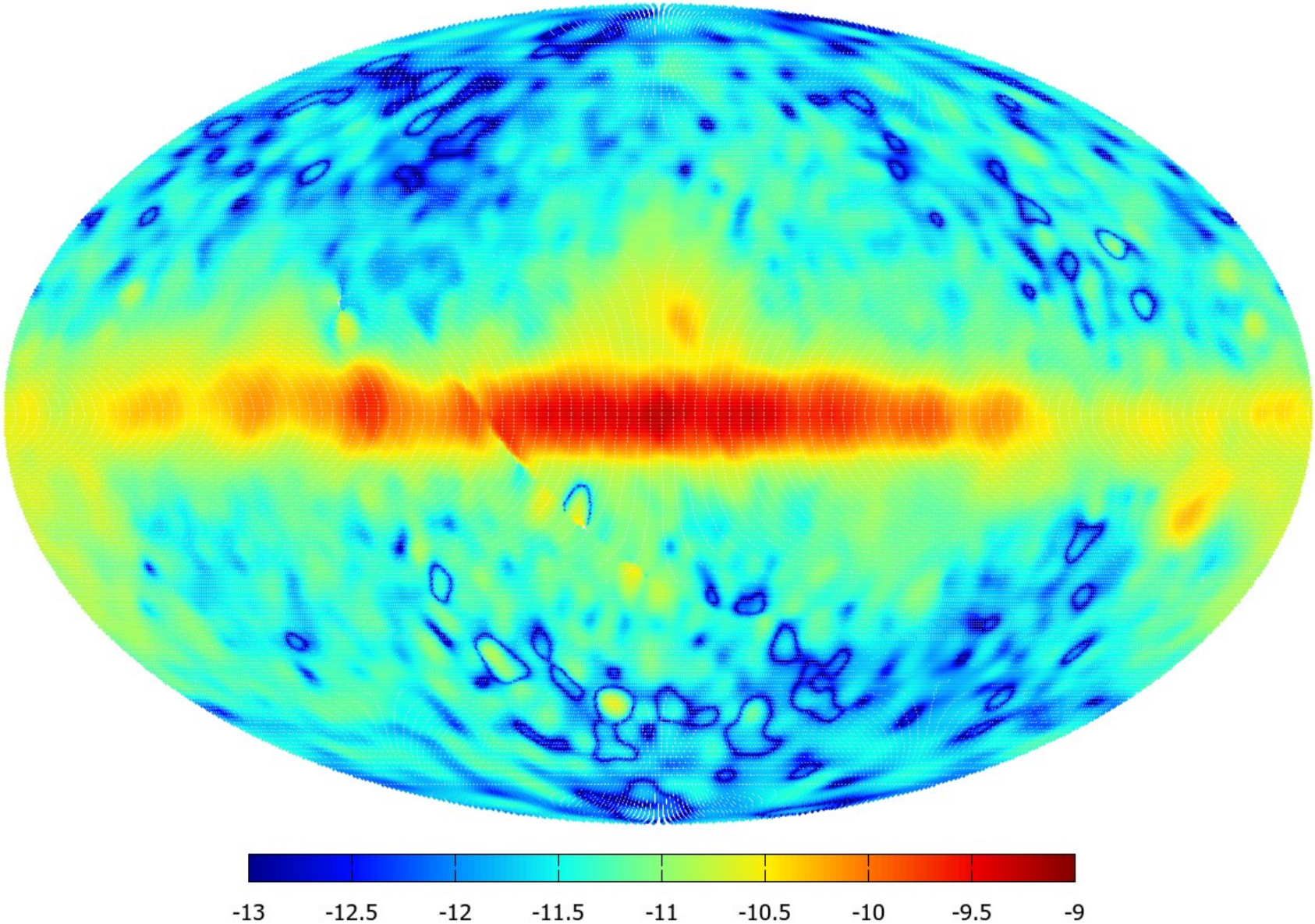
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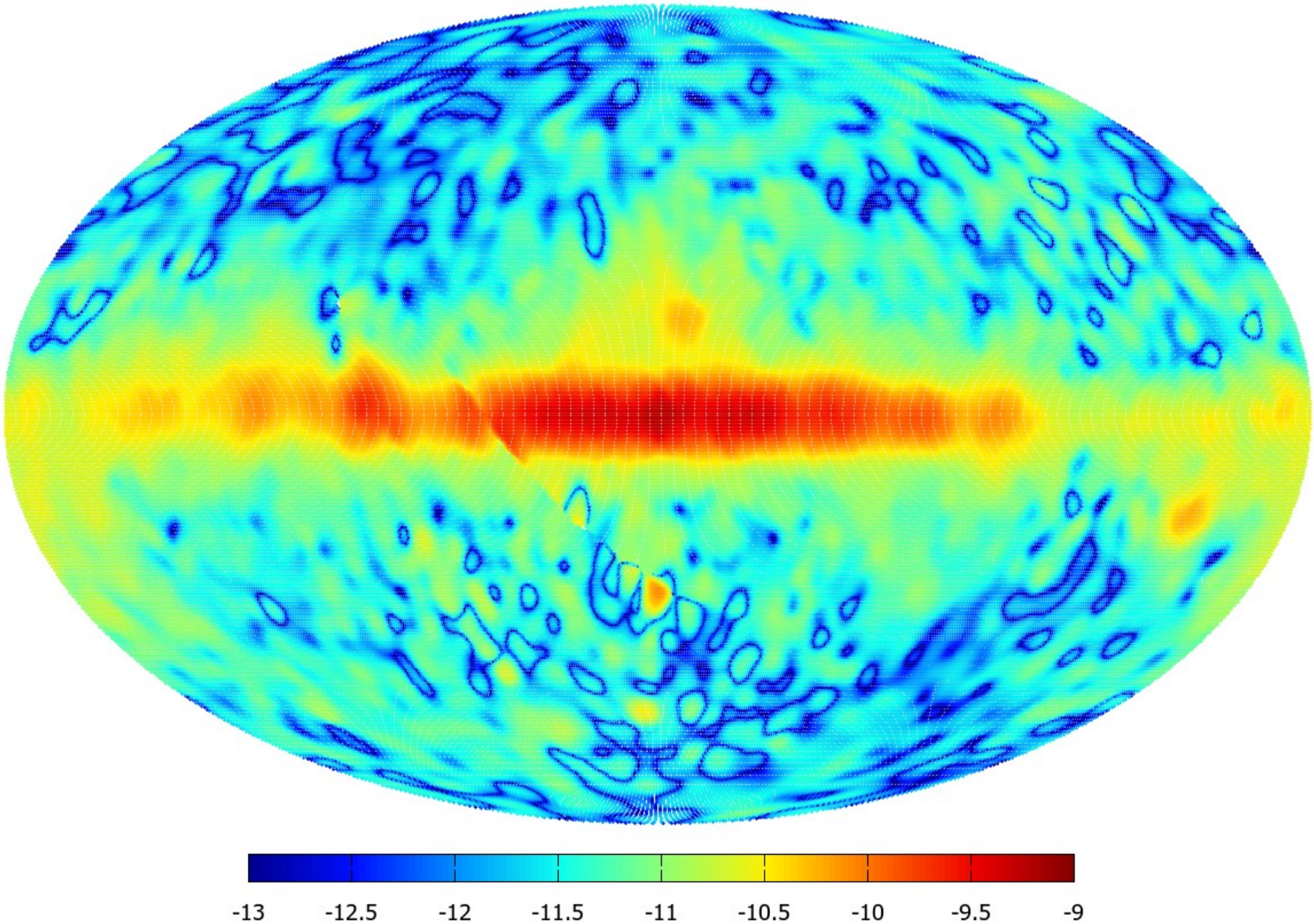
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