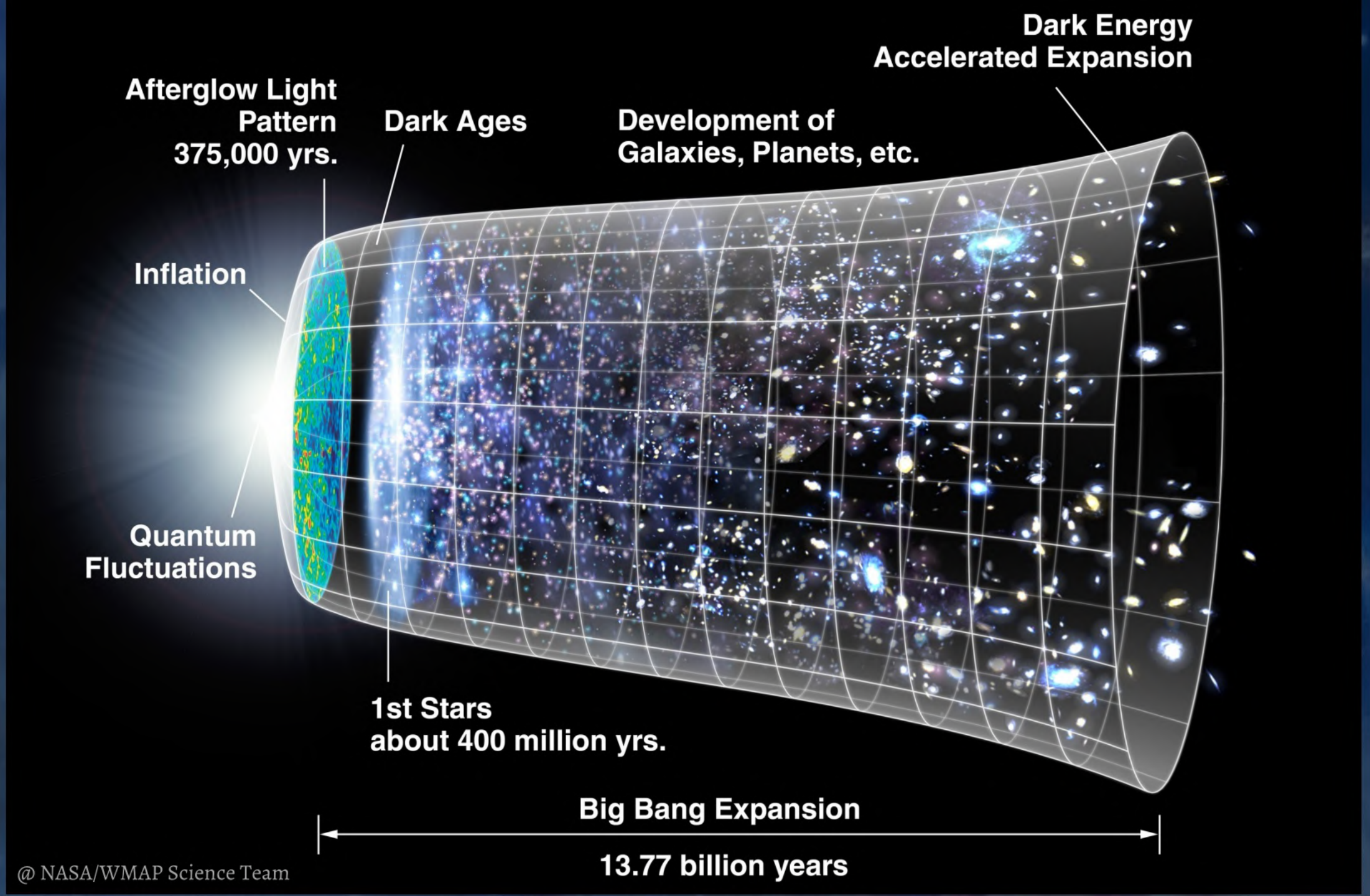
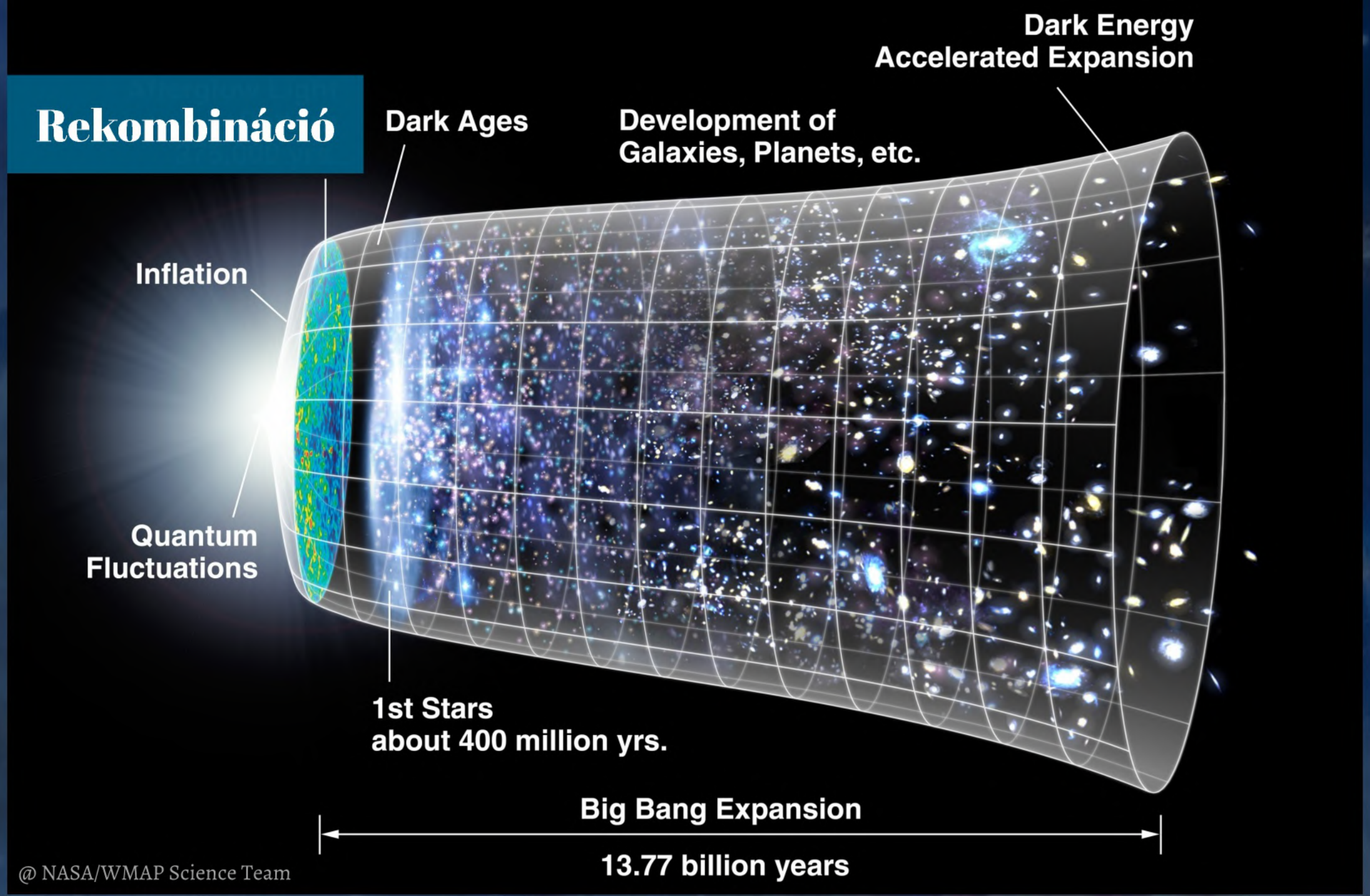
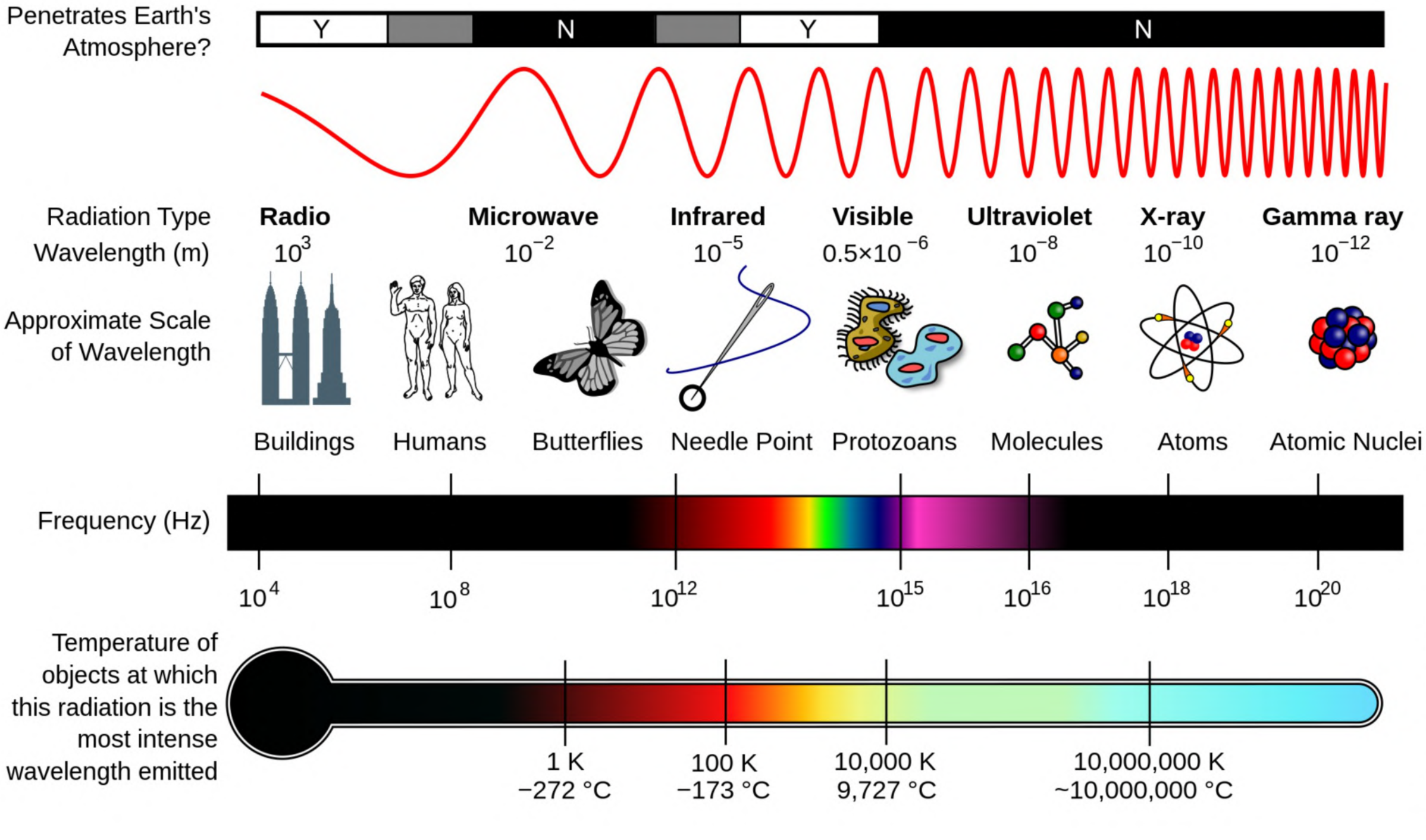


Terítéken a távoli világűr

Kis-Tóth Ágnes * Atomcsill 20 24 10 24

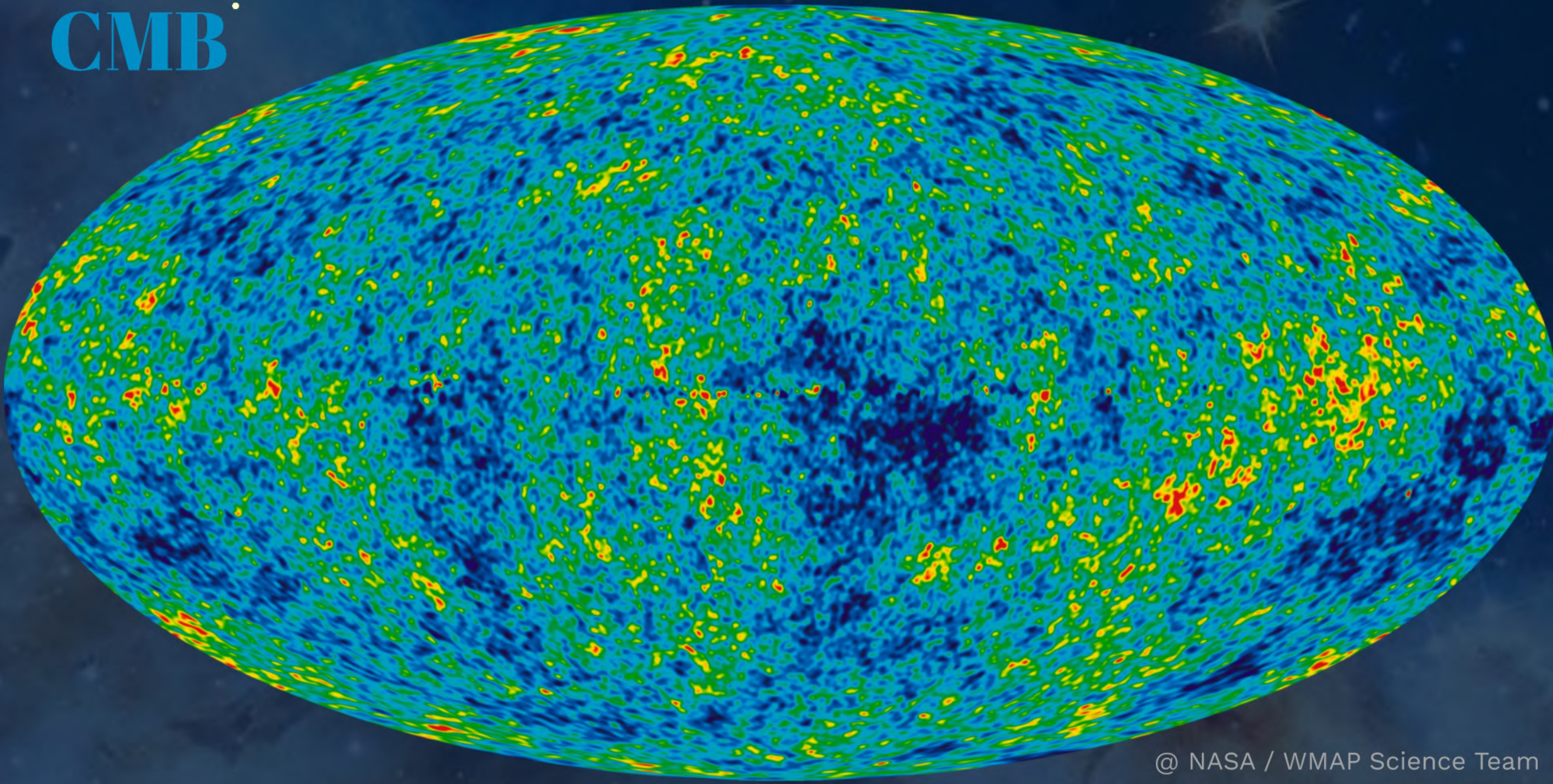

Dark Energy
Accelerated Expansion
Afterglow Light
Pattern
375,000 yrs.
Dark Ages
Development of
Galaxies, Planets, etc.
Inflation
Quantum
Fluctuations
1st Stars
about 400 million yrs.
Big Bang Expansion
13.77 billion years
@ NASA/WMAP Science Team


Rekombináció
Dark Energy
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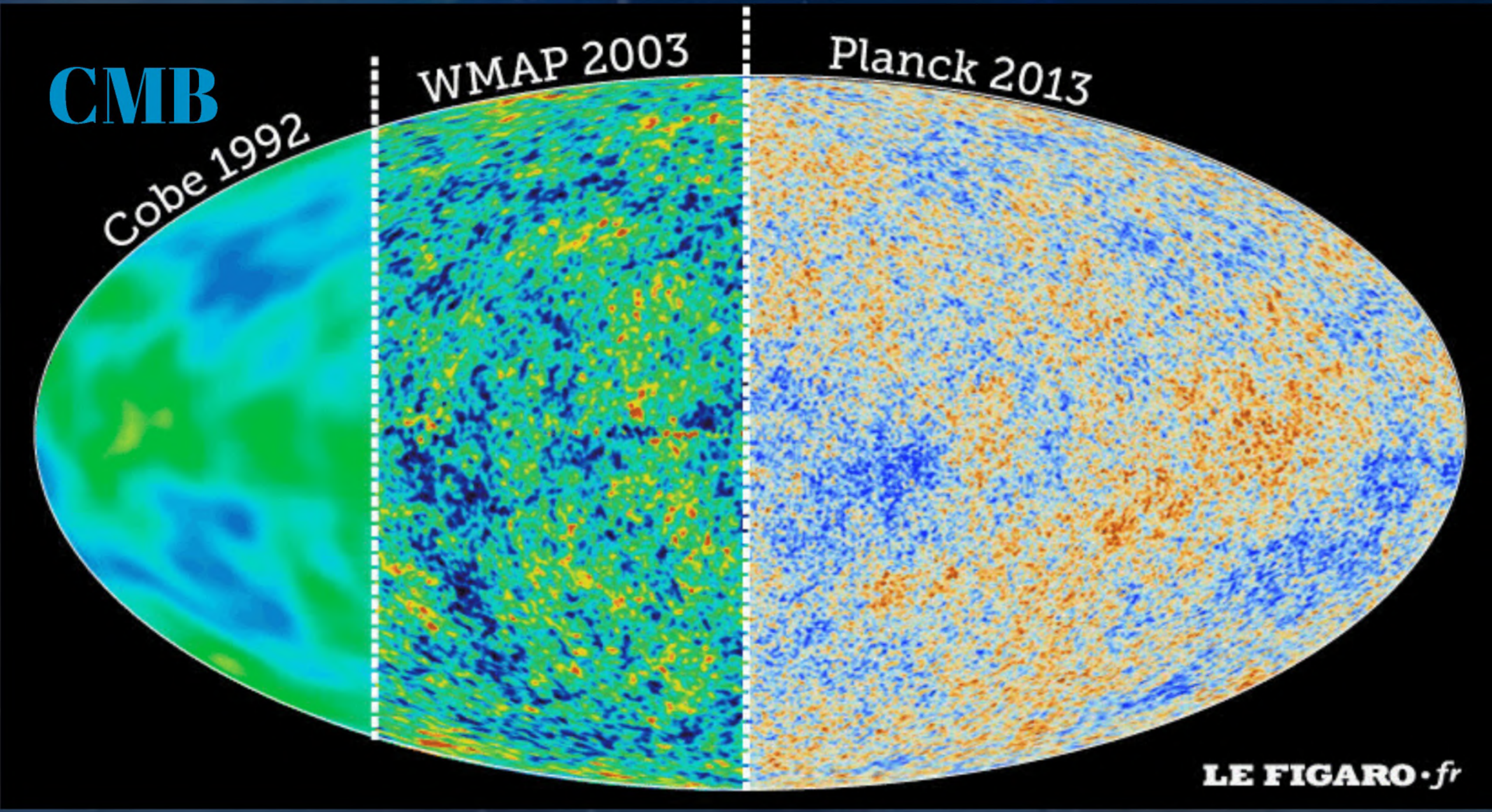

Penetrates Earth's Atmosphere?
Y
N
Y
N
Radiation Type
Wavelength (m)
Approximate Scale of Wavelength
Radio
10^{3}
Microwave
10^{-2}
Infrared
10^{-5}
Visible
0.5×10^{-6}
Ultraviolet
10^{-8}
X-ray
10^{-10}
Gamma ray
10^{-12}
Buildings
Humans
Butterflies
Needle Point
Protozoans
Molecules
Atoms
Atomic Nuclei
Frequency (Hz)
10^{4}
10^{8}
10^{12}
10^{15}
10^{16}
10^{18}
10^{20}
Temperature of objects at which this radiation is the most intense wavelength emitted
1 K
−272 °C
100 K
−173 °C
10,000 K
9,727 °C
10,000,000 K
~10,000,000 °C
@ Inductiveload, NASA

A legrégebben útnak induló fény, aminek a segítségével a legtávolabbra pillanthatunk ~ 380 ezer év Nb.u.

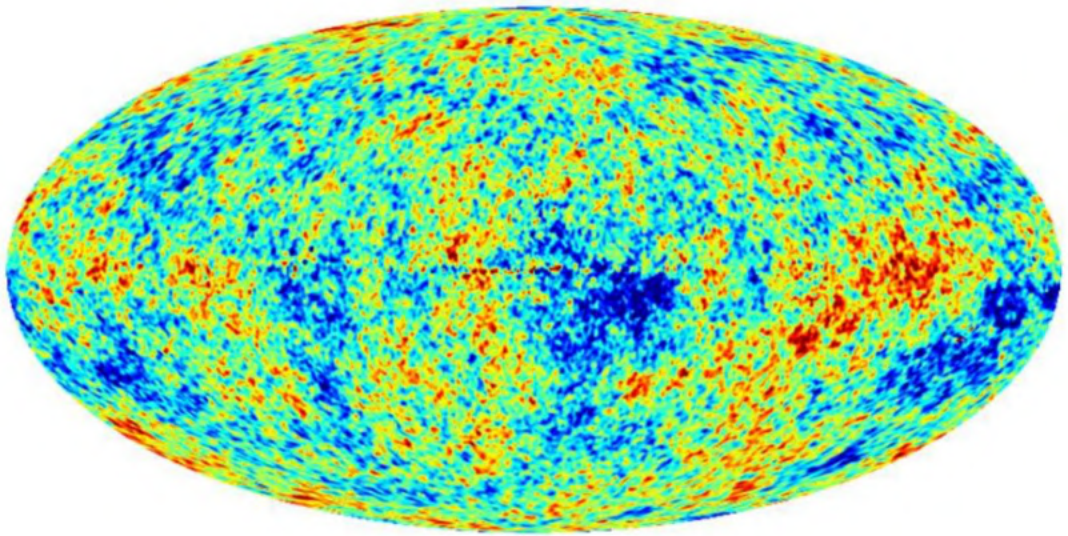
CMB



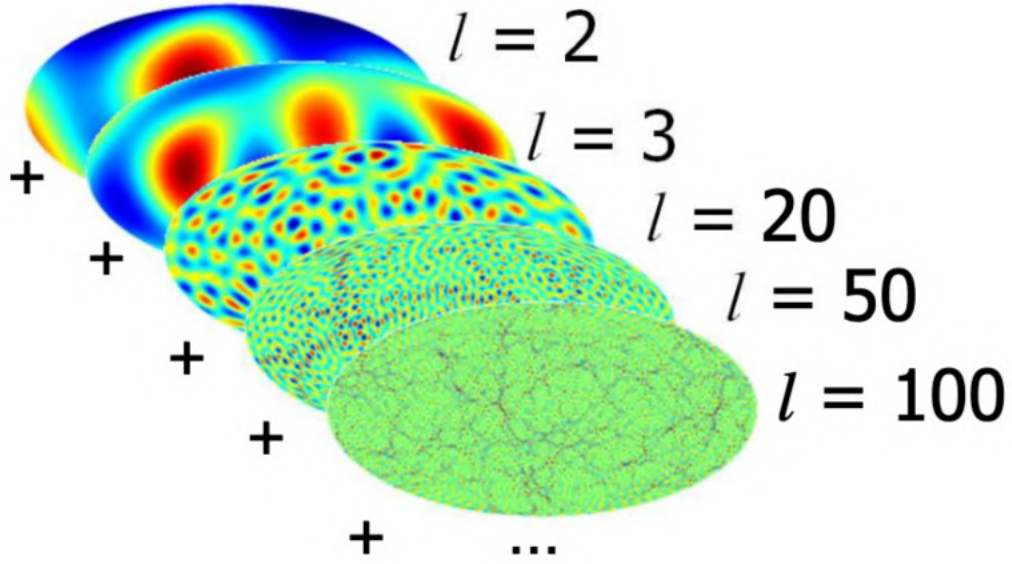
@ NASA / WMAP Science Team


CMB
Cobe 1992
WMAP 2003
Planck 2013
LE FIGARO·fr

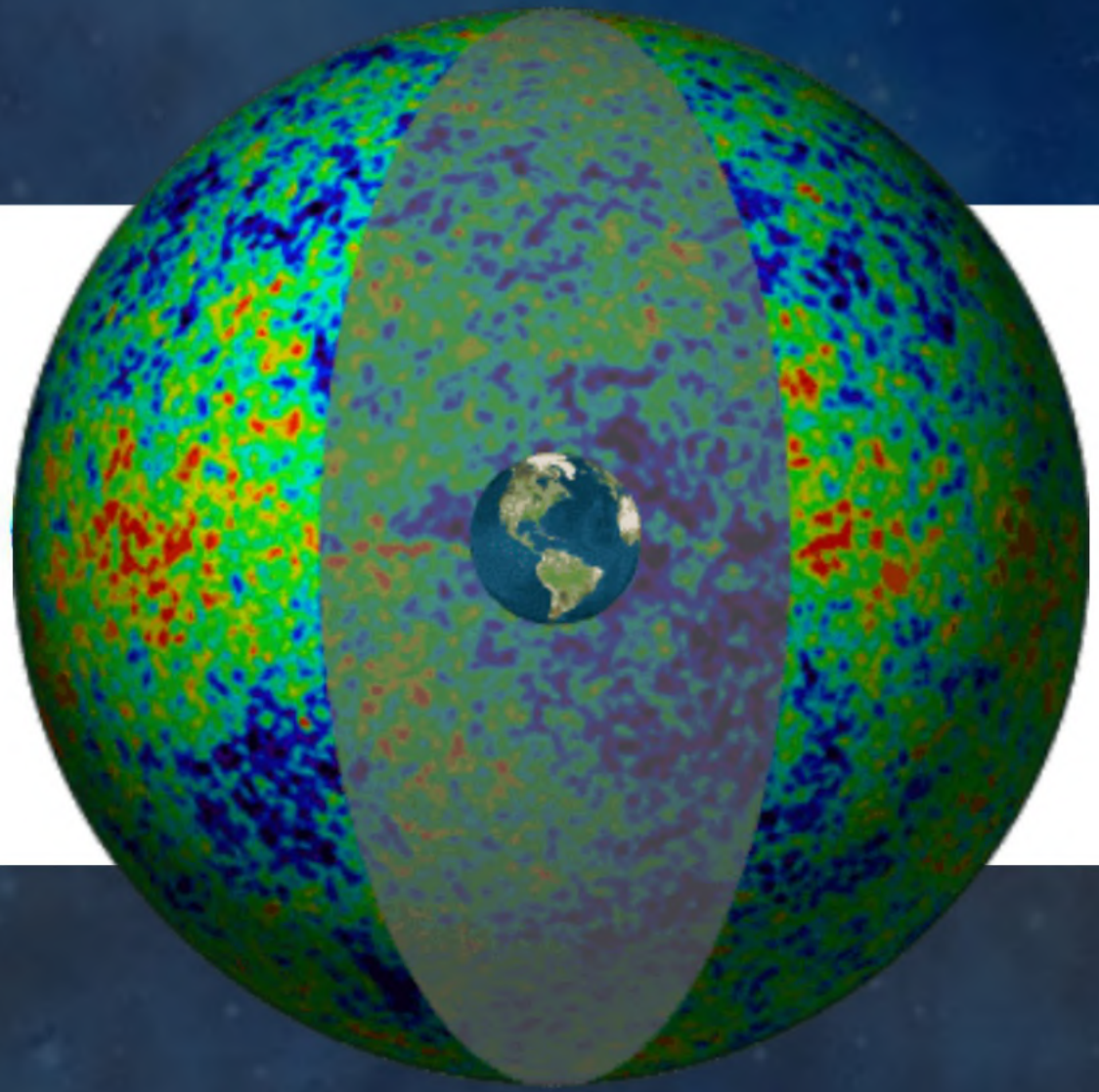
Gömbfüggvények



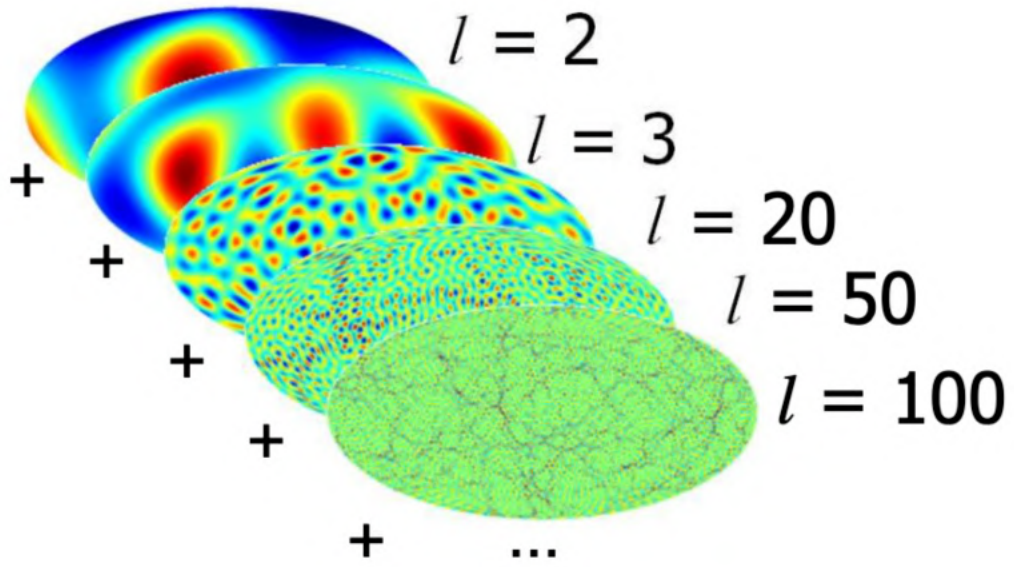
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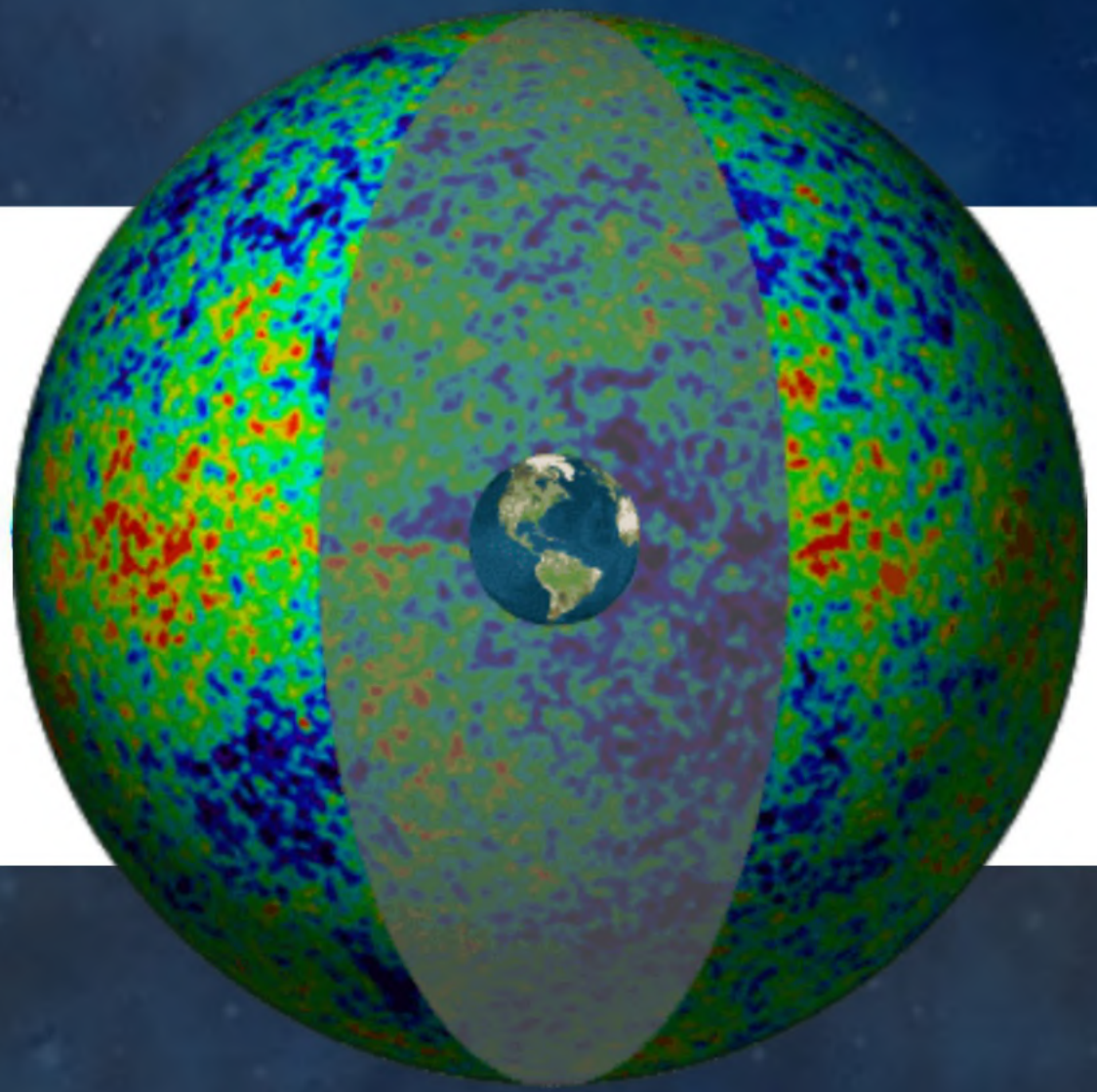
Gömbfüggvények



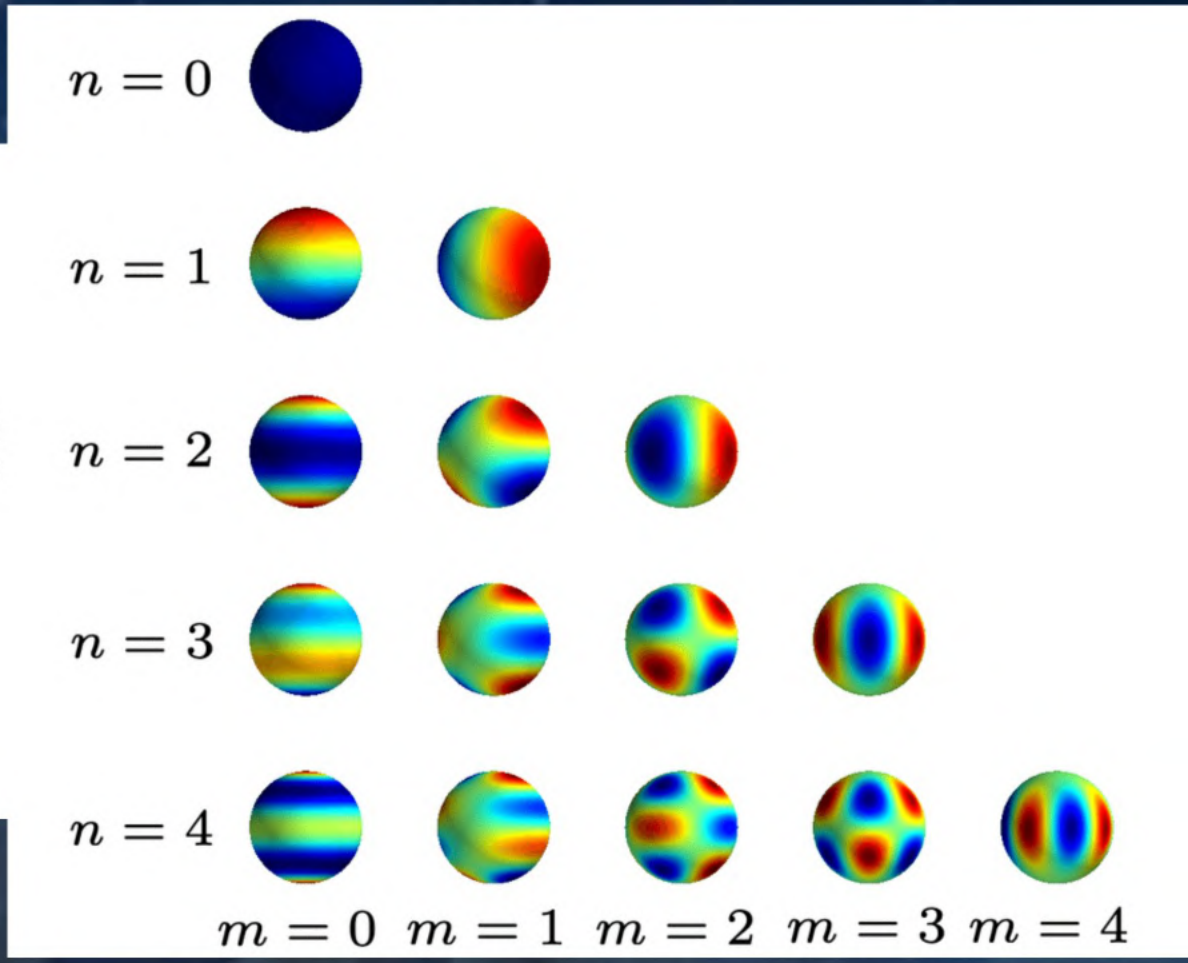
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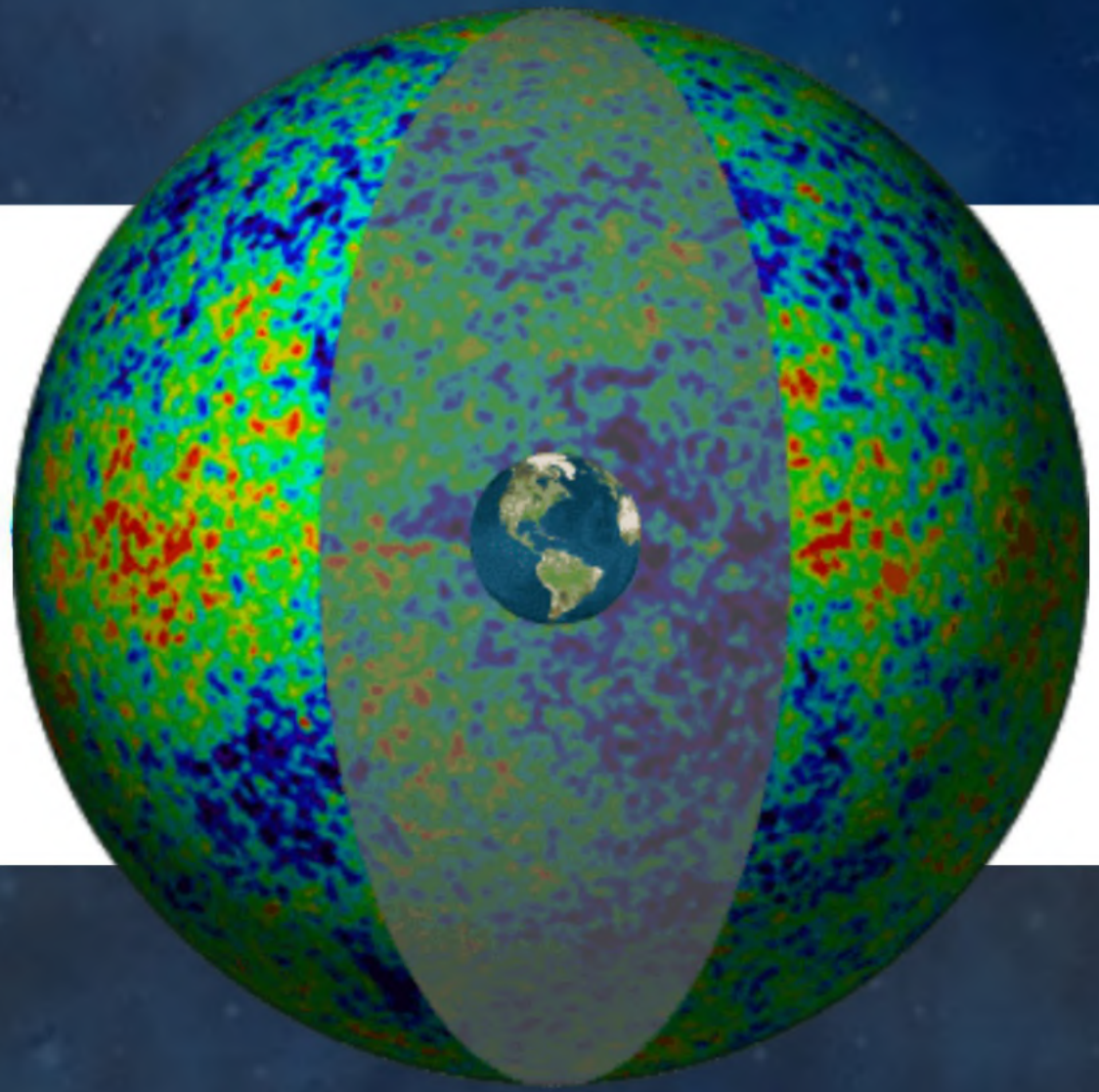
Gömbfüggvények



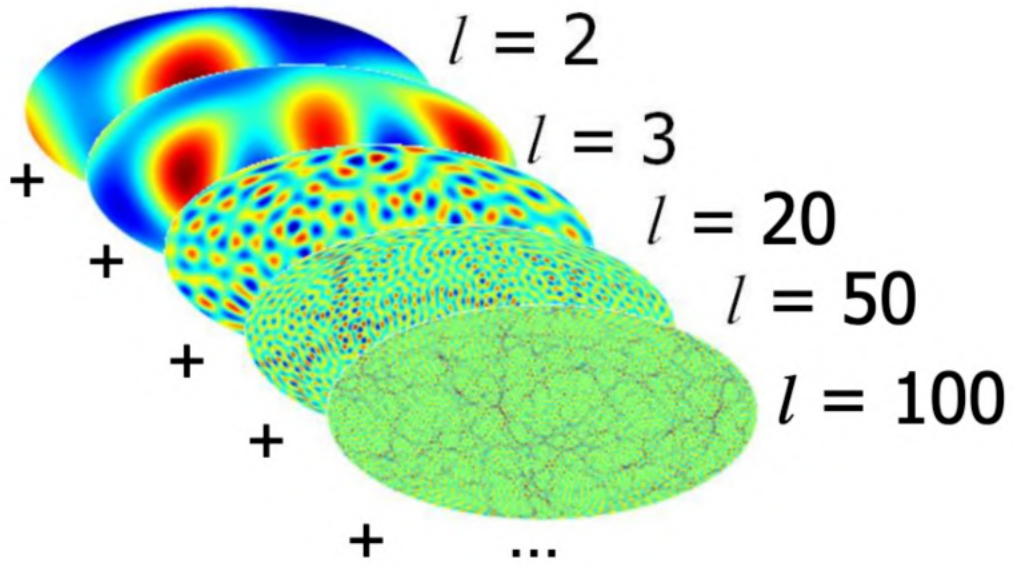
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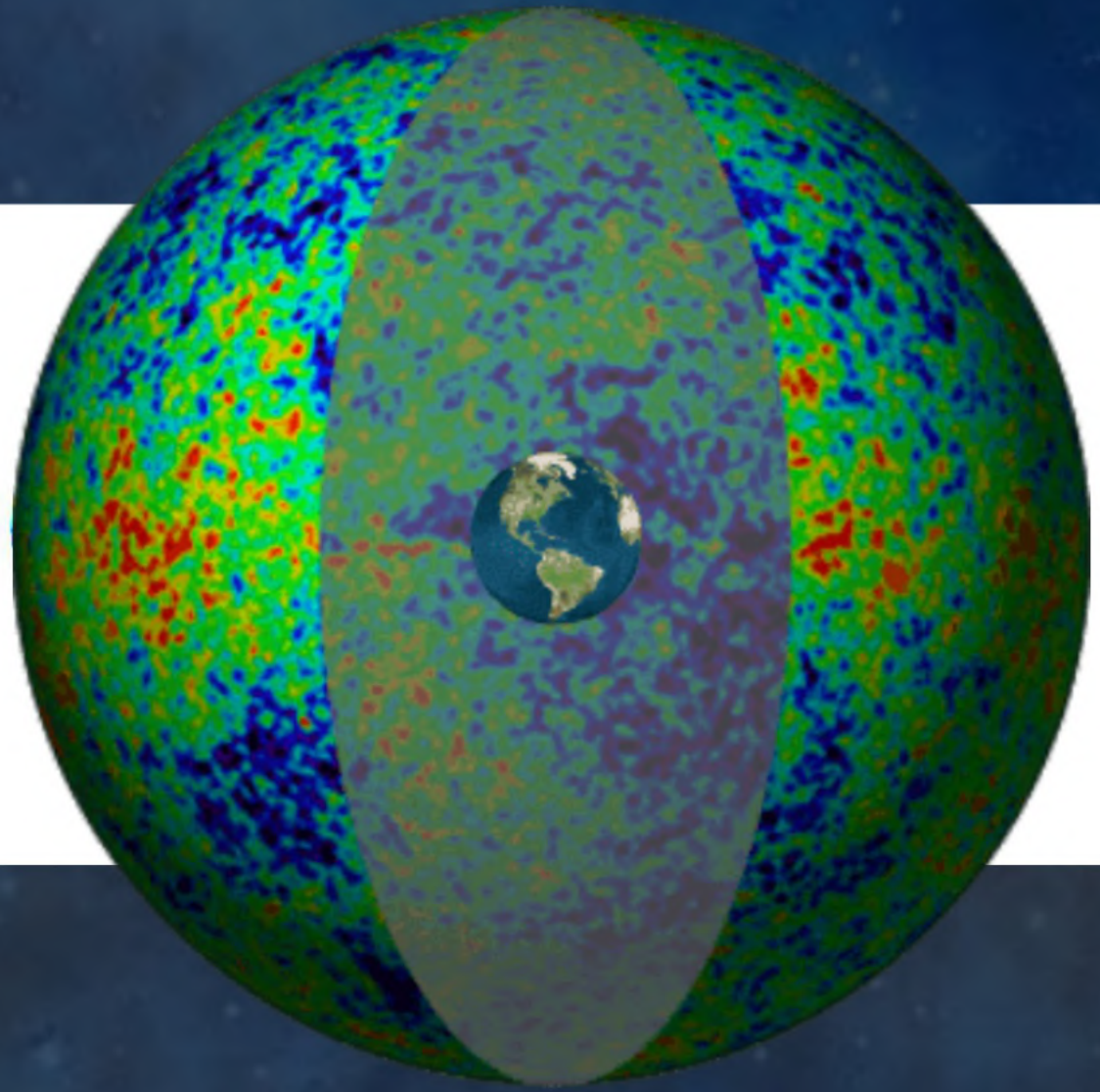
Gömbfüggvények



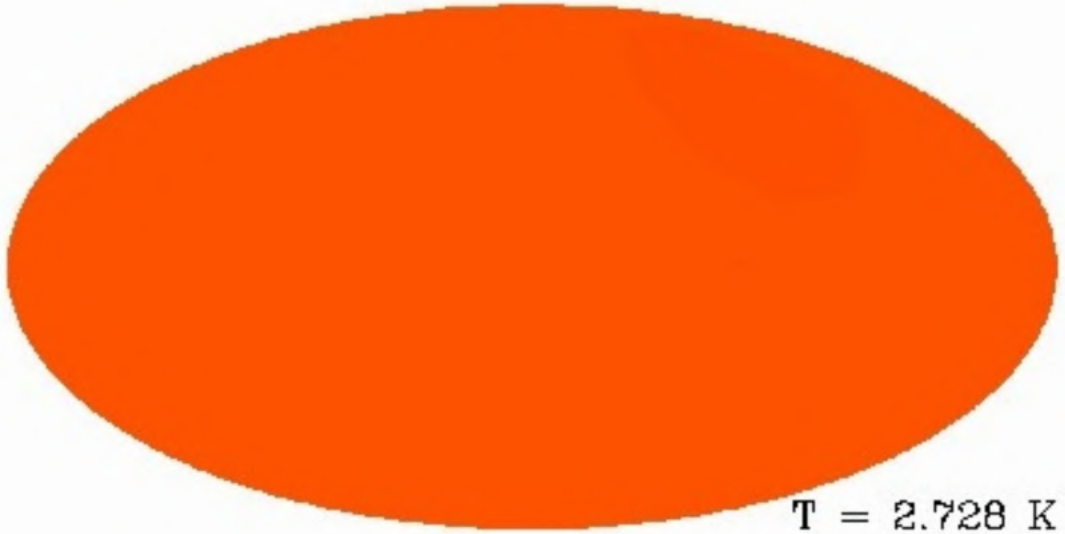
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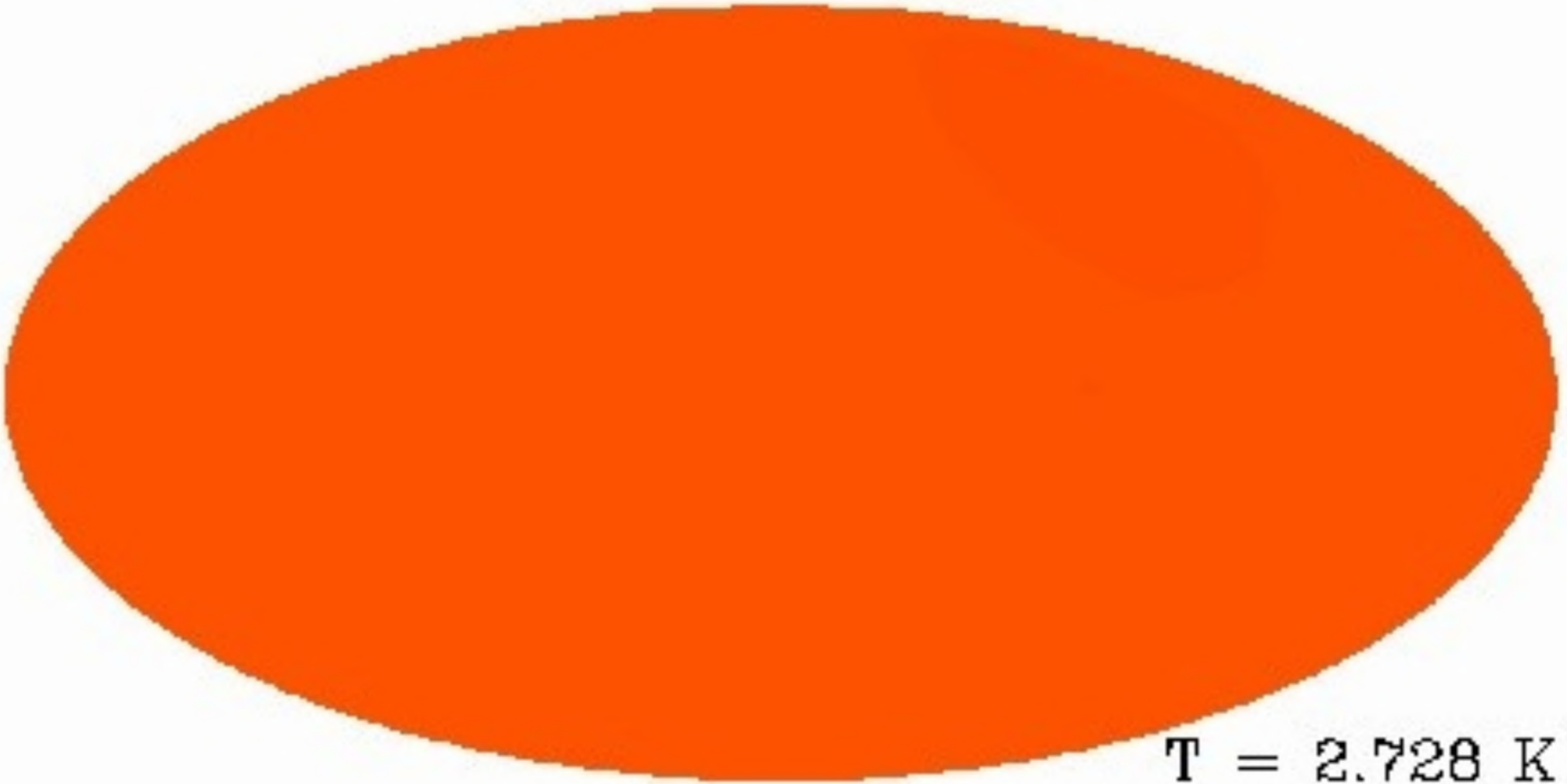


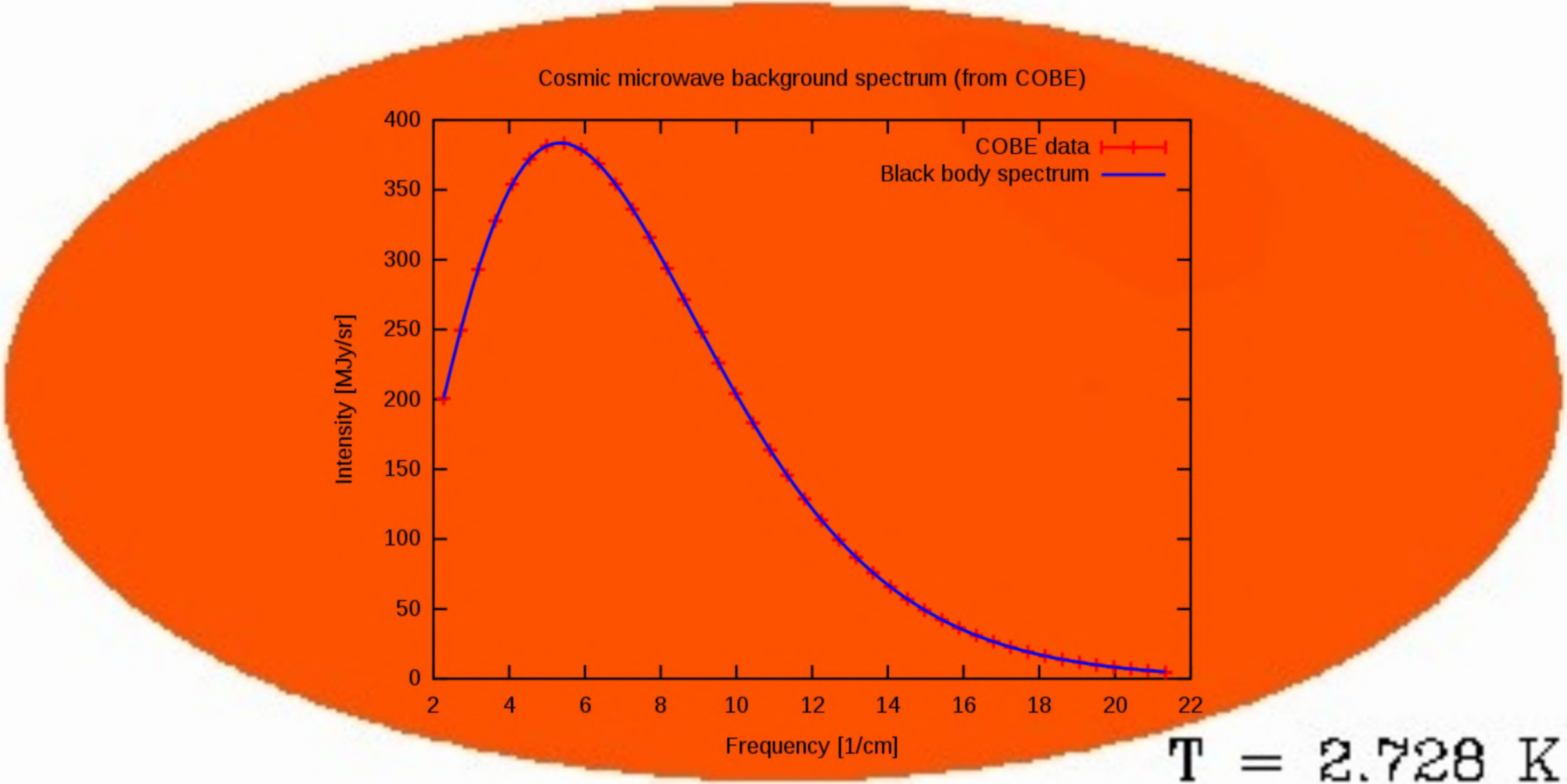
Gömbfüggvények



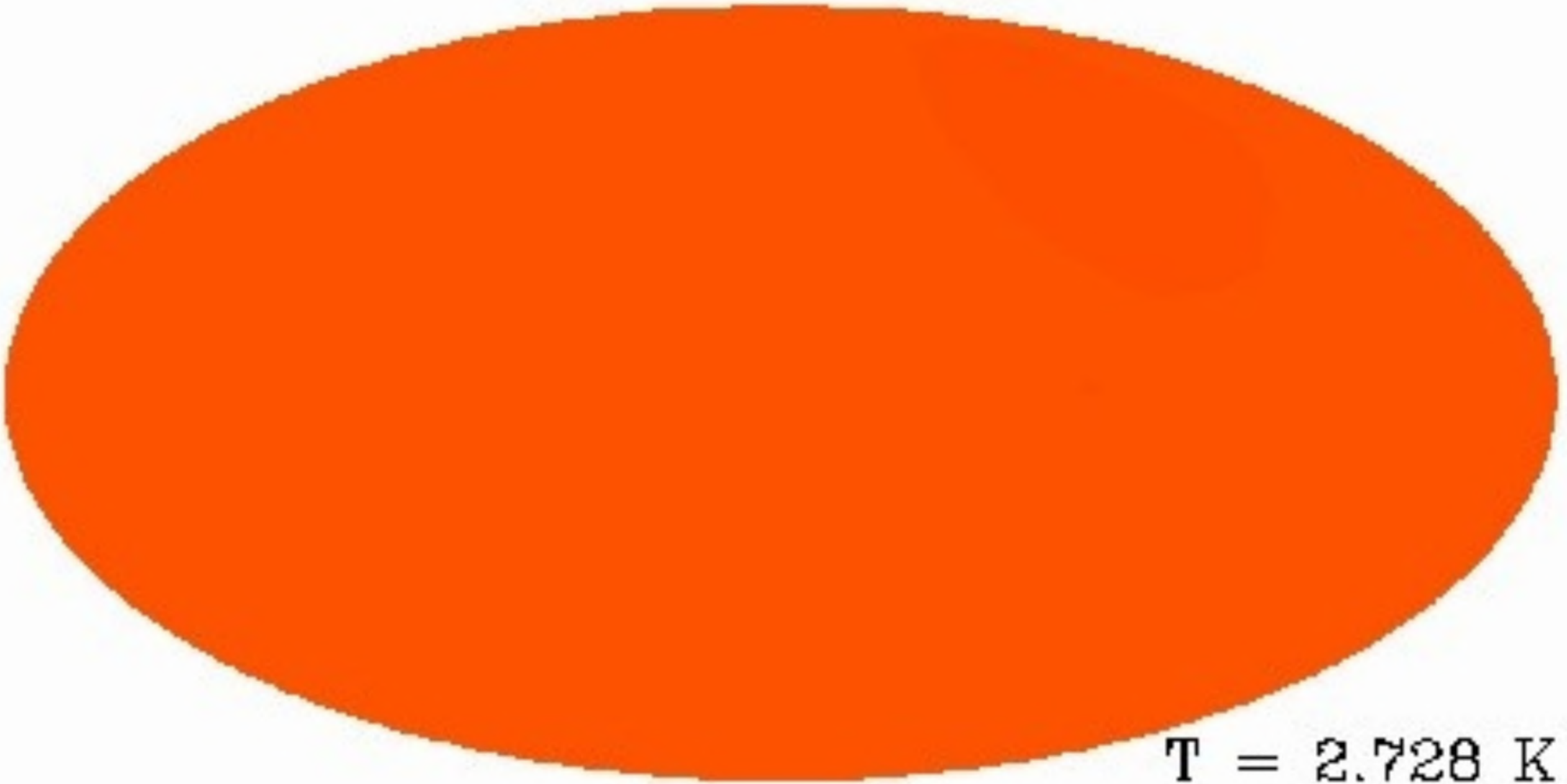
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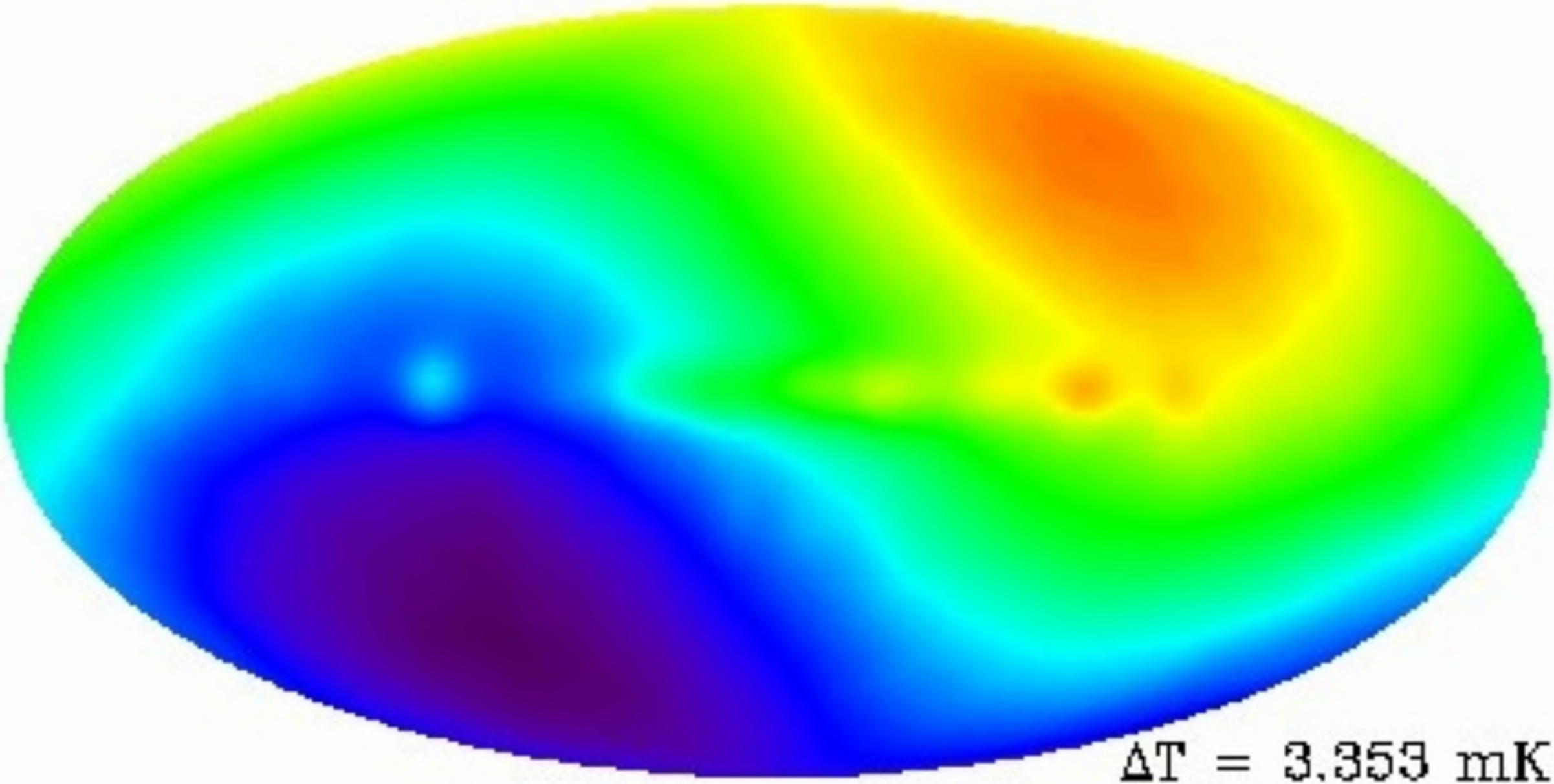


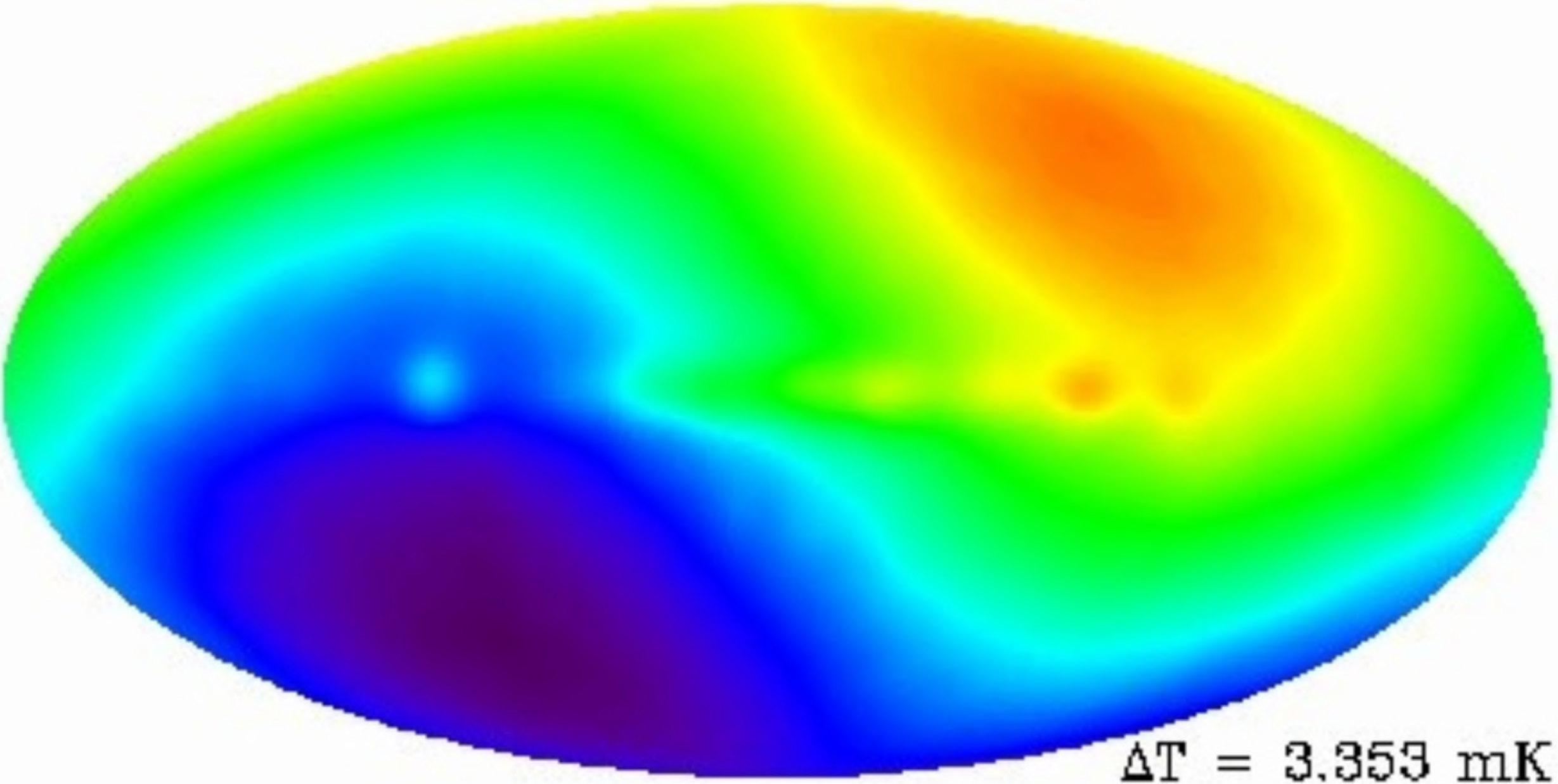

T = 2.728 K

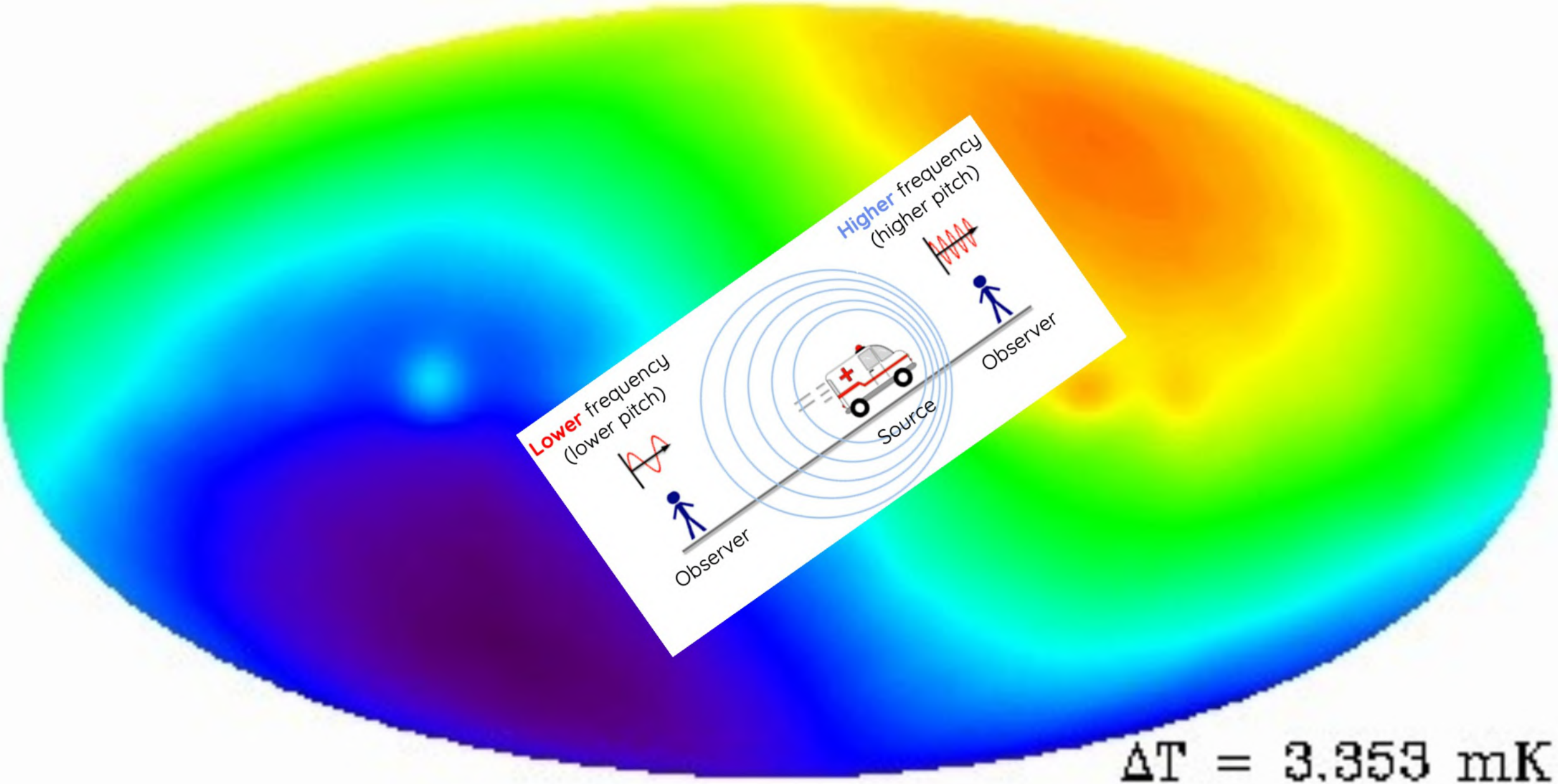

Cosmic microwave background spectrum (from COBE)
COBE data
Black body spectrum
Intensity [MJy/sr]
Frequency [1/cm]
0
50
100
150
200
250
300
350
400
2
4
6
8
10
12
14
16
18
20
22

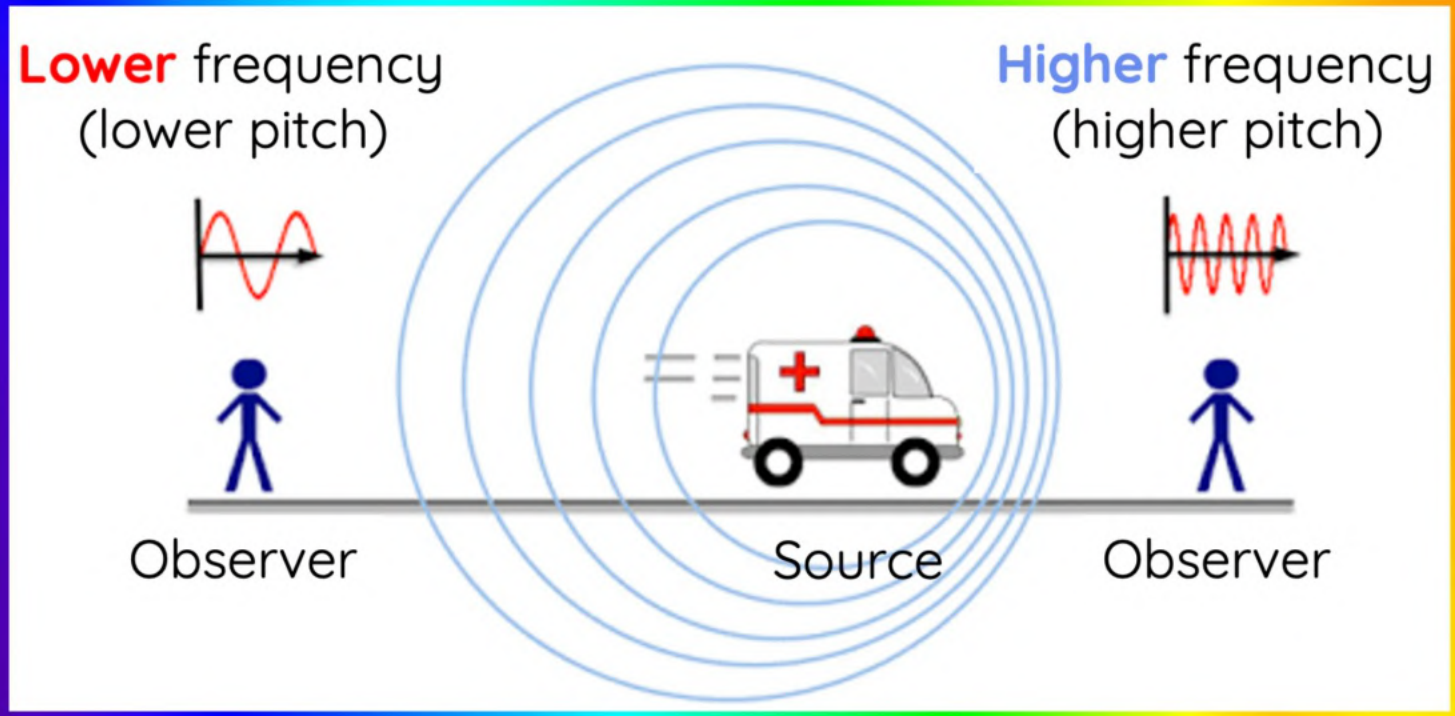
$T = 2.728\ K$

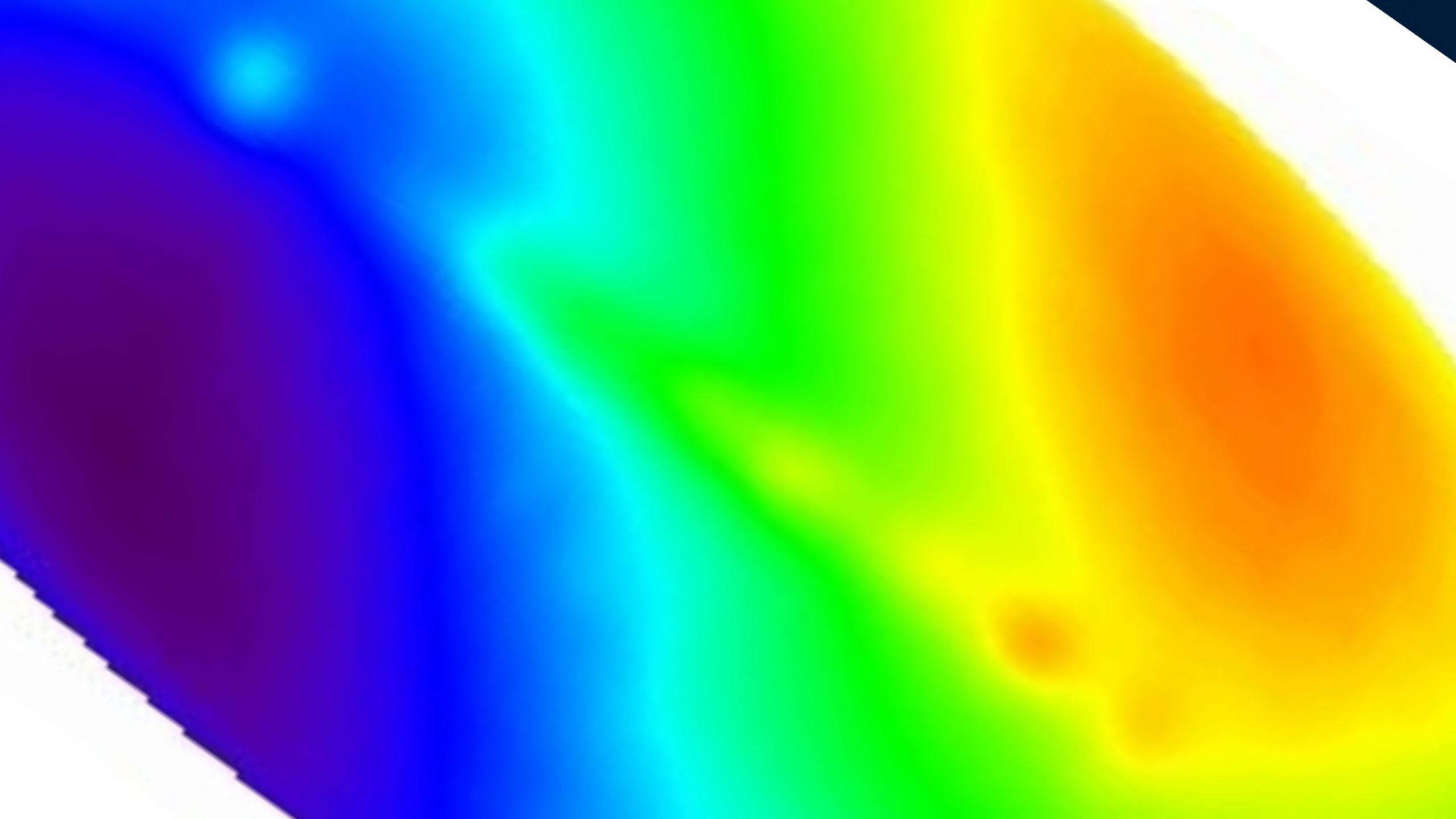

T = 2.728 K

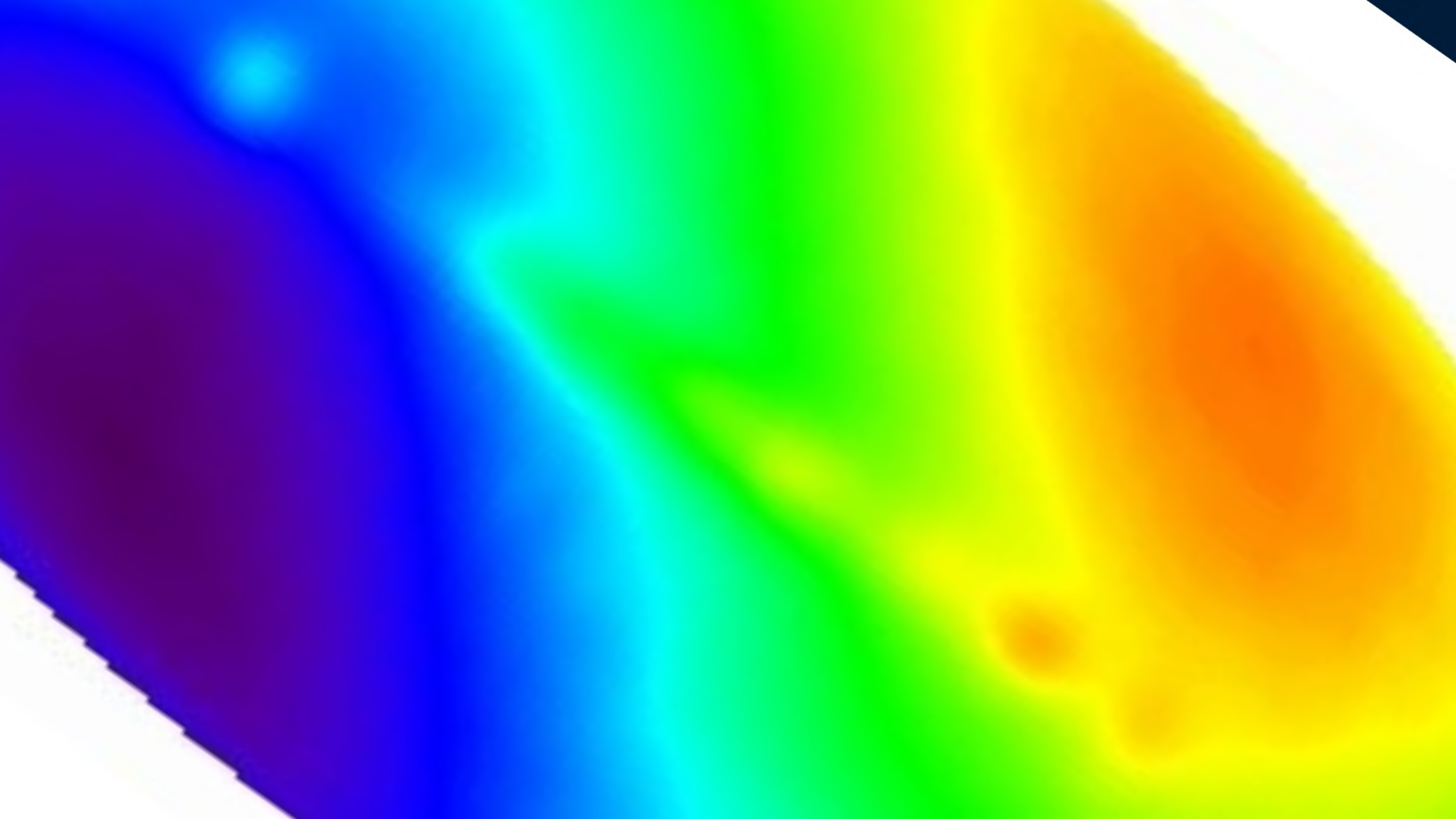

ΔT = 3.353 mK

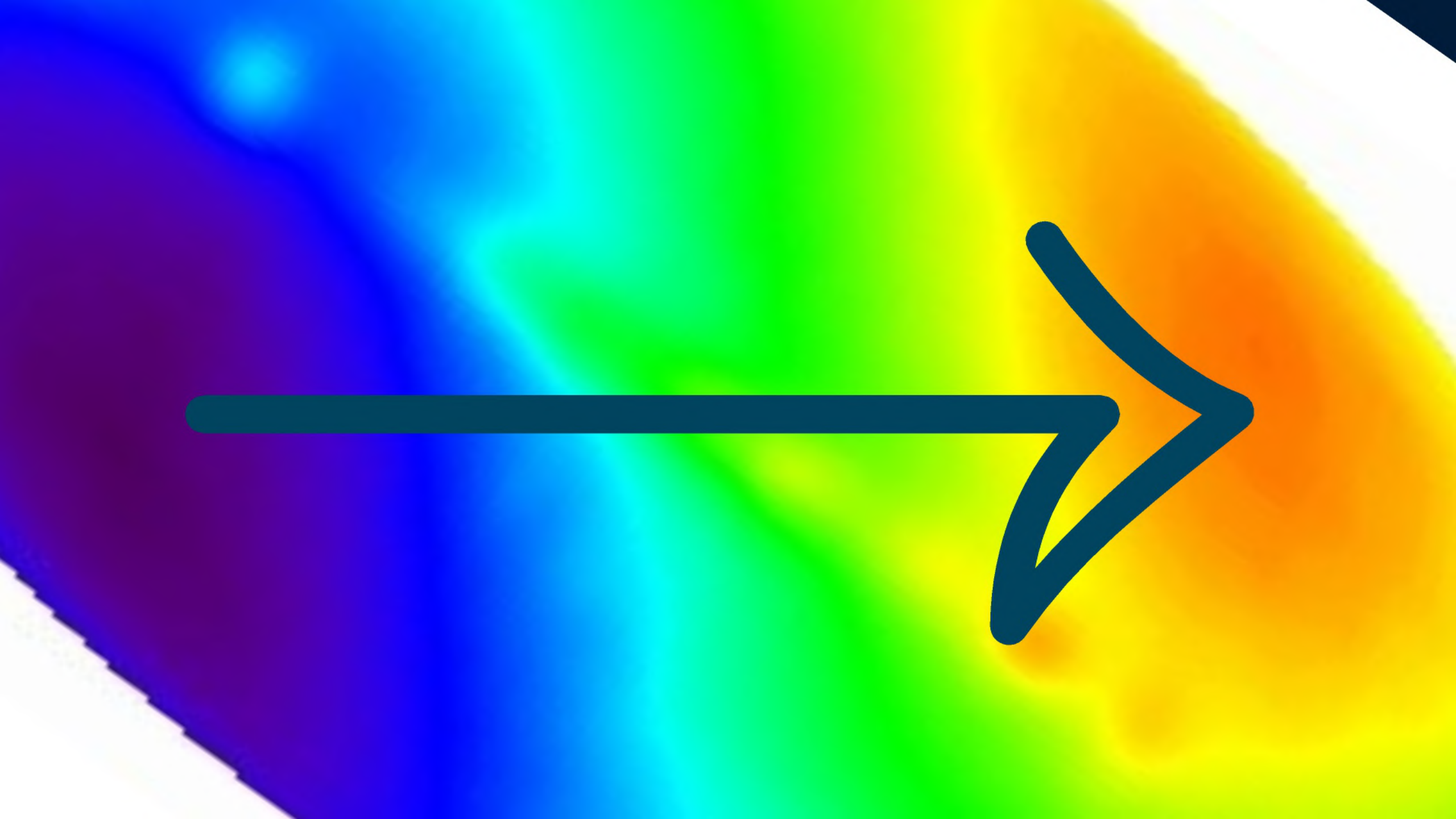

ΔT = 3.353 mK

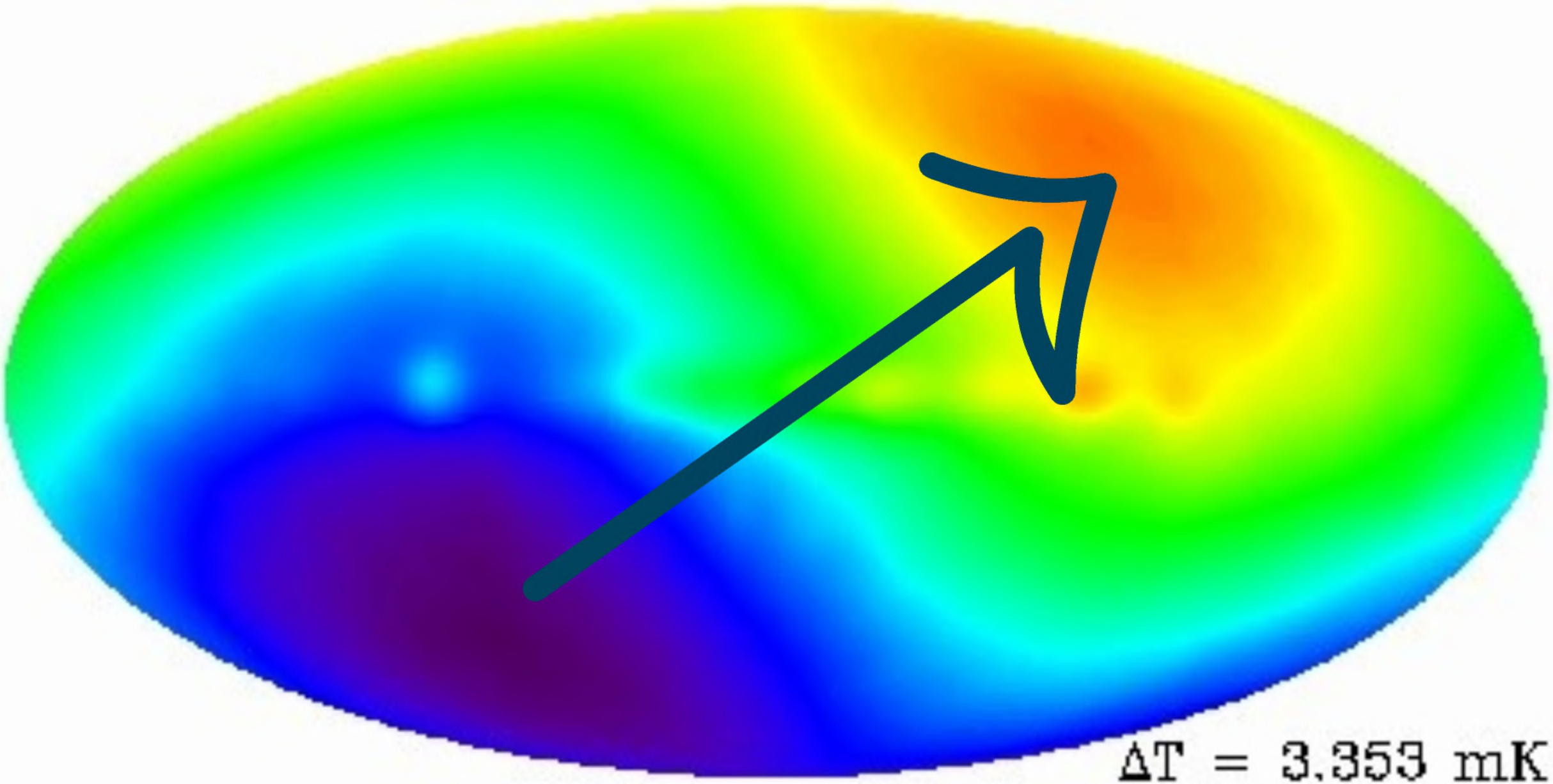

Lower frequency
(lower pitch)
Higher frequency
(higher pitch)
Observer
Source
Observer
ΔT = 3.353 mK


Lower frequency
(lower pitch)
Higher frequency
(higher pitch)
Observer
Source
Observer