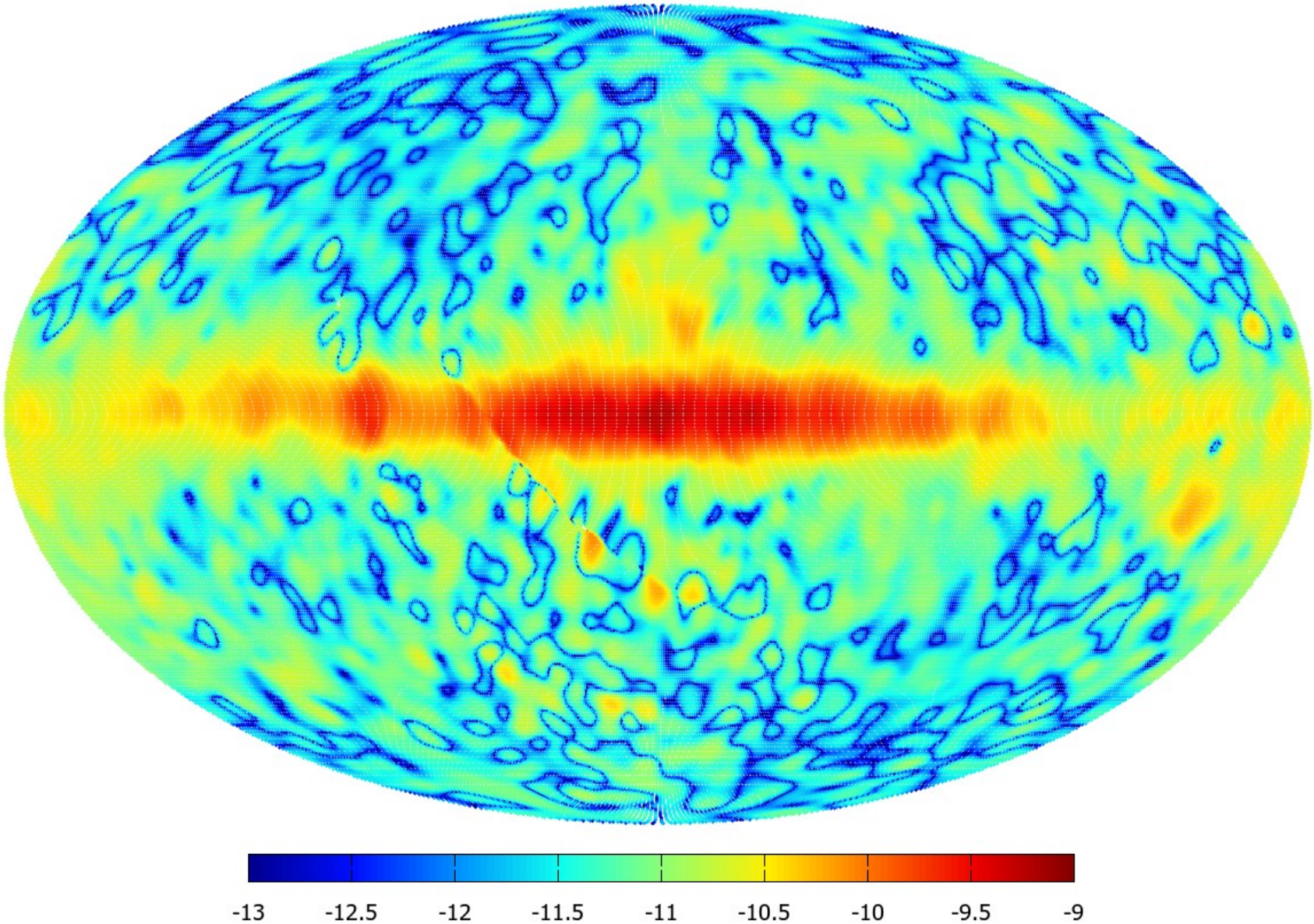
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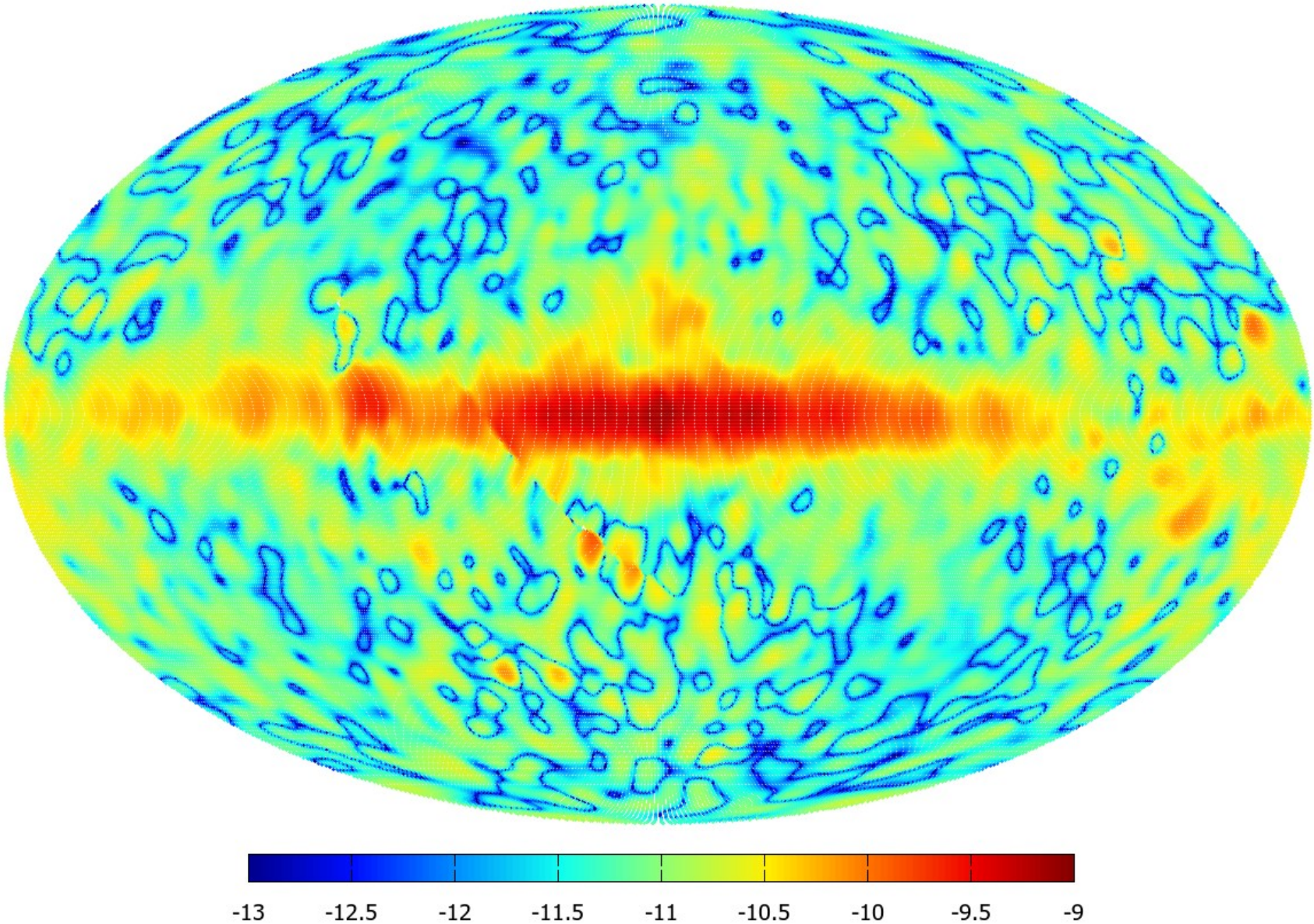
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