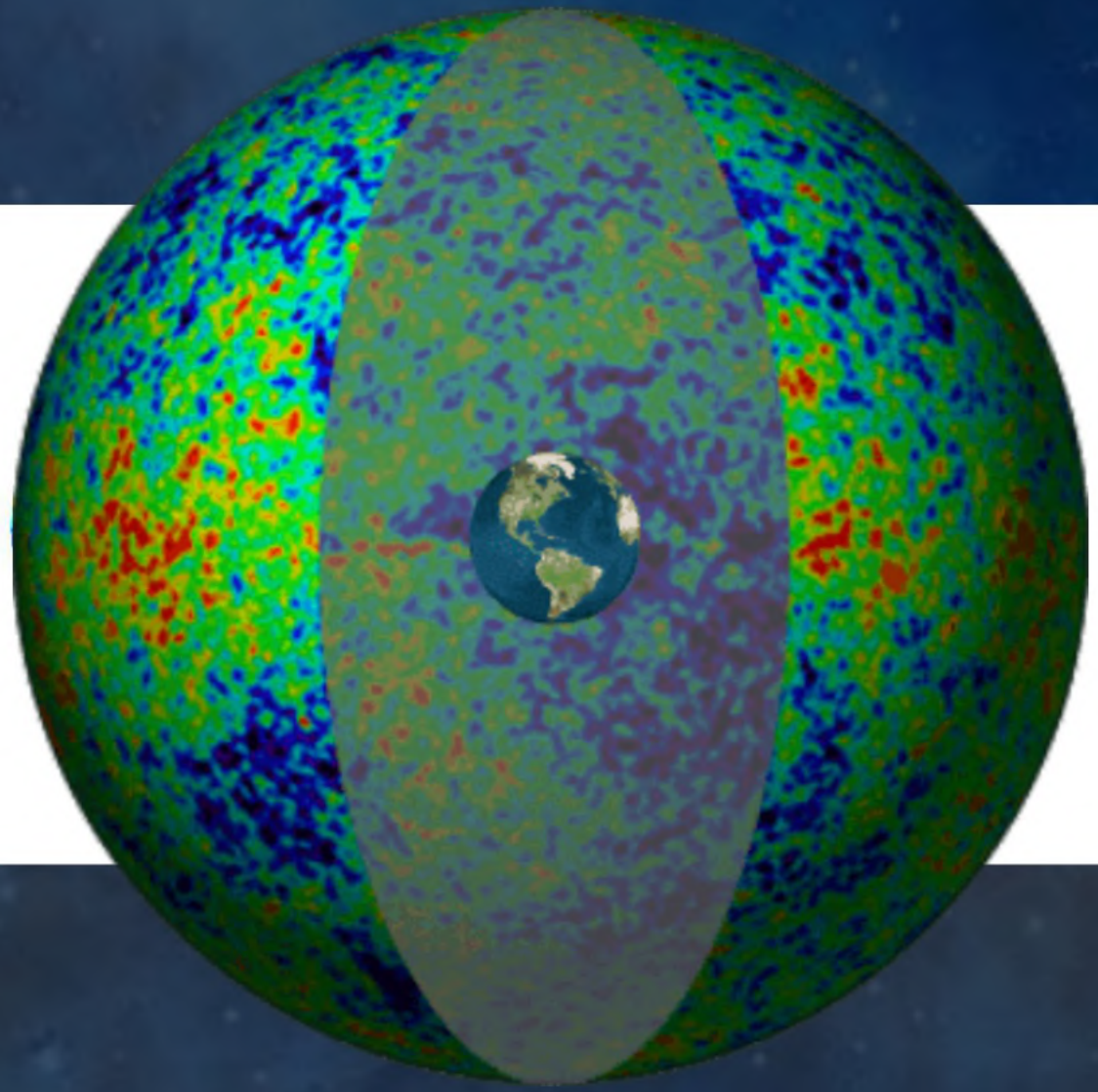




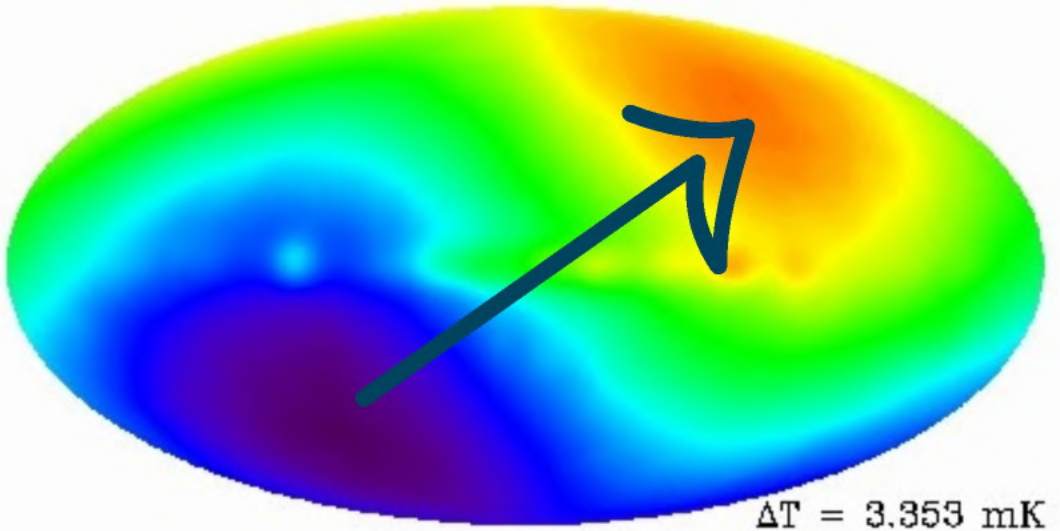



ΔT = 3.353 mK

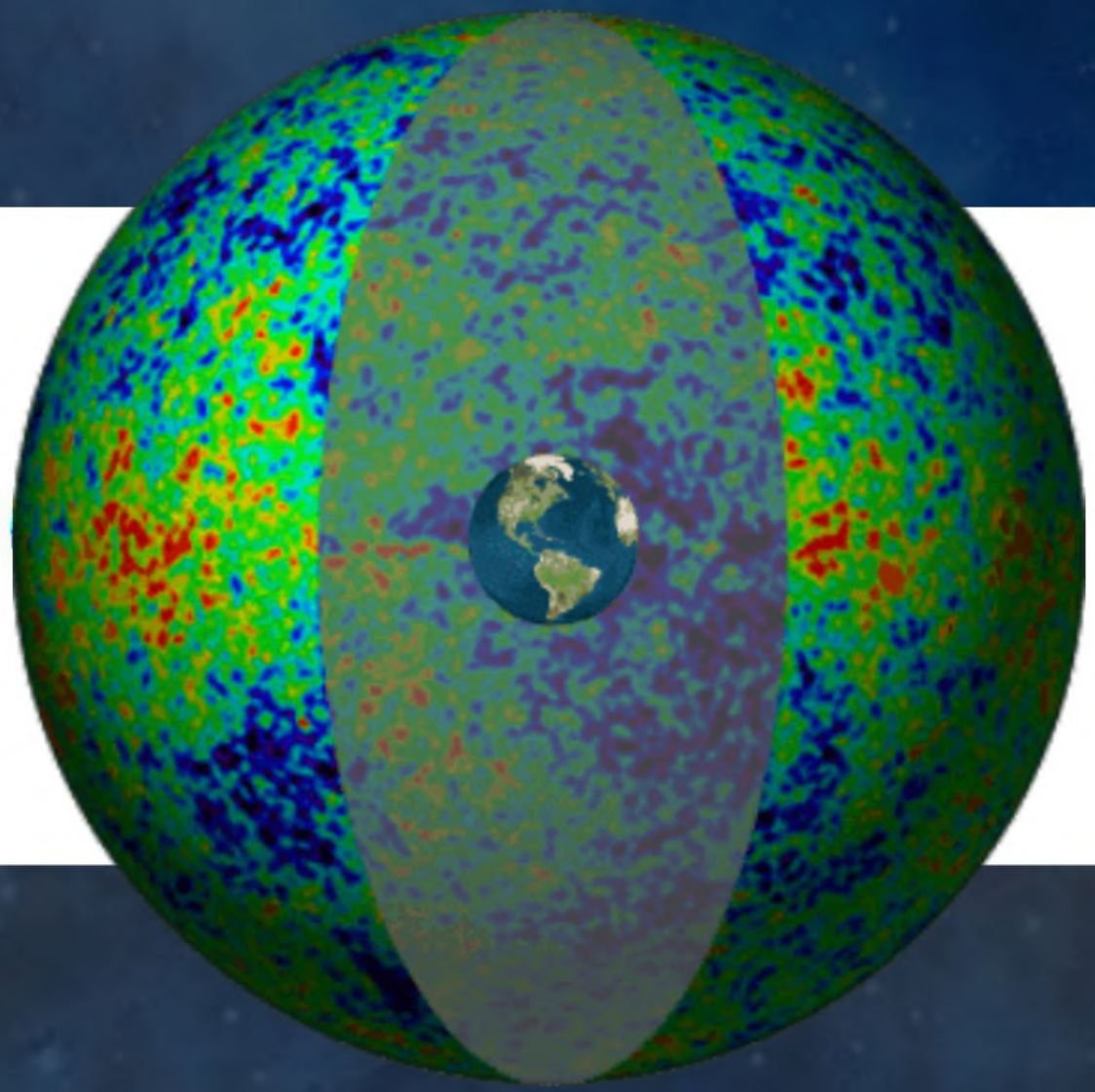
Gömbfüggvények



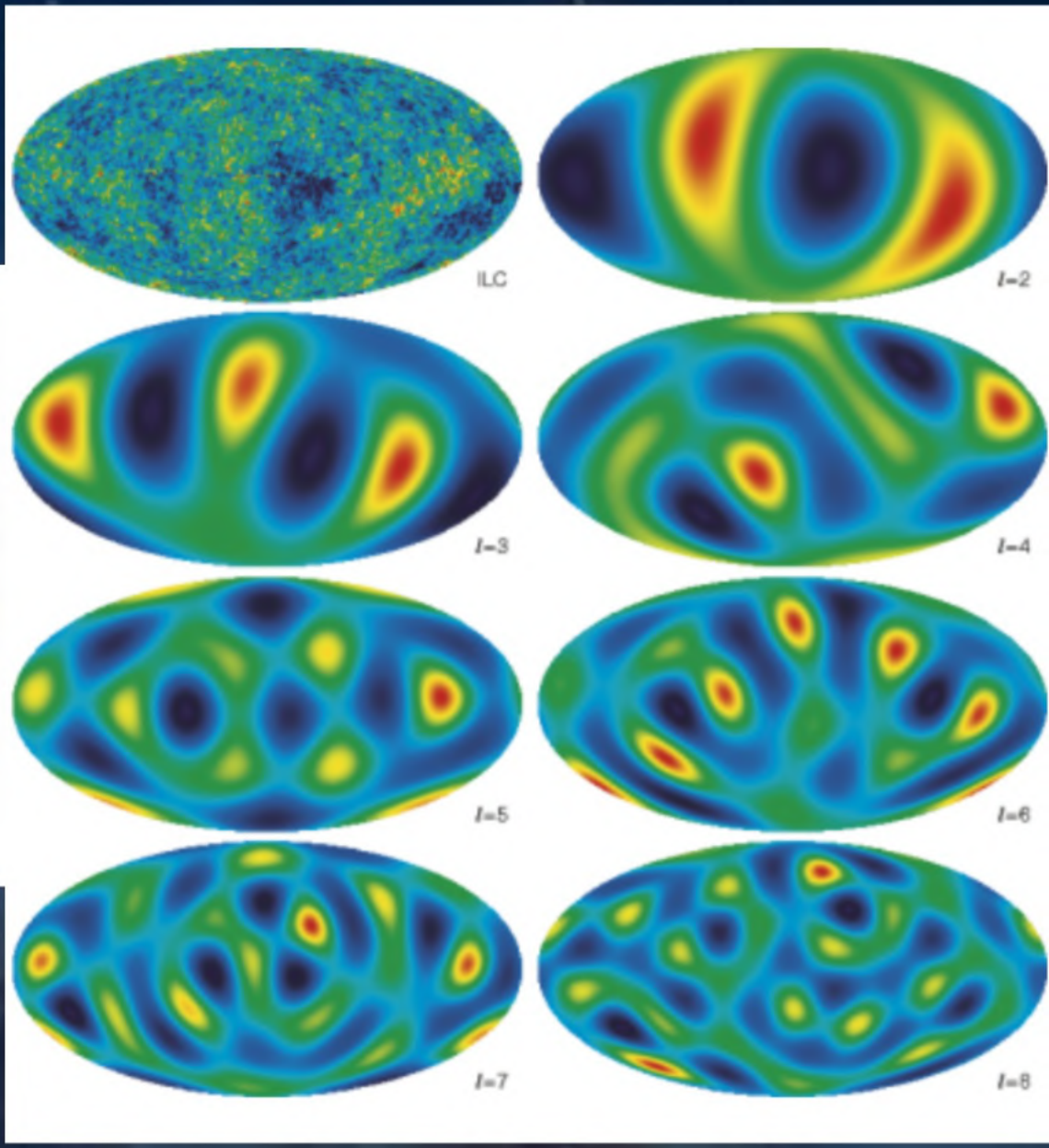
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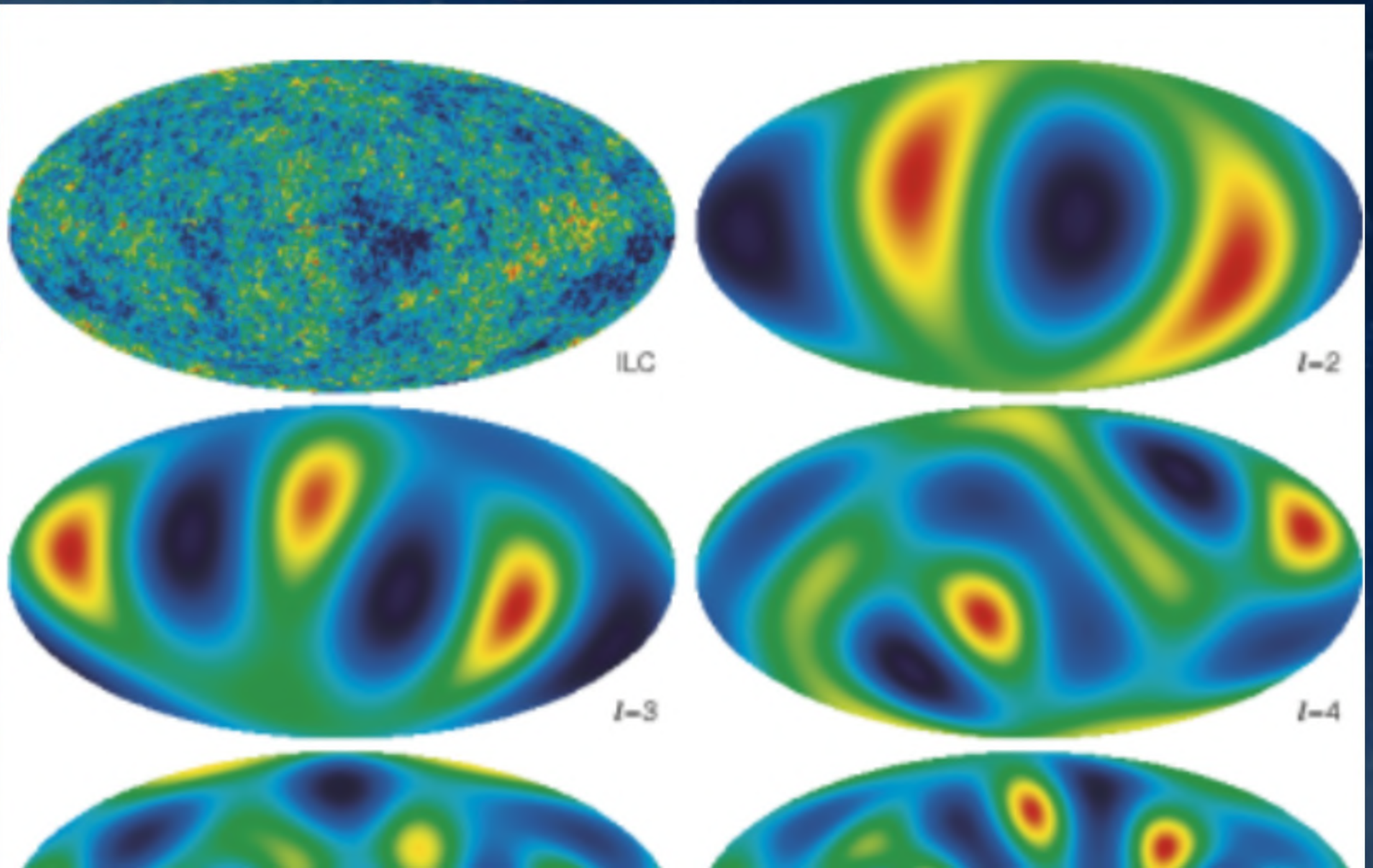


Gömbfüggvények

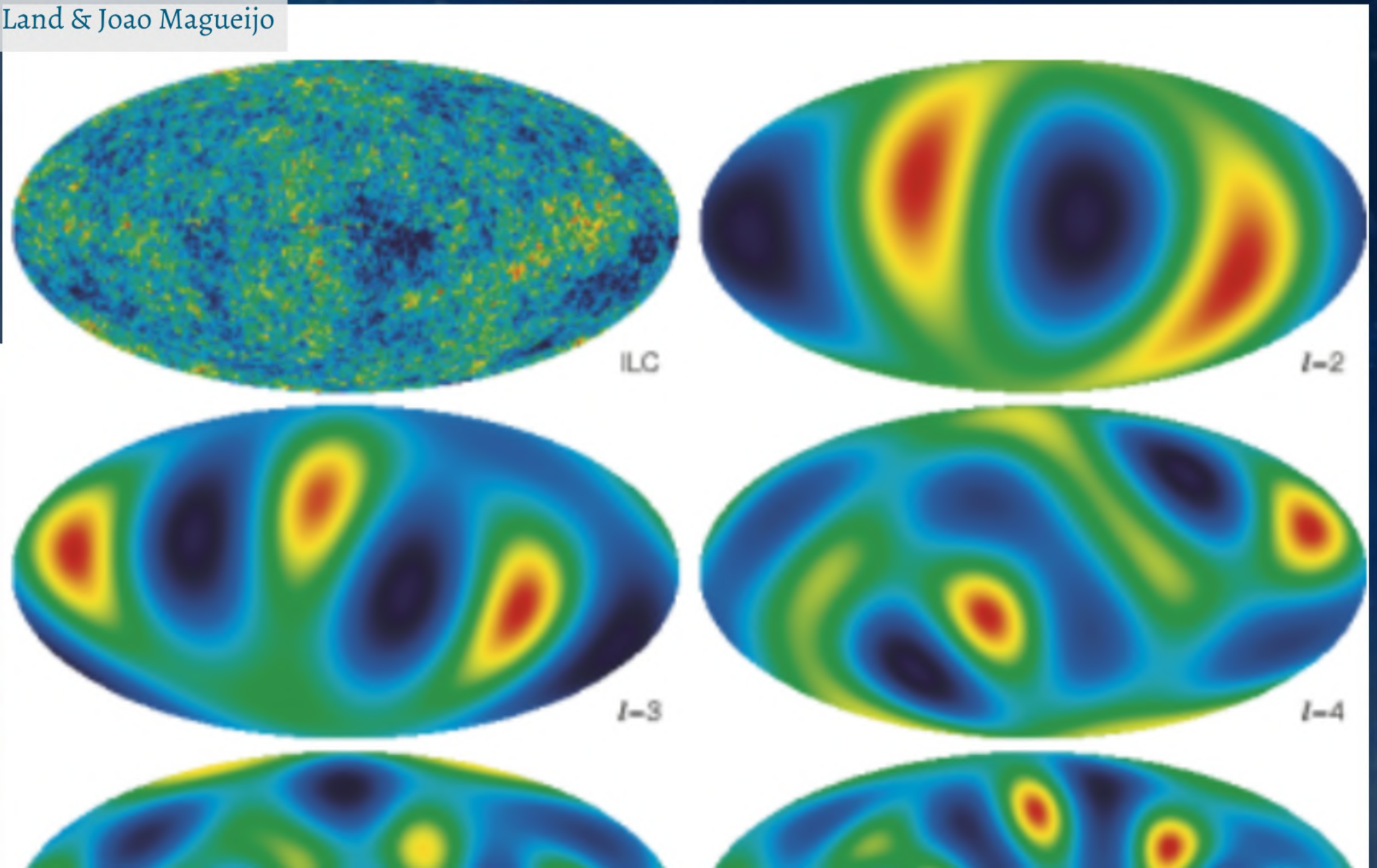


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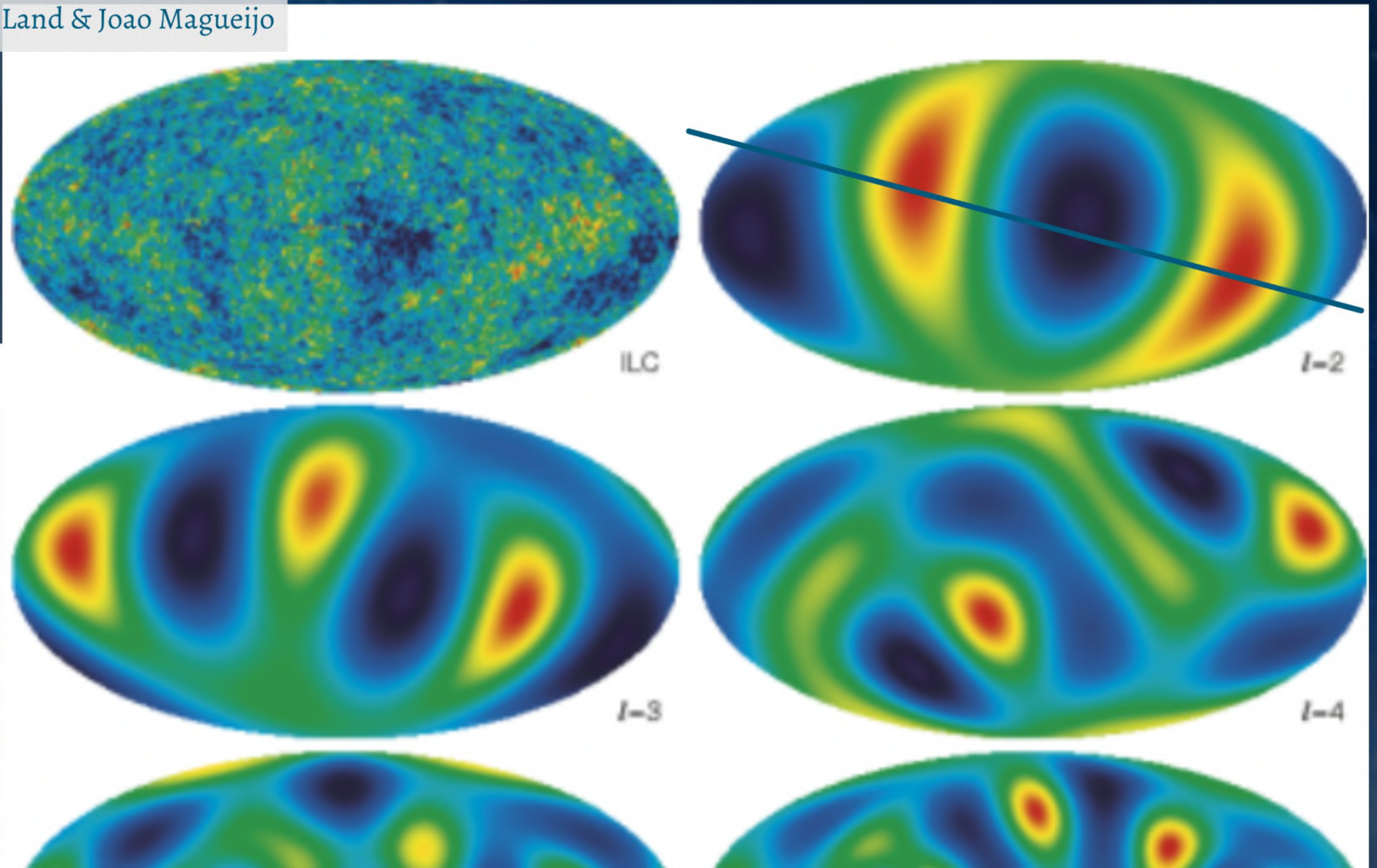



ILC
l=2
l=3
l=4

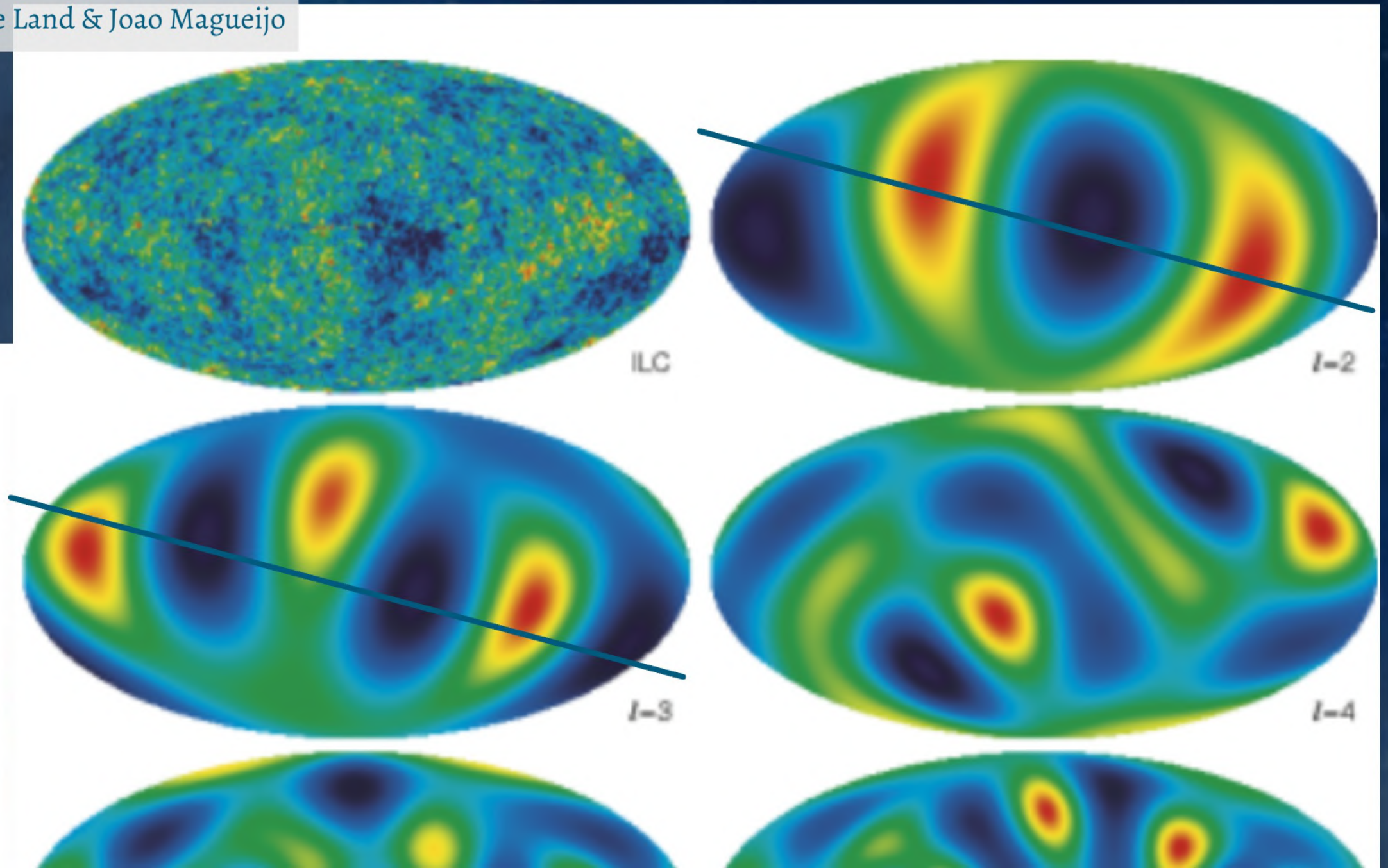
@ Kate Land & Joao Magueijo



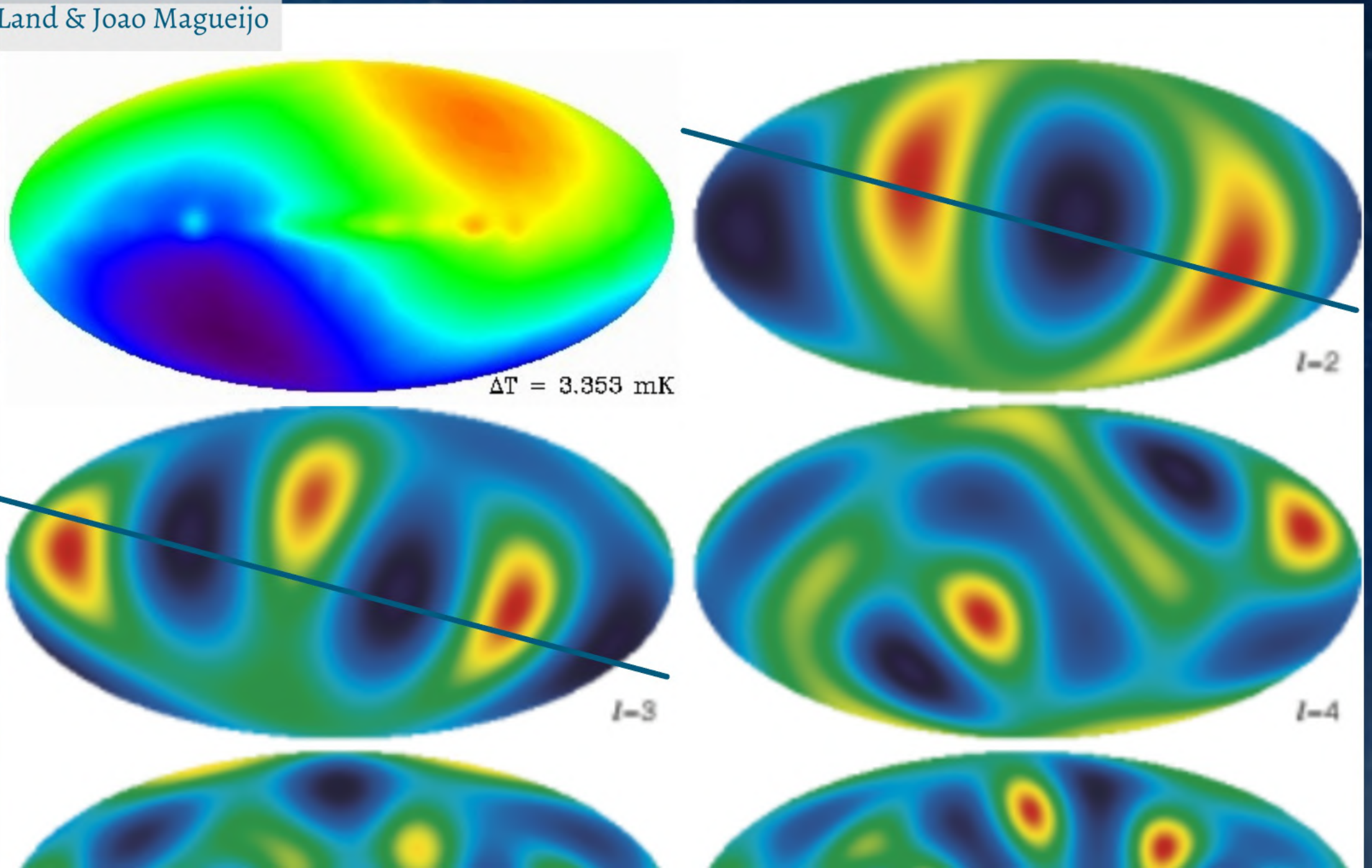
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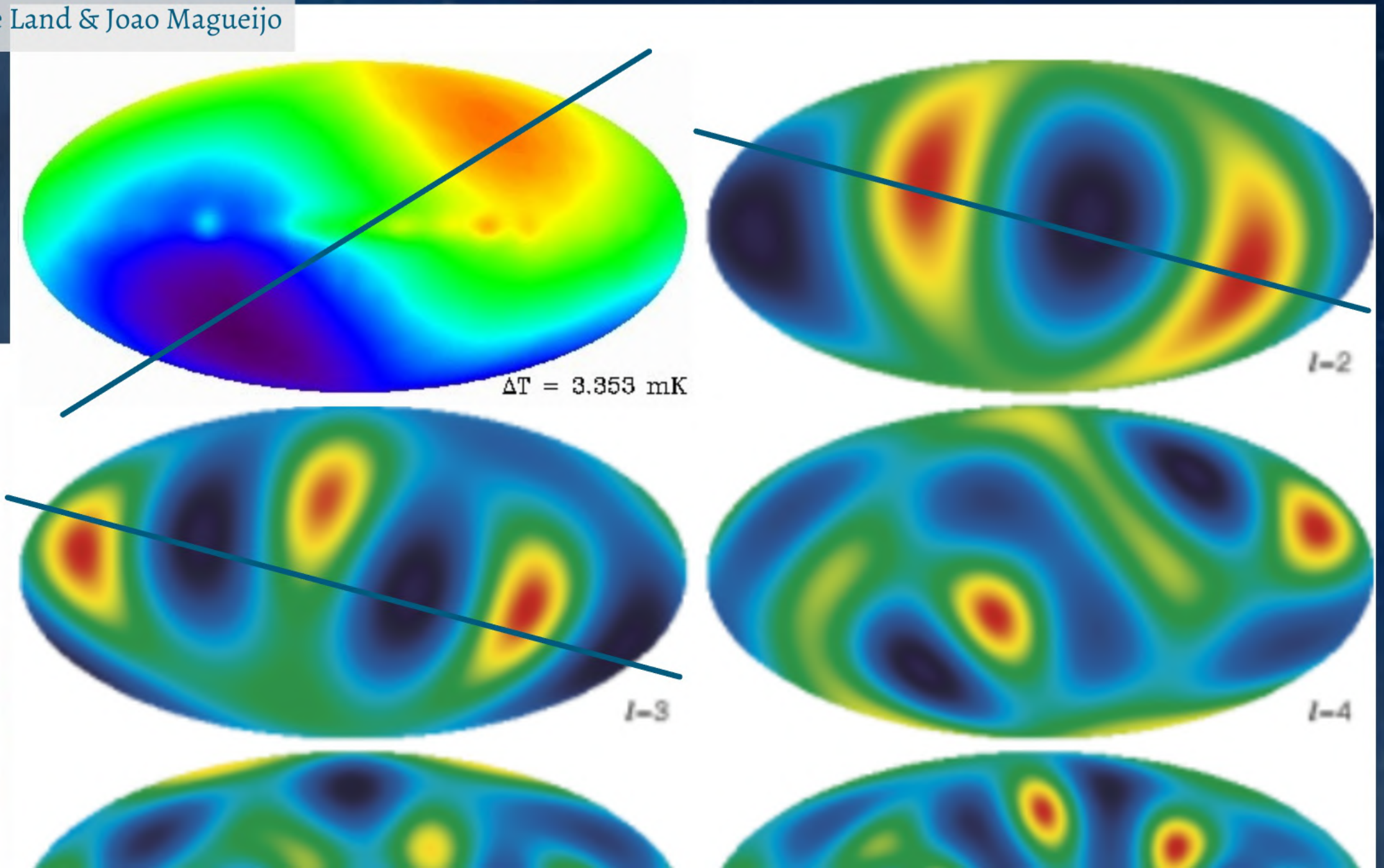
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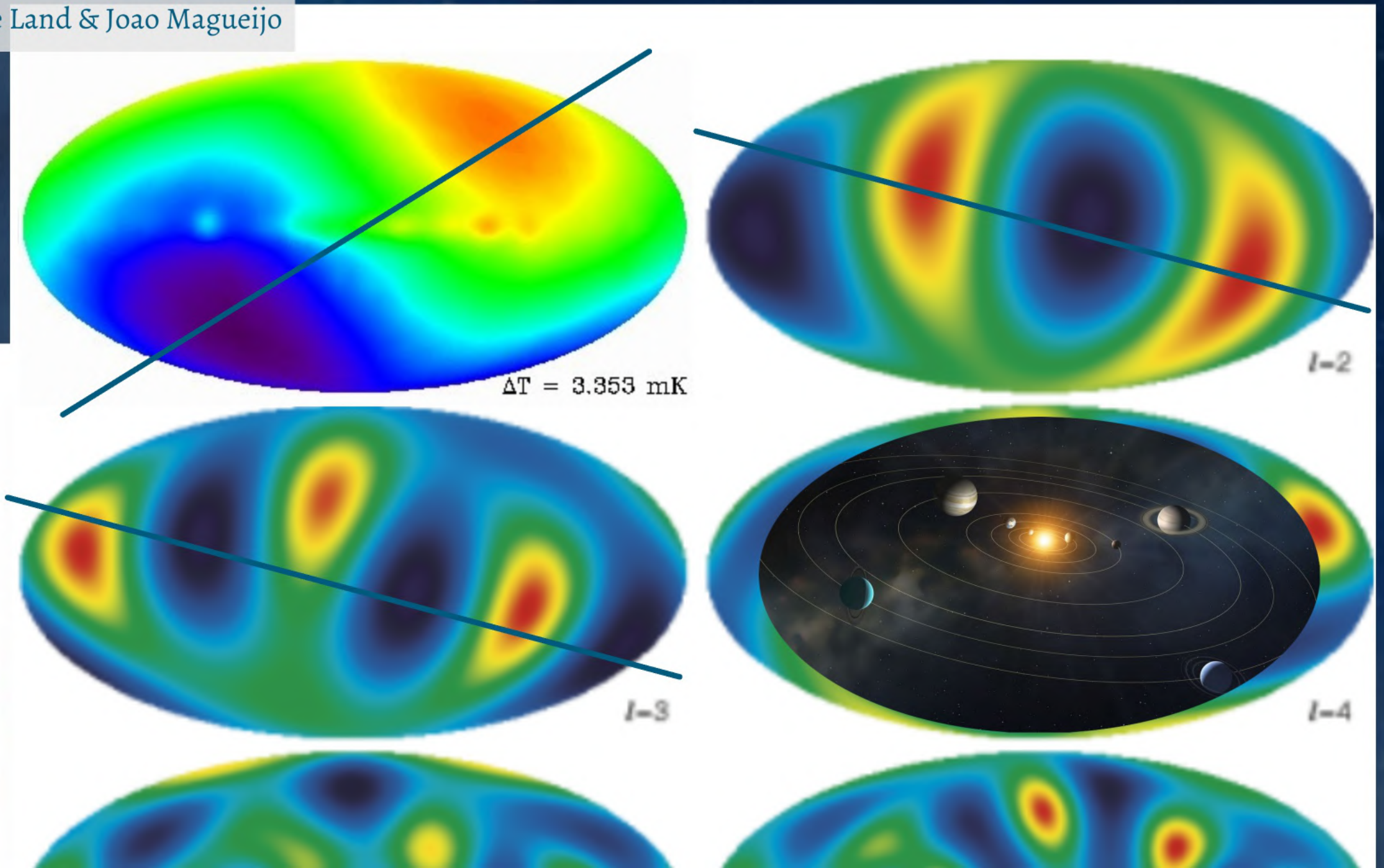
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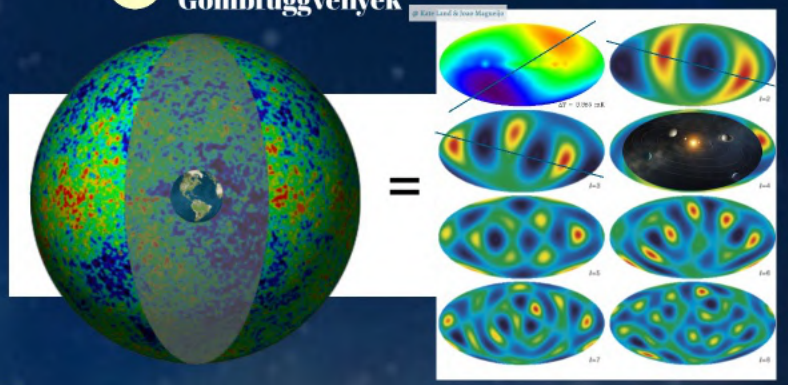
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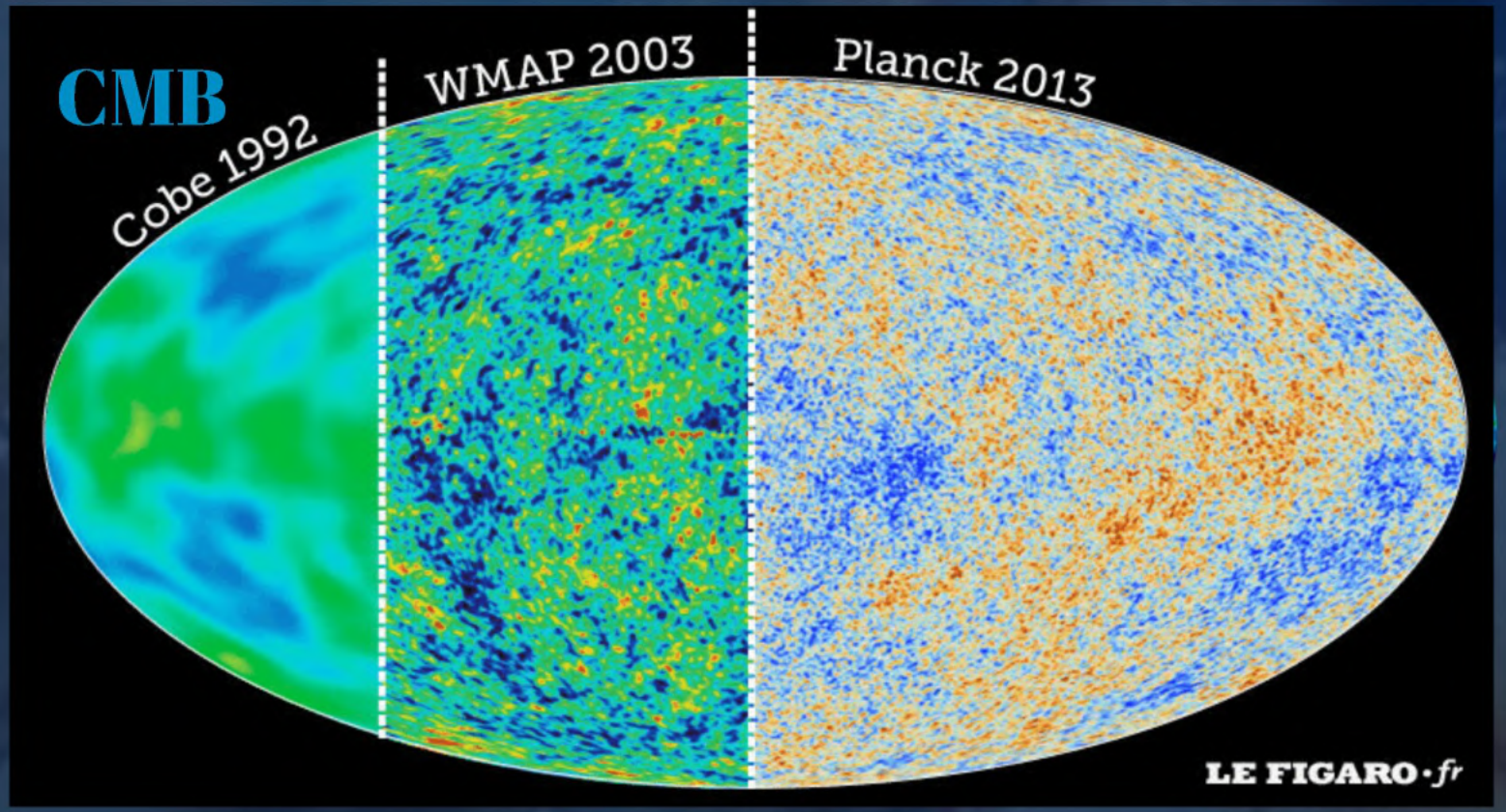


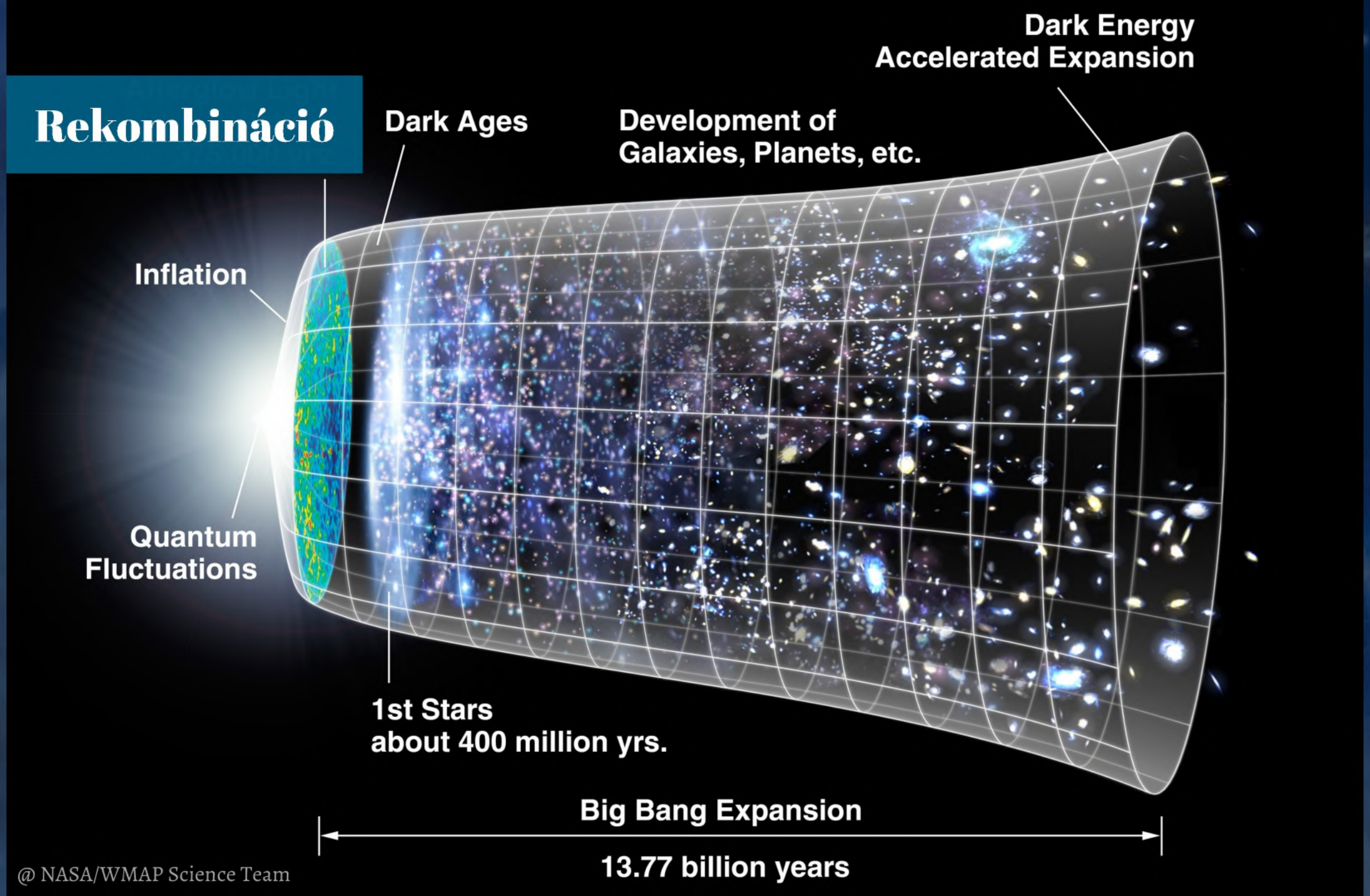
@ Kate Land & Joao Magueijo



Gömbfüggvények



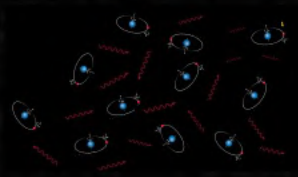



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Dark Ages - Sötét korszak

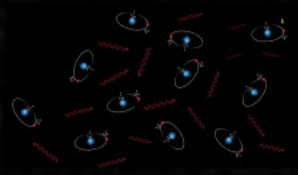


Dark Ages - Sötét korszak



Dark Ages - Sötét korszak





Dark Ages - Sötét korszak







Dark Ages - Sötét korszak





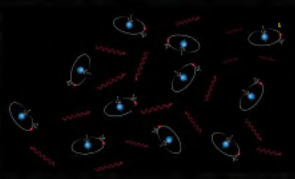




Dark Ages - Sötét korszak









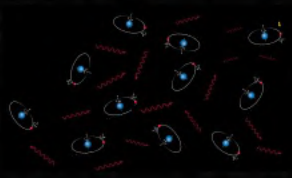


Dark Ages - Sötét korszak









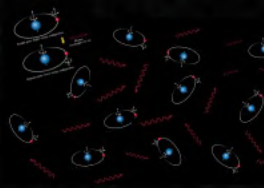


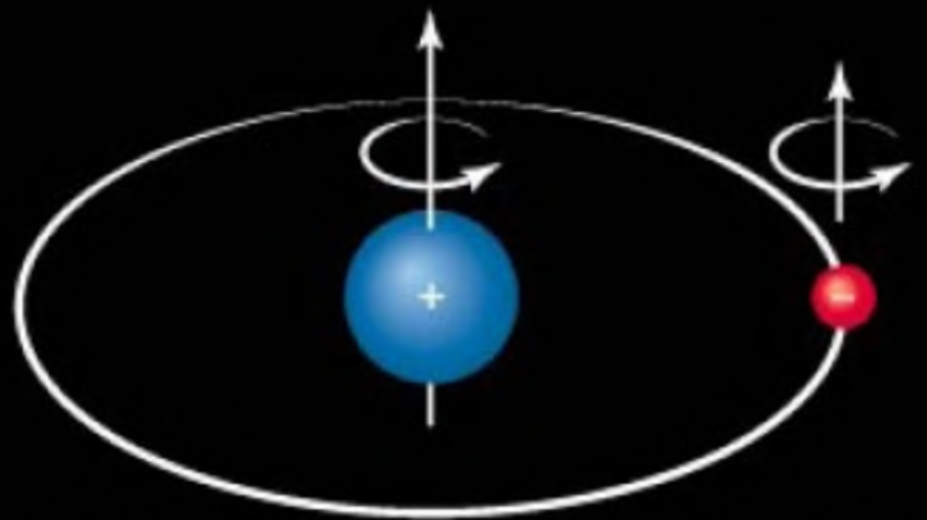
Dark Ages - Sötét korszak



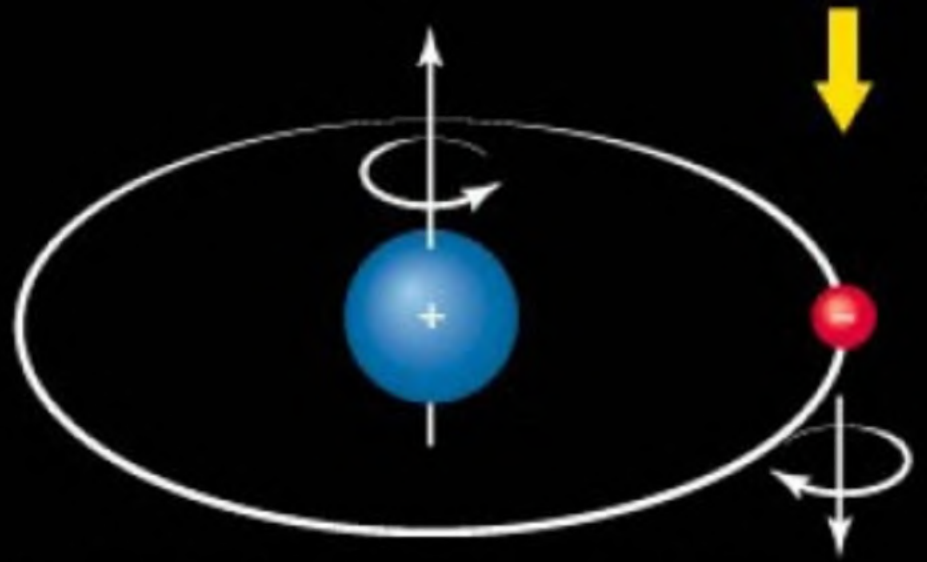






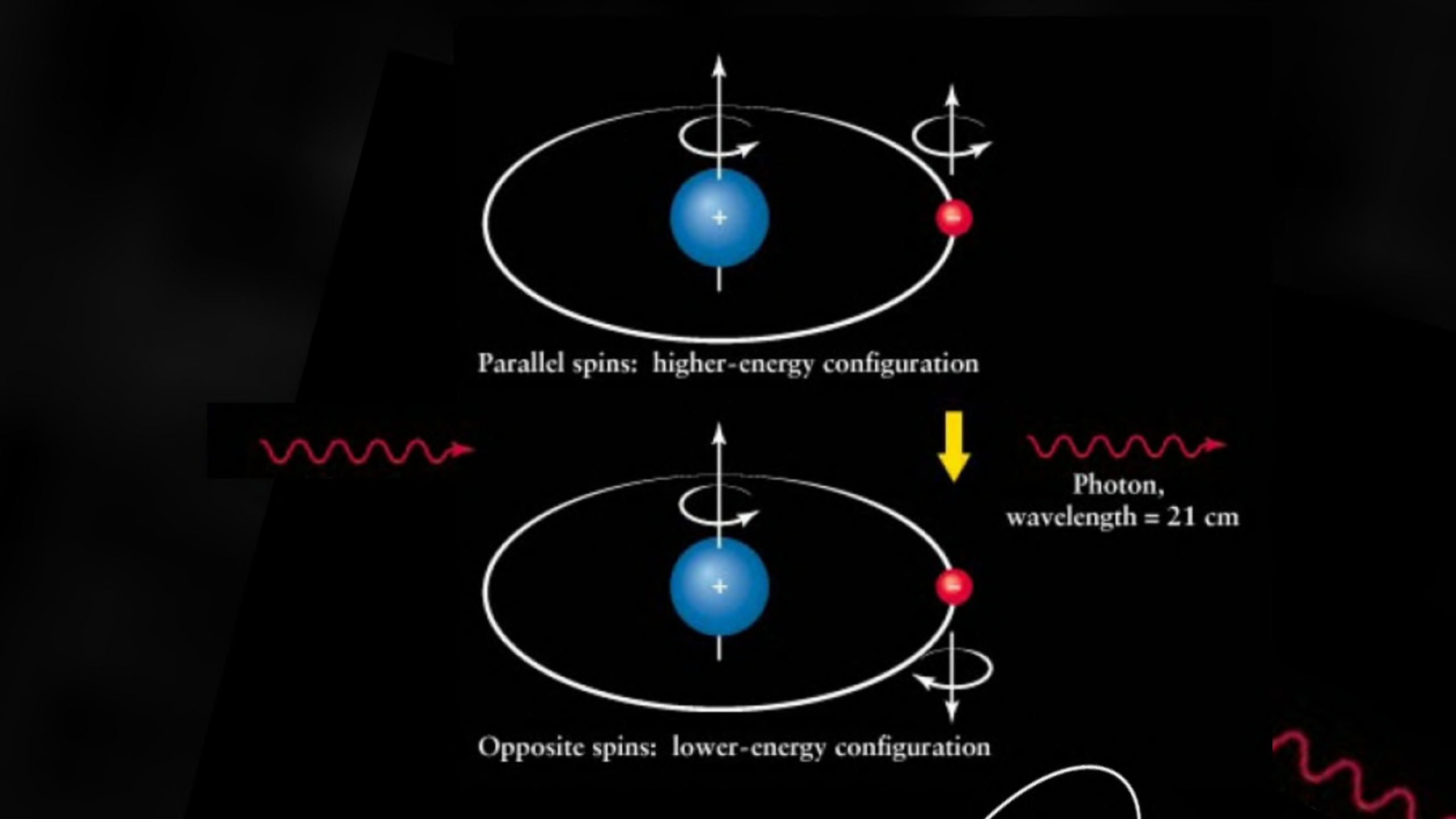


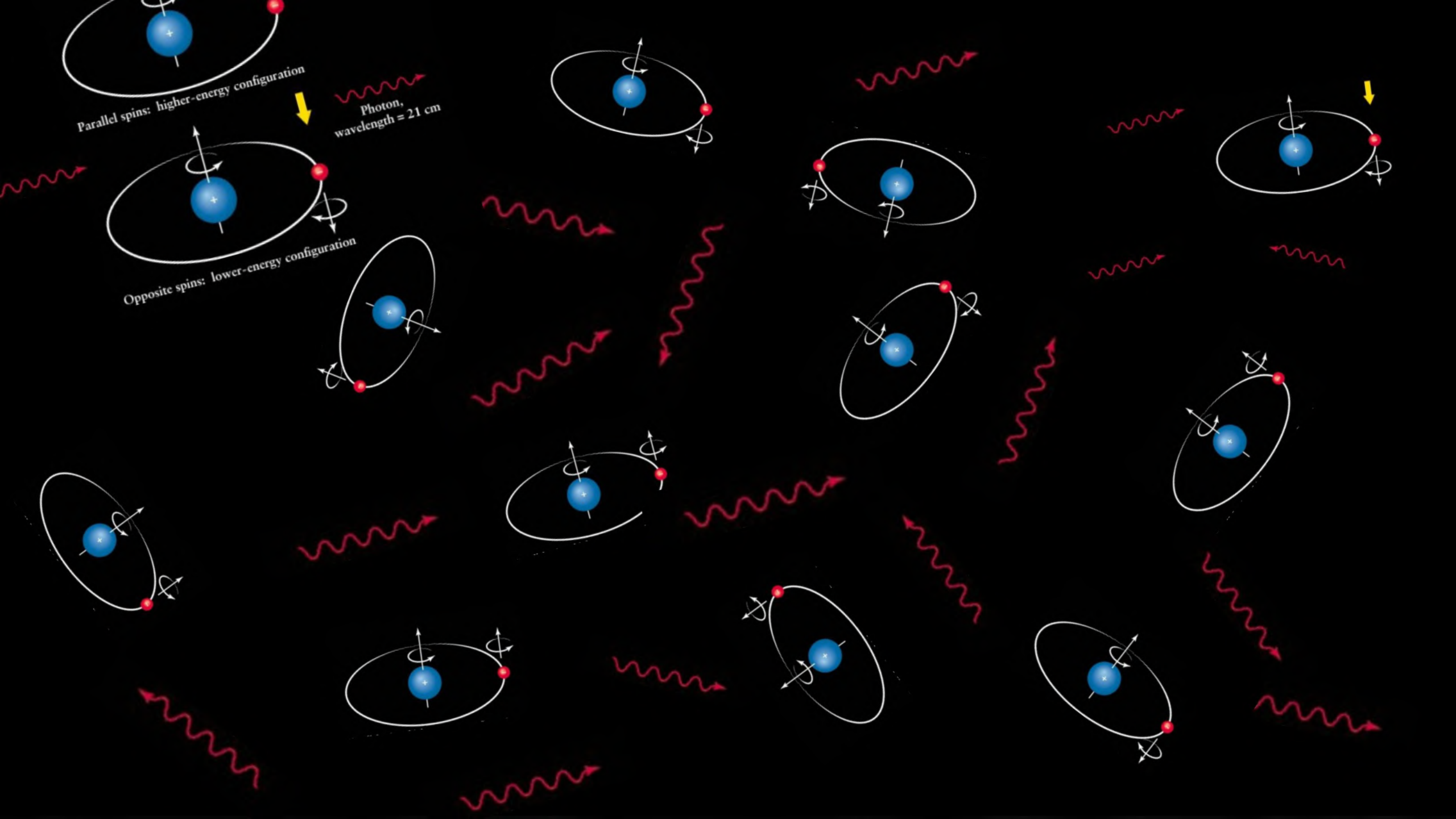
Parallel spins: higher-energy configuration

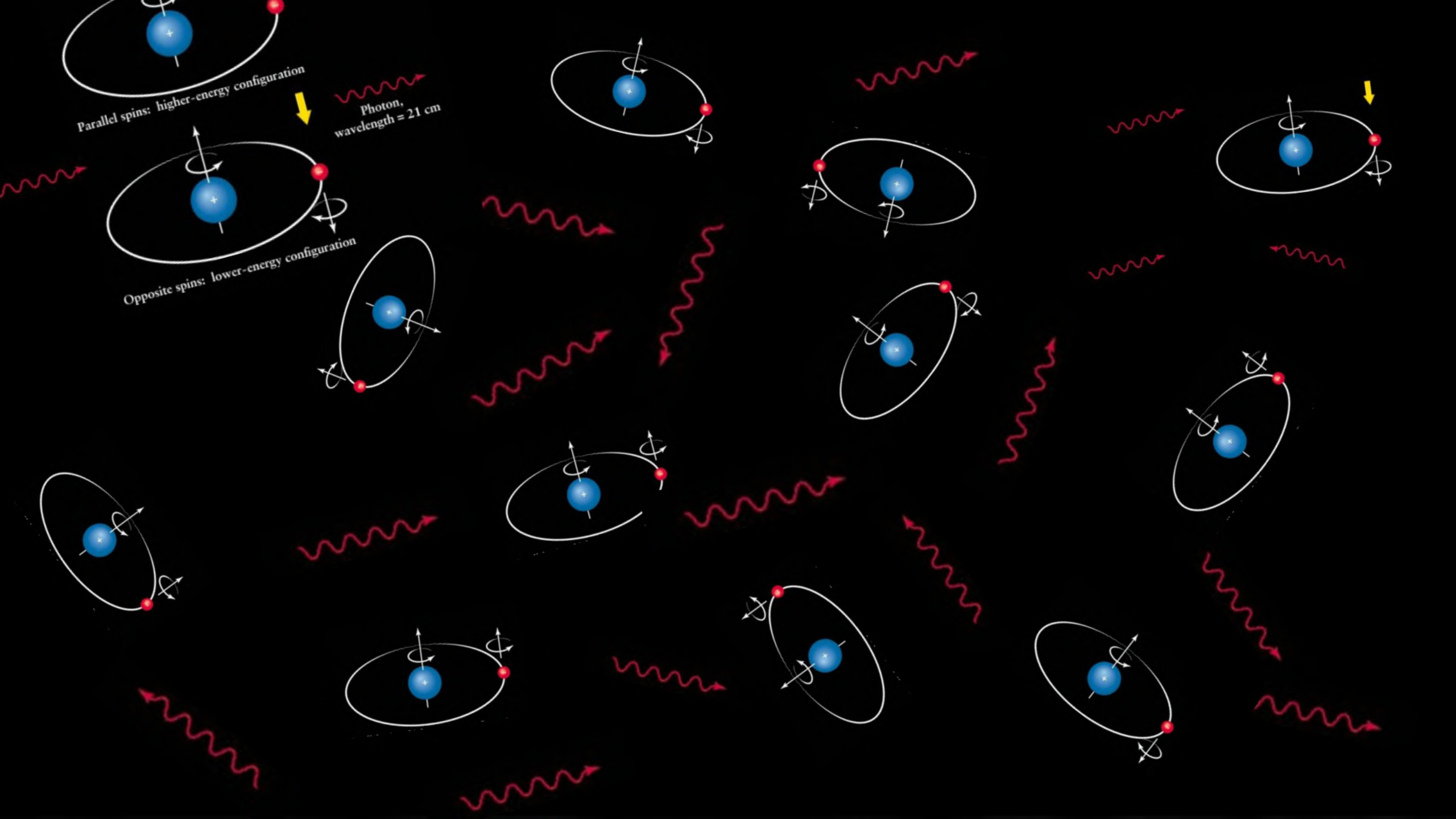


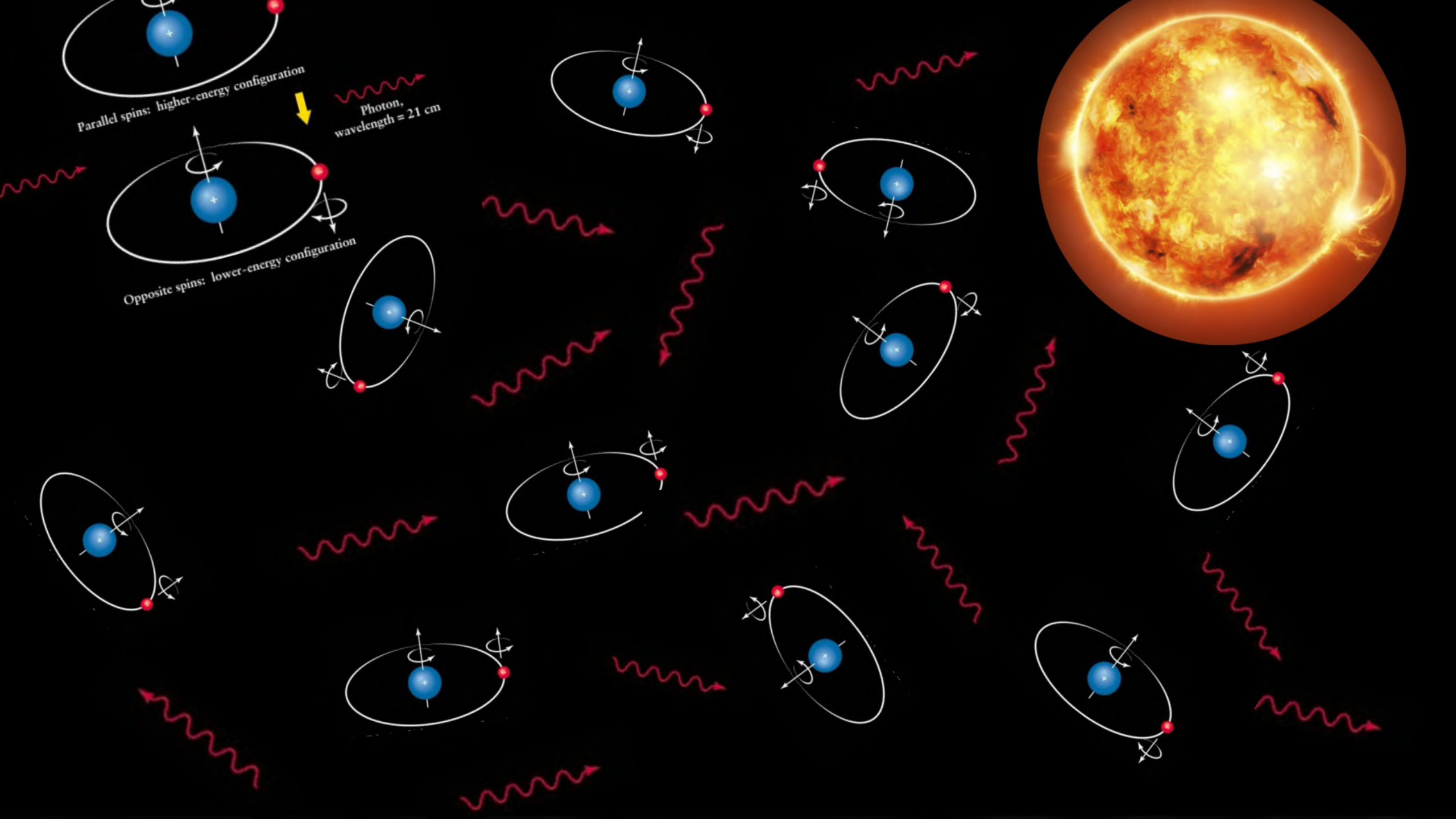
Photon,
wavelength = 21 cm

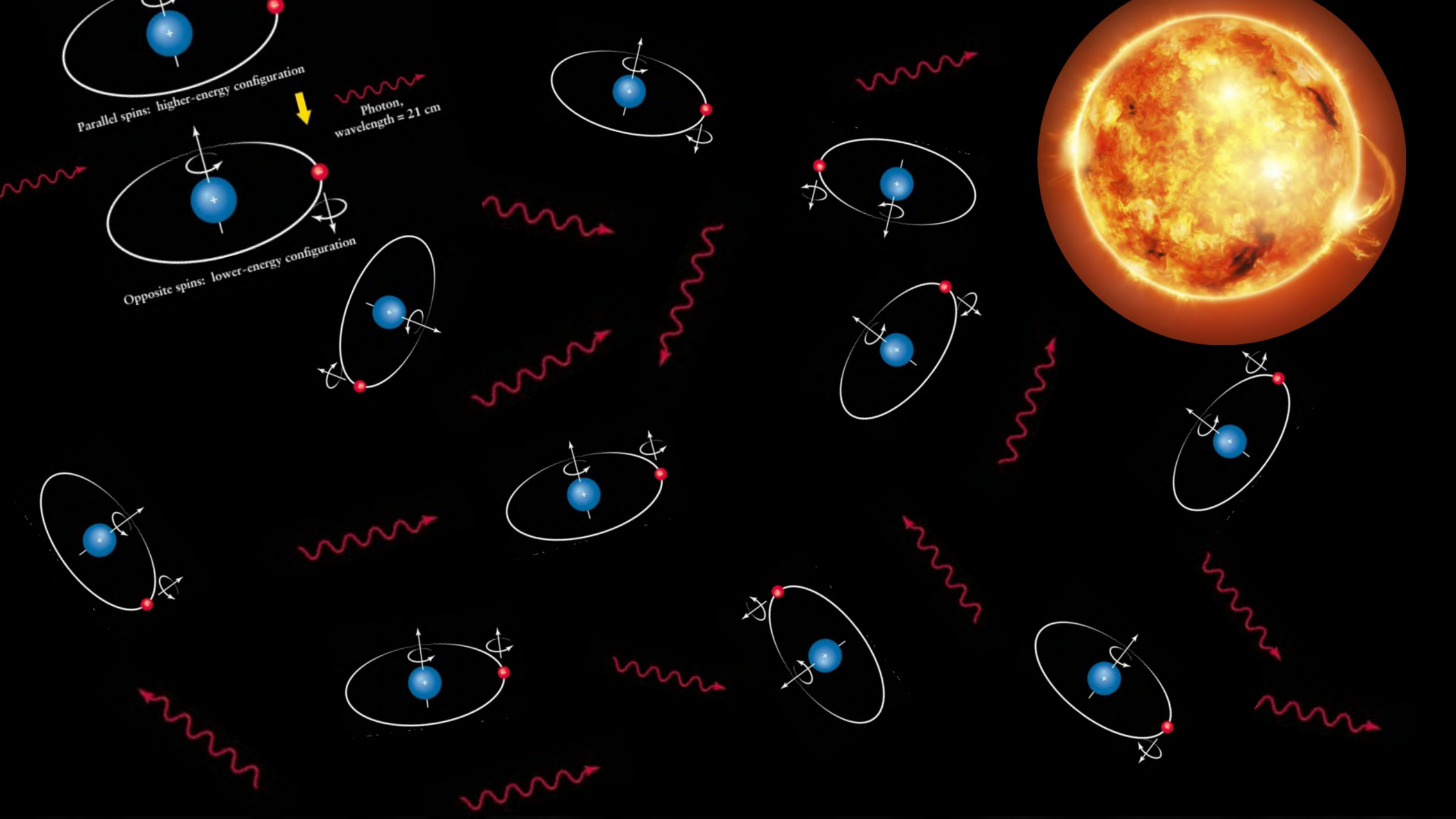
Opposite spins: lower-energy configuration

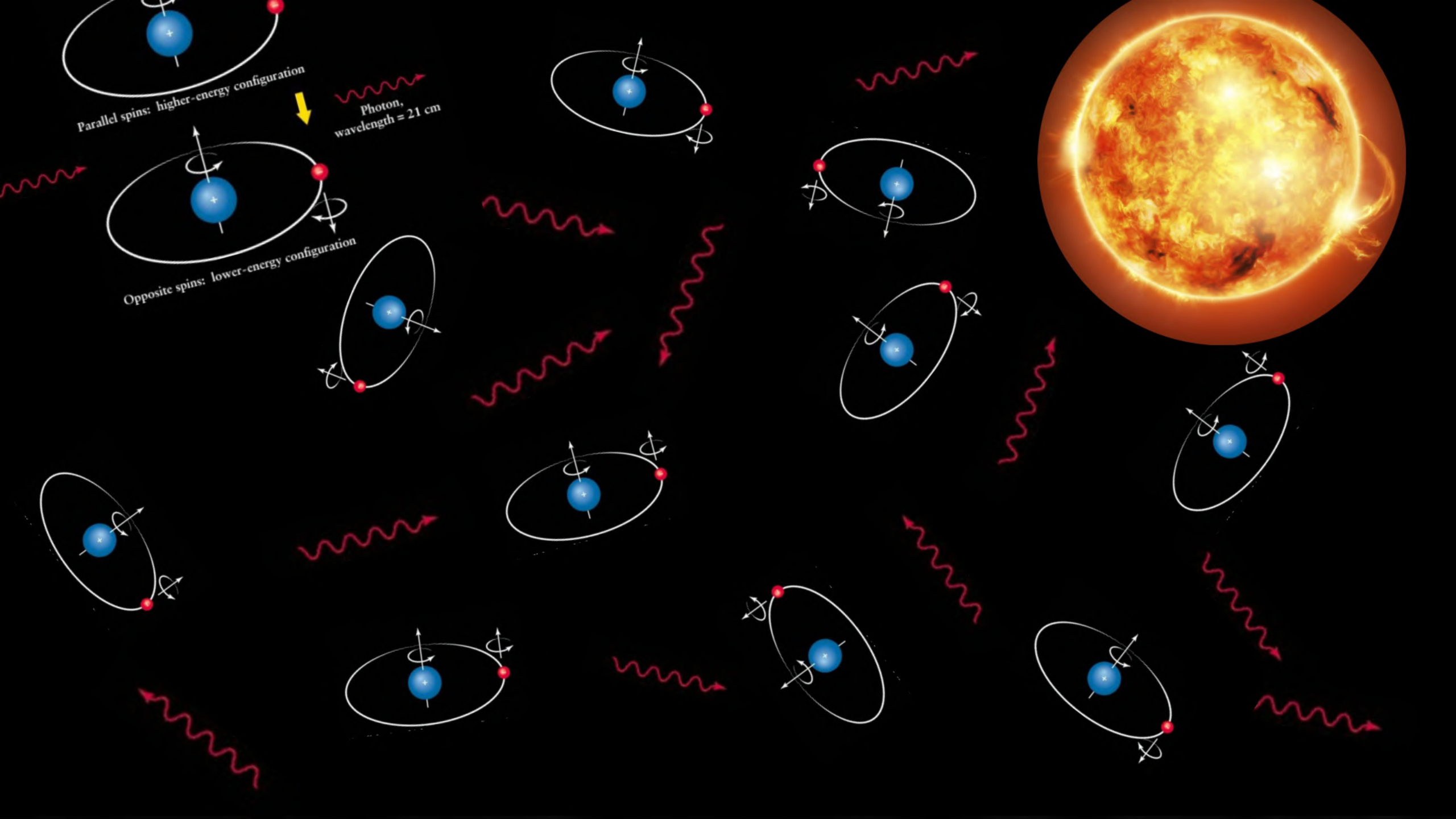

Parallel spins: higher-energy configuration
Photon,
wavelength = 21 cm
Opposite spins: lower-energy configuration

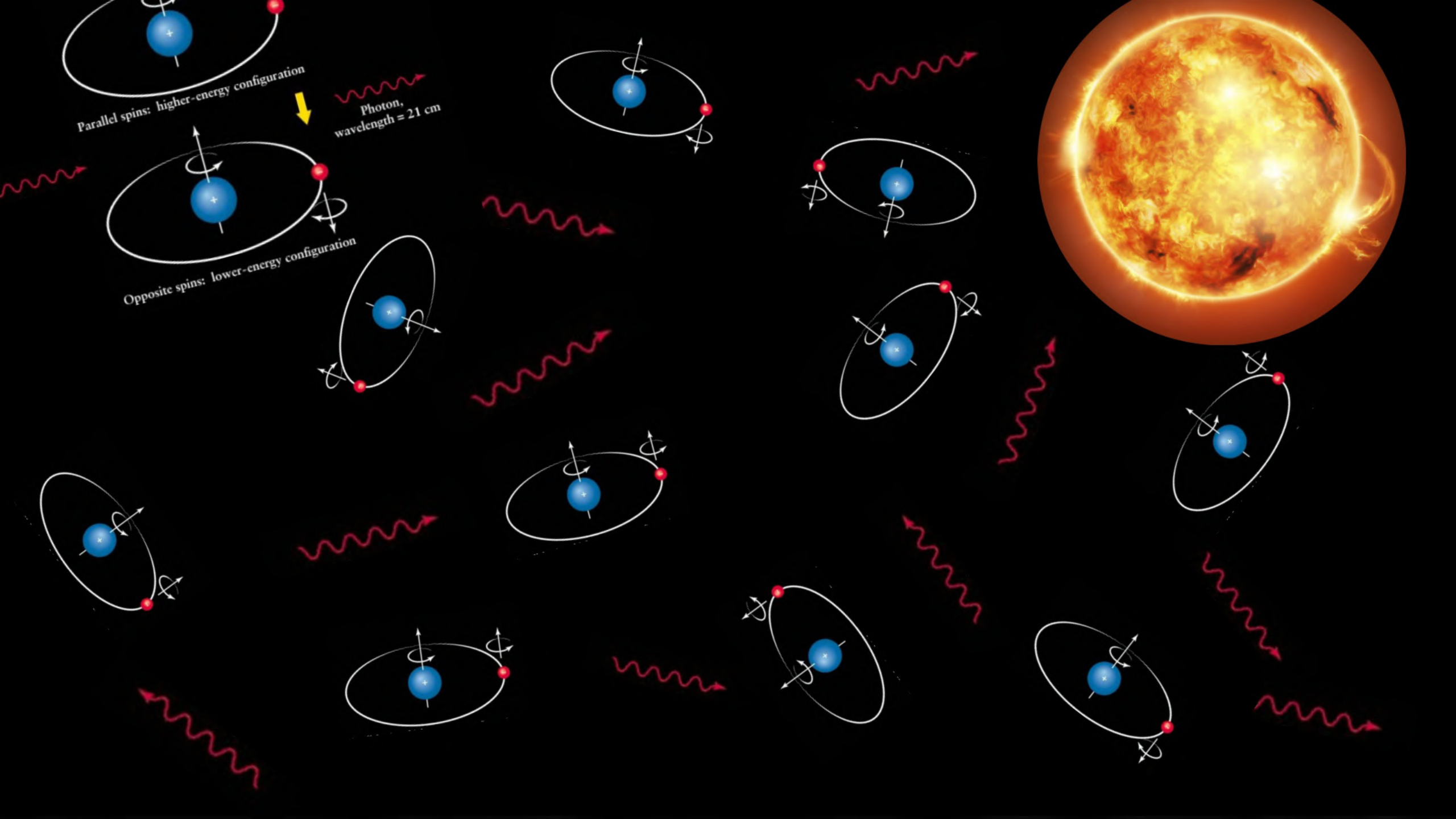

Parallel spins: higher-energy configuration
Photon, wavelength = 21 cm
Opposite spins: lower-energy configuration

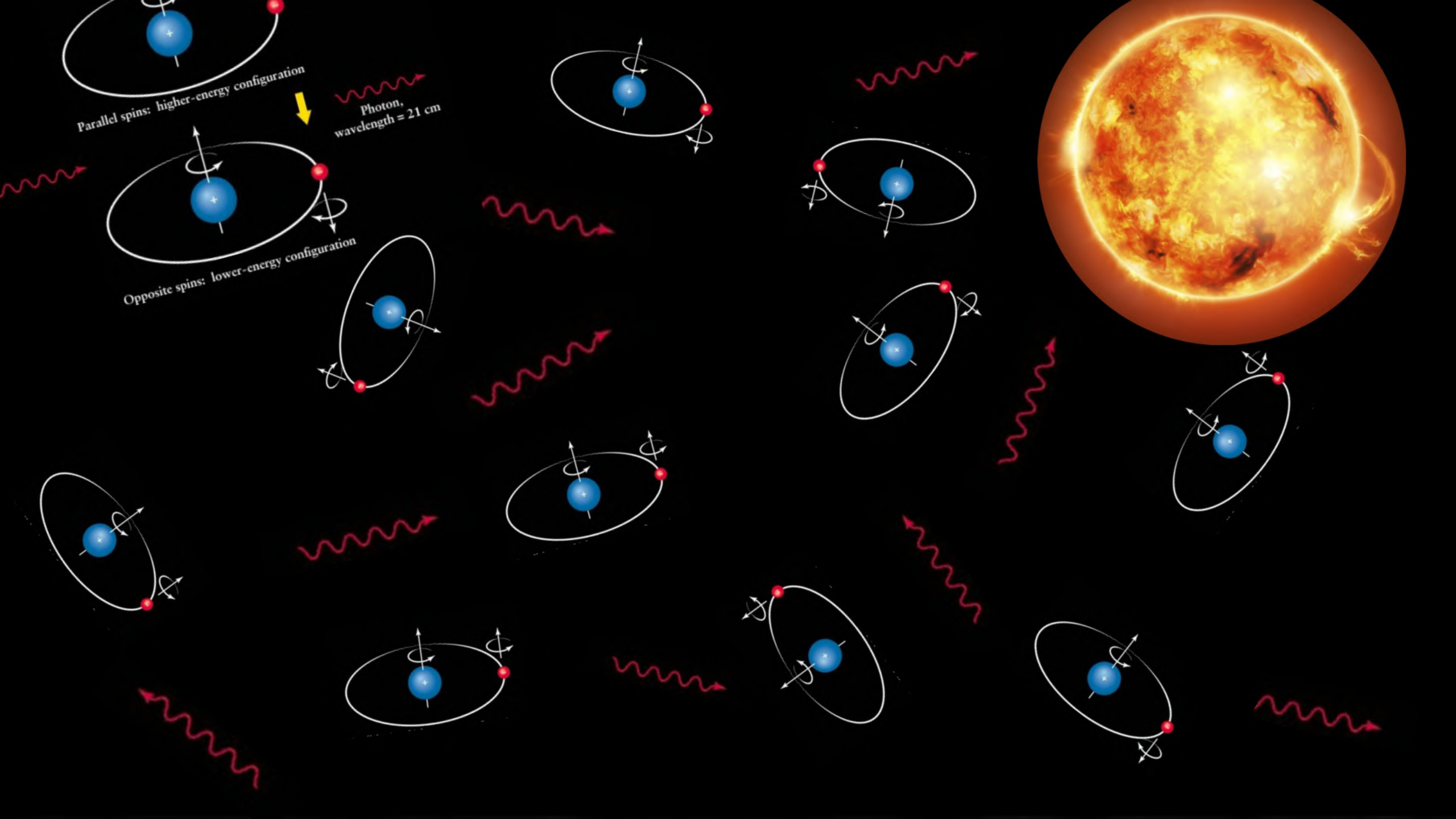

Parallel spins: higher-energy configuration
Photon, wavelength = 21 cm
Opposite spins: lower-energy configuration

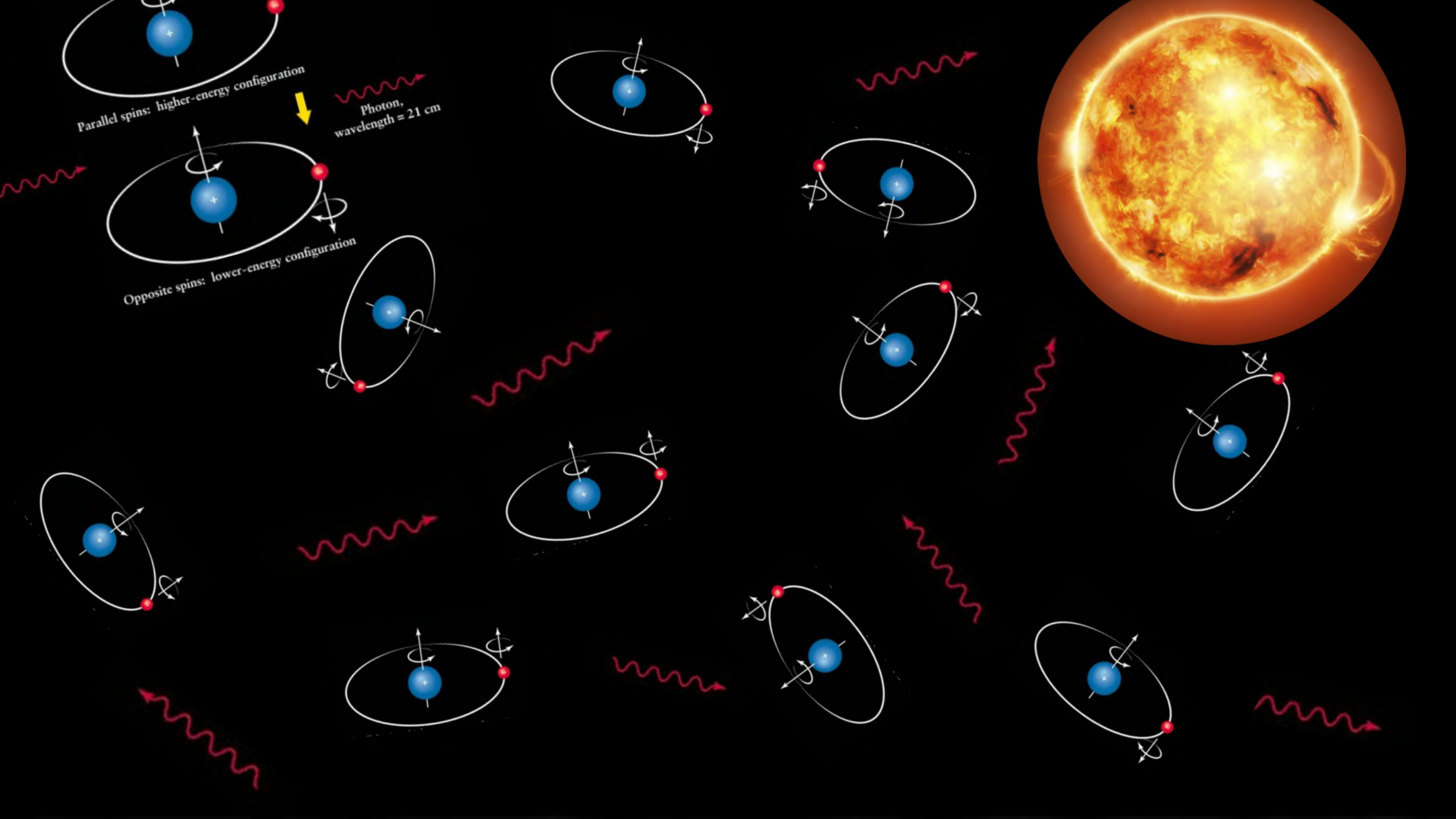

Parallel spins: higher-energy configuration
Photon, wavelength = 21 cm
Opposite spins: lower-energy configuration

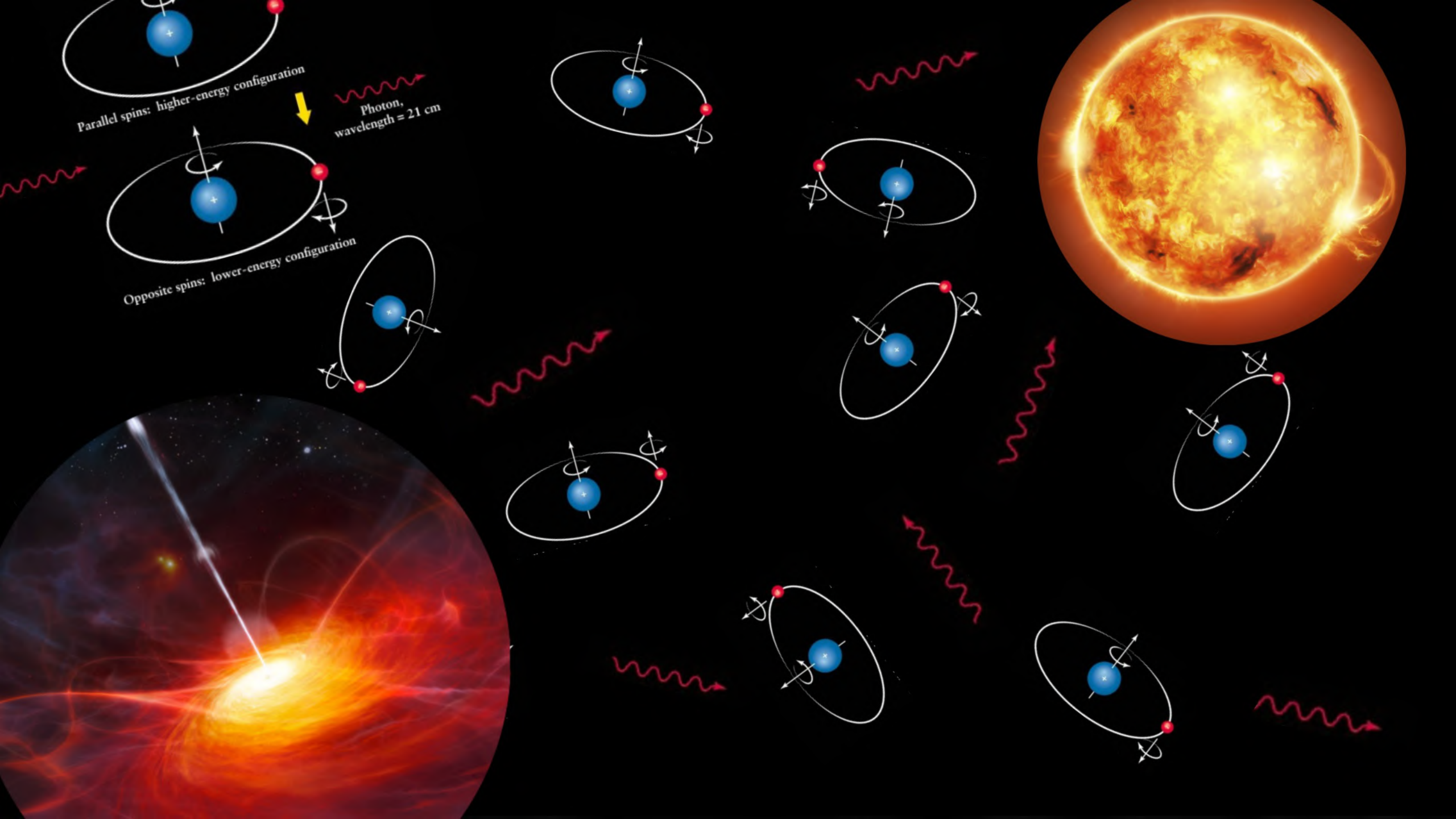

Parallel spins: higher-energy configuration
Photon, wavelength = 21 cm
Opposite spins: lower-energy configuration