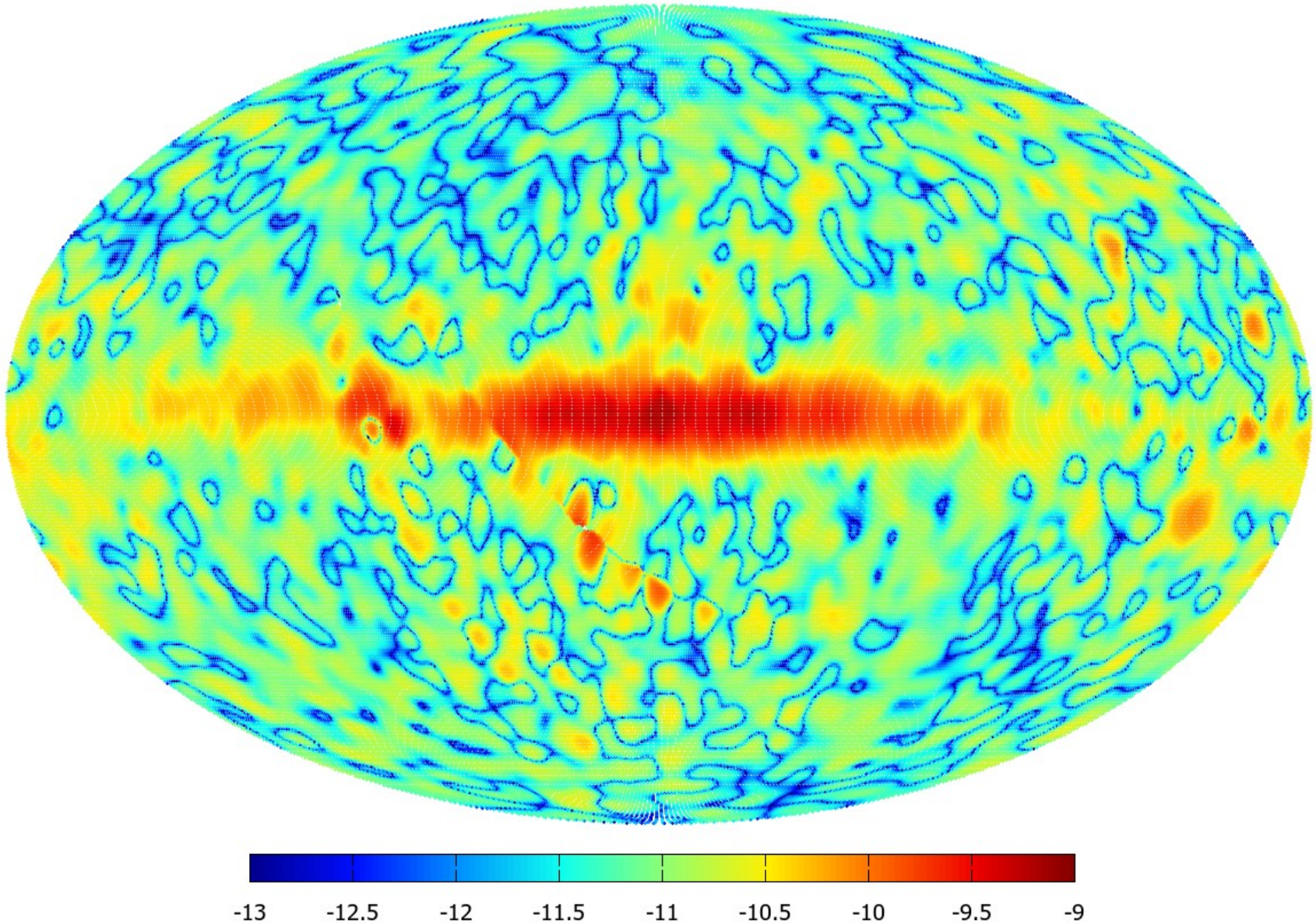
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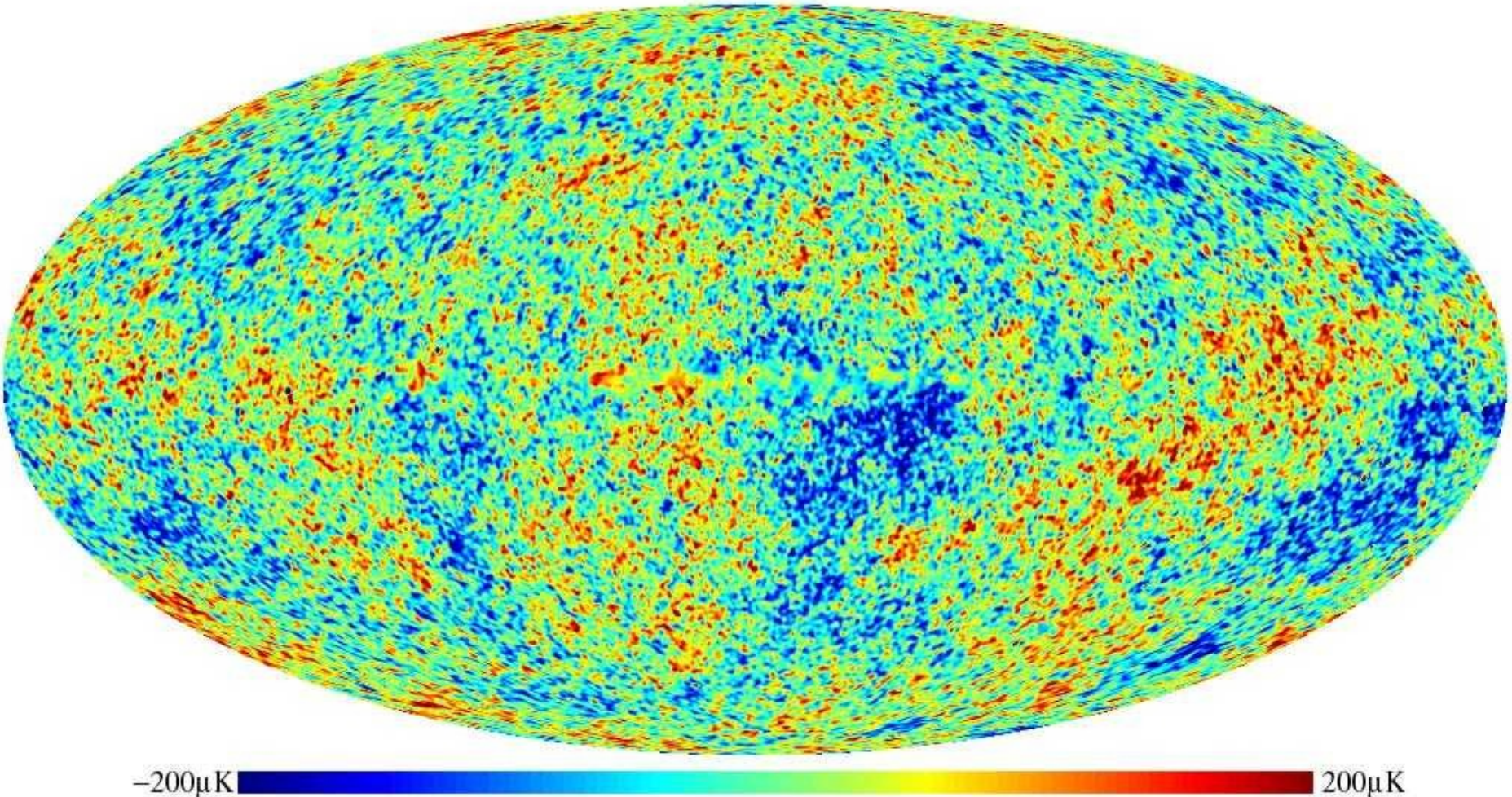
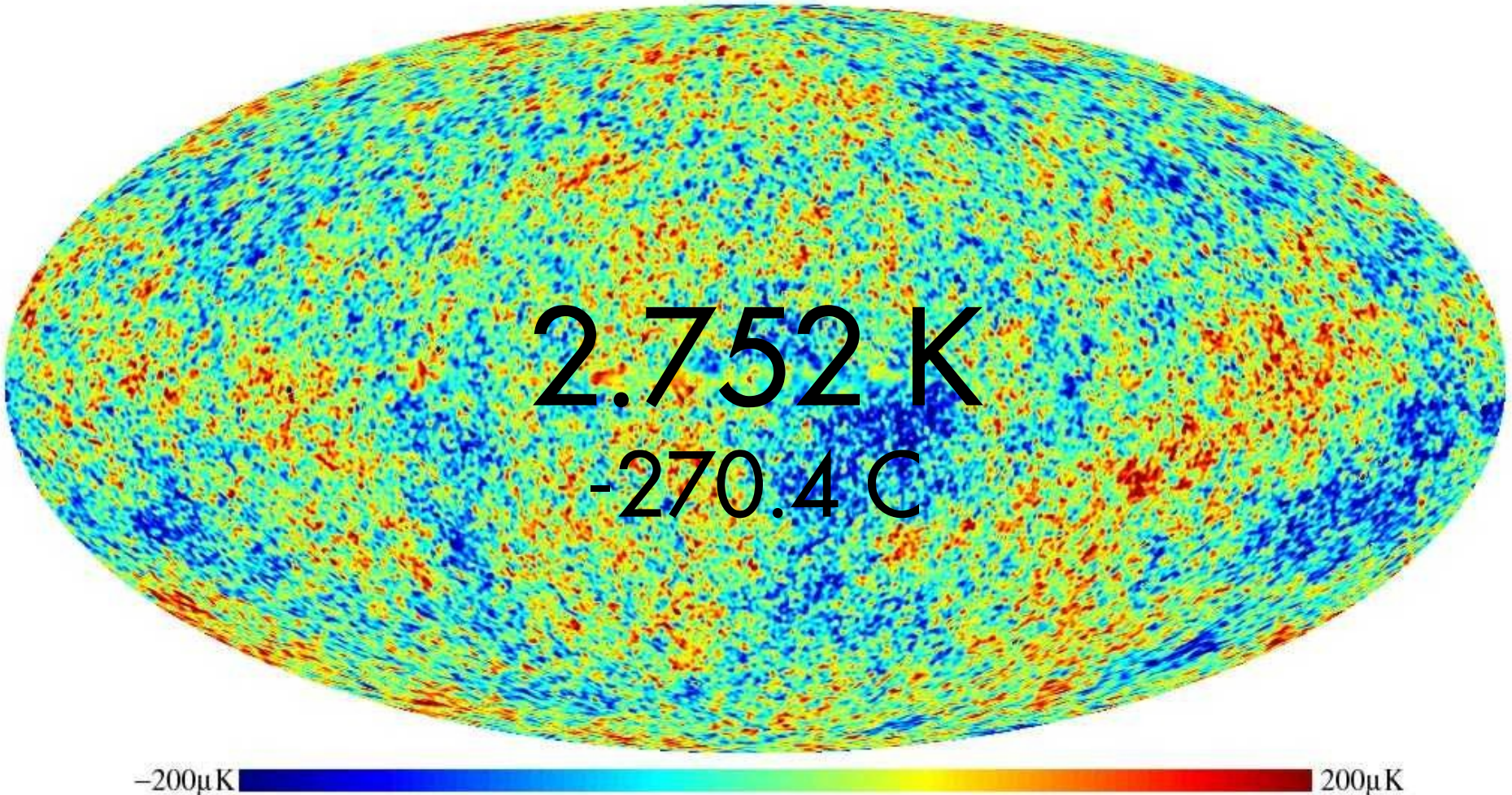
-11.5
-11
-10.5
-10
-9.5
-9