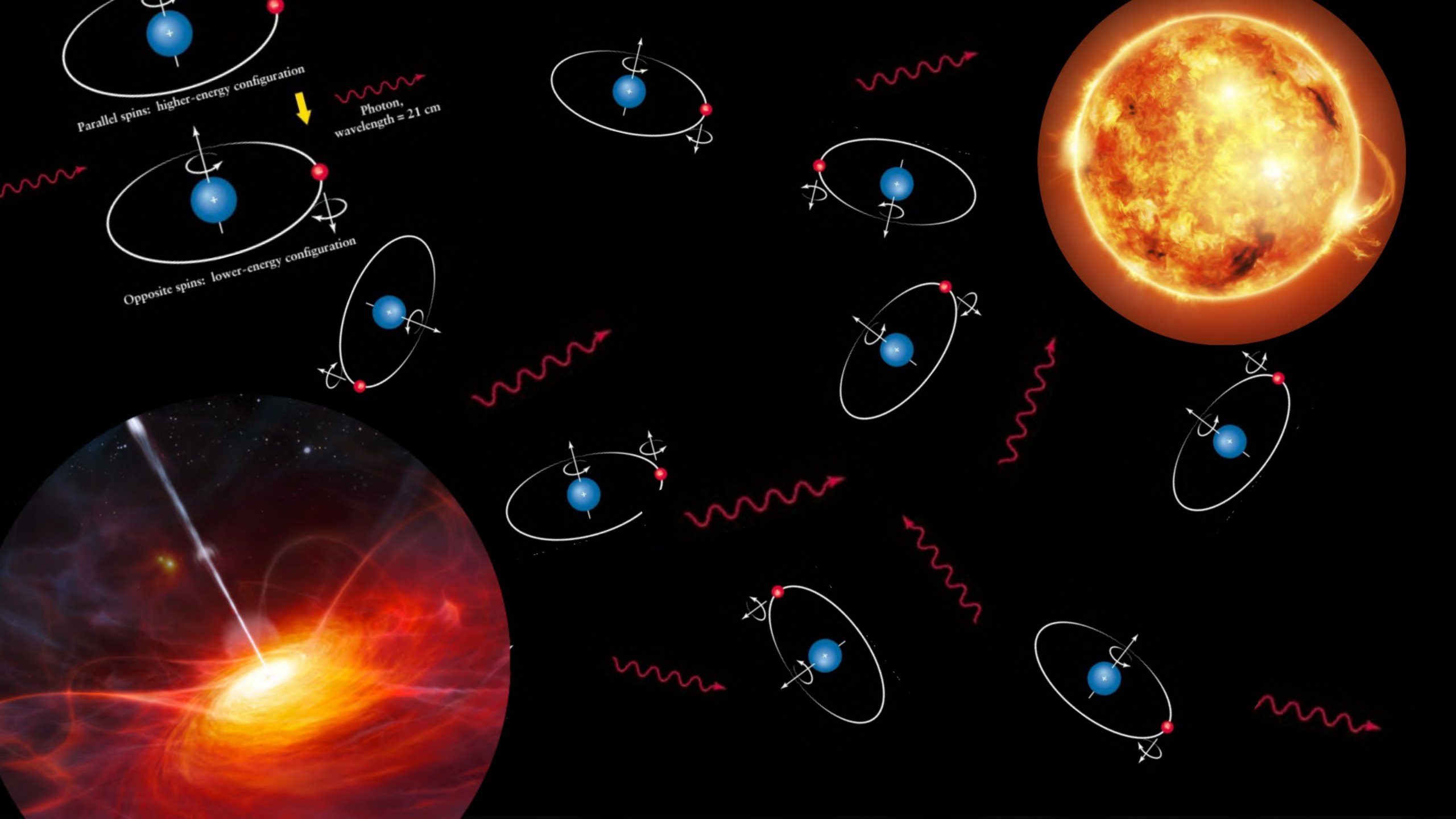

Parallel spins: higher-energy configuration
Photon, wavelength = 21 cm
Opposite spins: lower-energy configuration

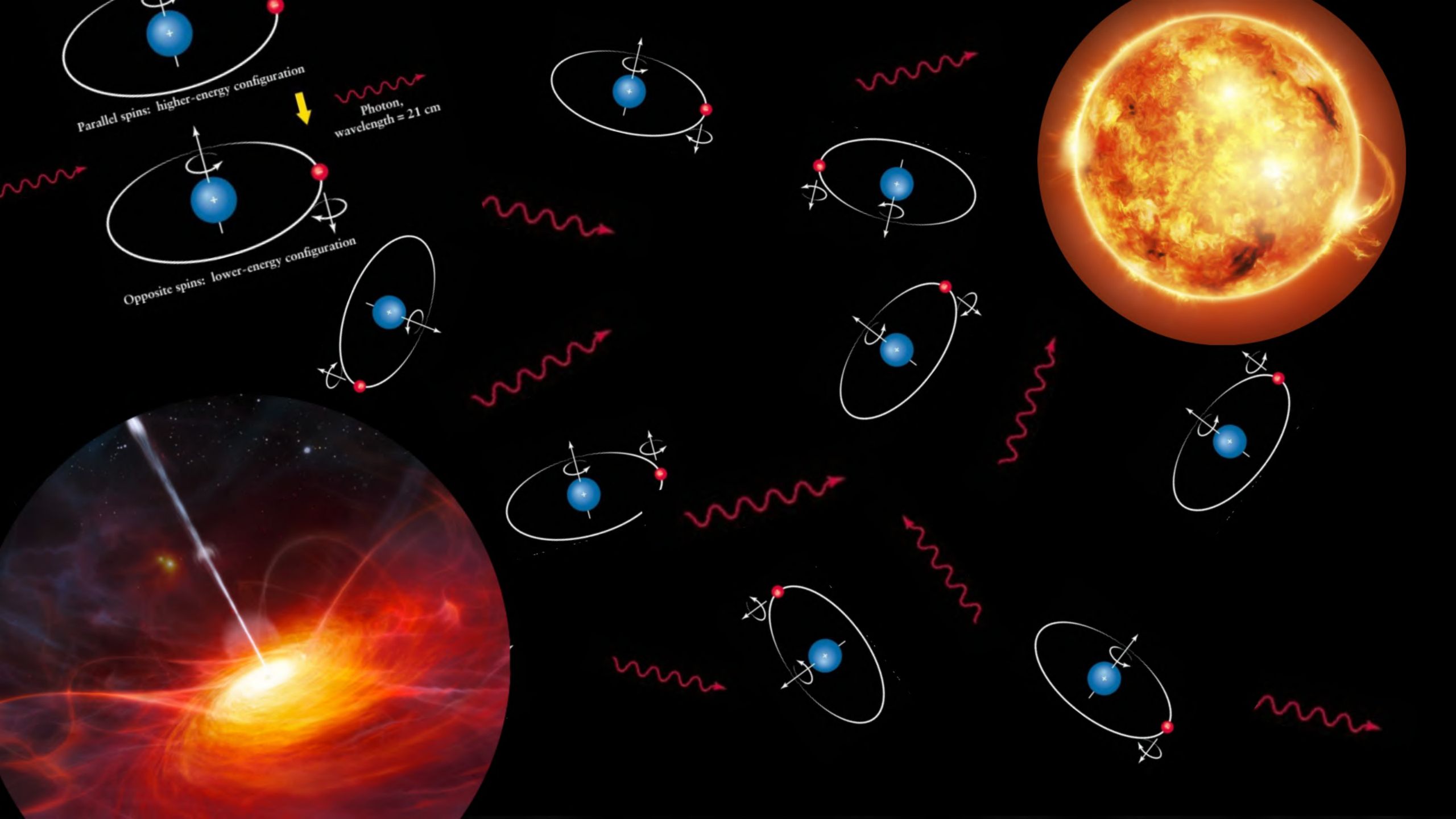

Parallel spins: higher-energy configuration
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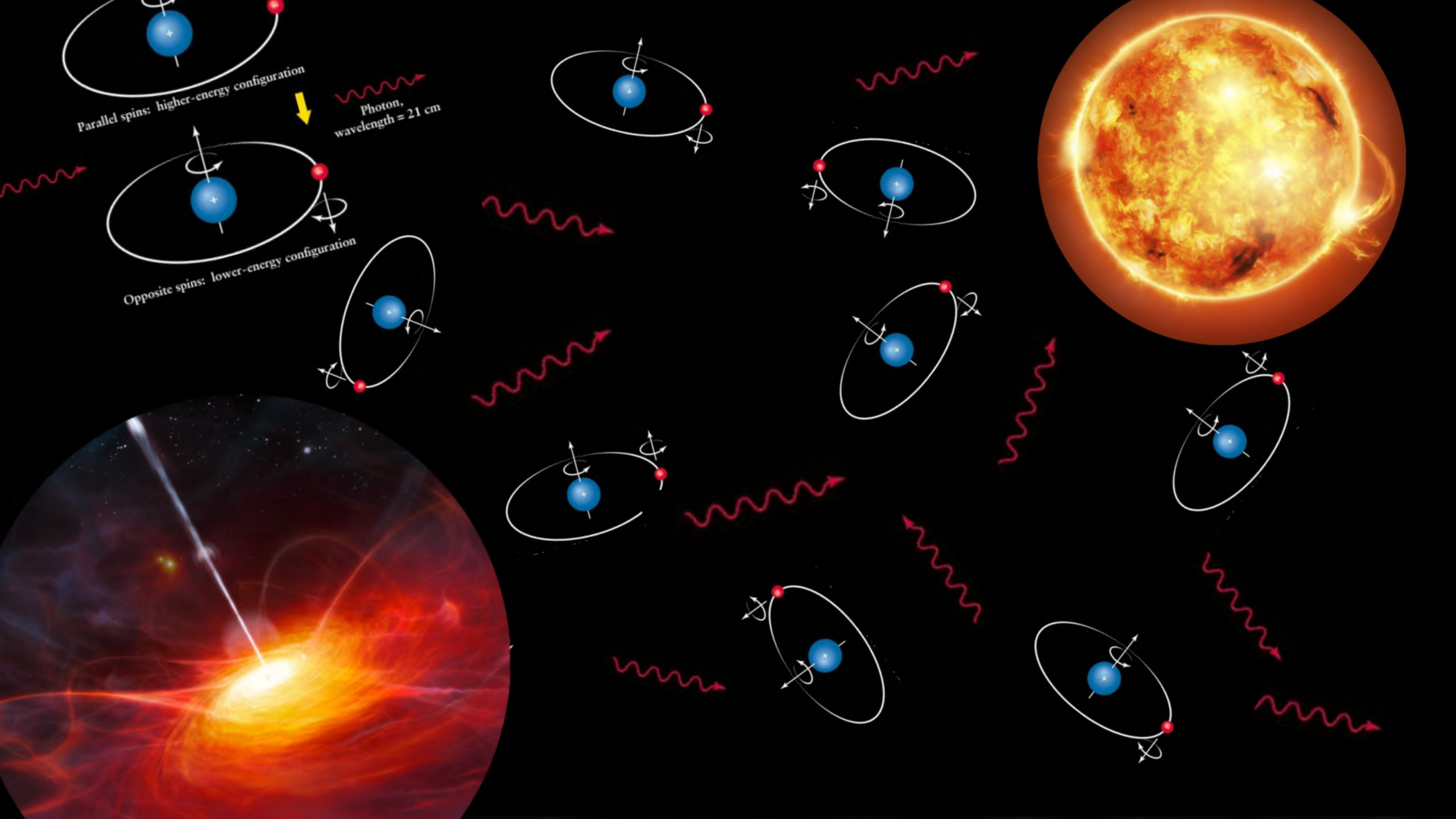

Parallel spins: higher-energy configuration
Photon, wavelength = 21 cm
Opposite spins: lower-energy configuration

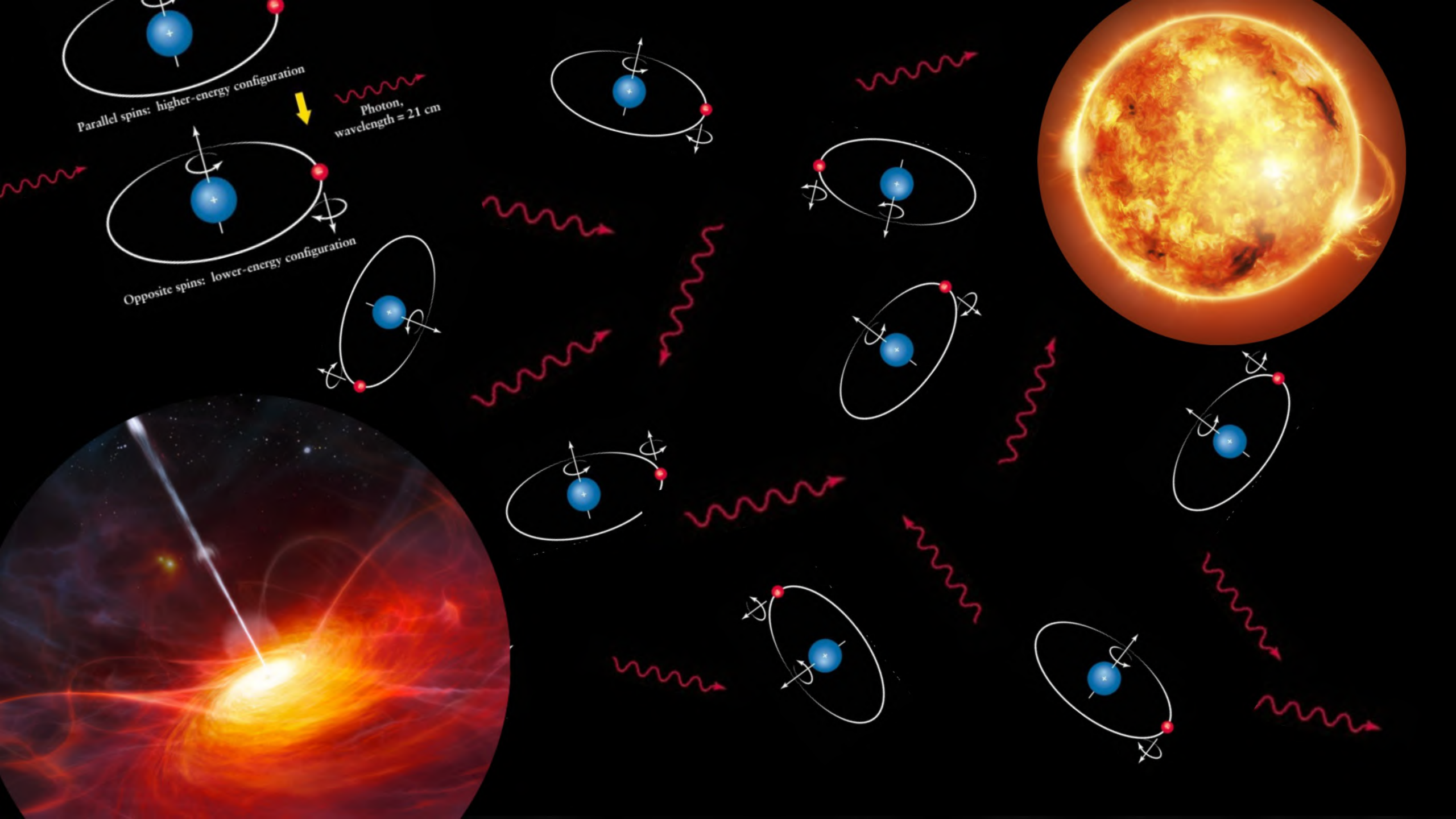

Parallel spins: higher-energy configuration
Photon, wavelength = 21 cm
Opposite spins: lower-energy configuration

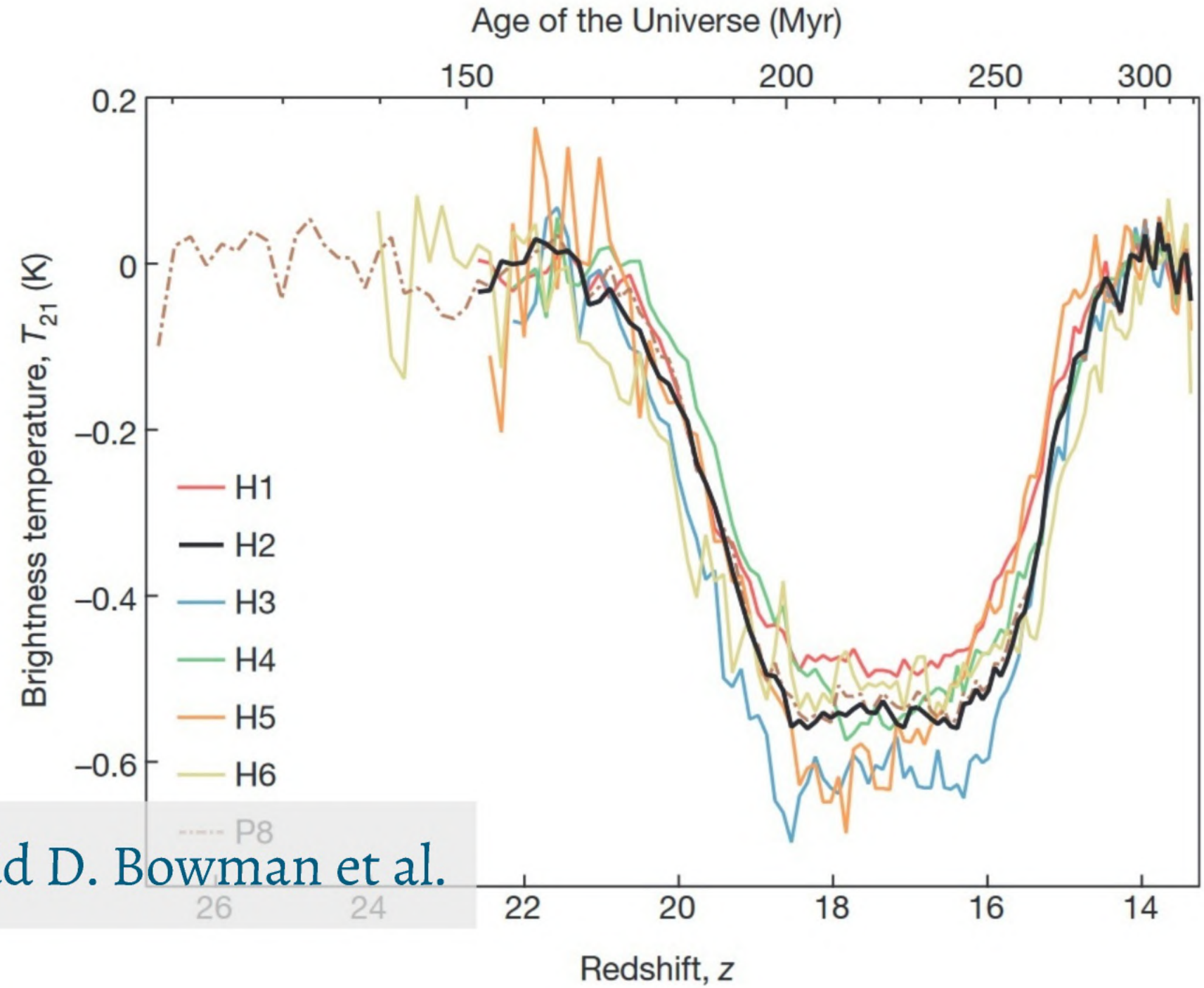

Parallel spins: higher-energy configuration
Photon, wavelength = 21 cm
Opposite spins: lower-energy configuration


Parallel spins: higher-energy configuration
Photon, wavelength = 21 cm
Opposite spins: lower-energy configuration

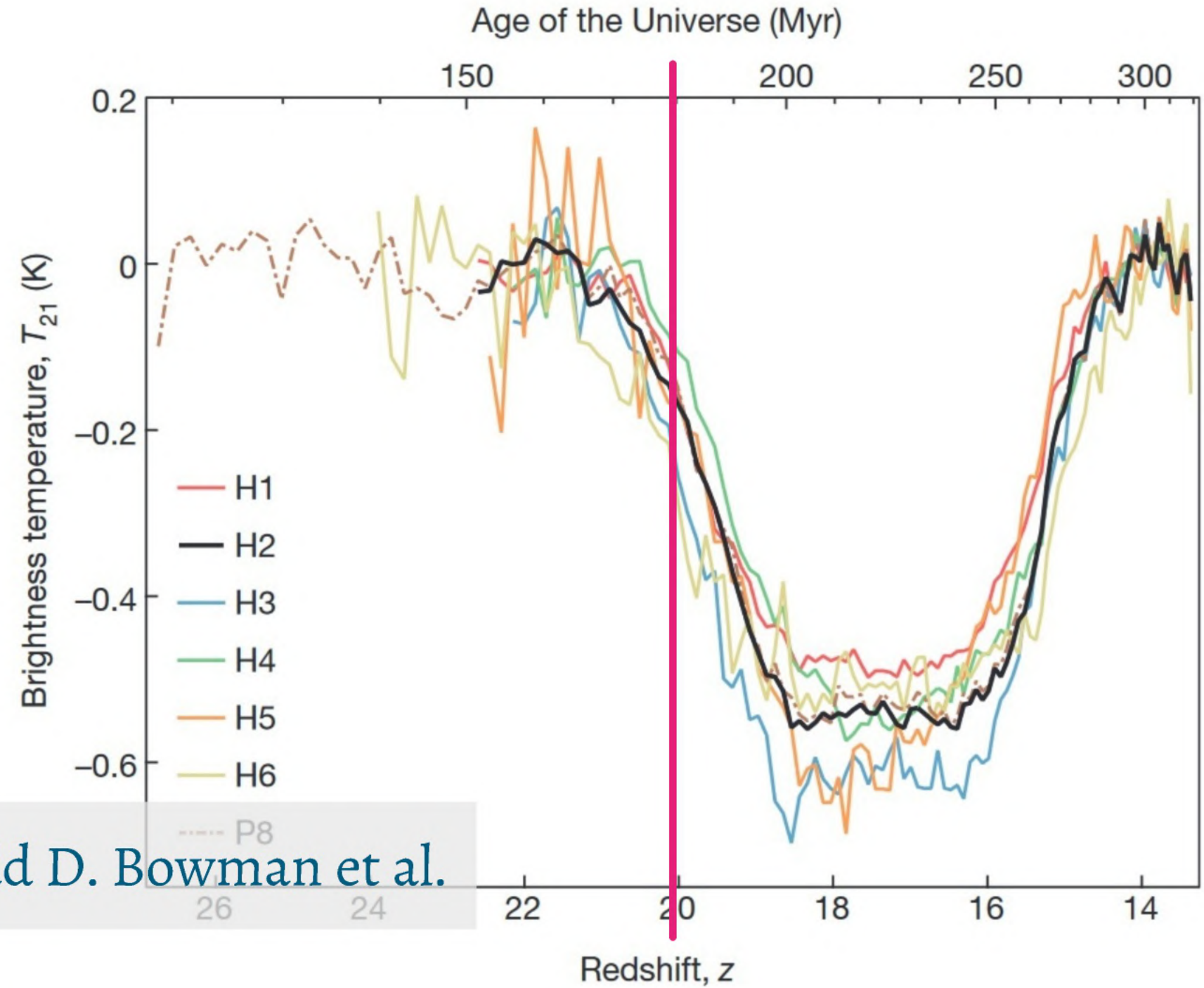

Parallel spins: higher-energy configuration
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Parallel spins: higher-energy configuration
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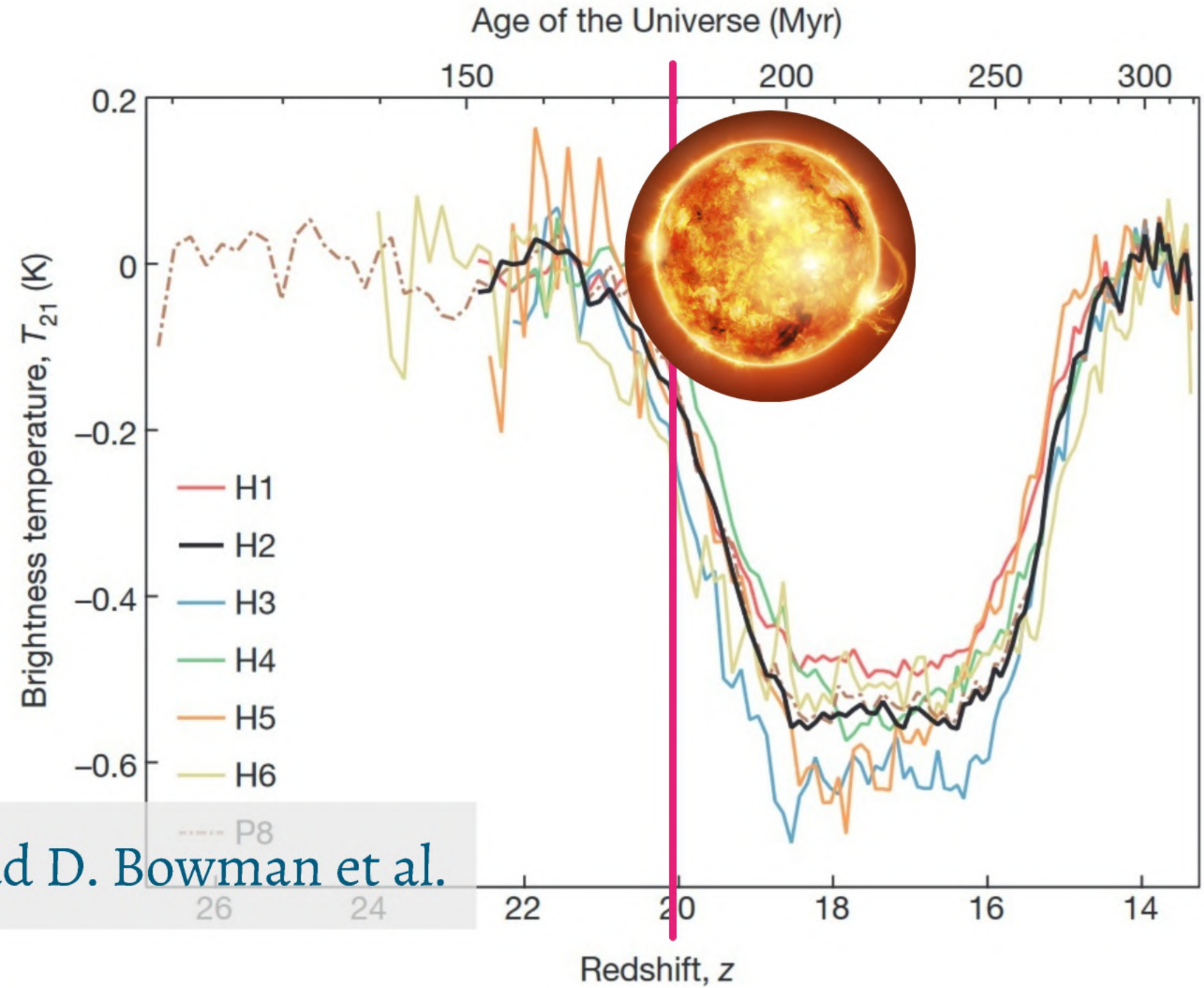

Parallel spins: higher-energy configuration
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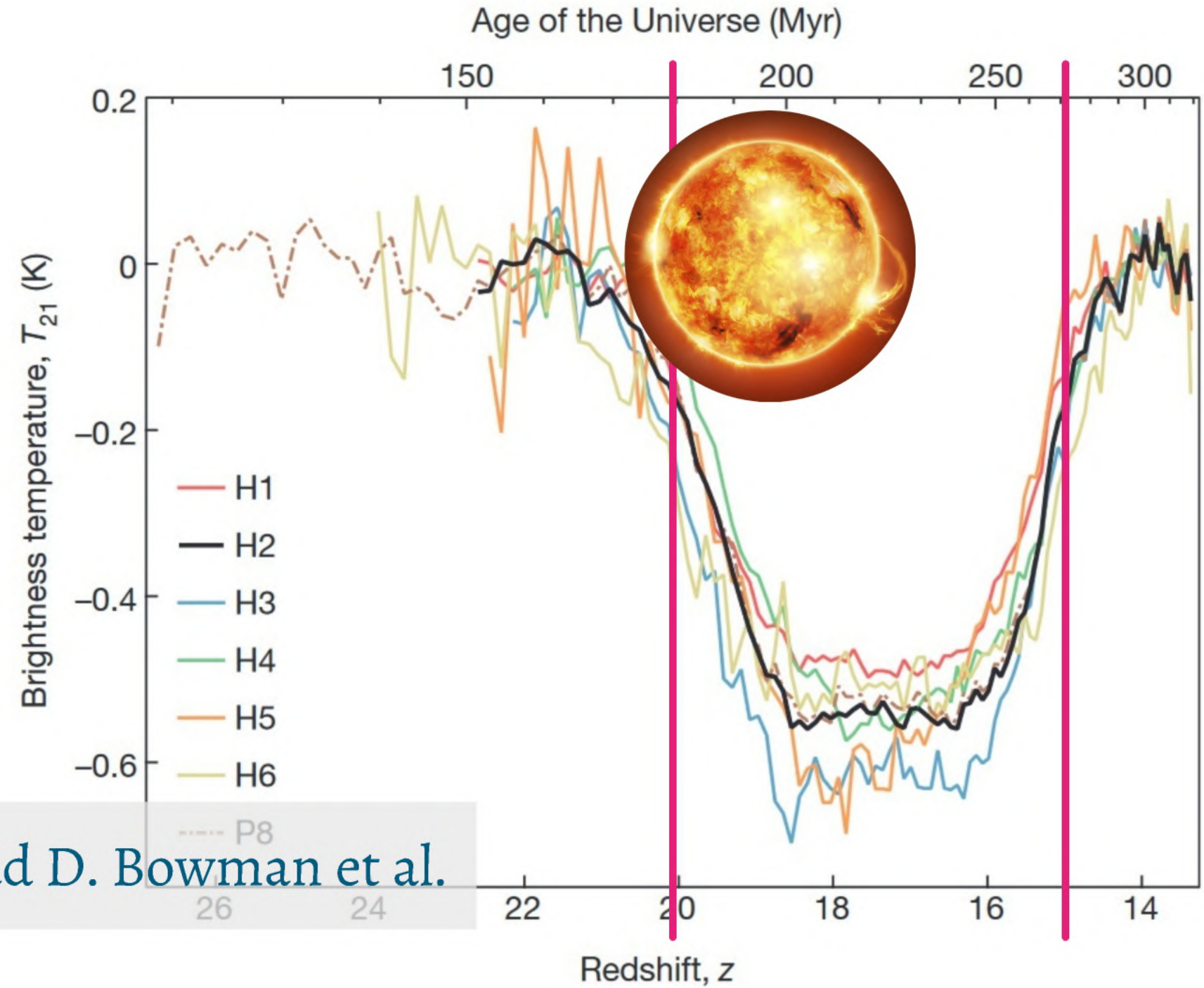
@ Judd D. Bowman et al.



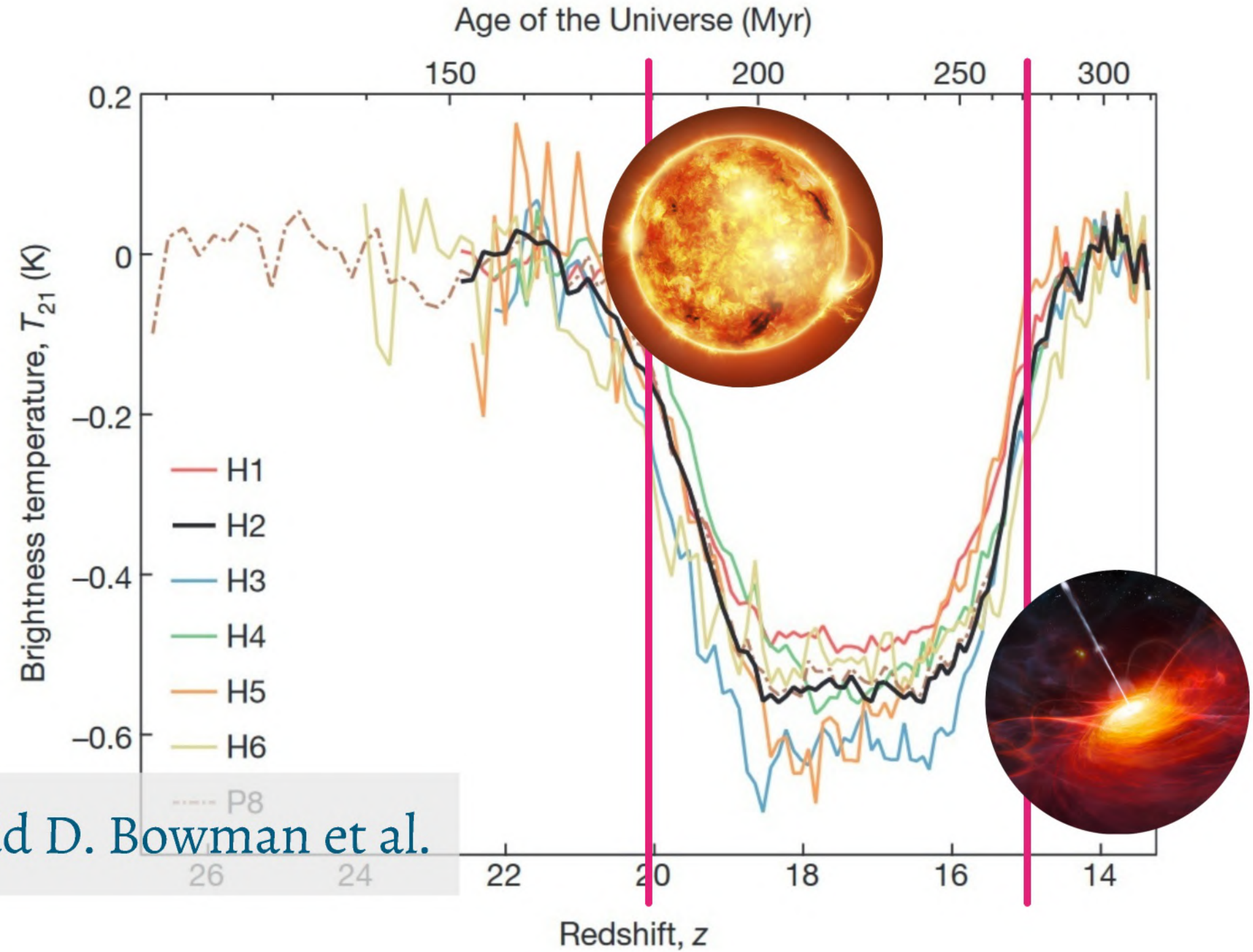
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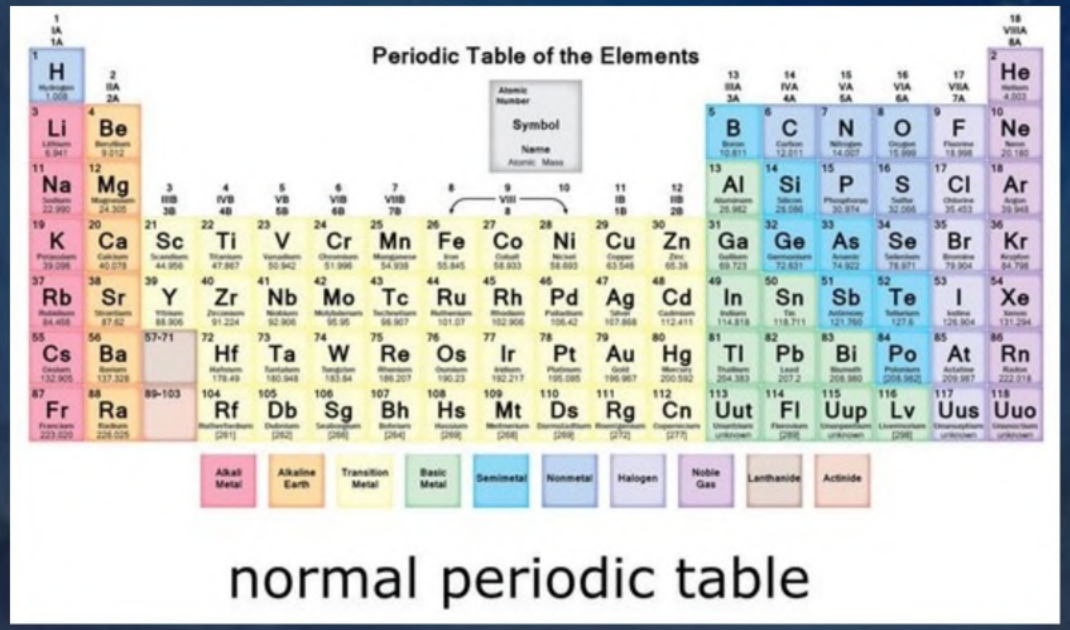
@ Judd D. Bowman et al.

Legelső csillagok?

III. populációs csillagok

Legelső csillagok?

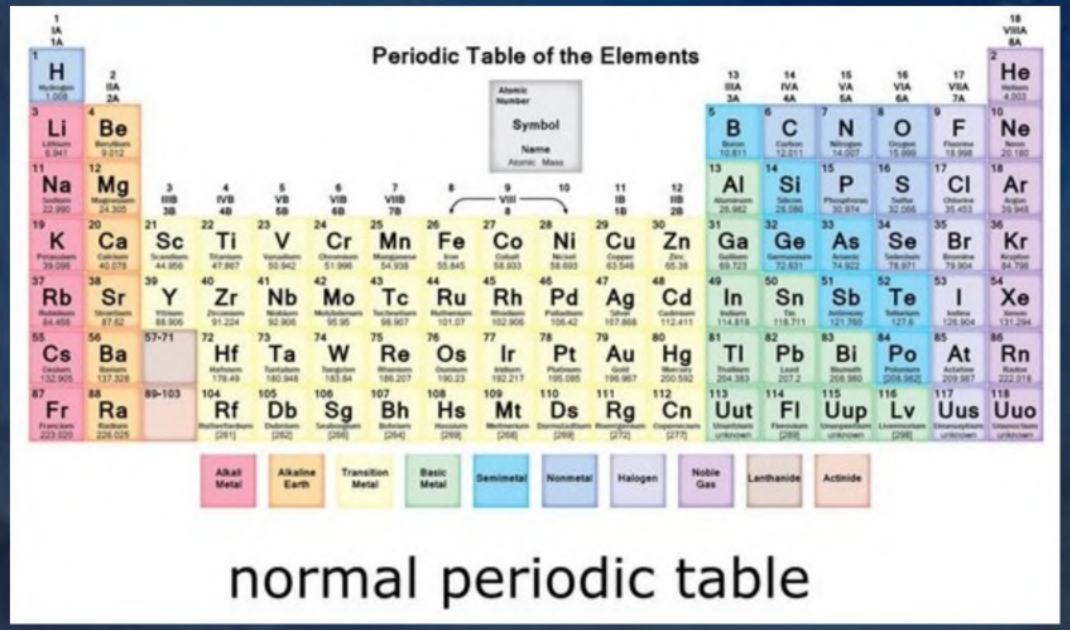
III. populációs csillagok



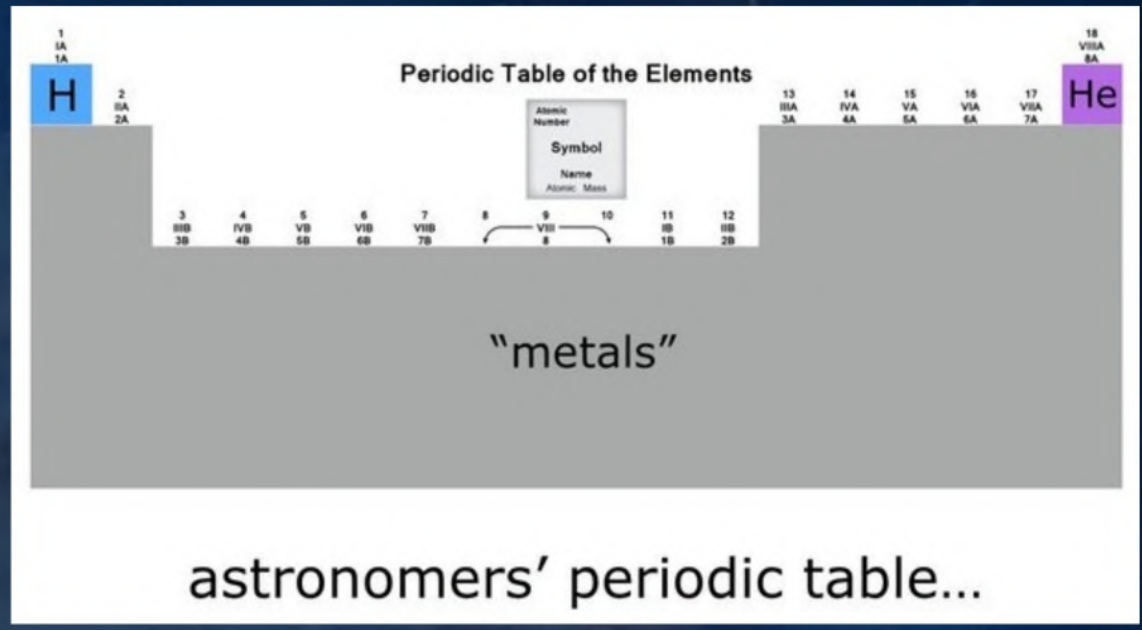
normal periodic table

Legelső csillagok?

III. populációs csillagok



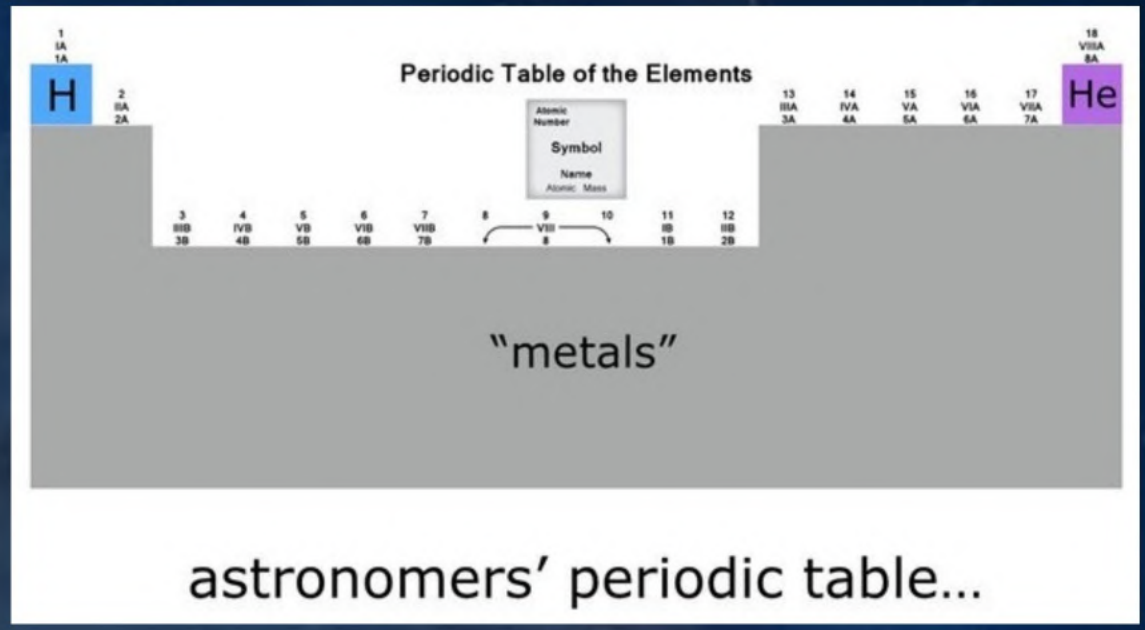
normal periodic table



astronomers' periodic table...

Legelső csillagok?

III. populációs csillagok



astronomers' periodic table...

Legelső csillagok?

III. populációs csillagok

Legelső csillagok?

III. populációs csillagok



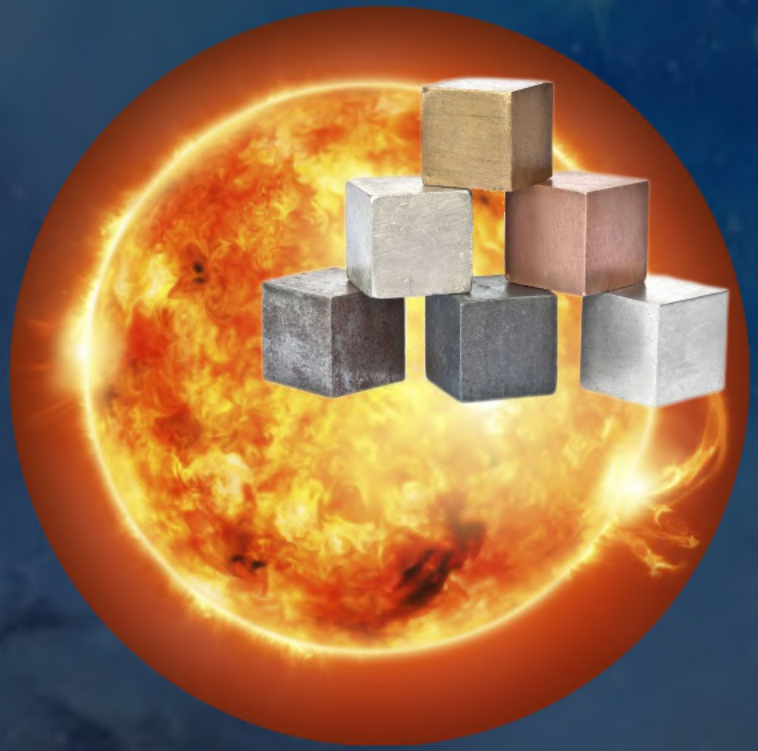
Legelső csillagok?

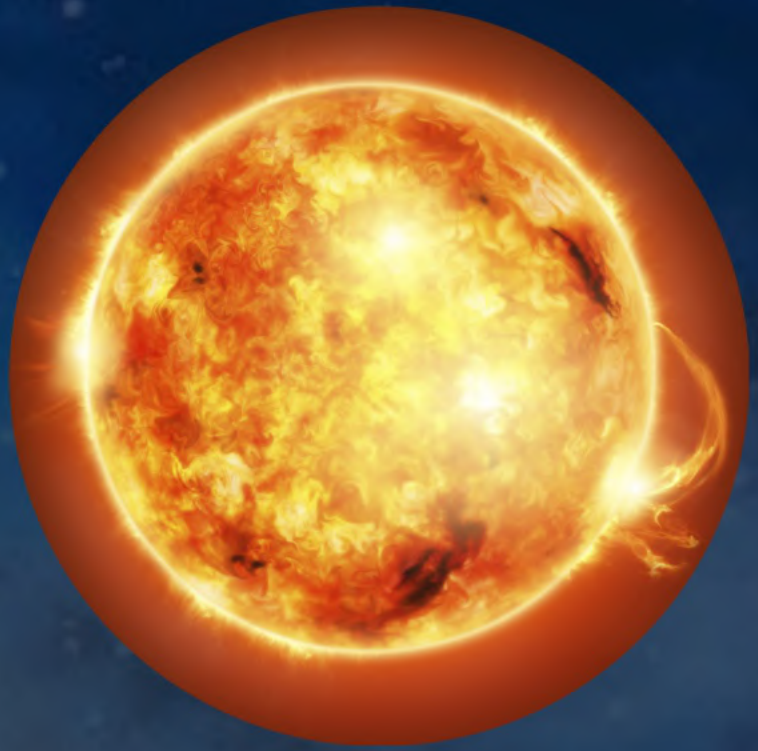
III. populációs csillagok



Legelső csillagok?

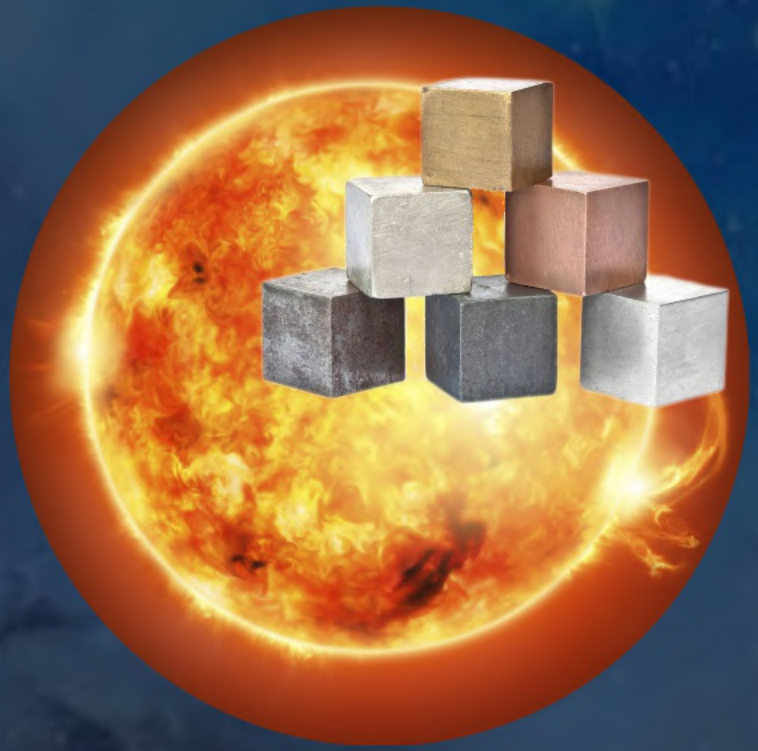
III. populációs csillagok





Legelső csillagok?

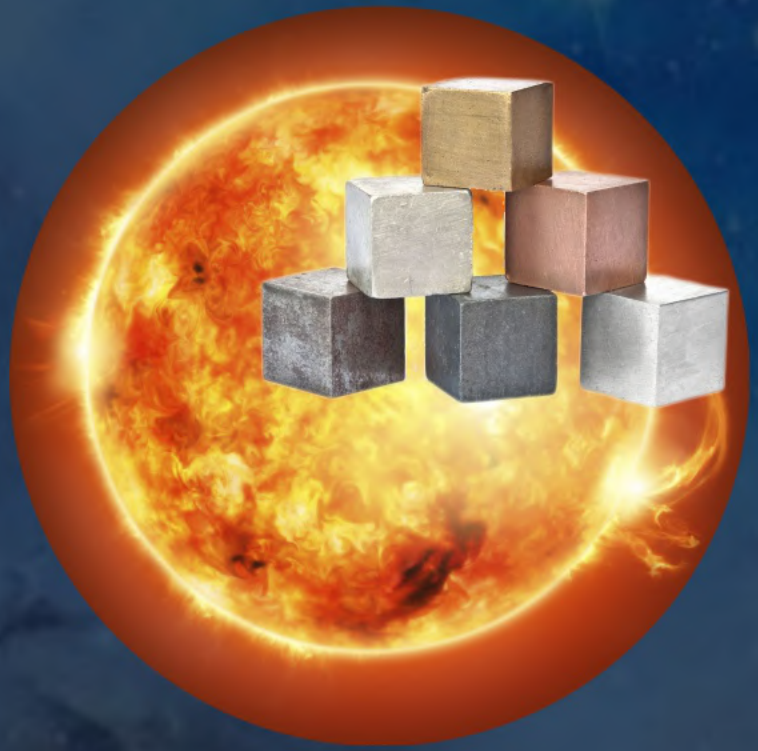
III. populációs csillagok





Legelső csillagok?

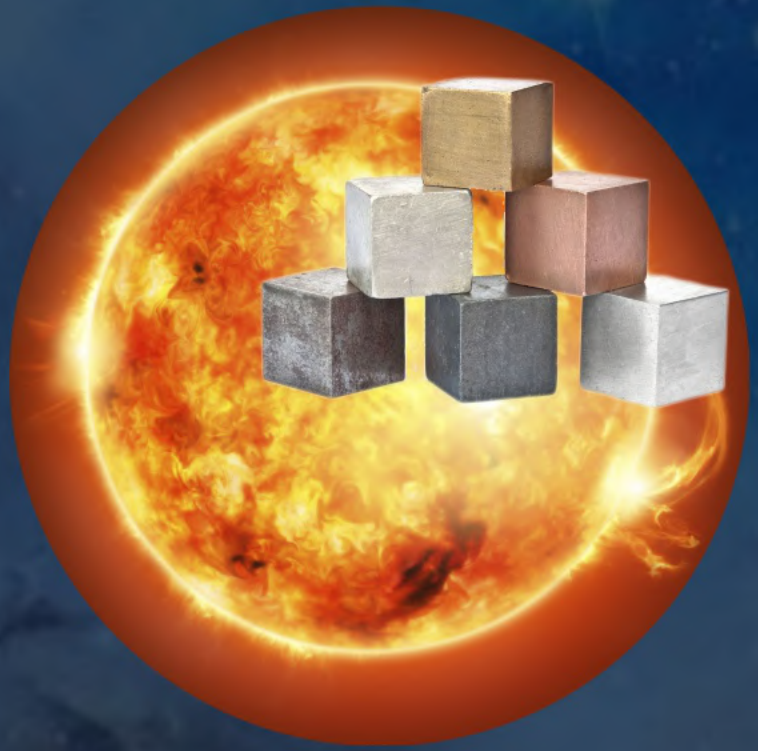
III. populációs csillagok





Legelső csillagok?

III. populációs csillagok



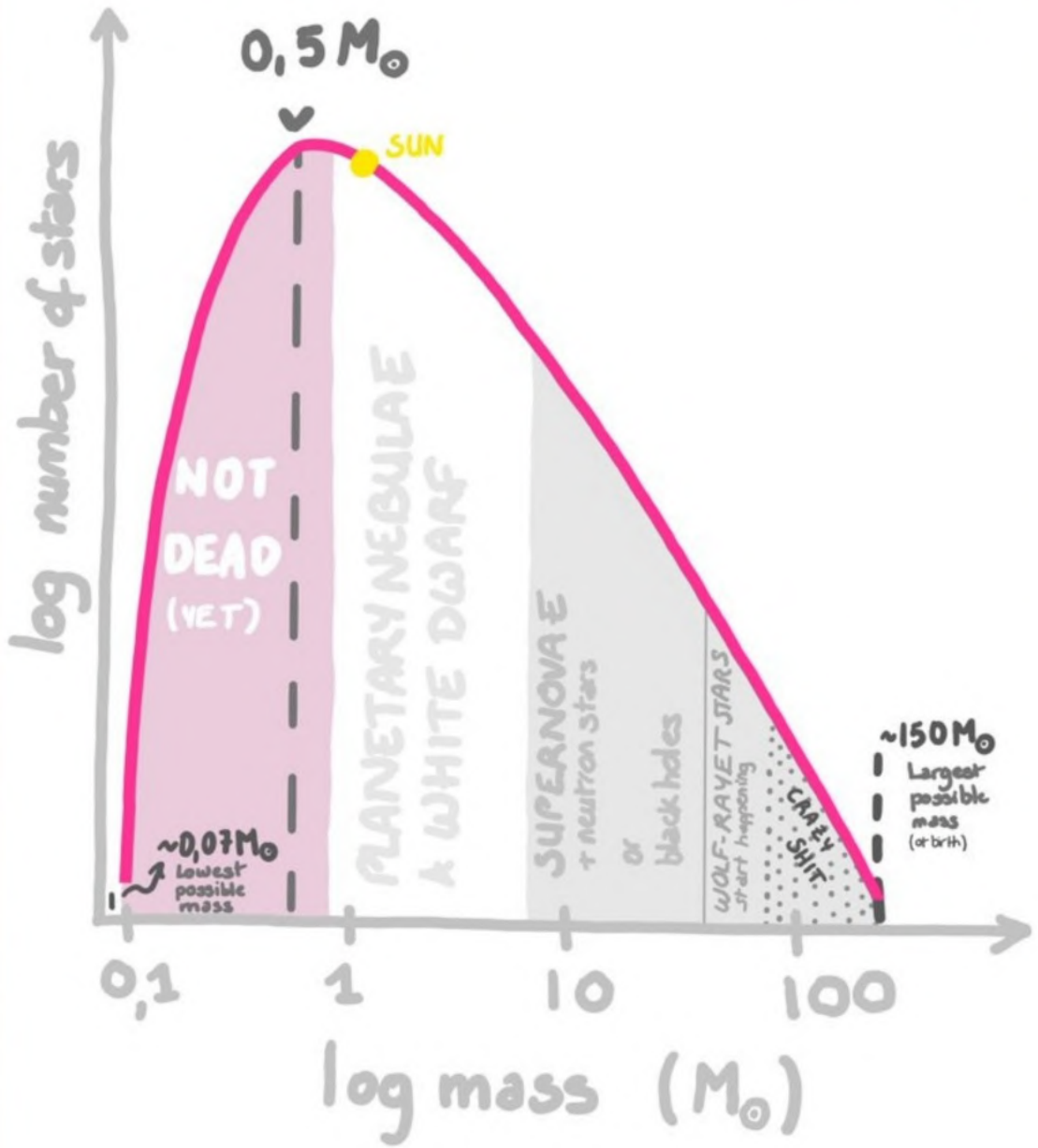




BAD INITIAL MASS FUNCTION

by @Sydonahi

(and how stars die)

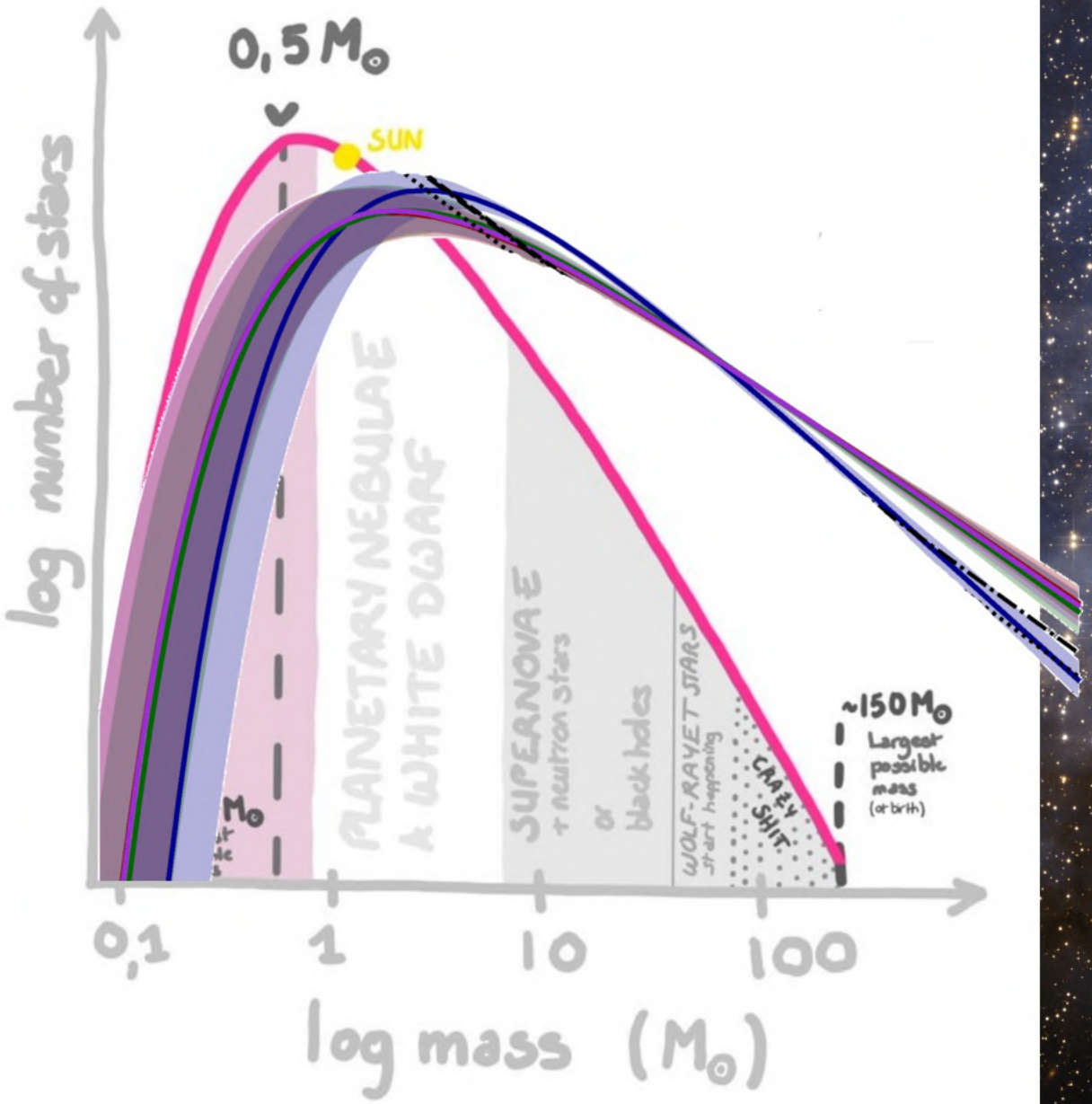




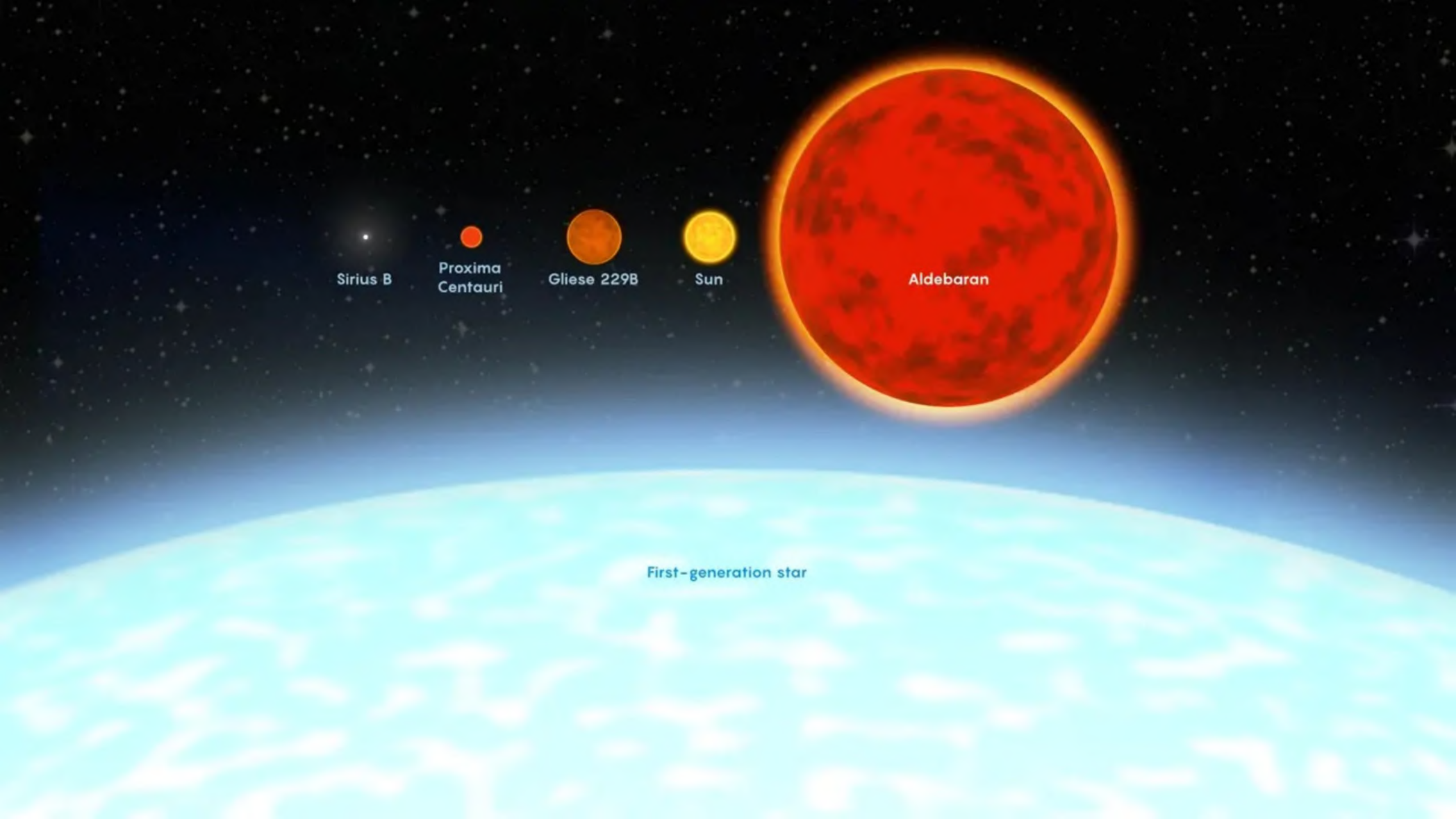
BAD INITIAL MASS FUNCTION

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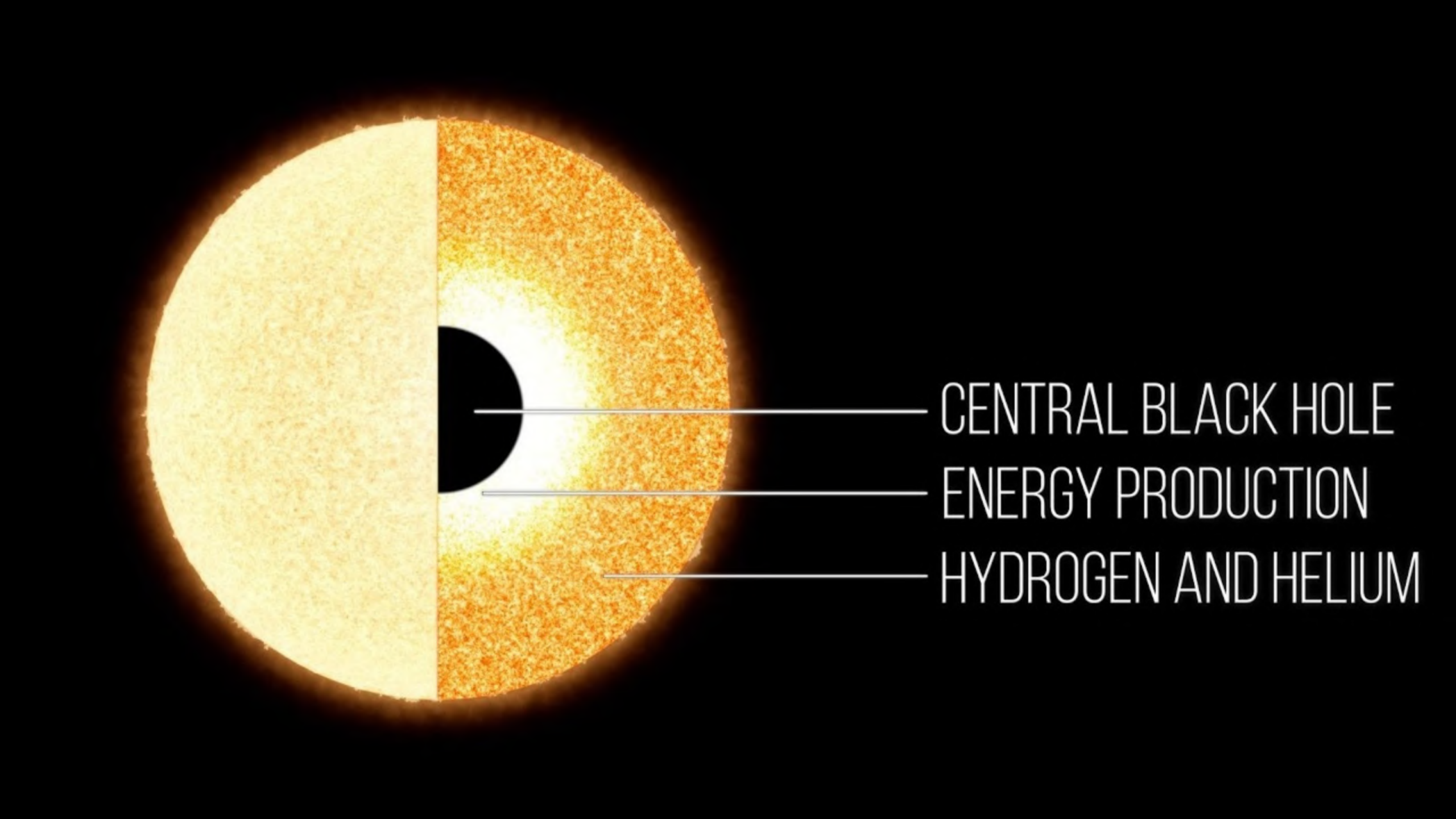
(and how stars die)






Sirius B
Proxima Centauri
Gliese 229B
Sun
Aldebaran
First-generation star




CENTRAL BLACK HOLE
ENERGY PRODUCTION
HYDROGEN AND HELIUM



Galaxisok



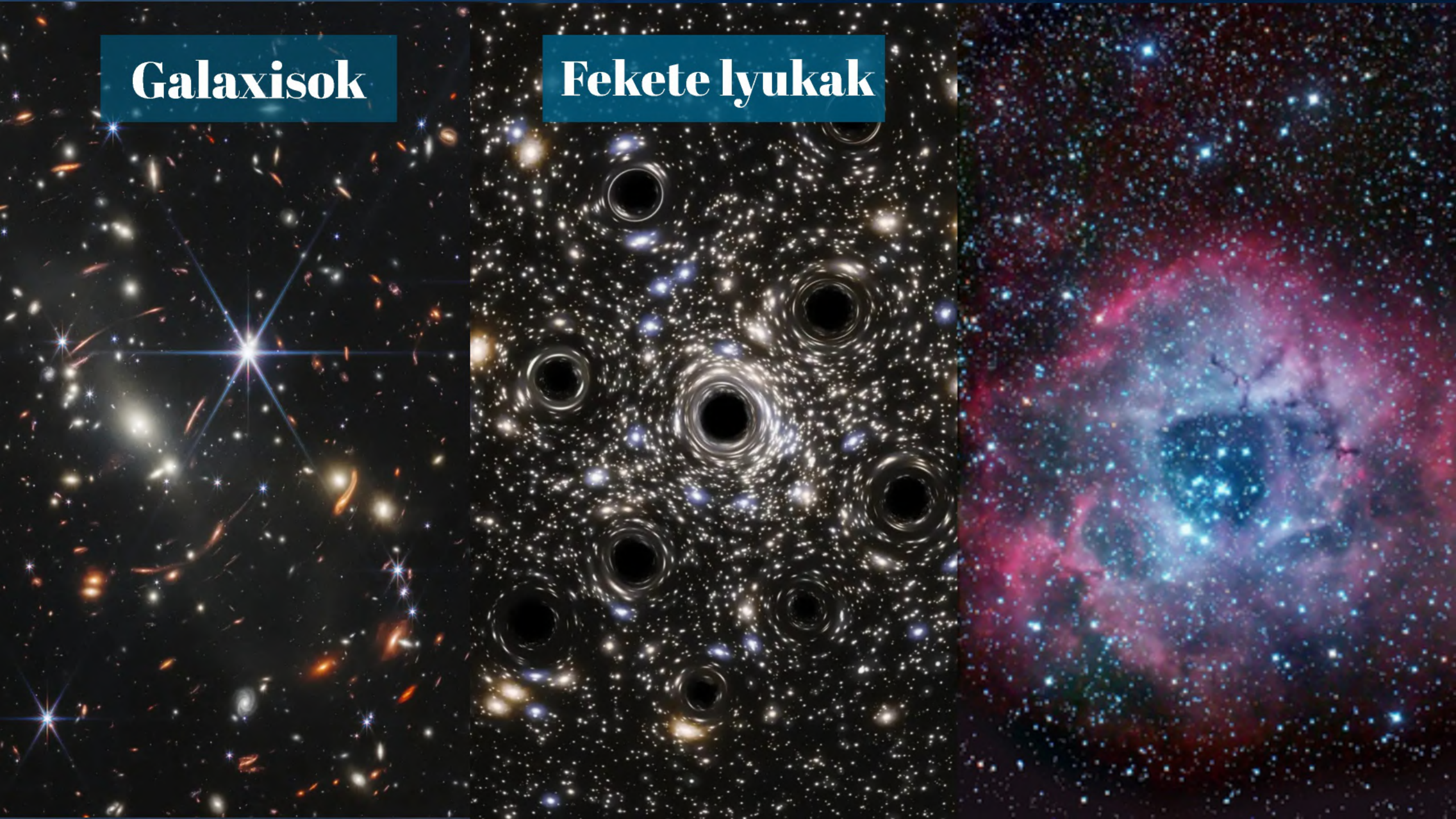
Galaxisok

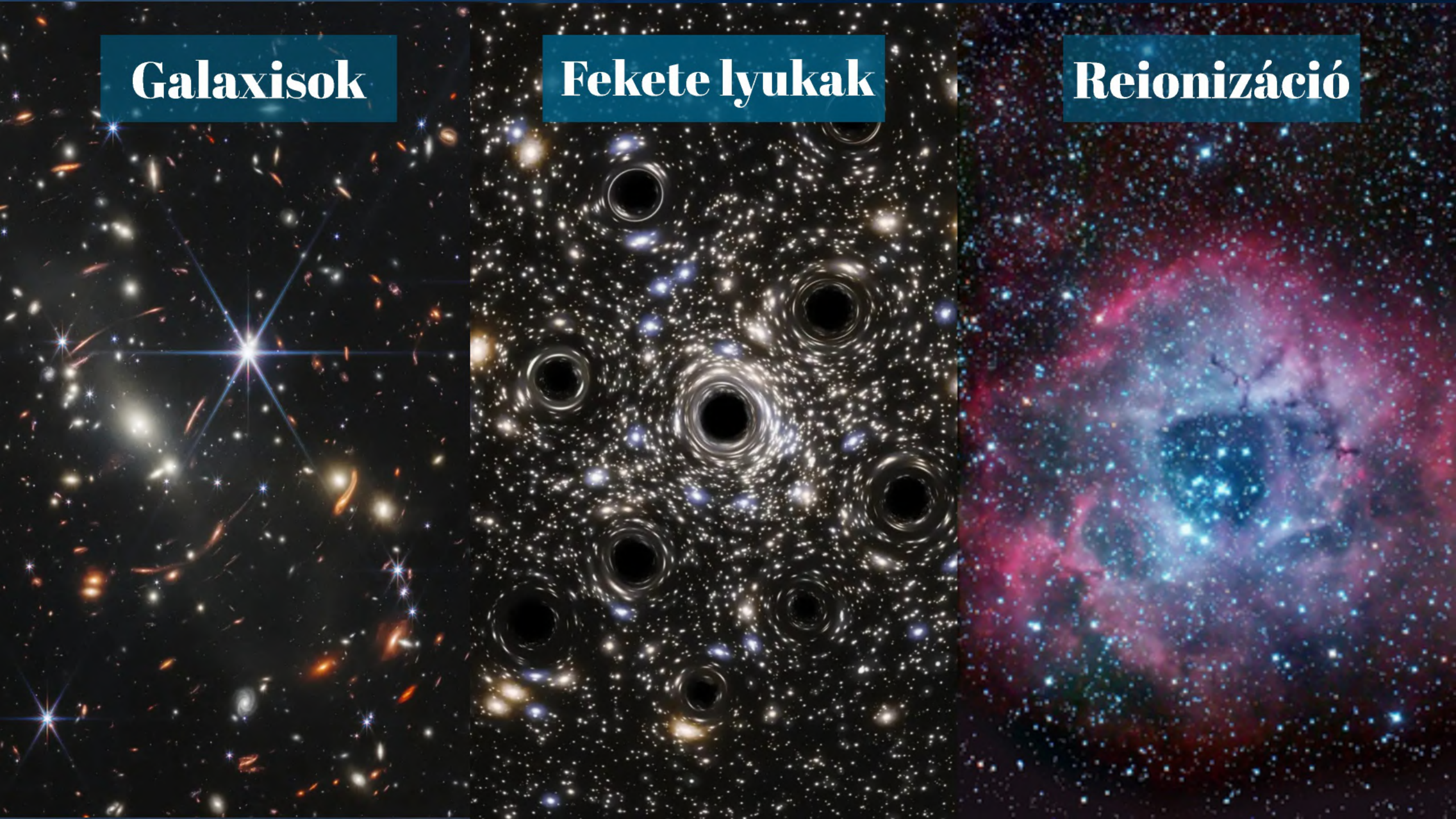


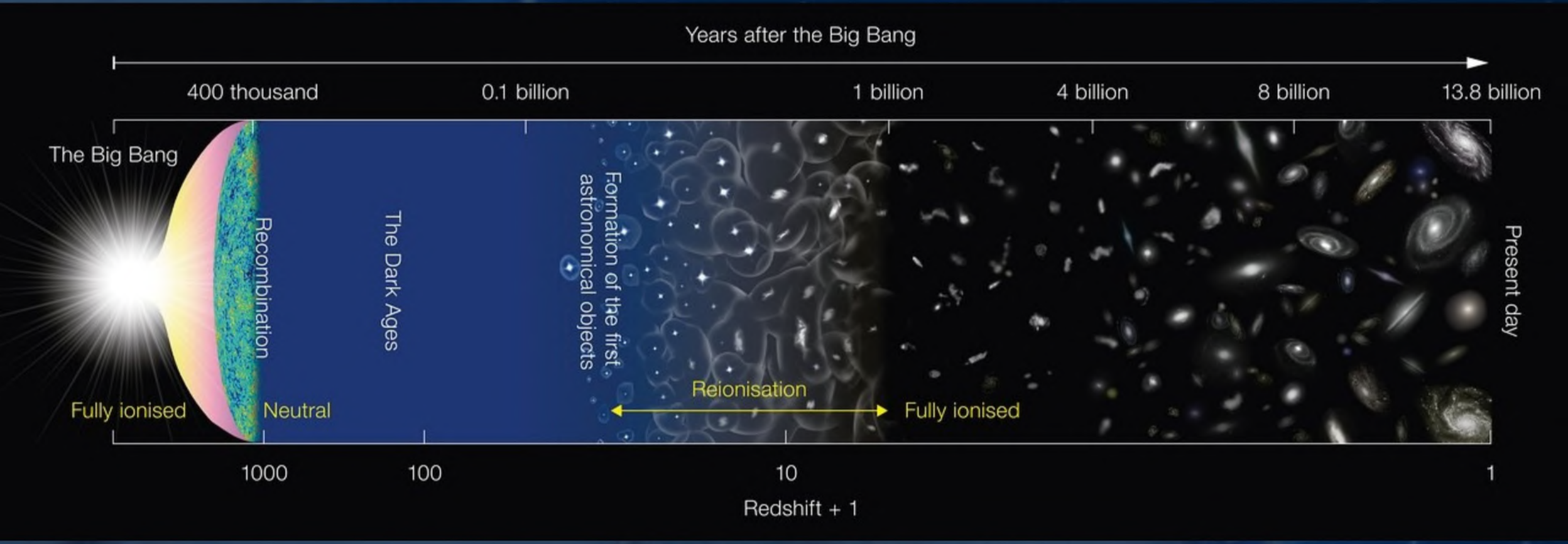



Galaxisok


Fekete lyukak

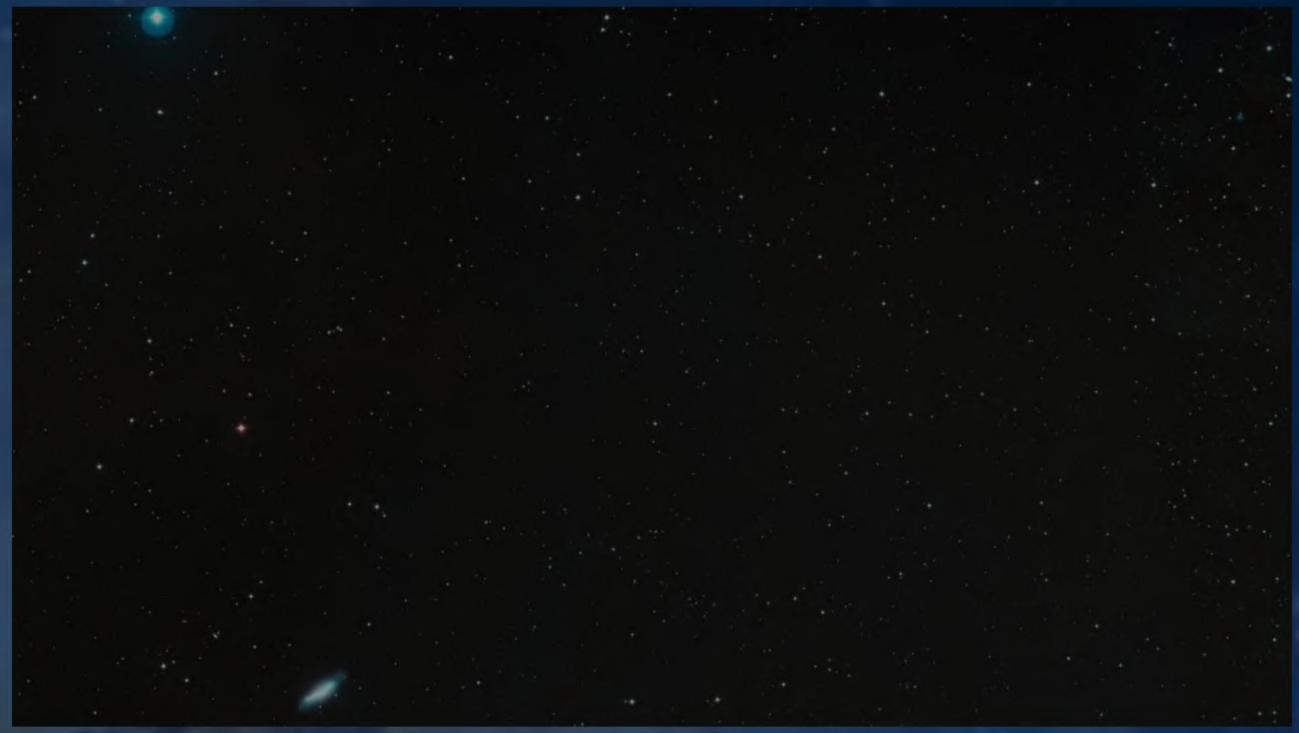

Galaxisok
Fekete lyukak


Galaxisok
Fekete lyukak
Reionizáció

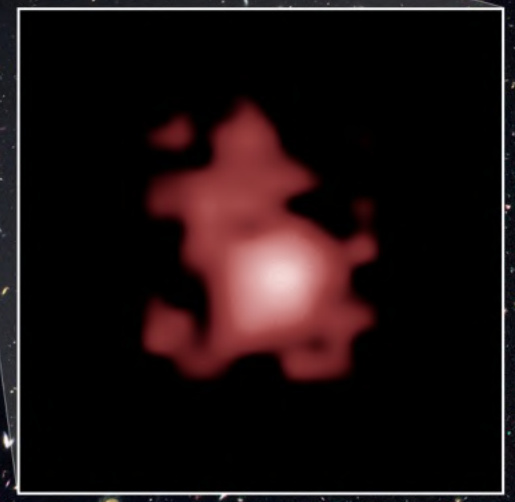

Years after the Big Bang
400 thousand
0.1 billion
1 billion
4 billion
8 billion
13.8 billion
The Big Bang
Recombination
The Dark Ages
Formation of the first astronomical objects
Reionisation
Present day
Fully ionised
Neutral
Fully ionised
1000
100
10
1
Redshift + 1

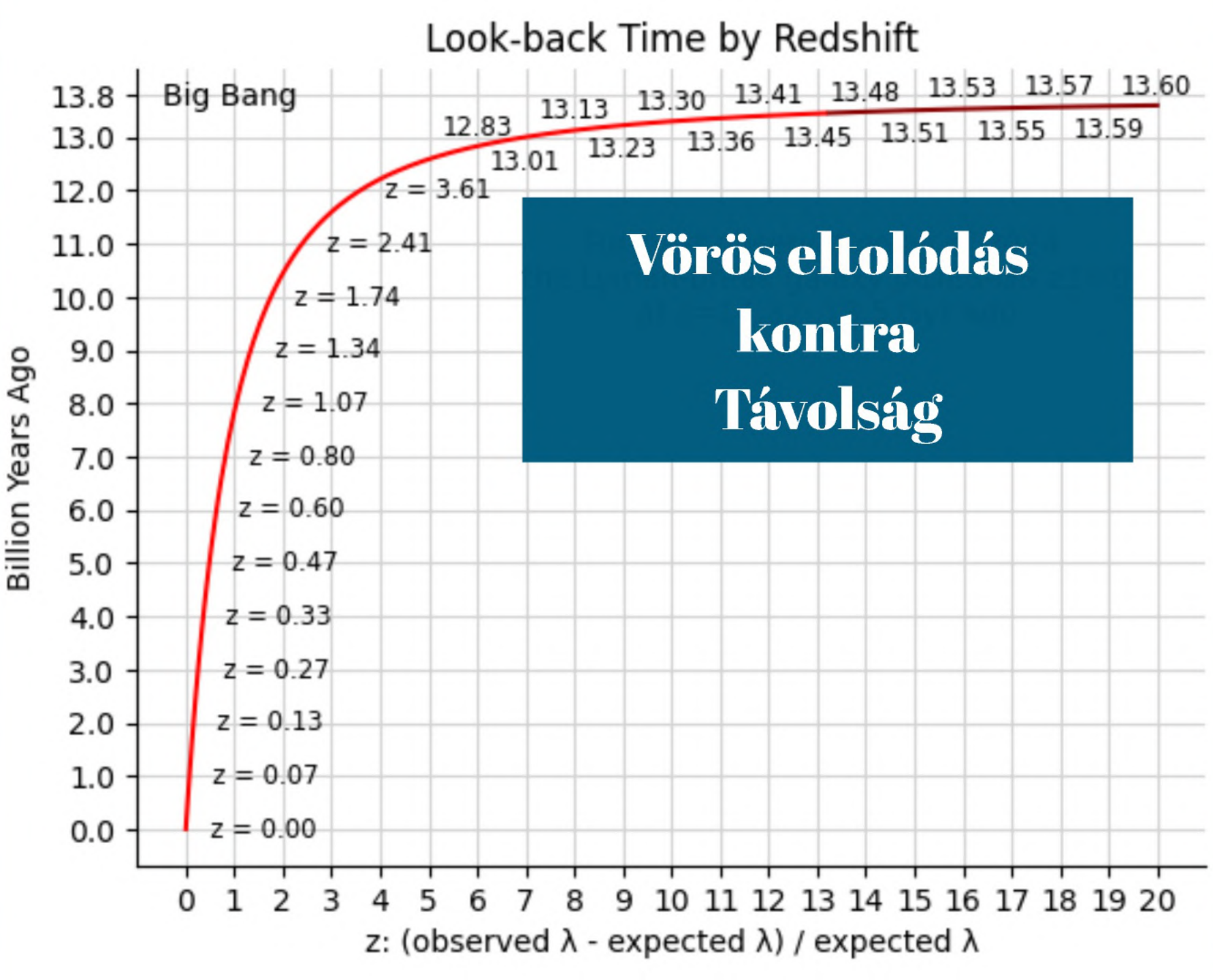


GN Z-11



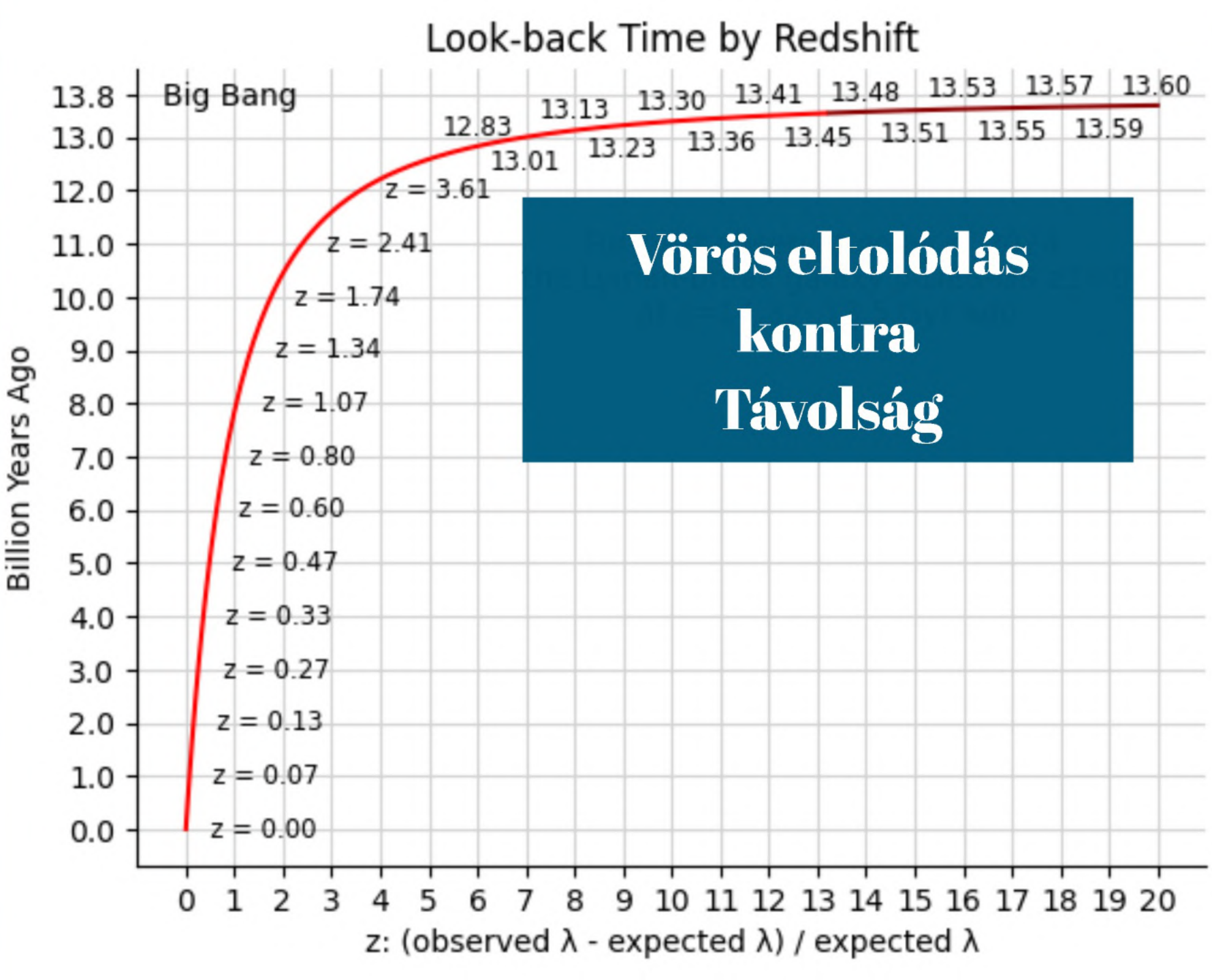
GN Z-11





Vörös eltolódás kontra Távolság

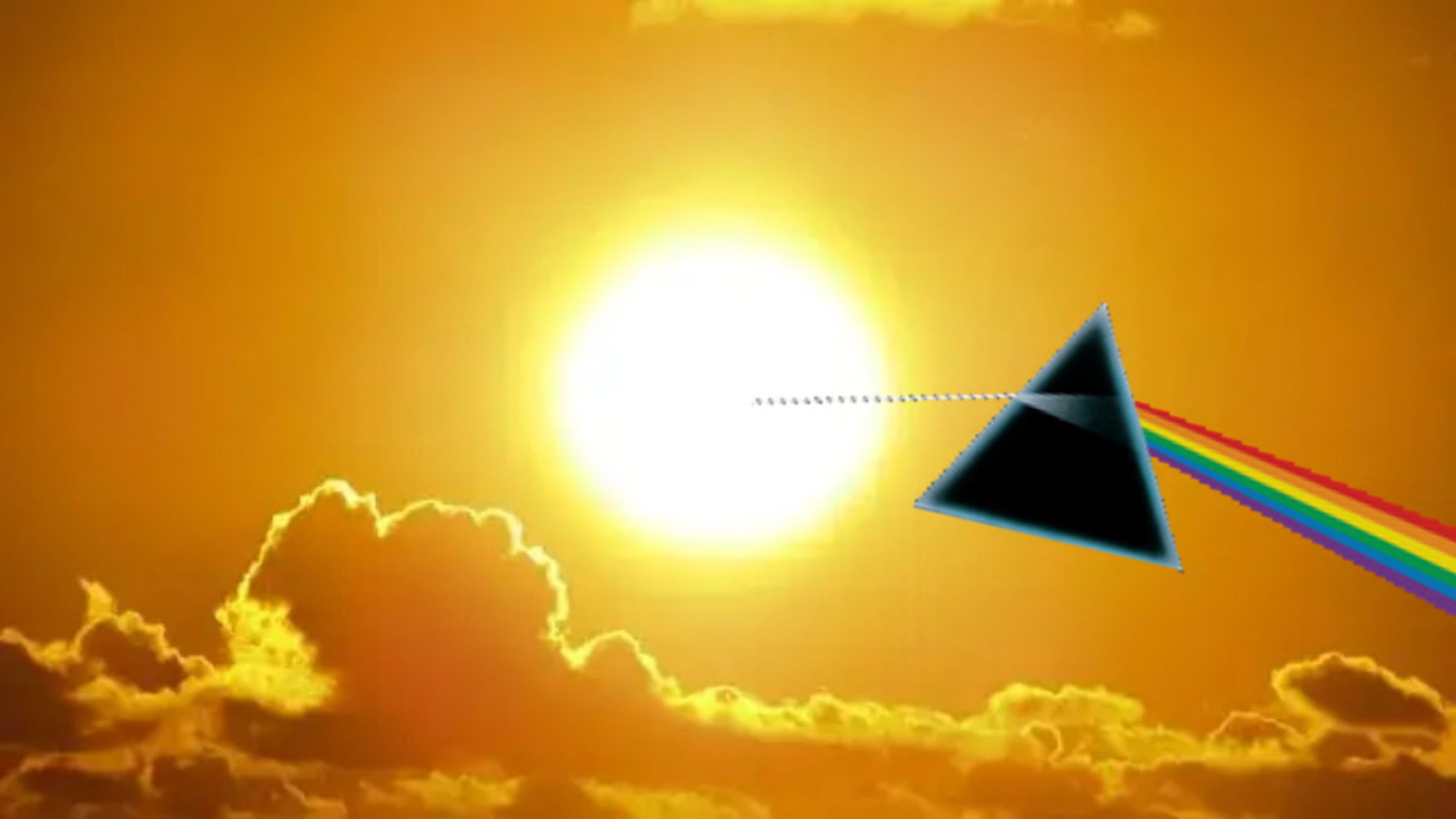
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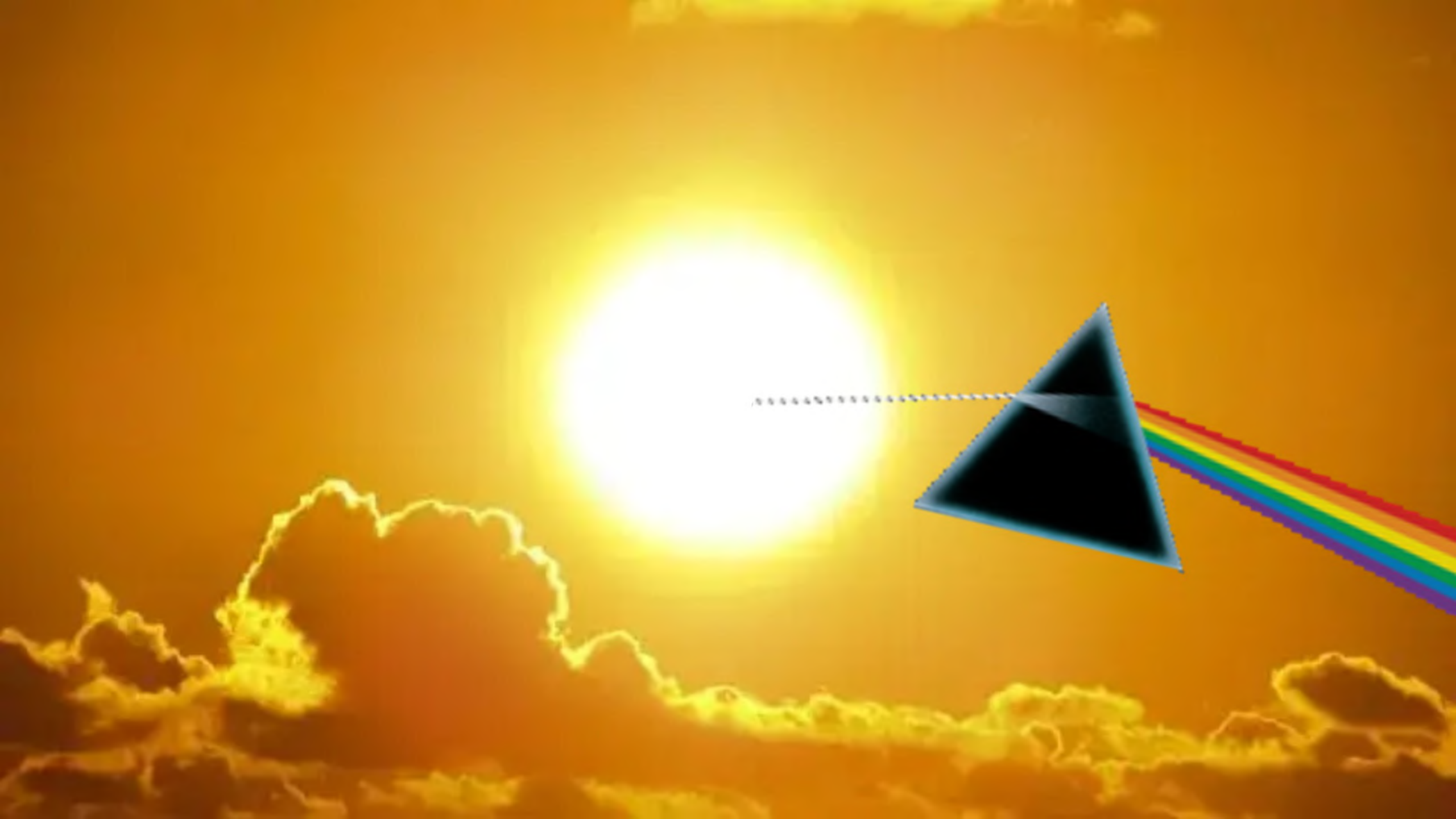