FCM está lleno de anisotropias



la huella digital del Big Bang



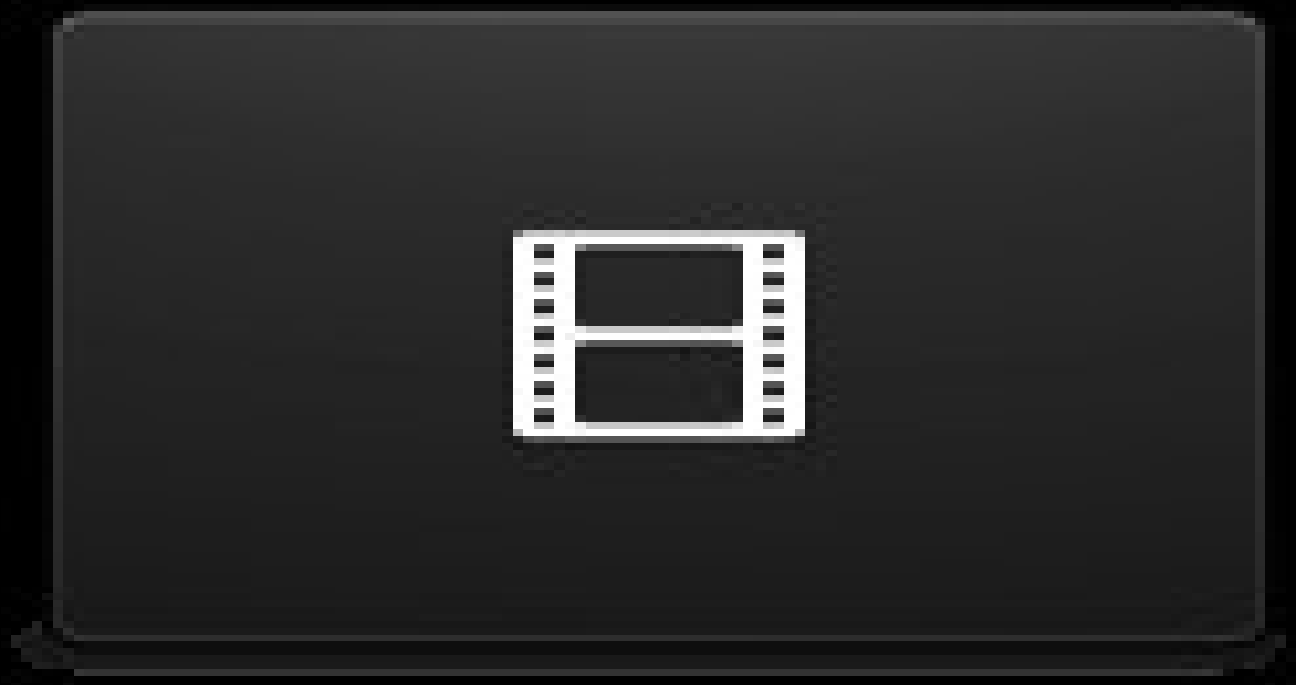
Observatorios de Rayos Gamma

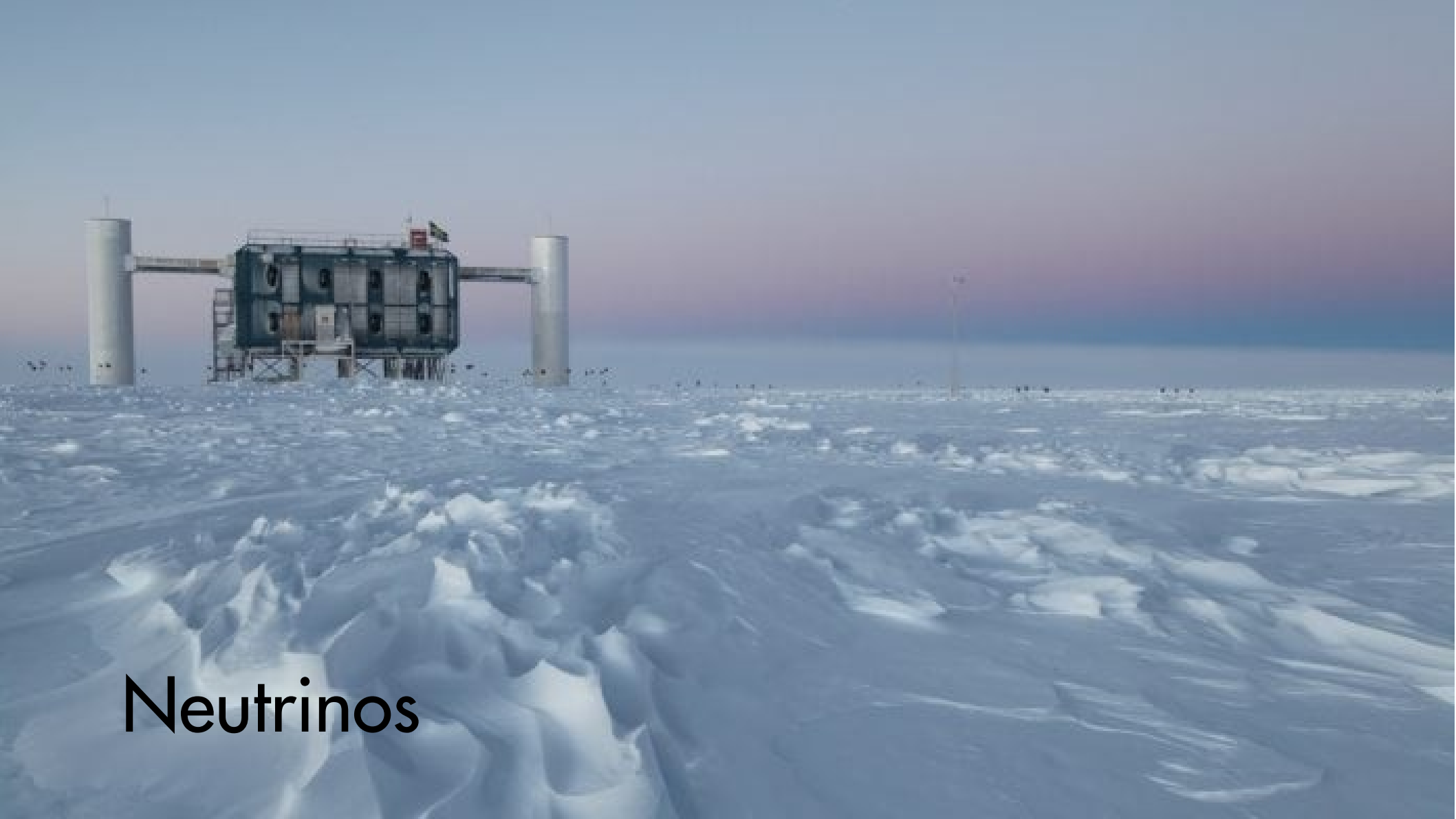
Fermi-LAT (Satélite)

HESS (Namibia), MAGIC (España),
CTA (España y Chile)

HAWC (México)

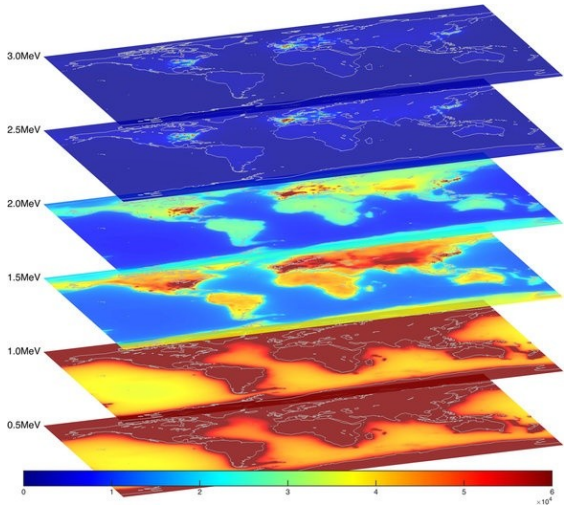
Observando Rayos Gamma



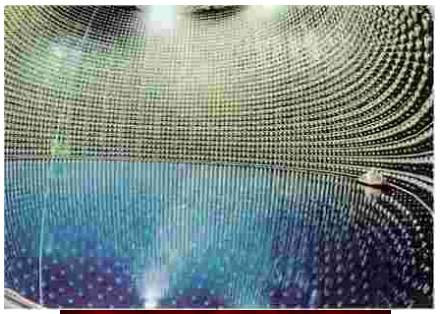


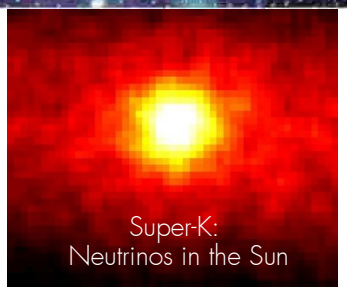
Neutrinos

Neutrinos

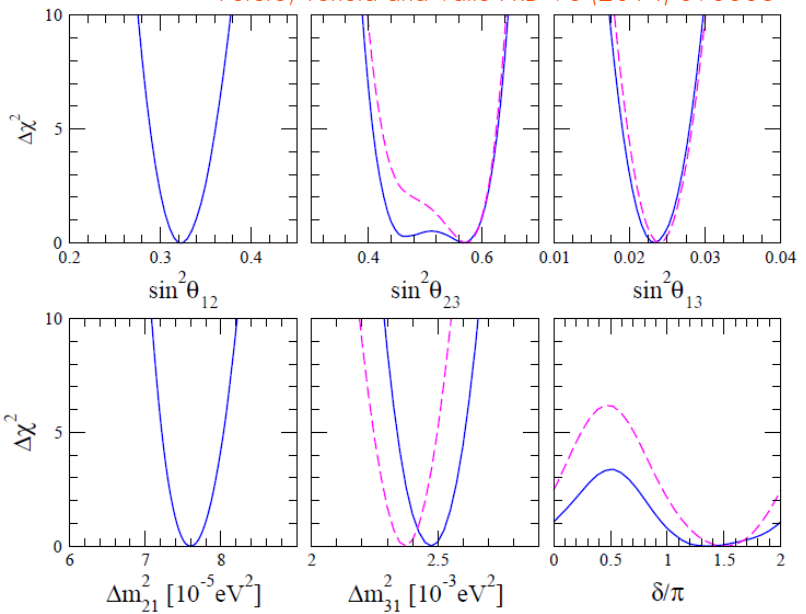


AGM2015: Antineutrino Global Map 2015



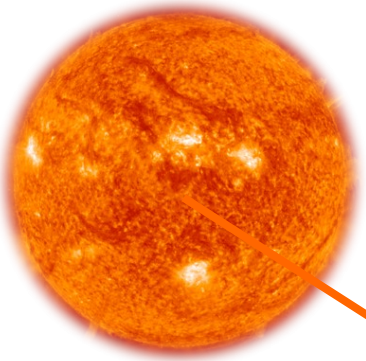


Forero, Tortola and Valle PRD 90 (2014) 093006

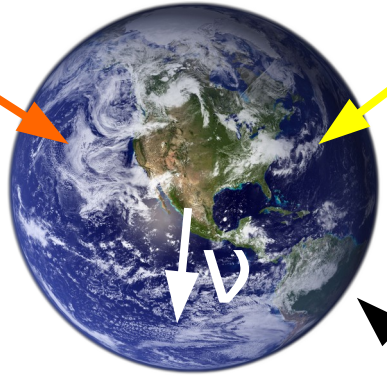


Son las partículas muy ligeras y misteriosas. Participan en los decaimientos radioactivos. Interactúan muy poco

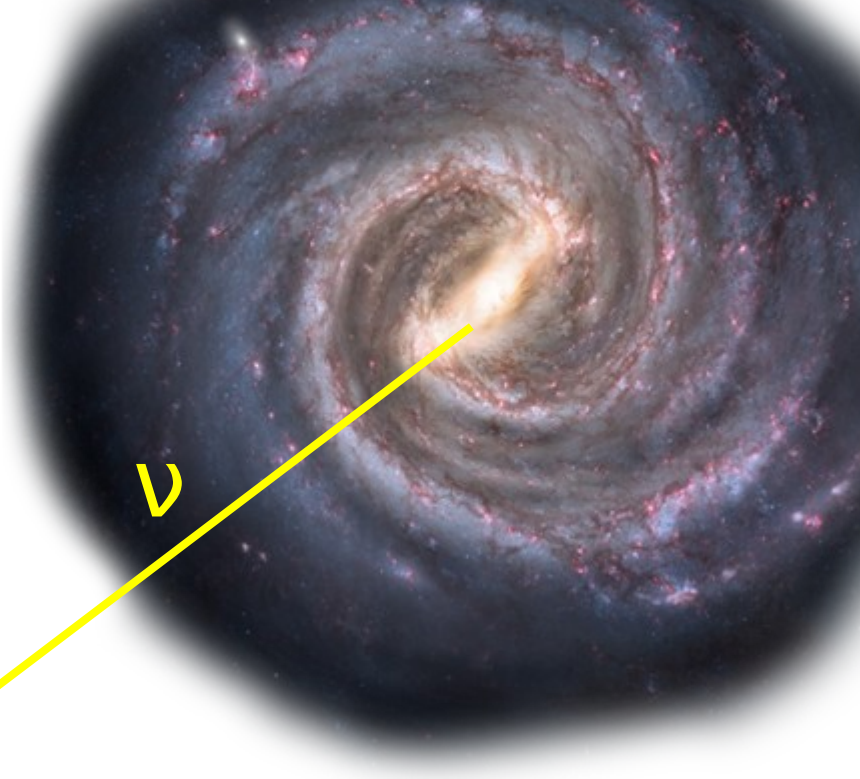
Fuentes de neutrinos



Sol

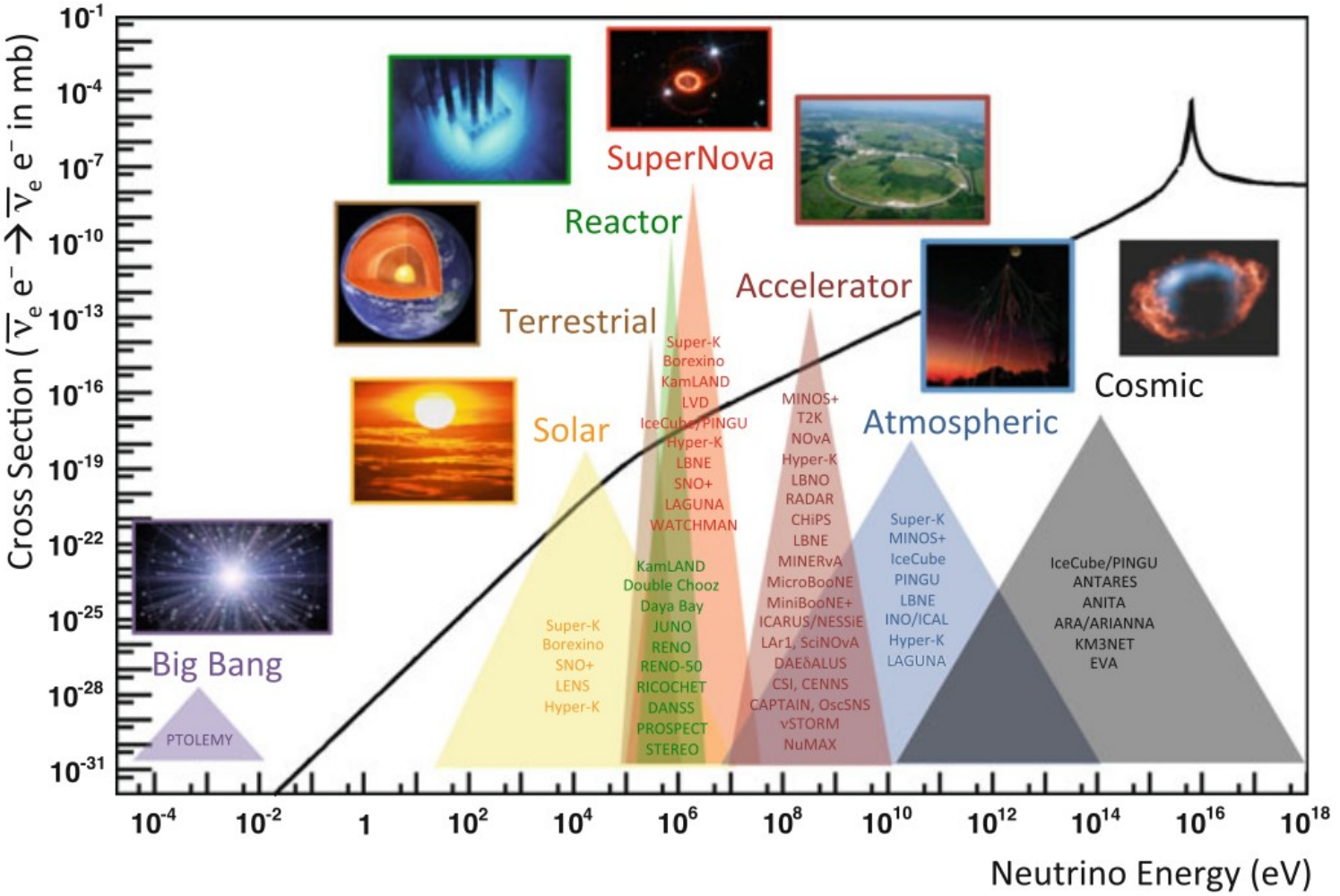


Reactores Nucleares
La Tierra
La atmósfera



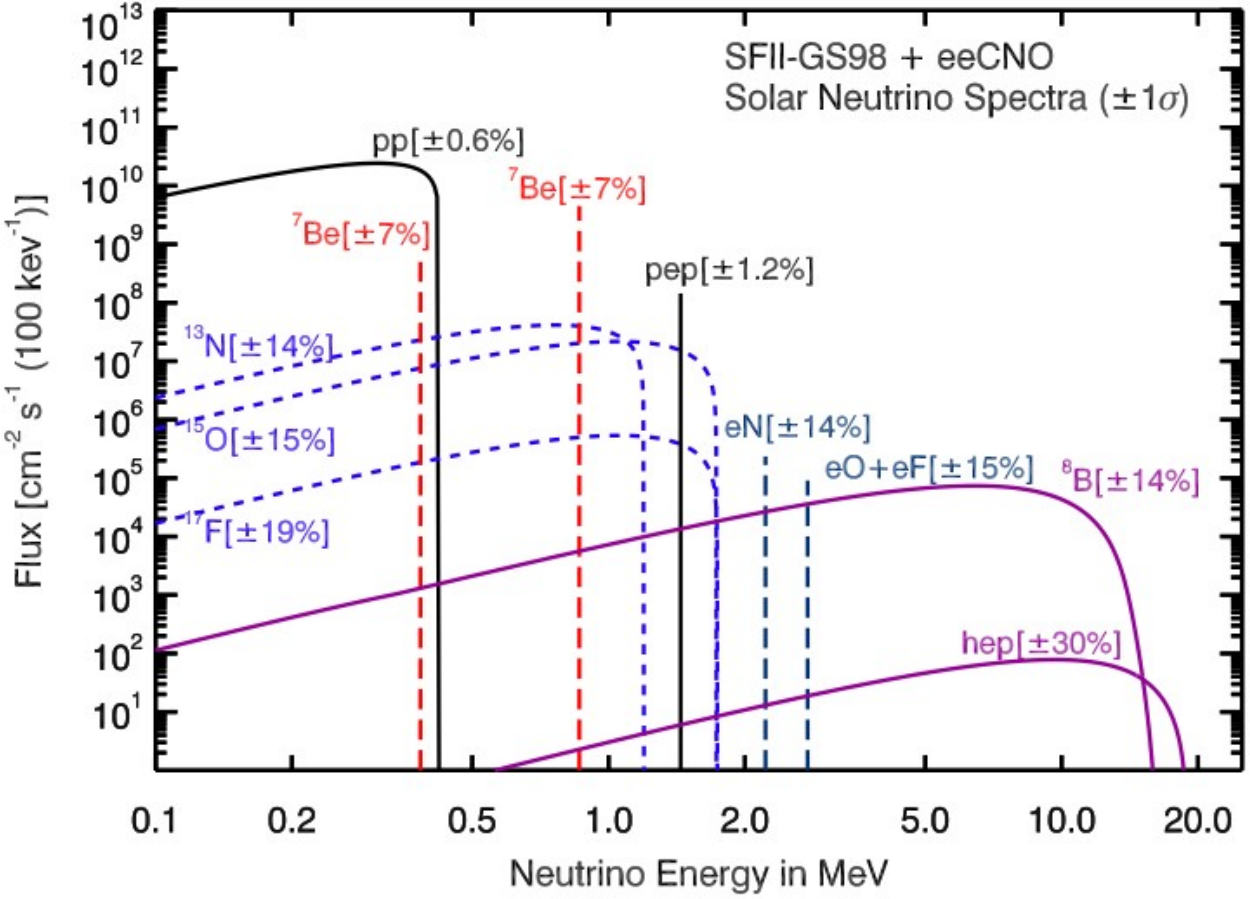
La vía Láctea
Centro galáctico
Big Bang

Fuentes de neutrinos

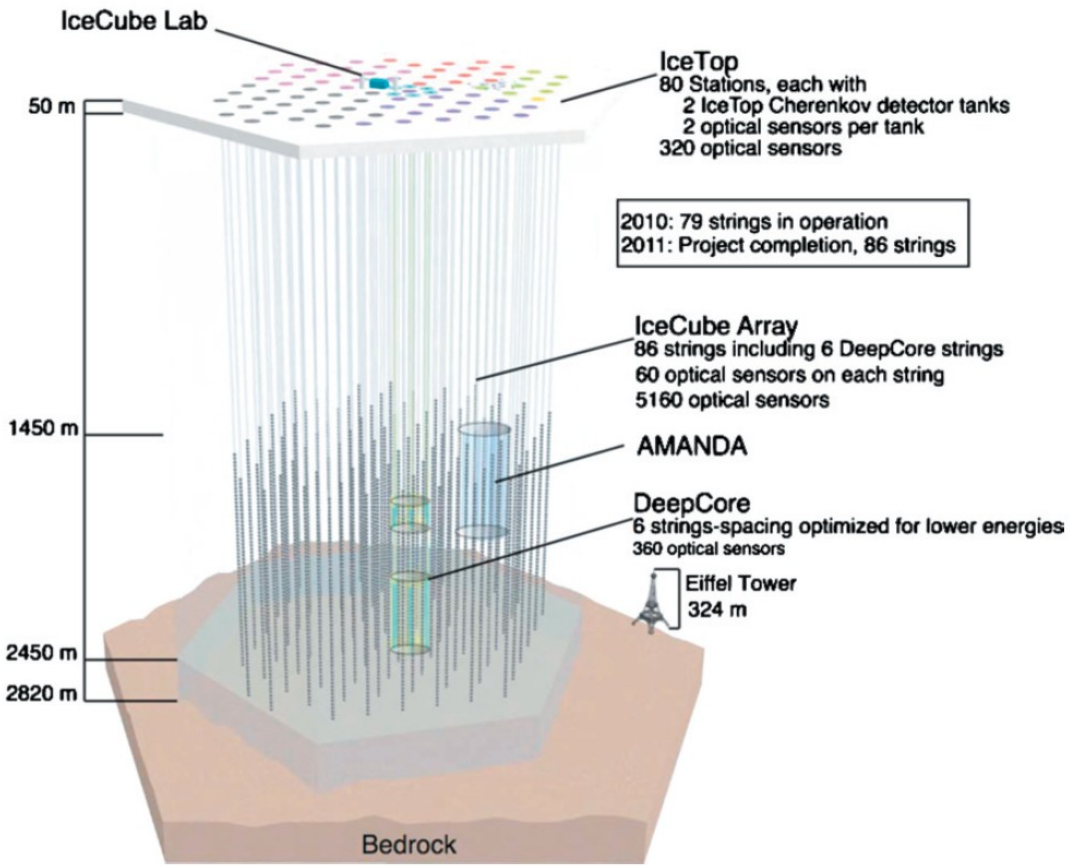


Neutrinos Solares

Los neutrinos nos permiten ver el interior del Sol!