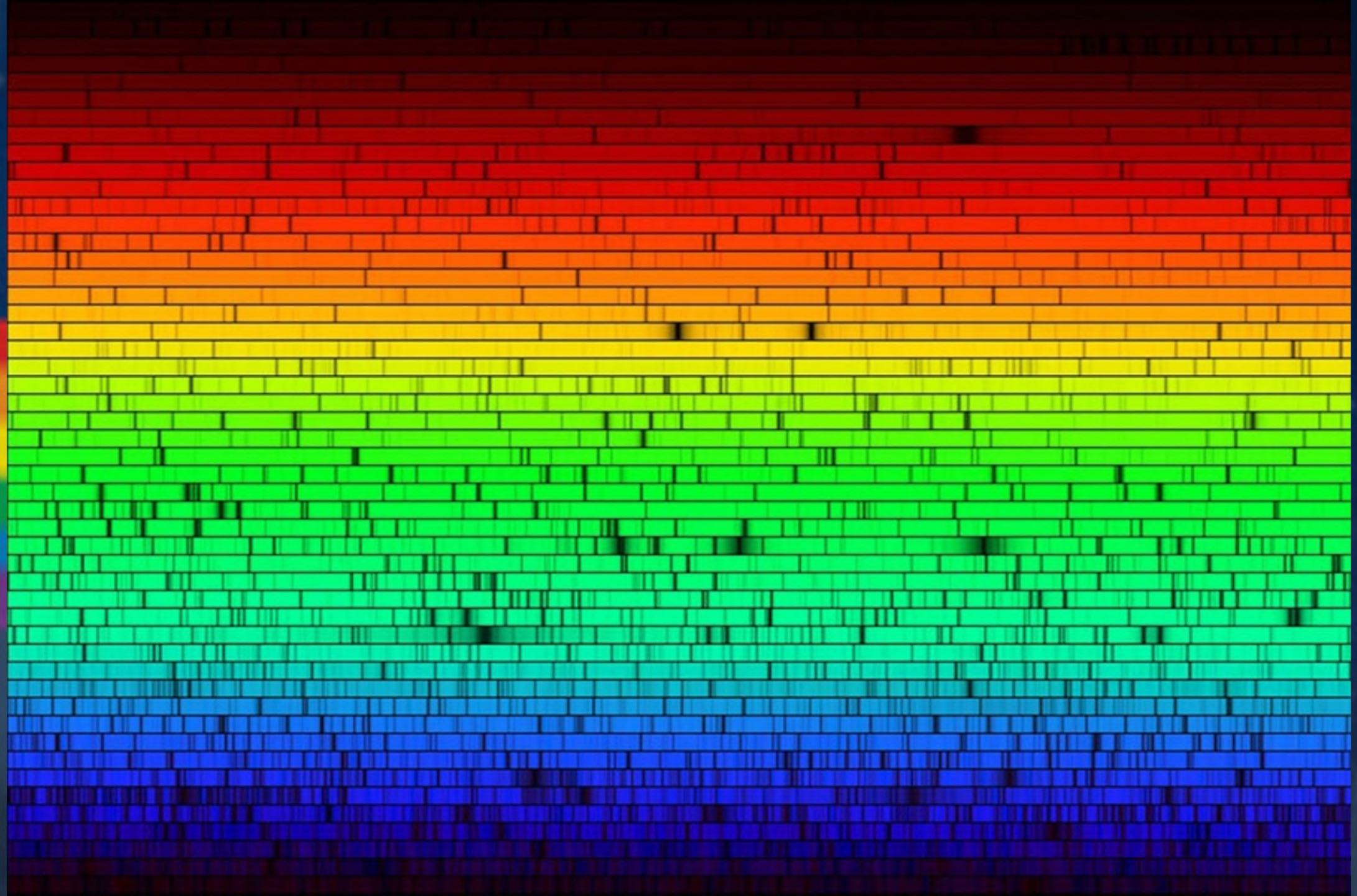
Vörös eltolódás kontra Távolság

1100

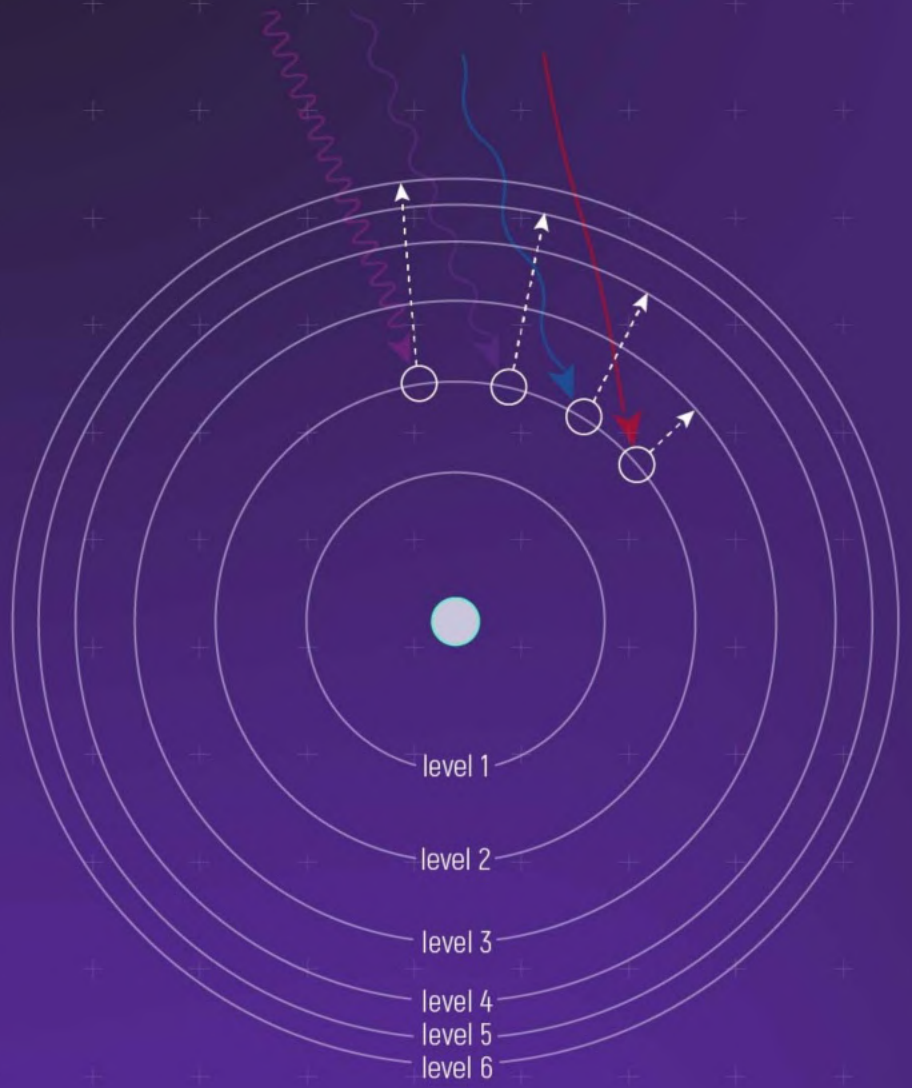


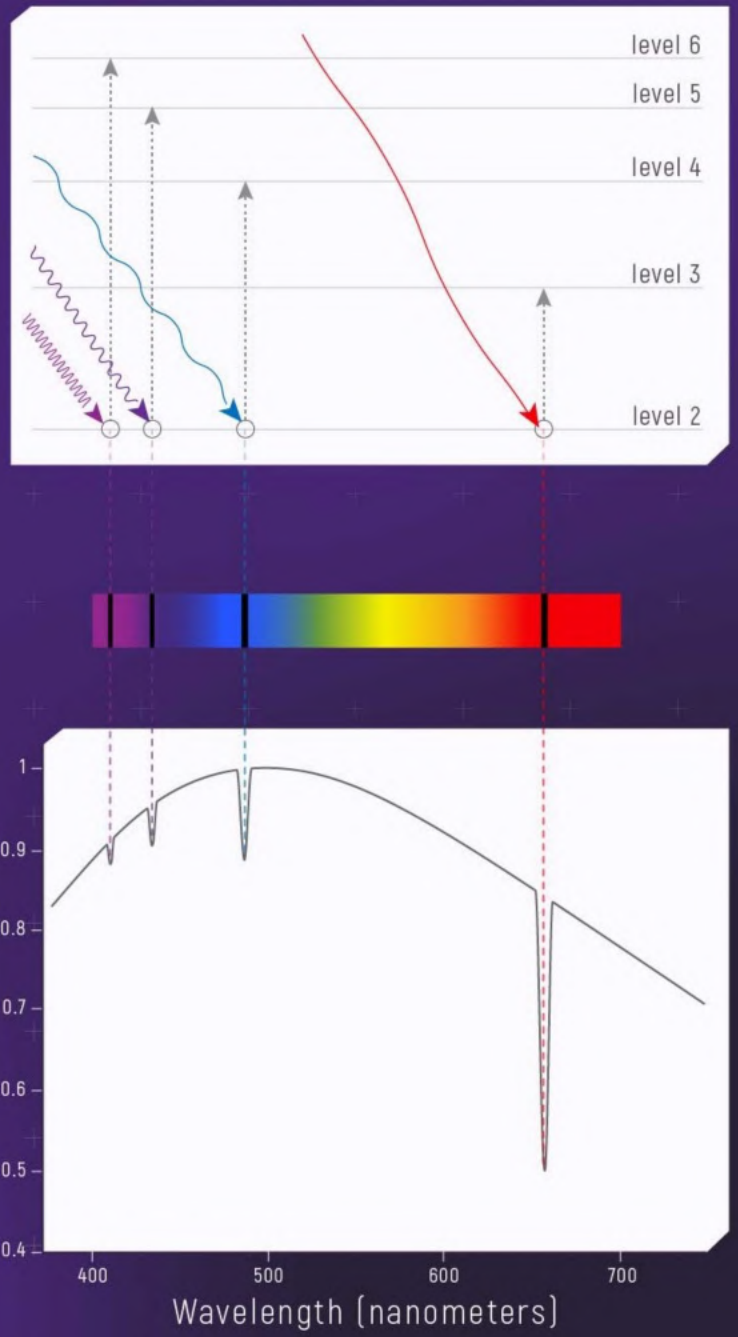






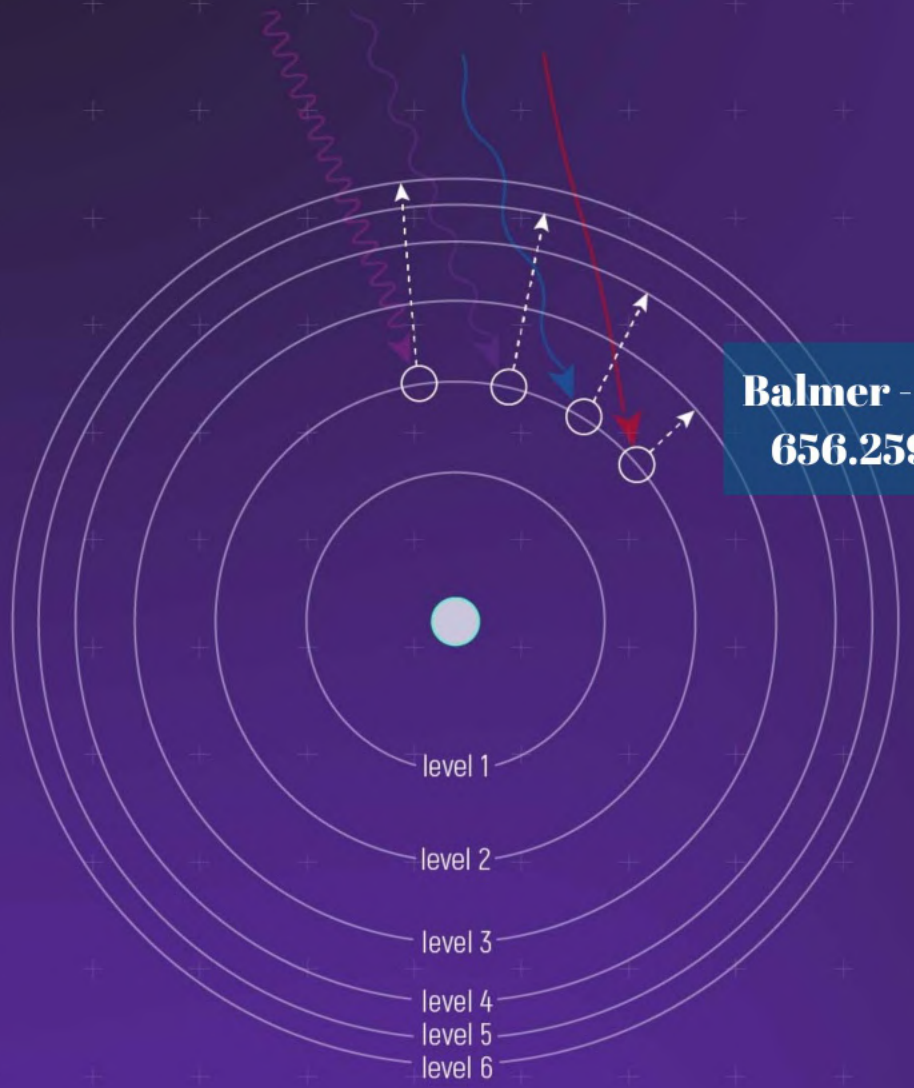
ABSORPTION OF LIGHT BY HYDROGEN

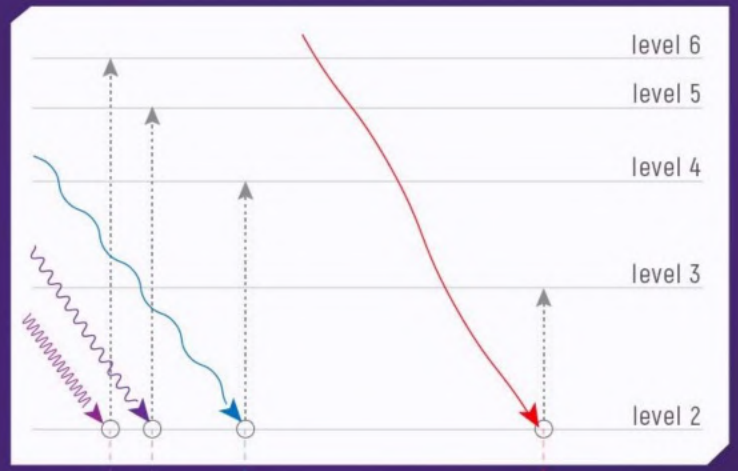




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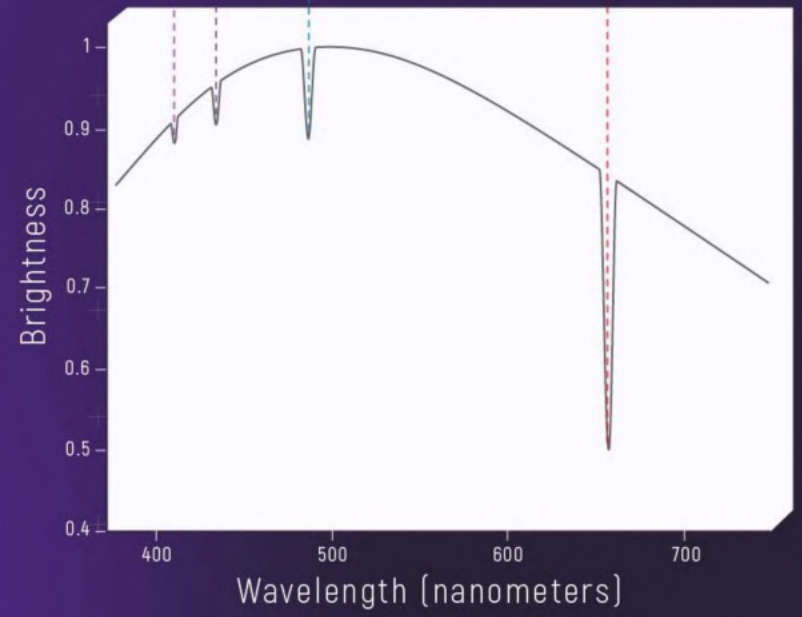
ABSORPTION OF LIGHT BY HYDROGEN





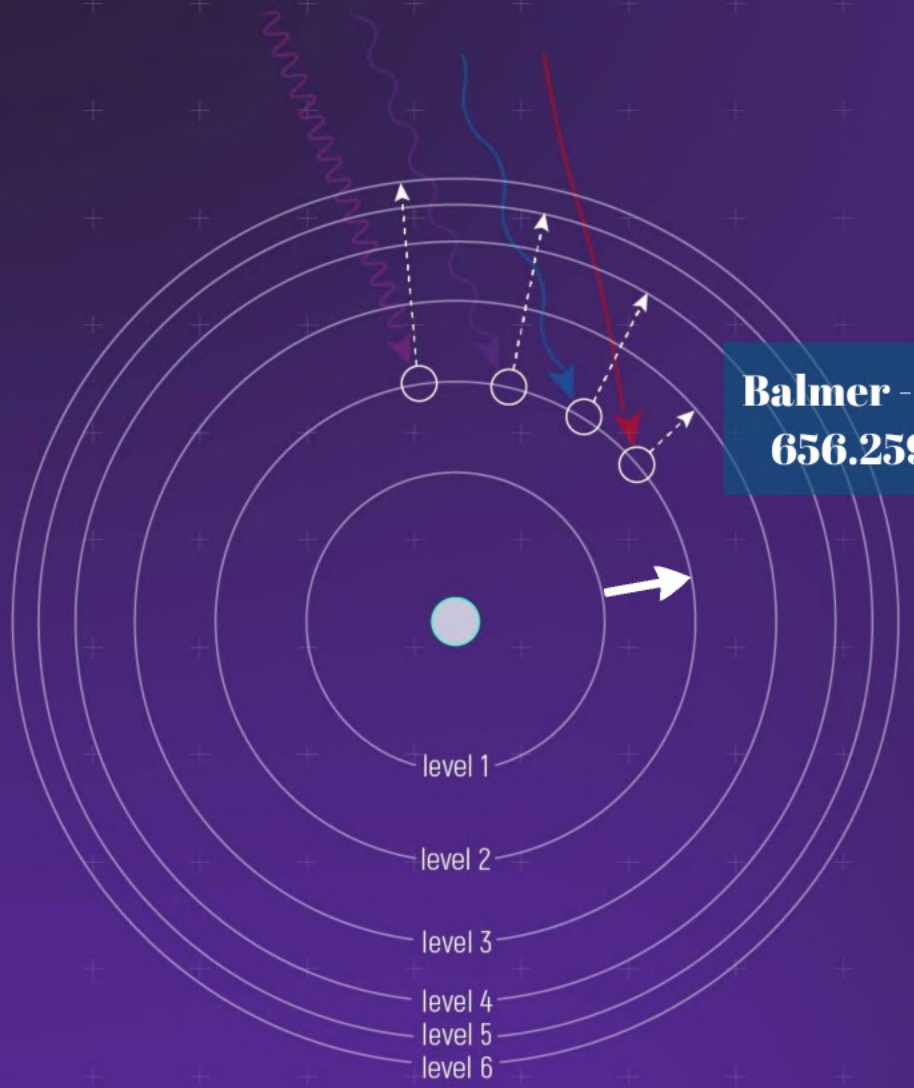
Balmer - alpha
656.259 nm

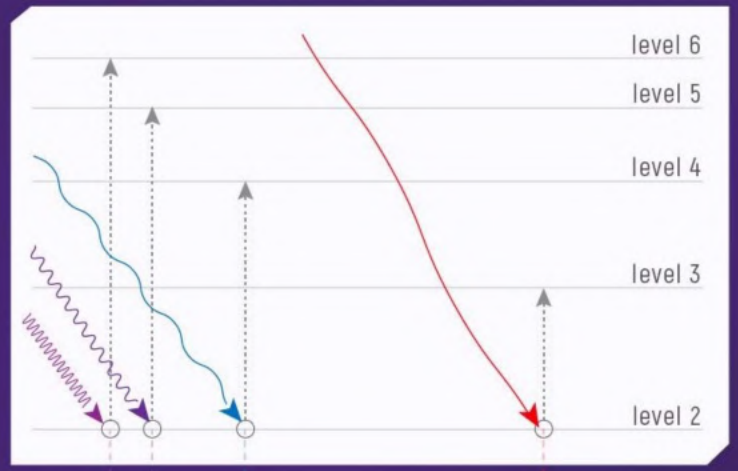




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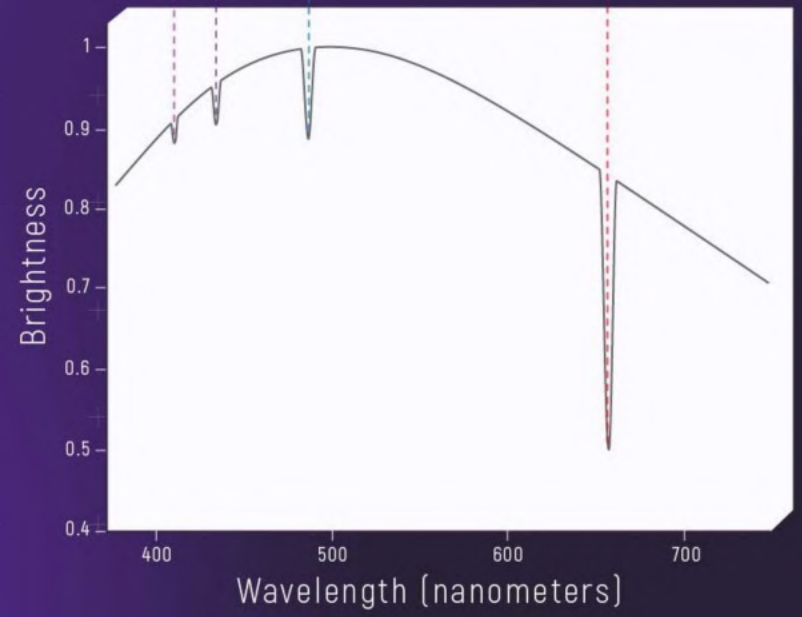
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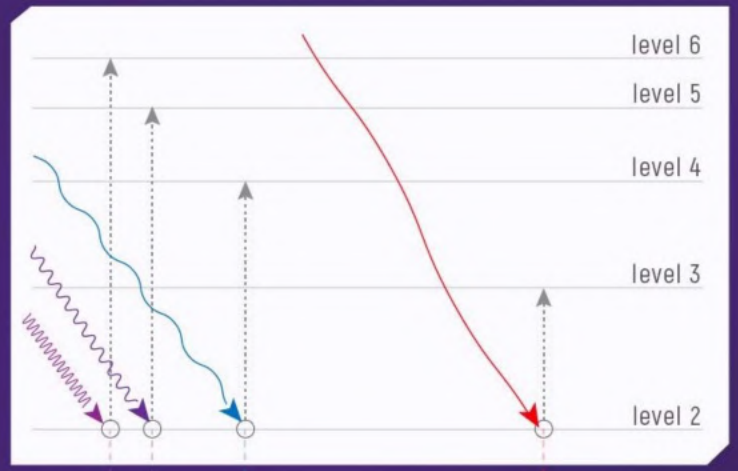
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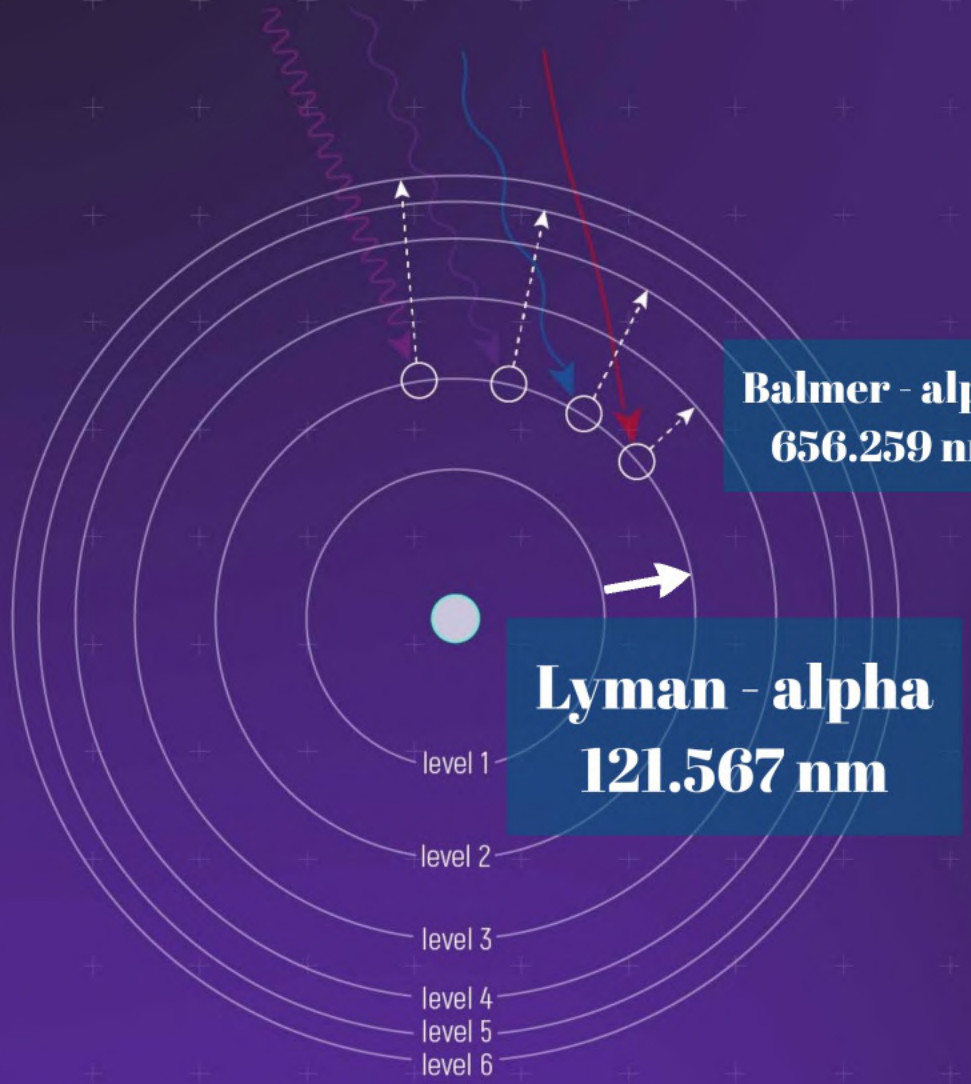




@ WEBB

ABSORPTION OF LIGHT BY HYDROGEN

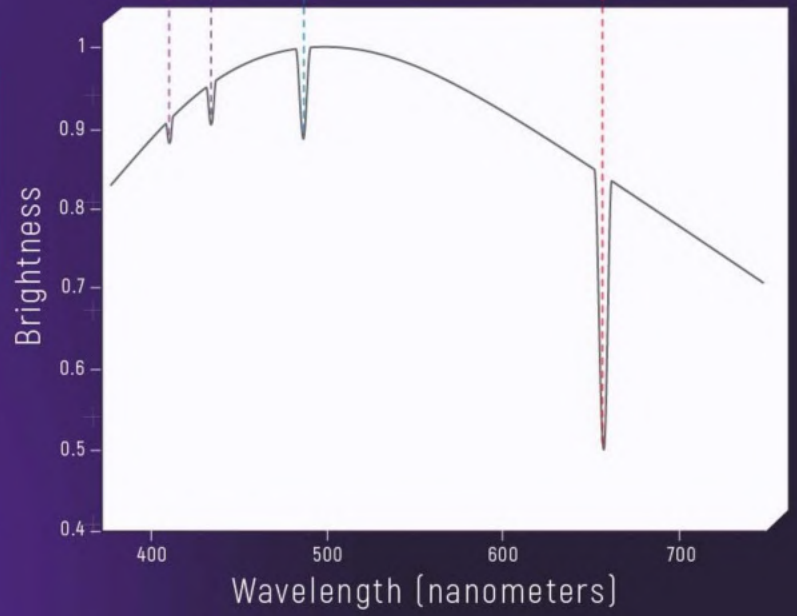




Balmer - alpha
656.259 nm

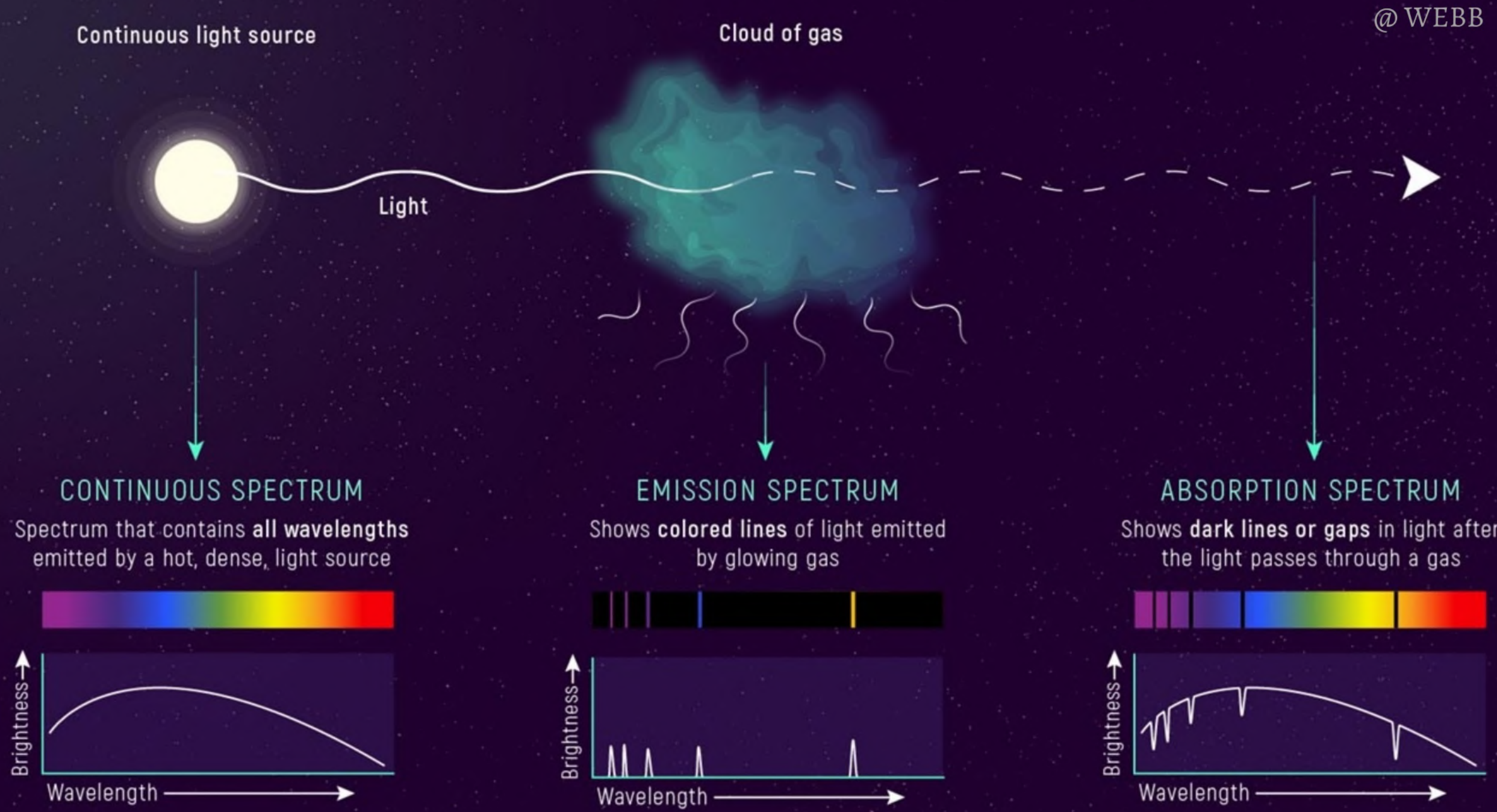


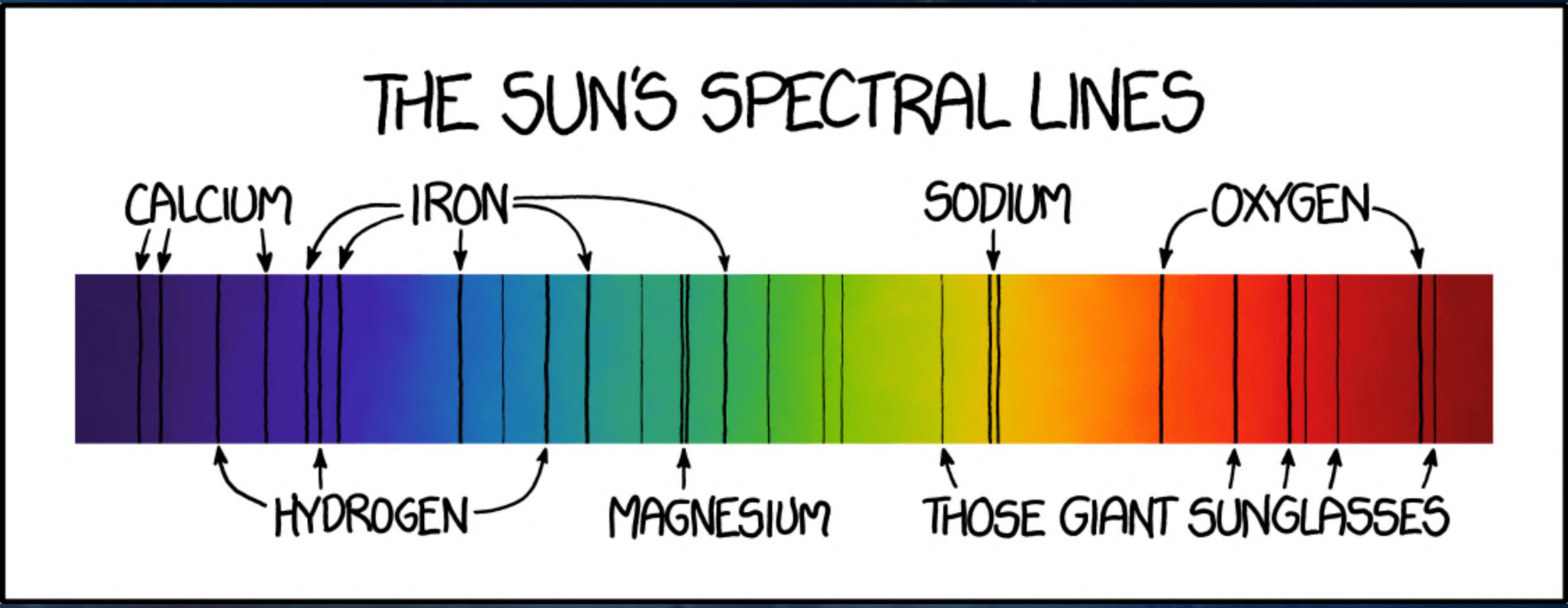
Lyman - alpha
121.567 nm



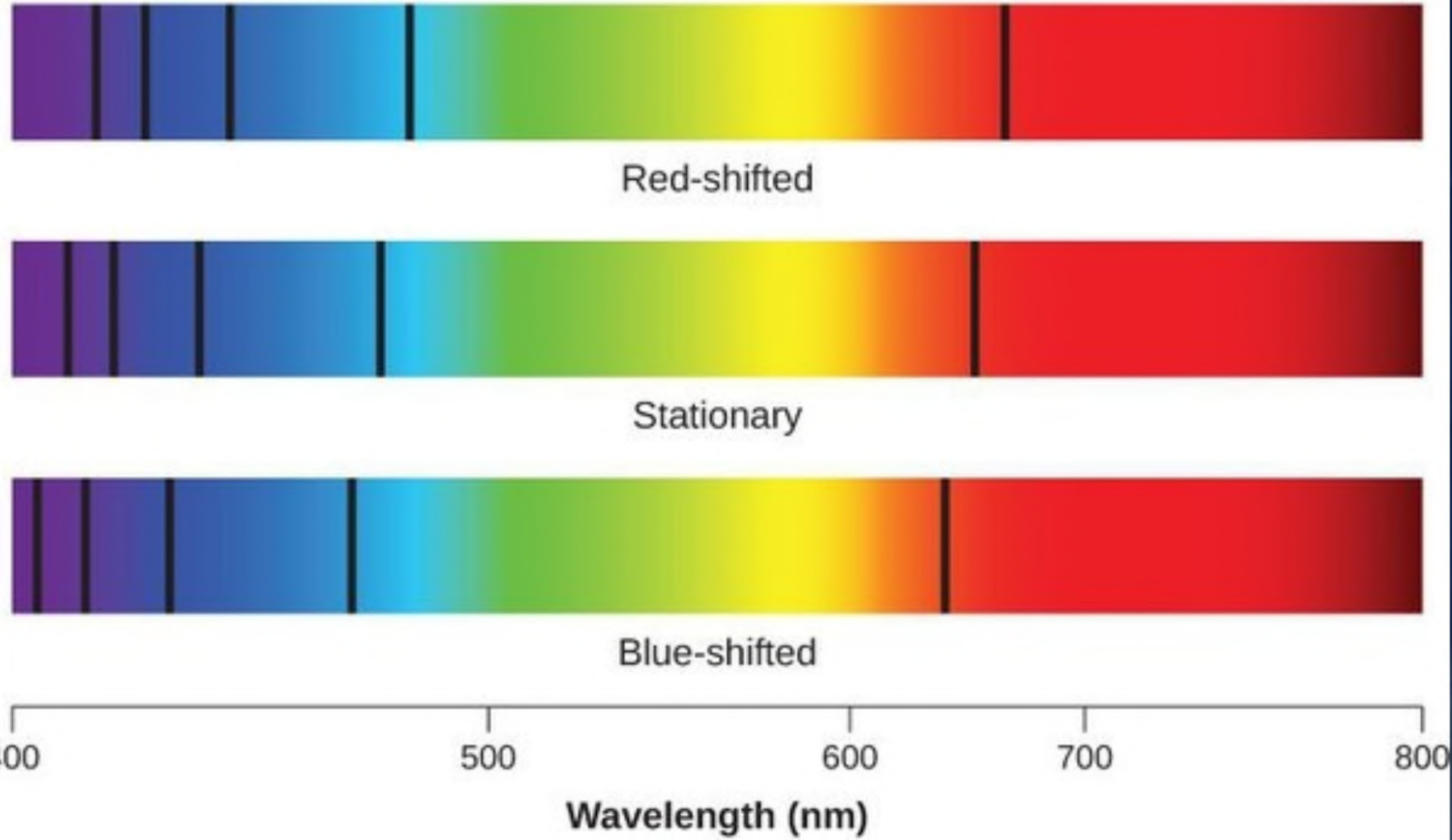
@ WEBB

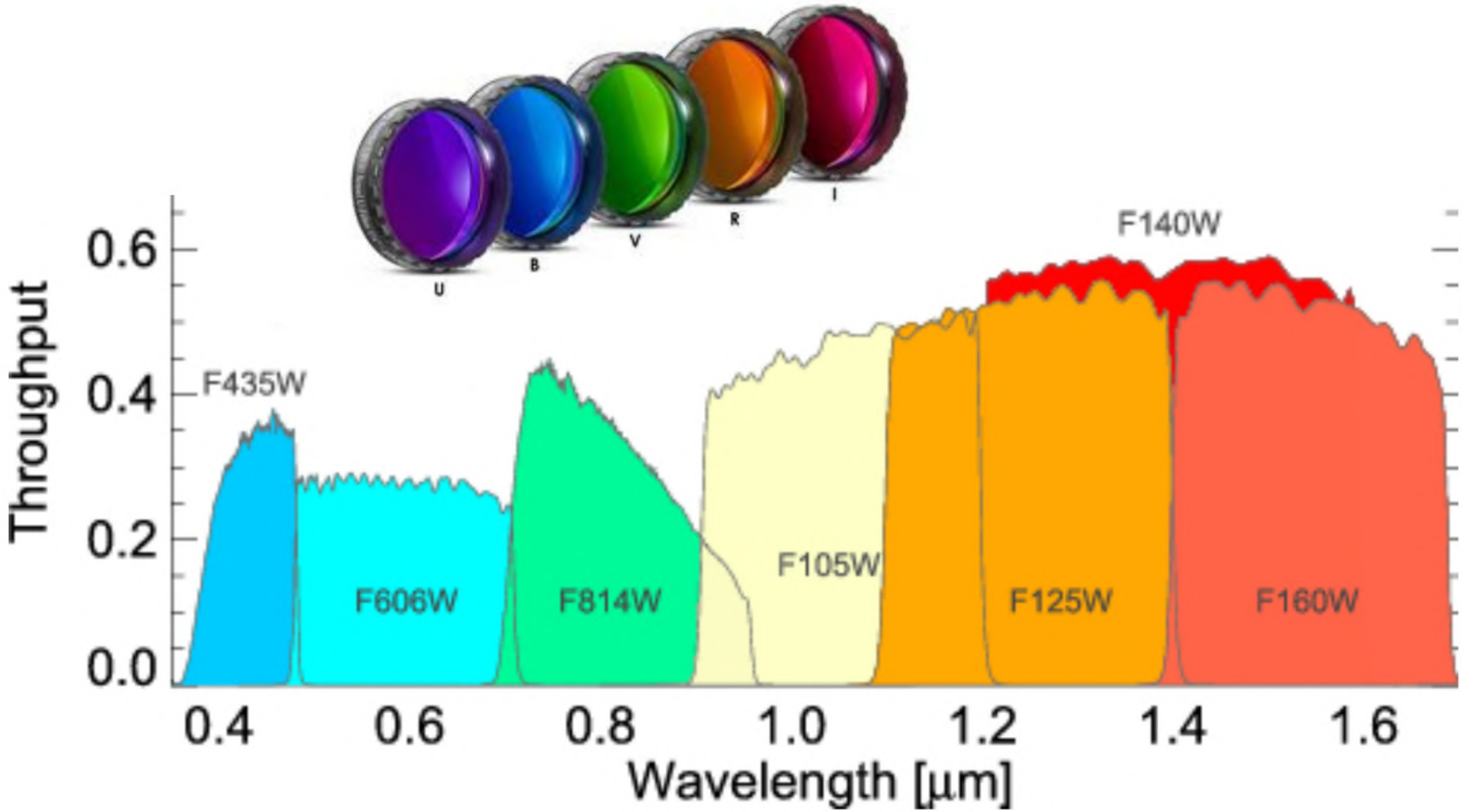
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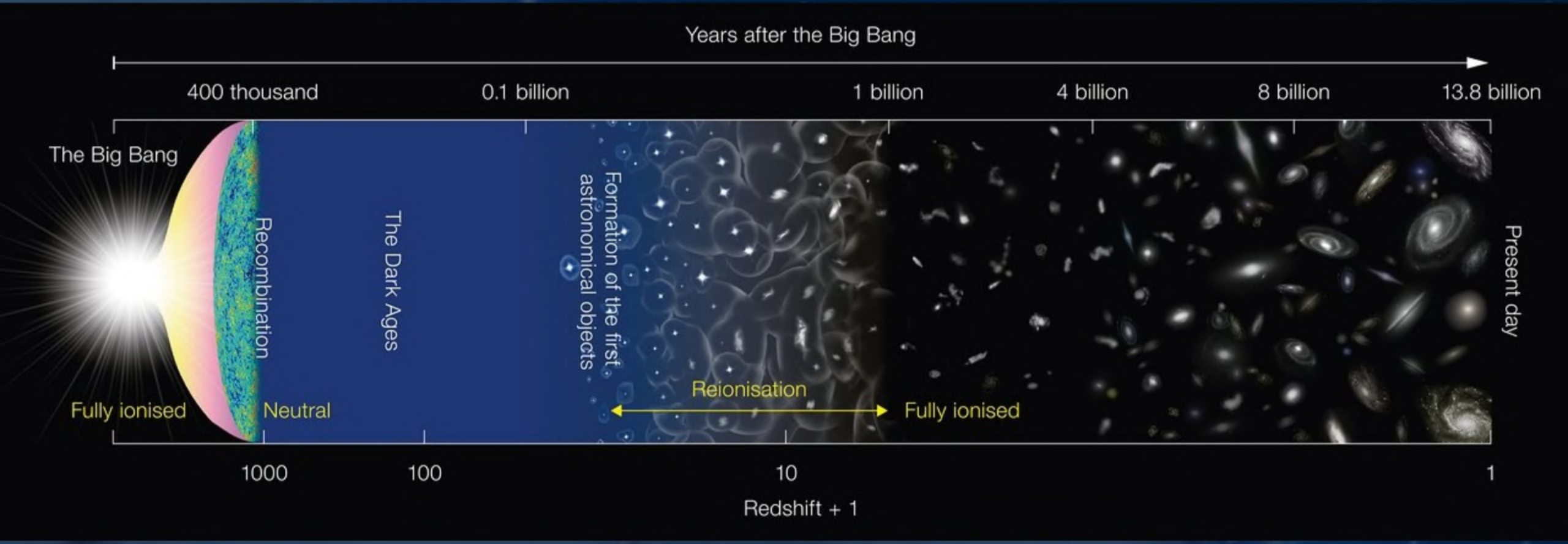