Observatorios

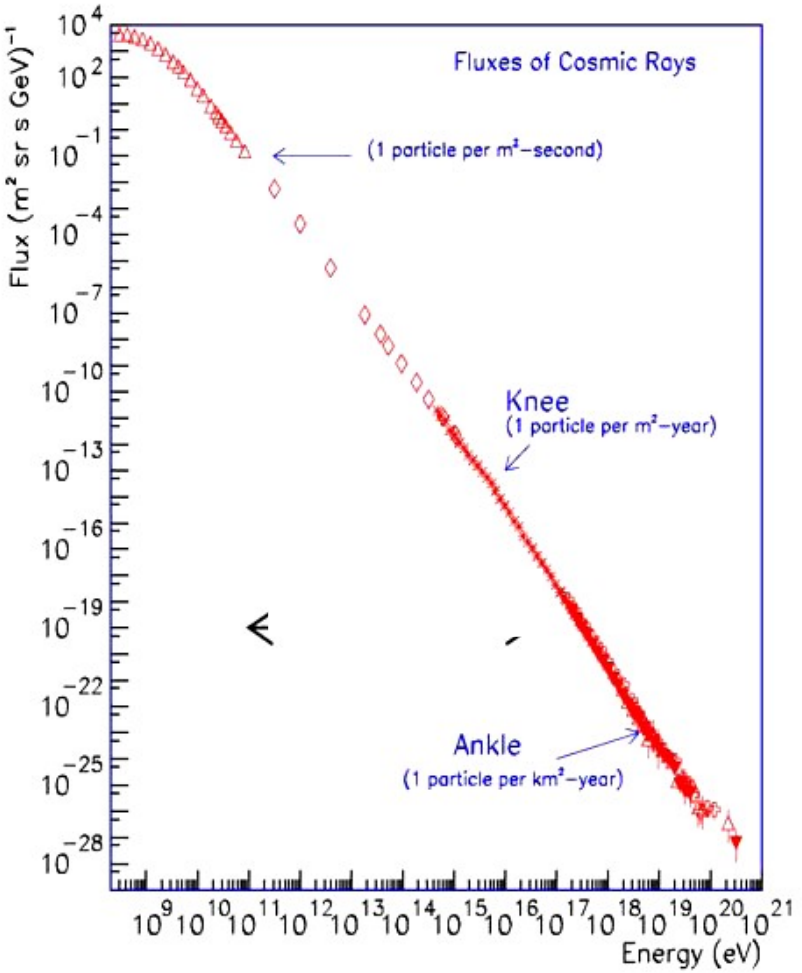


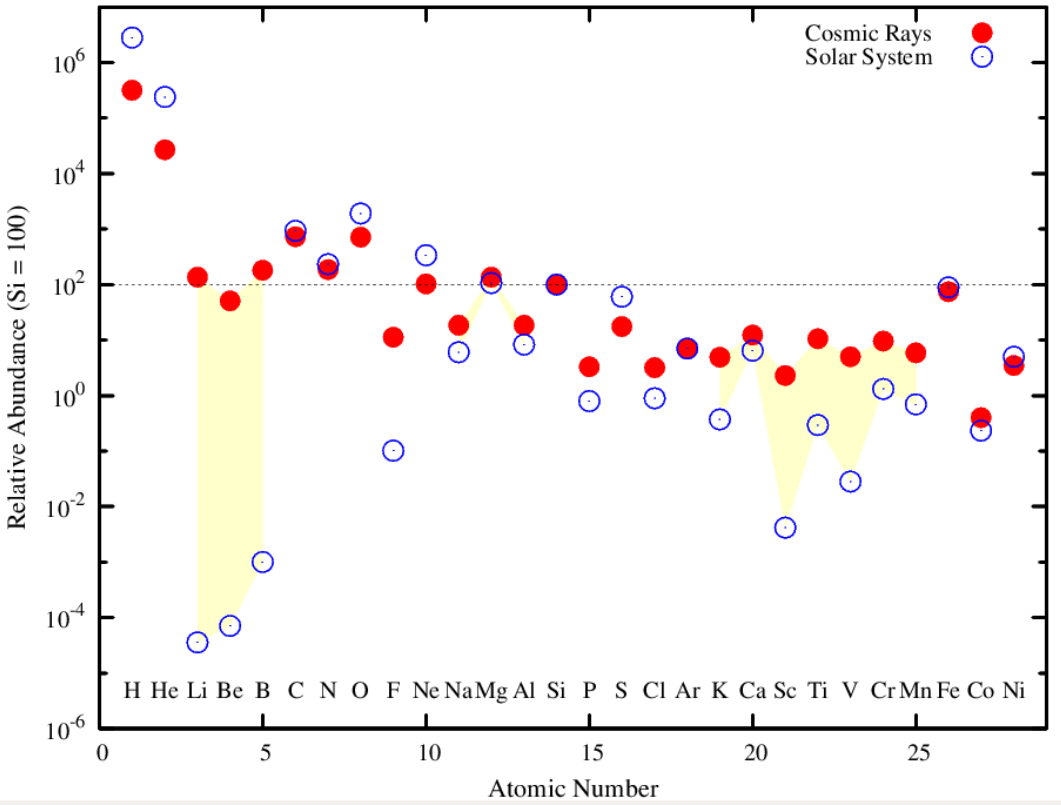
IceCube

Observando neutrinos in Icecube

Rayos Cósmicos

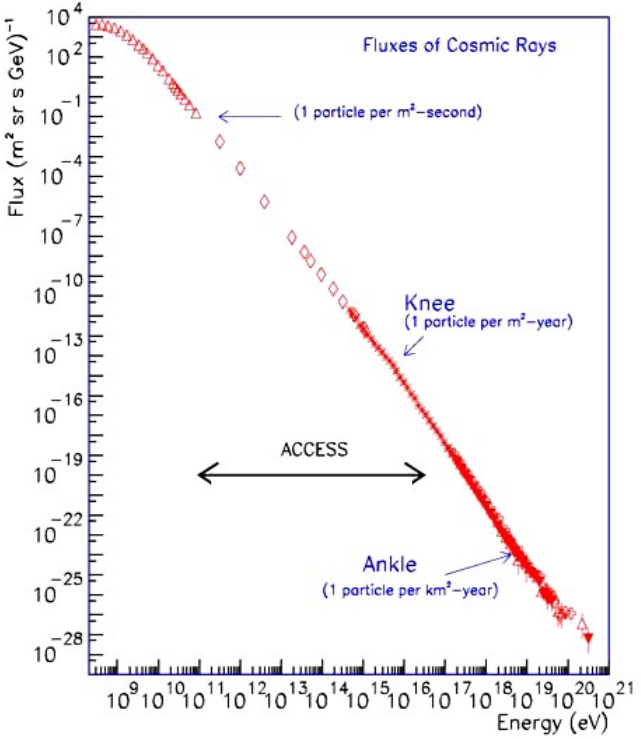
Energía y composición





¿Cómo observar Rayos Cósmicos?

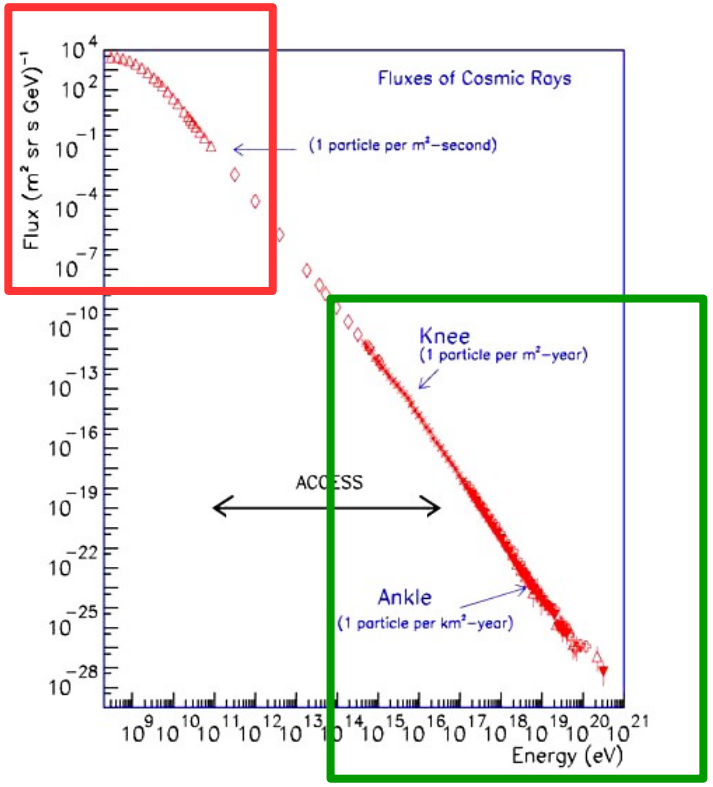
si la atmósfera absorbe gran cantidad de éstos.



¿Cómo observar Rayos Cósmicos?

si la atmósfera absorbe gran cantidad de éstos.

Detectores en el espacio



detectores de superficie

Observatorios de altitud

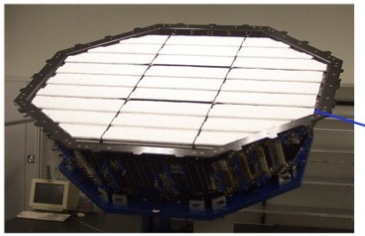
ATIC (antartida)

PAMELA (satélite)

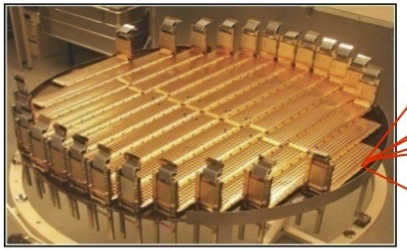
AMS02 (ISS)

Observatorios de altitud

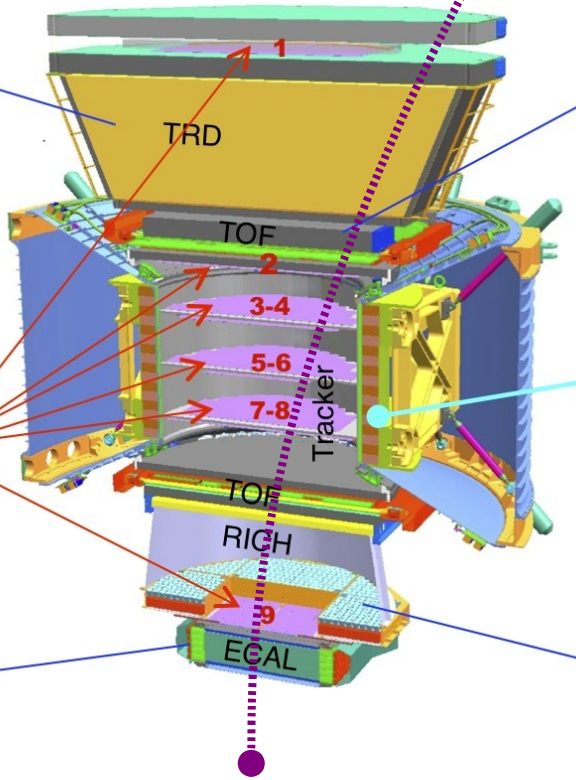
TRD



Silizium Spurdetektor

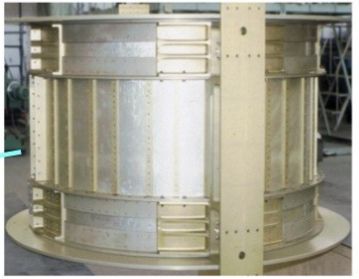


ECAL

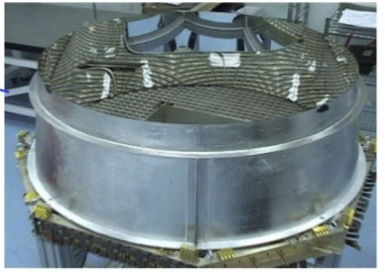


TOF

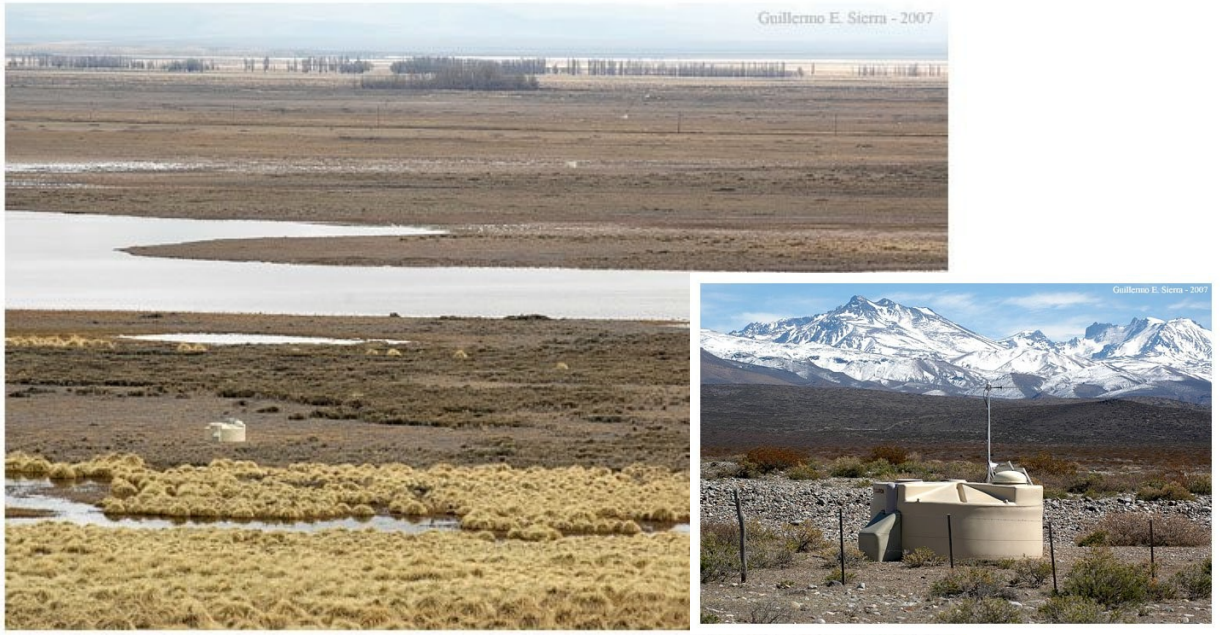
Magnet



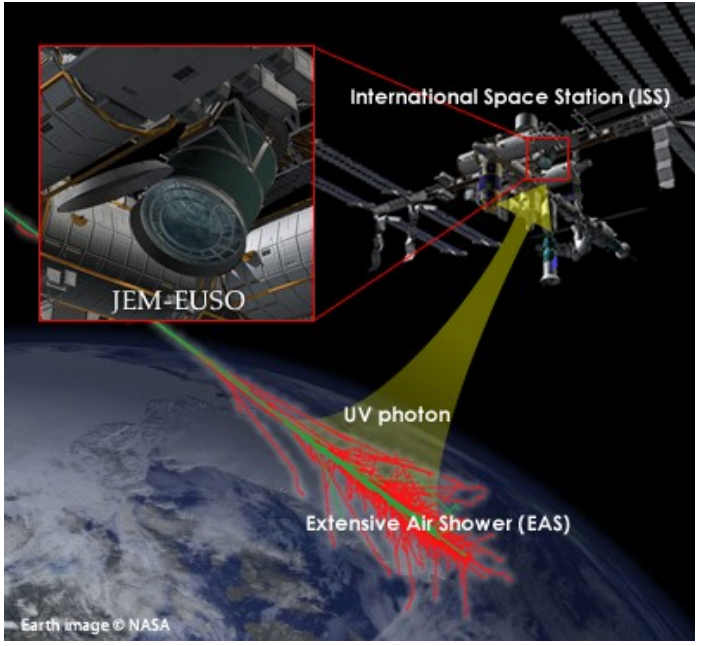
RICH



Observatorios de alta energía



Pierre Auger (Argentina)



JEM-EUSO (ISS)

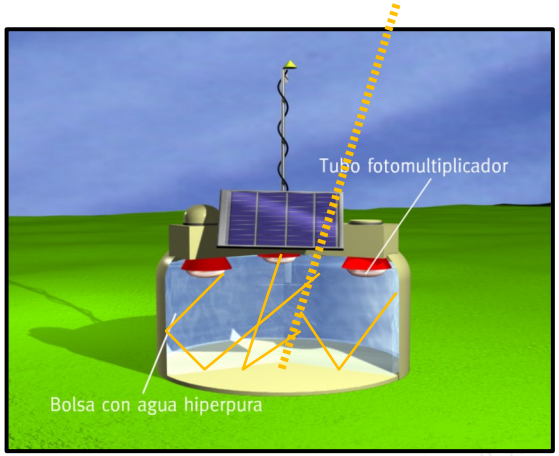
Observatorio Pierre Auger

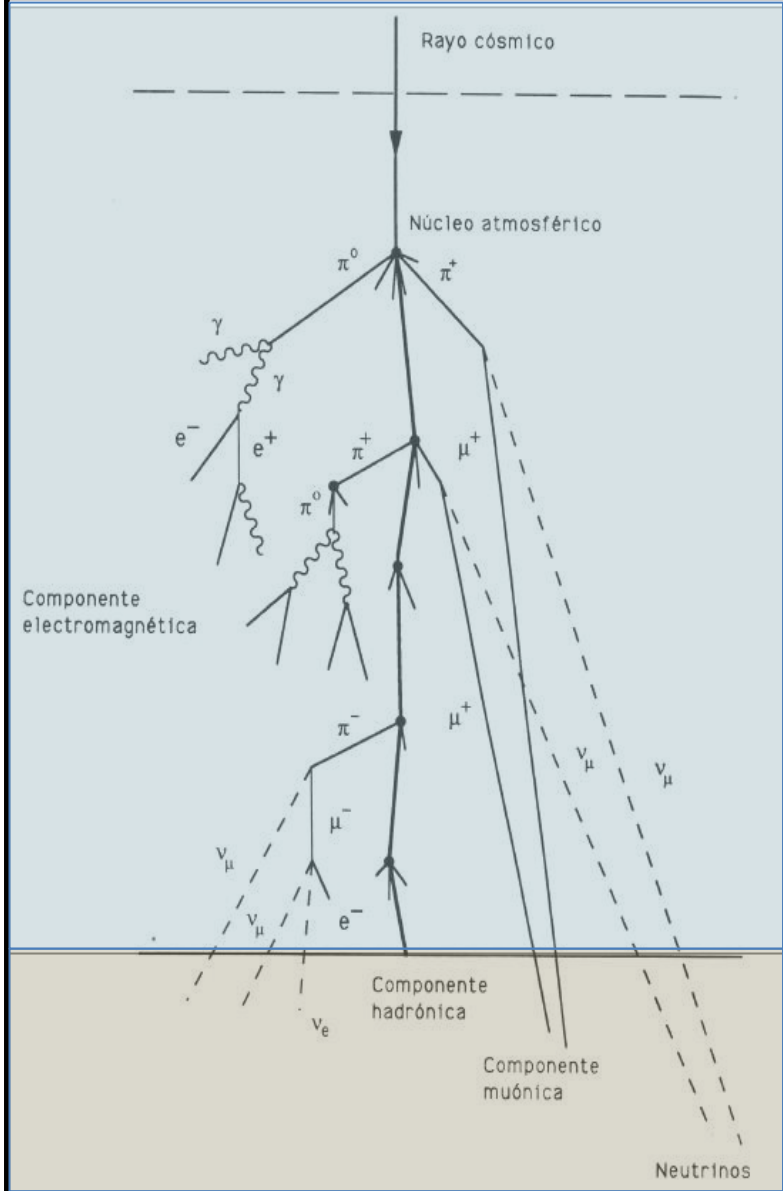
Telescopio de fluorescencia

Detector de superficie

Llueven Rayos Cósmicos

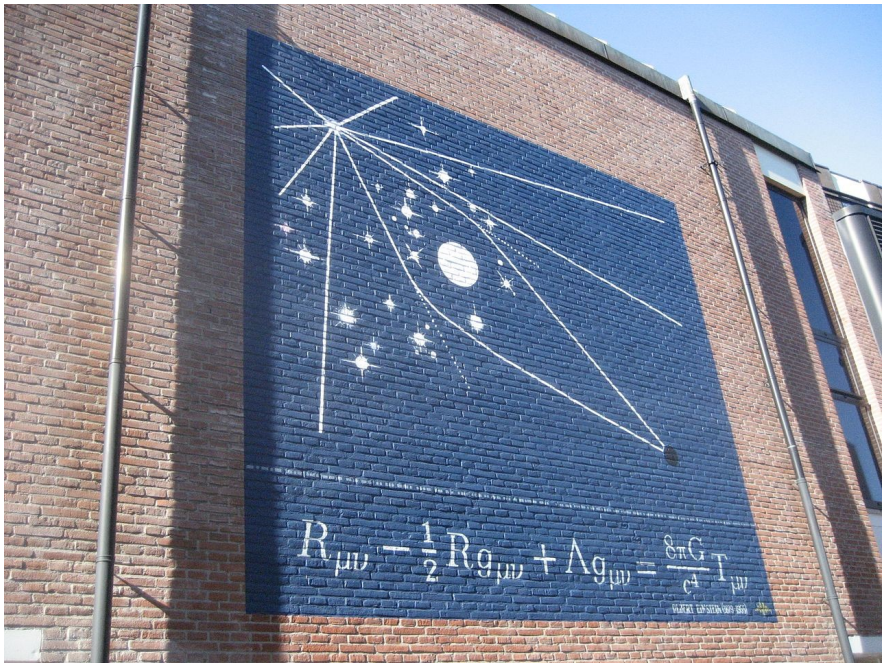
- Rayo cósmico primario interacciona con la alta atmósfera
- Se produce una reacción en cadena



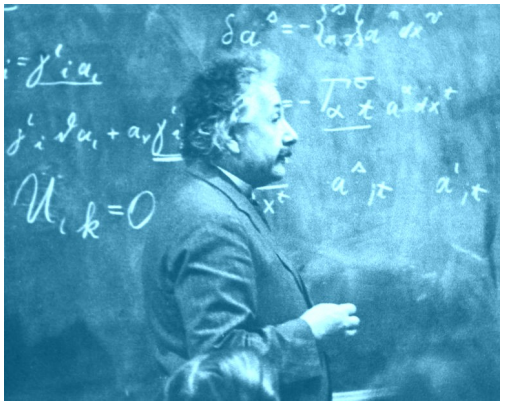


Ondas Gravitacionales

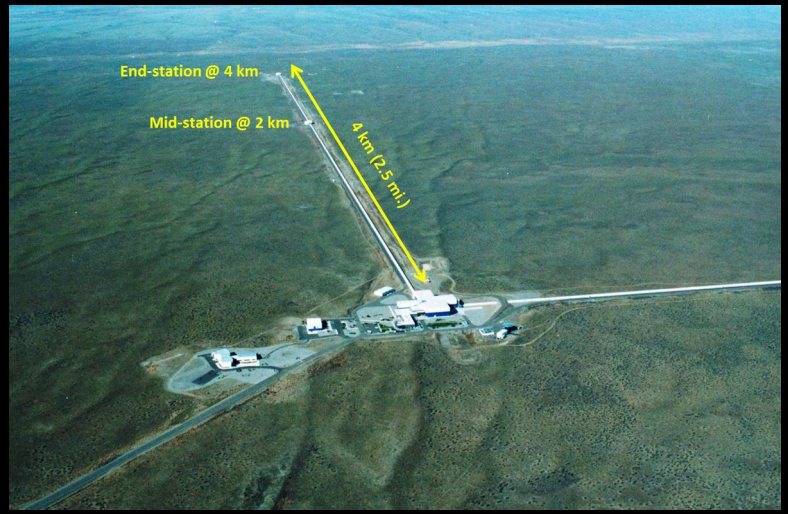
Ondas Gravitacionales



Son una de las muchas predicciones de la relatividad general que describe la gravedad como una deformación del espacio-tiempo

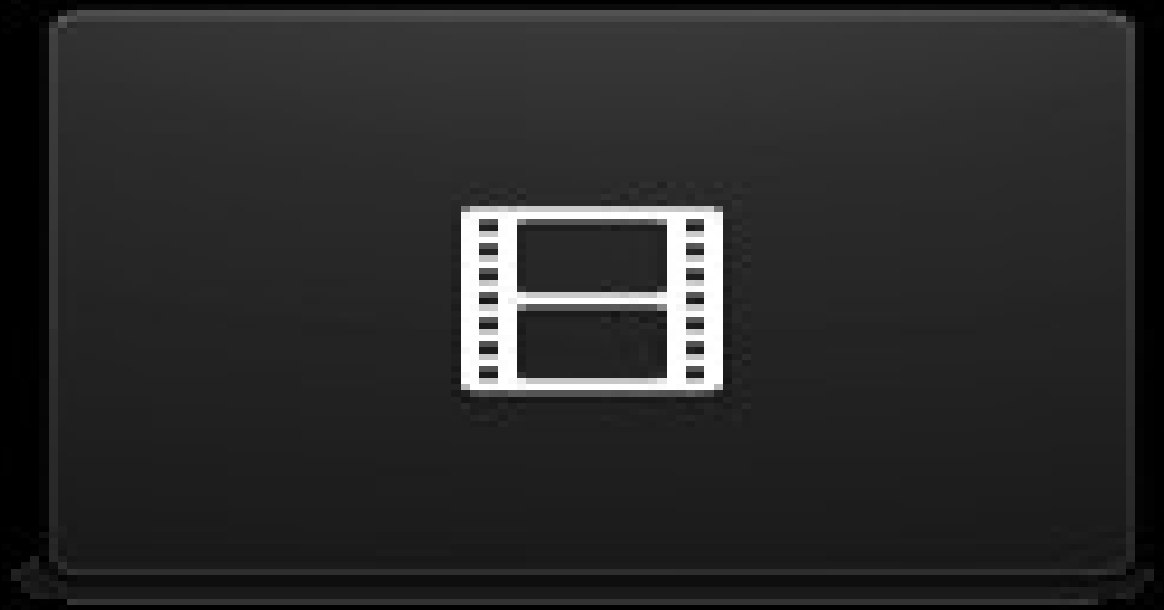


Ondas Gravitacionales



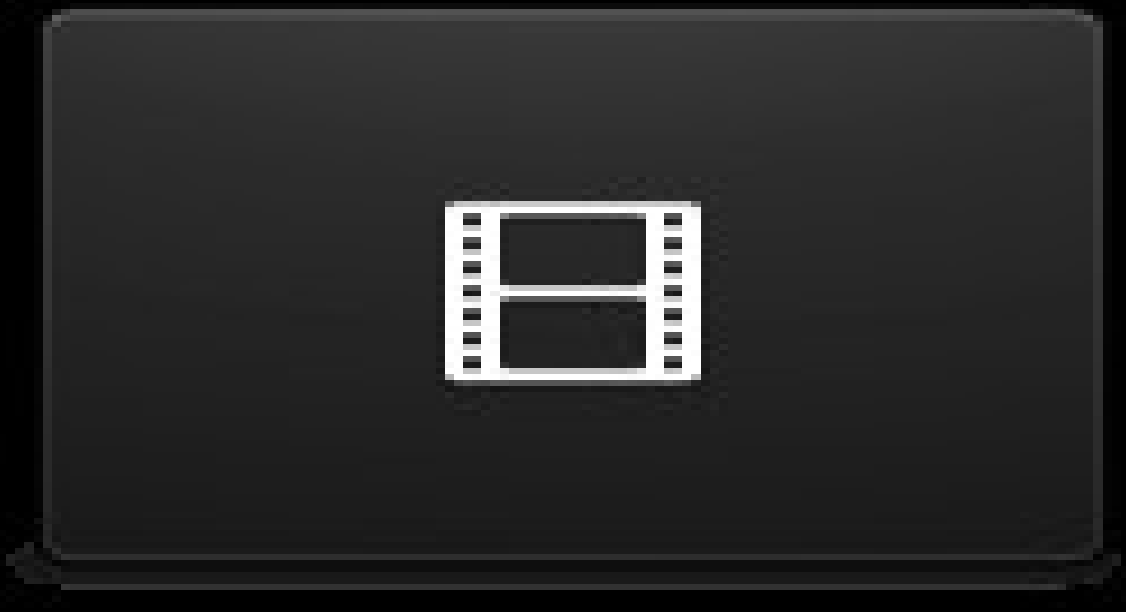
LIGO observa ondas gravitacionales usando interferometros de 4 km!

Ondas Gravitacionales



Los 2 Agujeros Negros bailan hasta que se fusionan

Ondas Gravitacionales



Los ladrillos fundamentales que forman el Universo nos permiten entender su evolución y su futuro.

Las astropartículas revelan aspectos desconocidos y fascinantes del Universo