Continuous light source
Cloud of gas
Light
CONTINUOUS SPECTRUM
Spectrum that contains **all wavelengths** emitted by a hot, dense, light source
Brightness
Wavelength
EMISSION SPECTRUM
Shows **colored lines** of light emitted by glowing gas
Brightness
Wavelength
ABSORPTION SPECTRUM
Shows **dark lines or gaps** in light after the light passes through a gas
Brightness
Wavelength

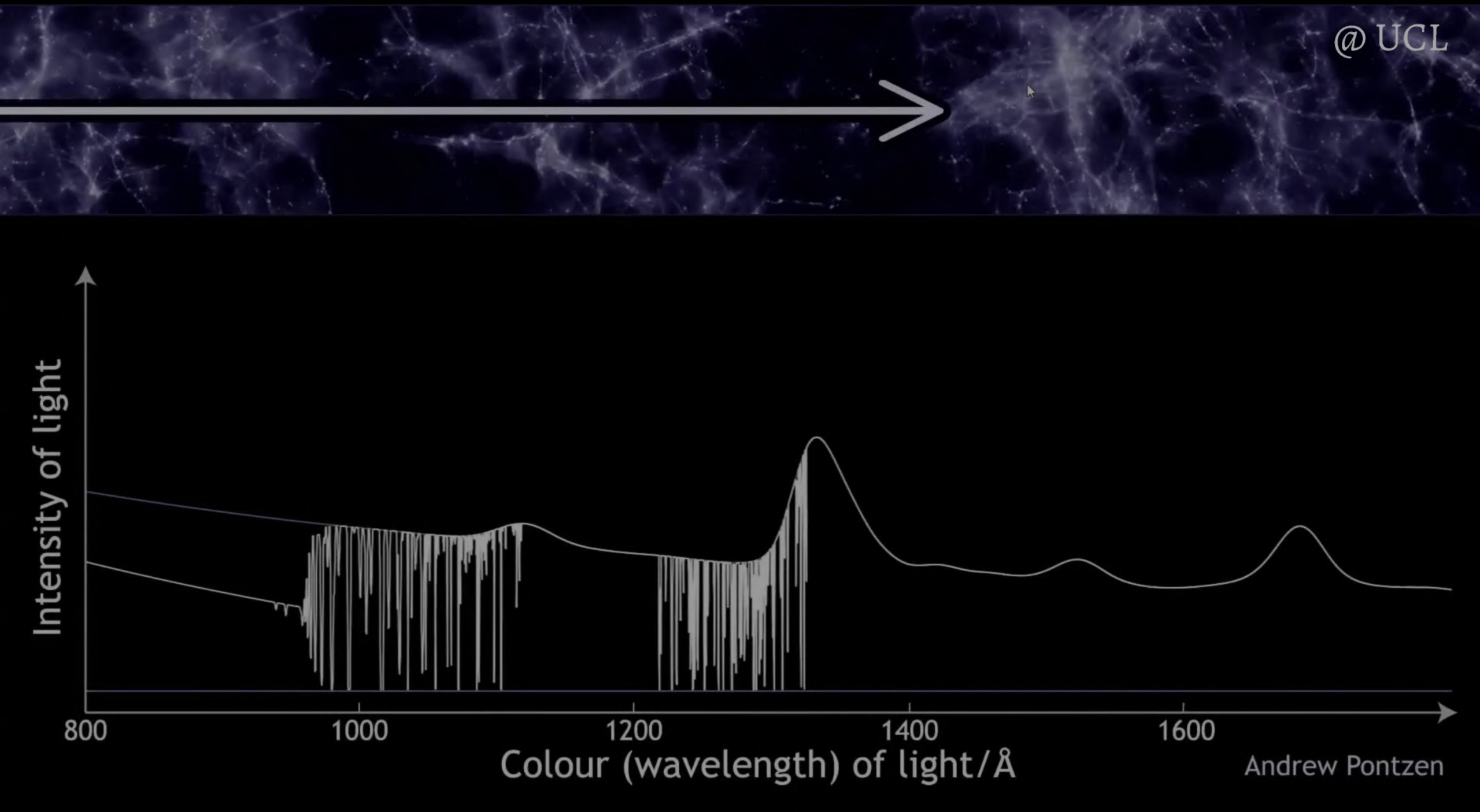

THE SUN'S SPECTRAL LINES
CALCIUM
IRON
SODIUM
OXYGEN
HYDROGEN
MAGNESIUM
THOSE GIANT SUNGLASSES

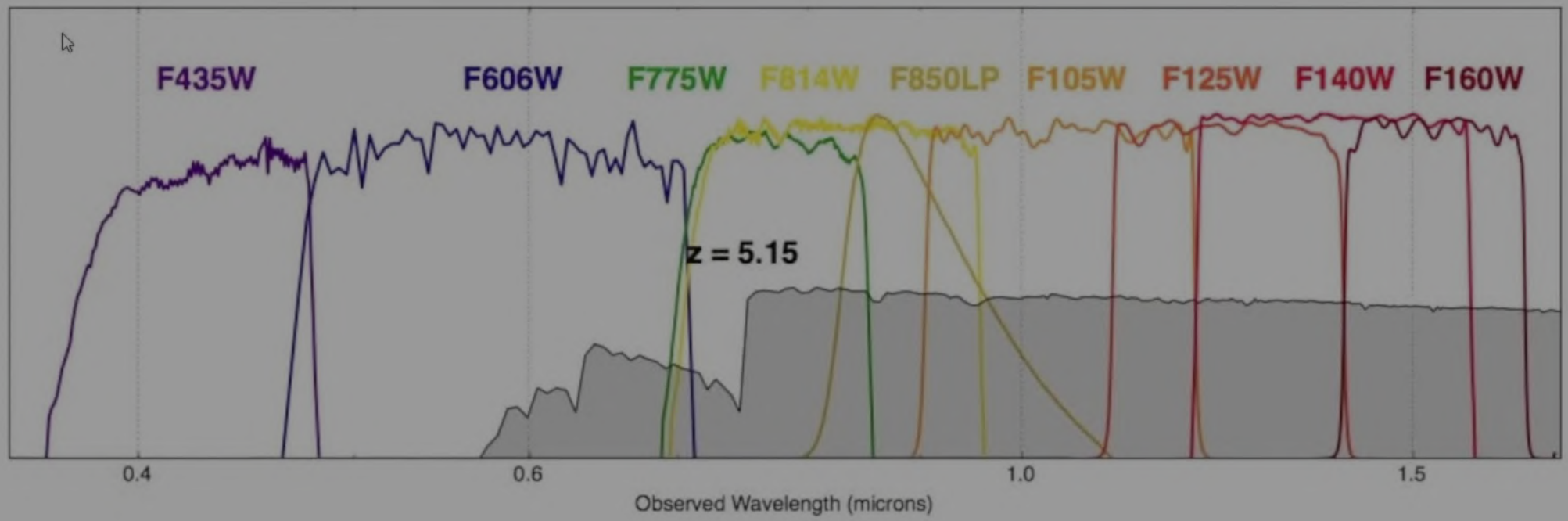
The Doppler Shift

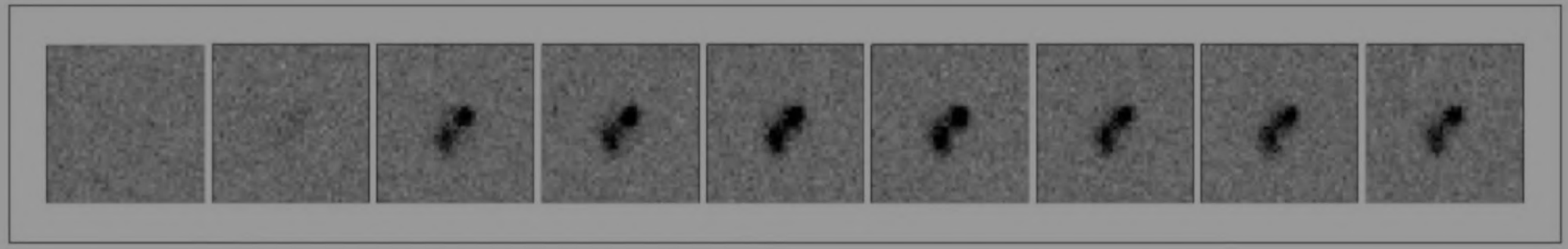



U
B
V
R
I
Throughput
0.0
0.2
0.4
0.6
F435W
F606W
F814W
F105W
F140W
F125W
F160W
0.4
0.6
0.8
1.0
1.2
1.4
1.6
Wavelength [μm]

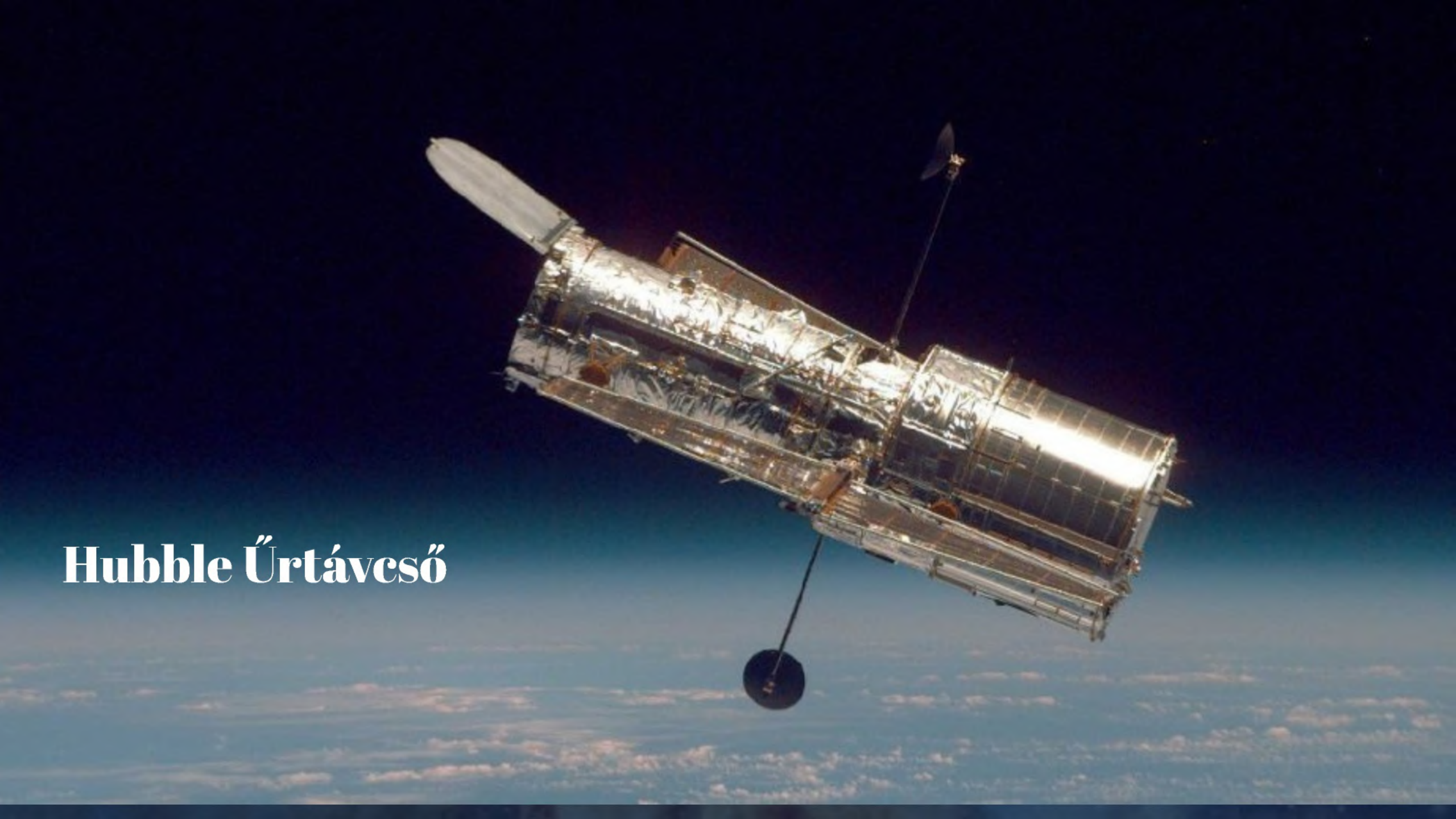

Years after the Big Bang
400 thousand
0.1 billion
1 billion
4 billion
8 billion
13.8 billion
The Big Bang
Recombination
The Dark Ages
Formation of the first astronomical objects
Reionisation
Present day
Fully ionised
Neutral
Fully ionised
1000
100
10
1
Redshift + 1


@ UCL
Intensity of light
800
1000
1200
1400
1600
Colour (wavelength) of light/Å
Andrew Pontzen

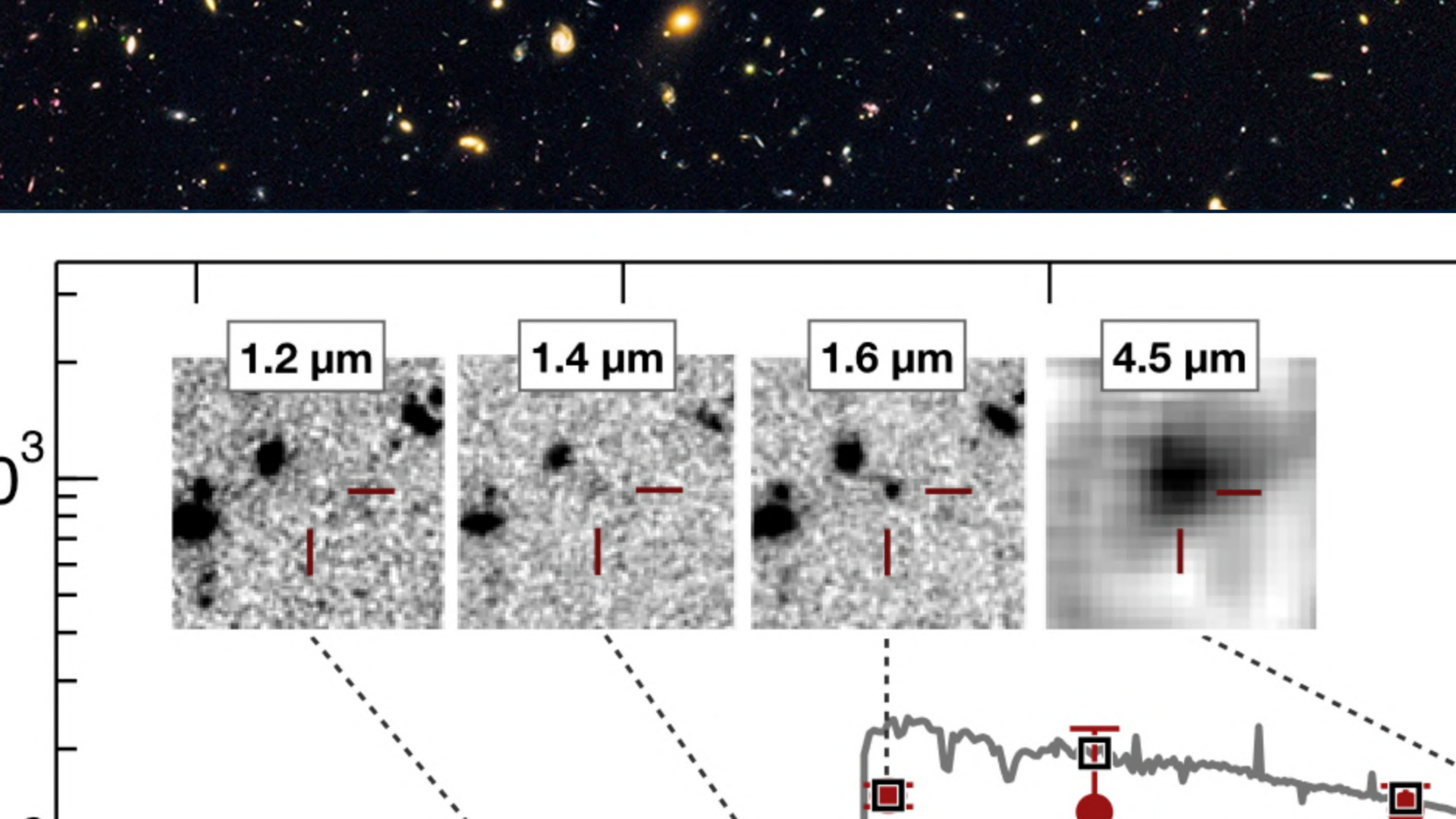


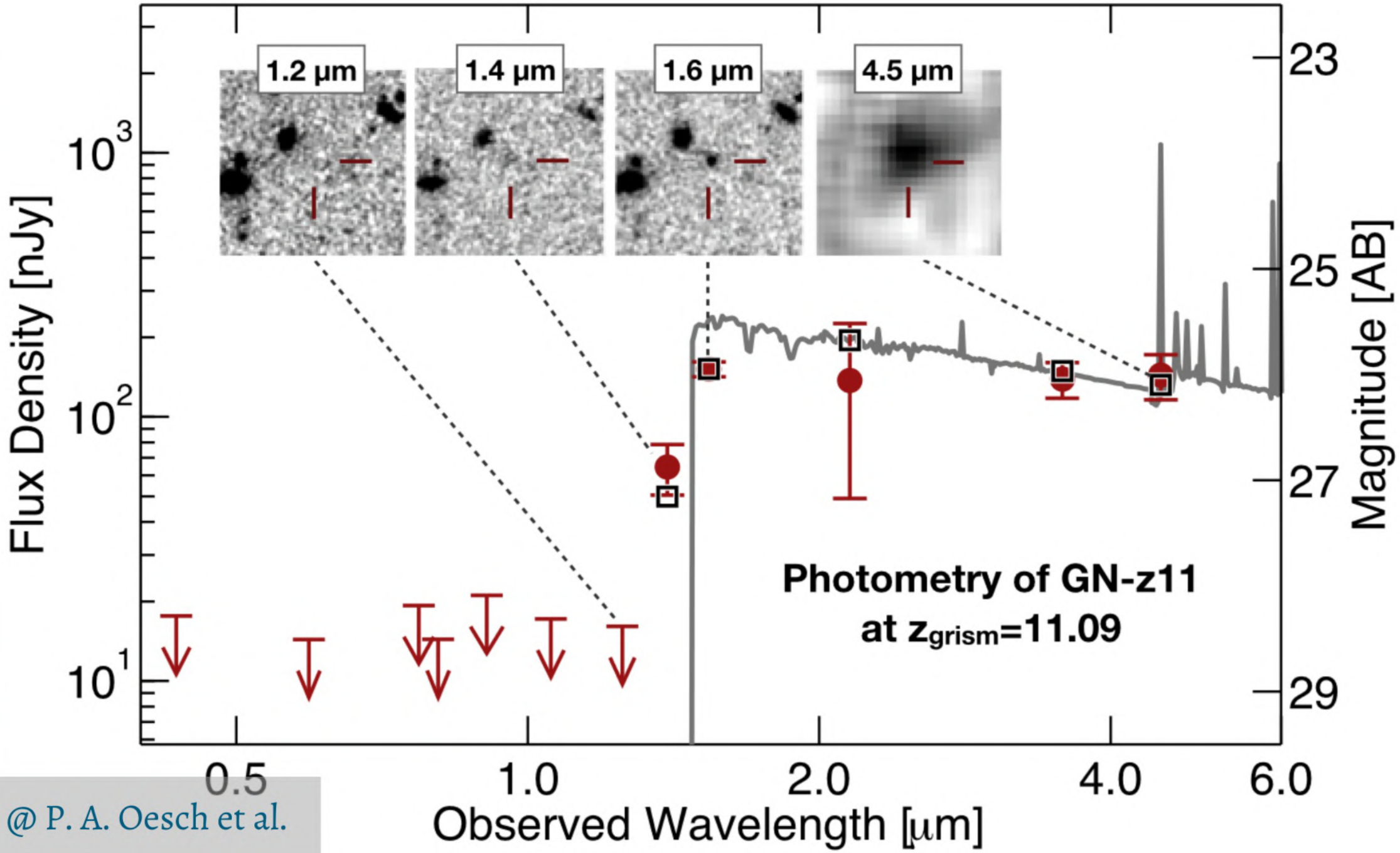


Credit: D. Magee, R. Bouwens, P. Oesch, & G. Illingworth

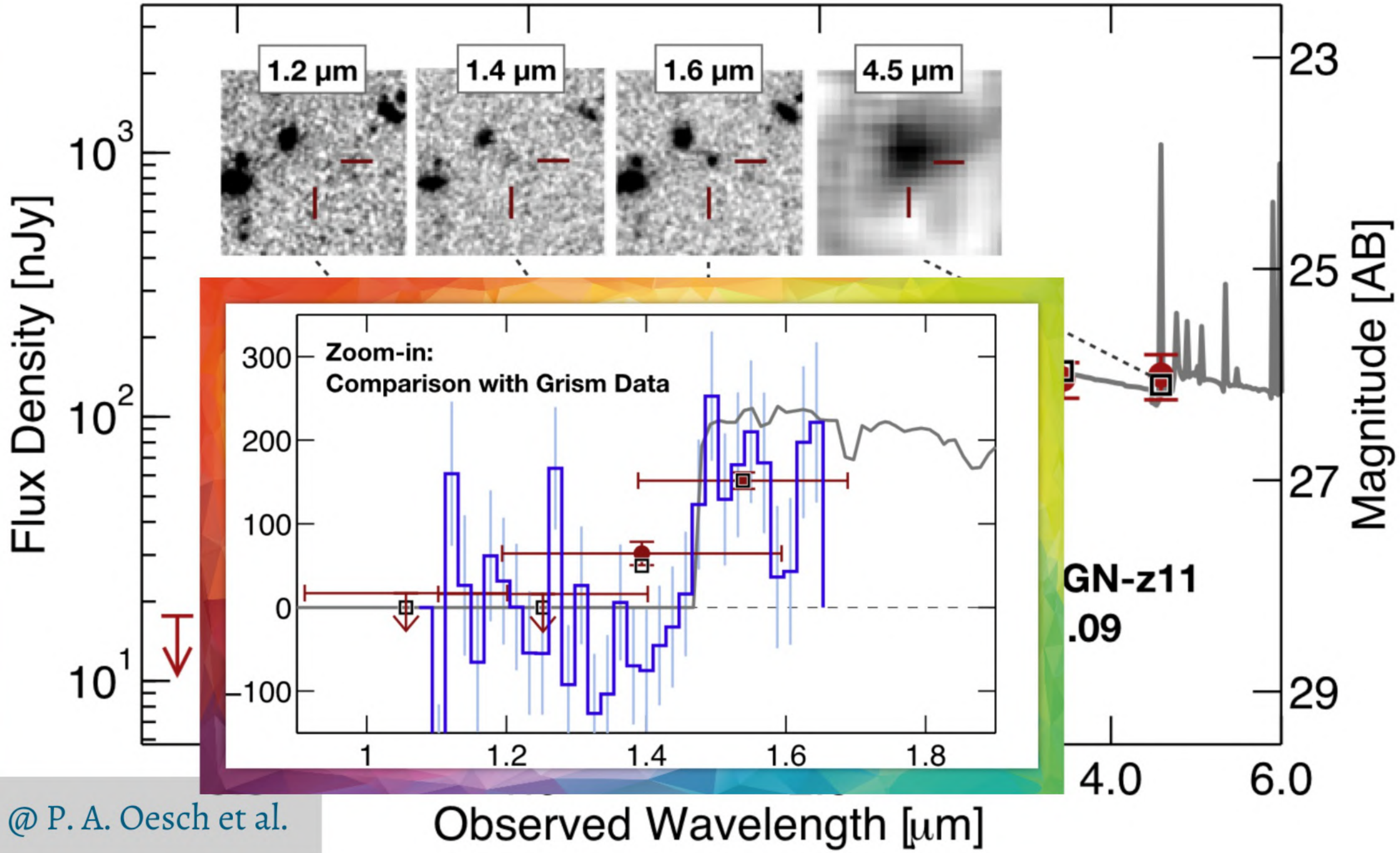


Hubble Űrtávcső


1.2 μm
1.4 μm
1.6 μm
4.5 μm
3



@ P. A. Oesch et al.



@ P. A. Oesch et al.

James Webb Űrtávcső
JWST

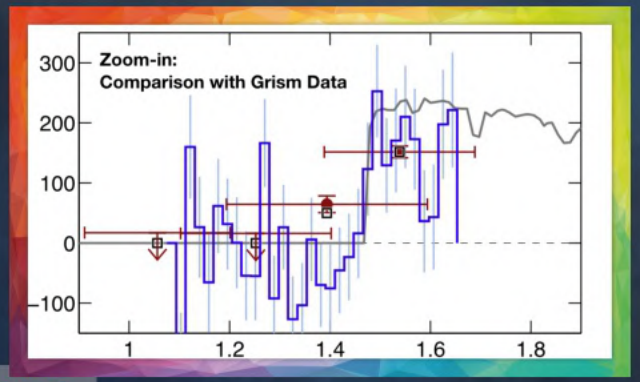


James Webb Űrtávcső
JWST

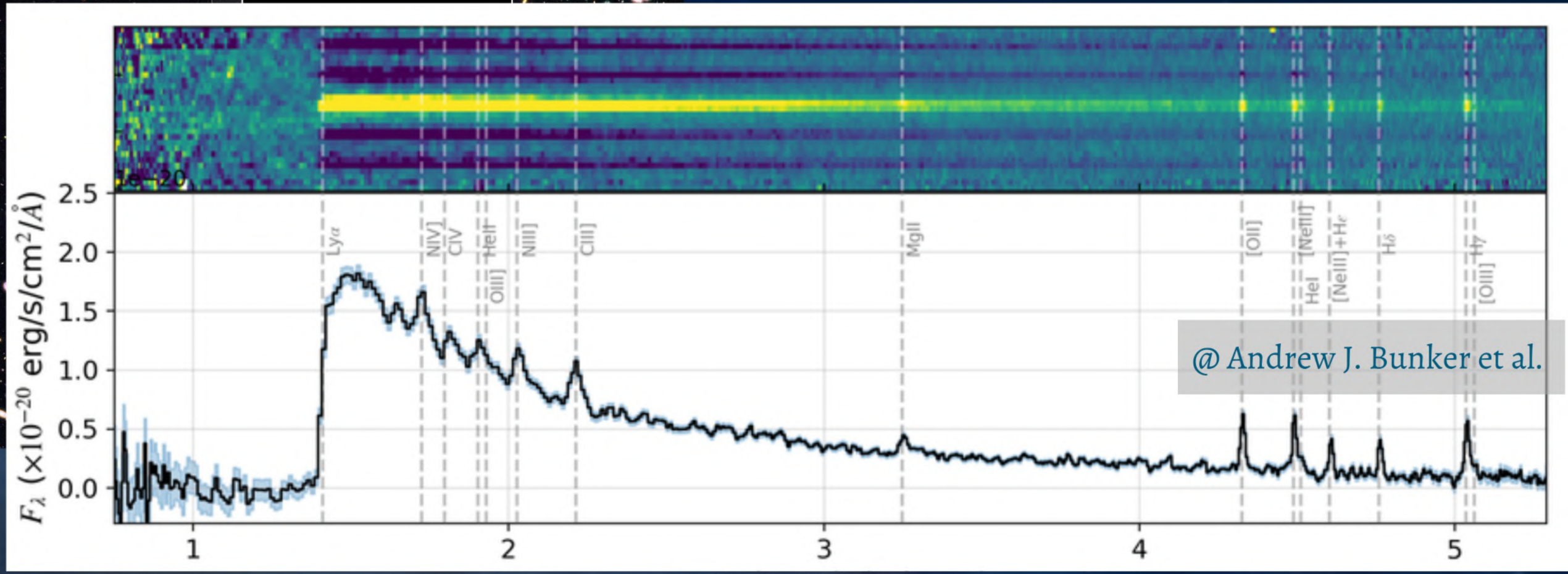




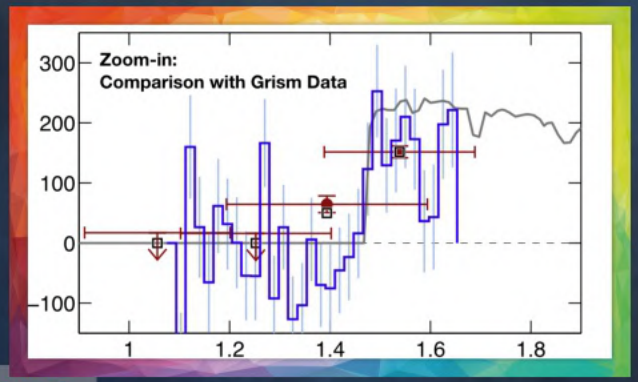
@ Andrew J. Bunker et al.



@ P. A. Oesch et al.



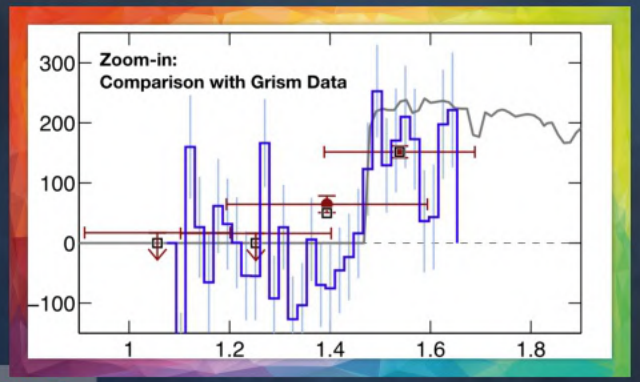
@ Andrew J. Bunker et al.



@ P. A. Oesch et al.



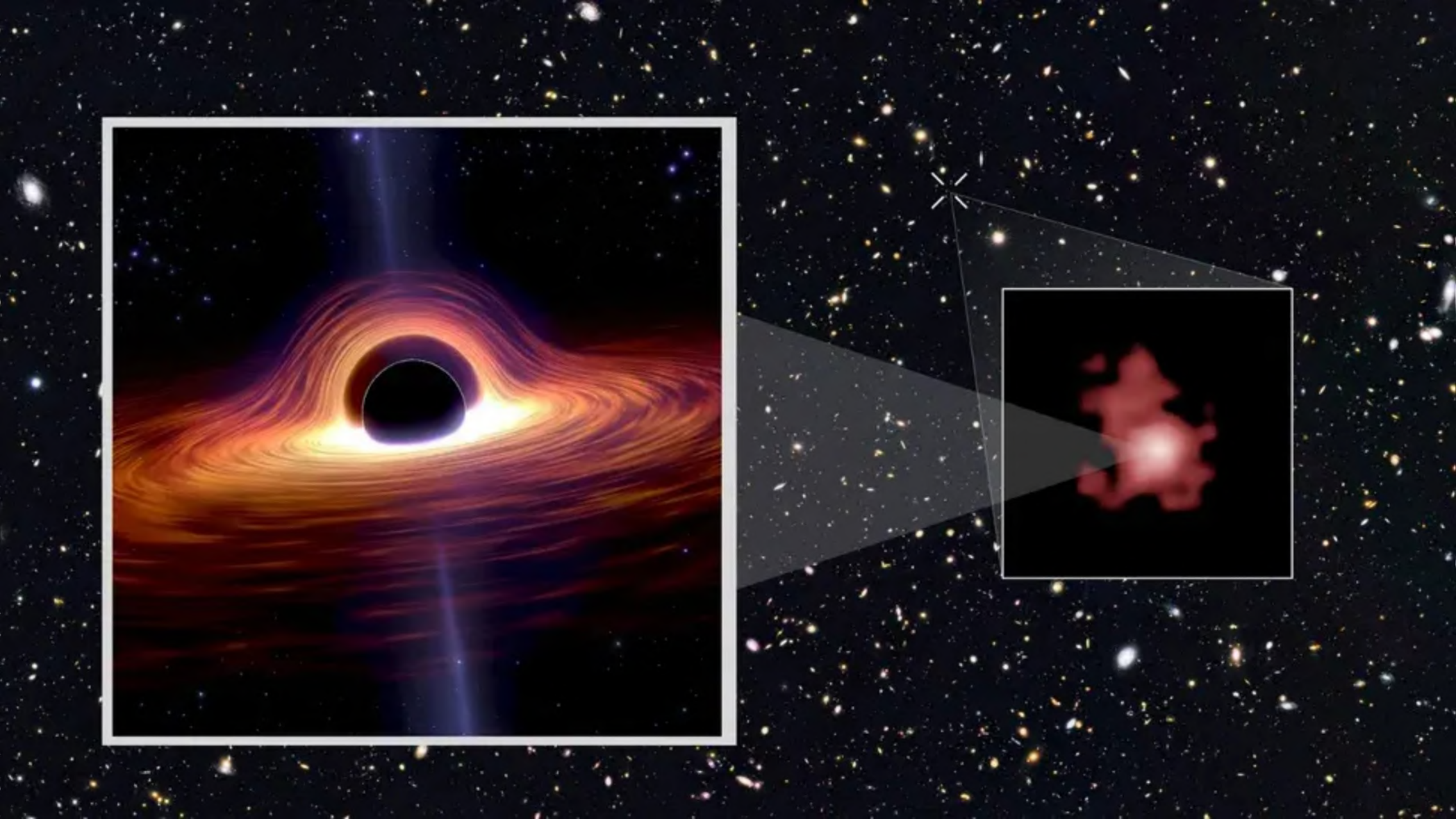
@ Andrew J. Bunker et al.

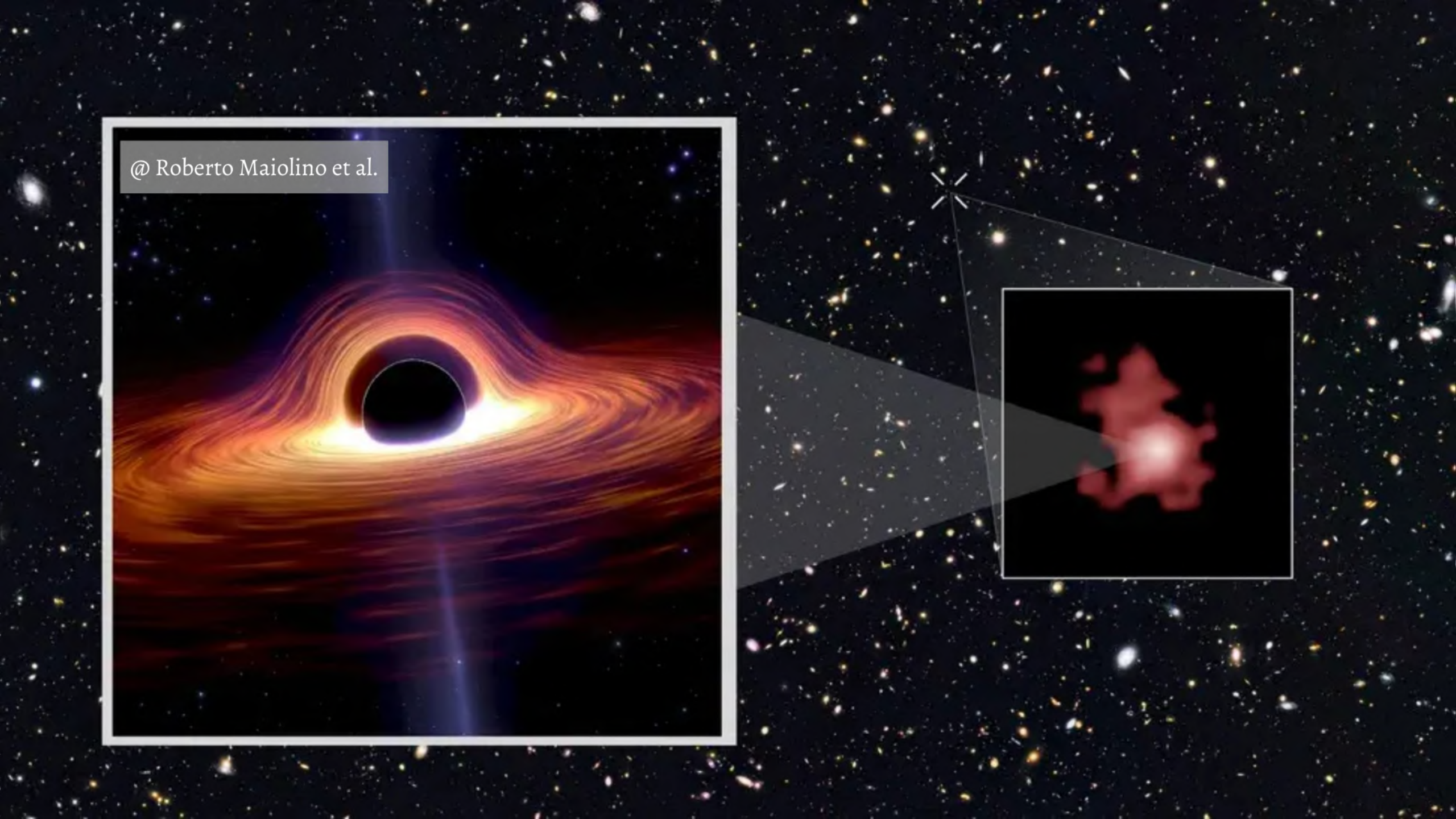


@ P. A. Oesch et al.

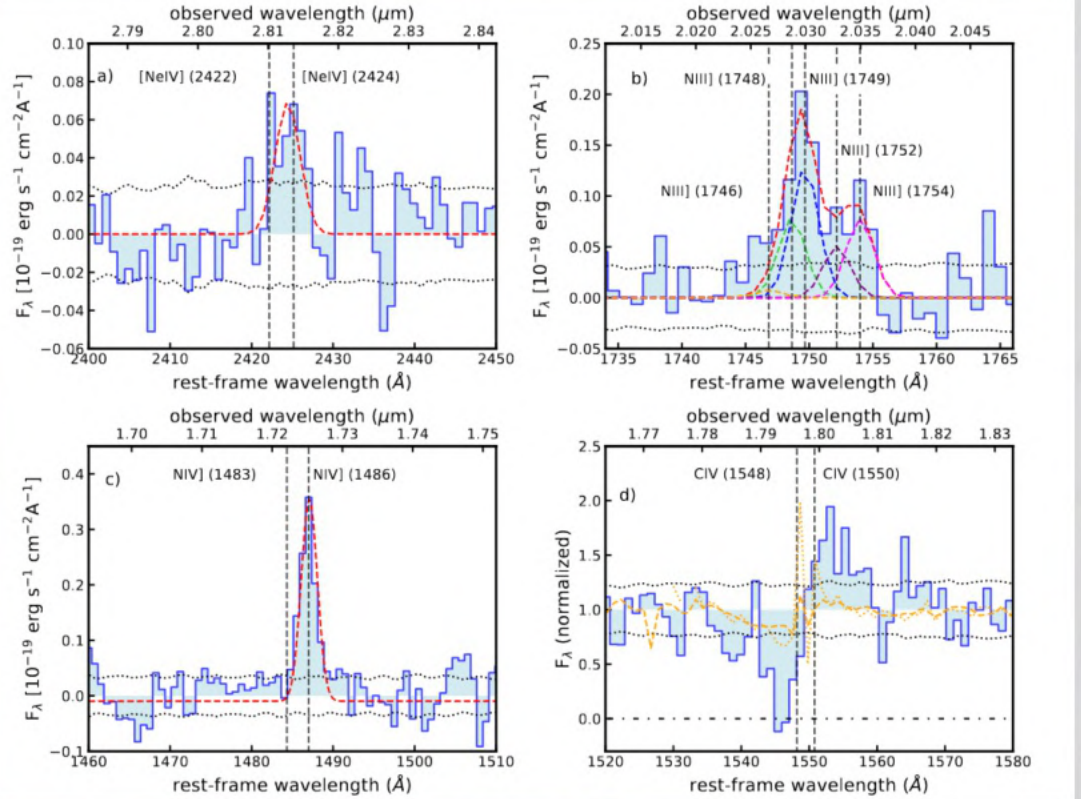
GN Z-11



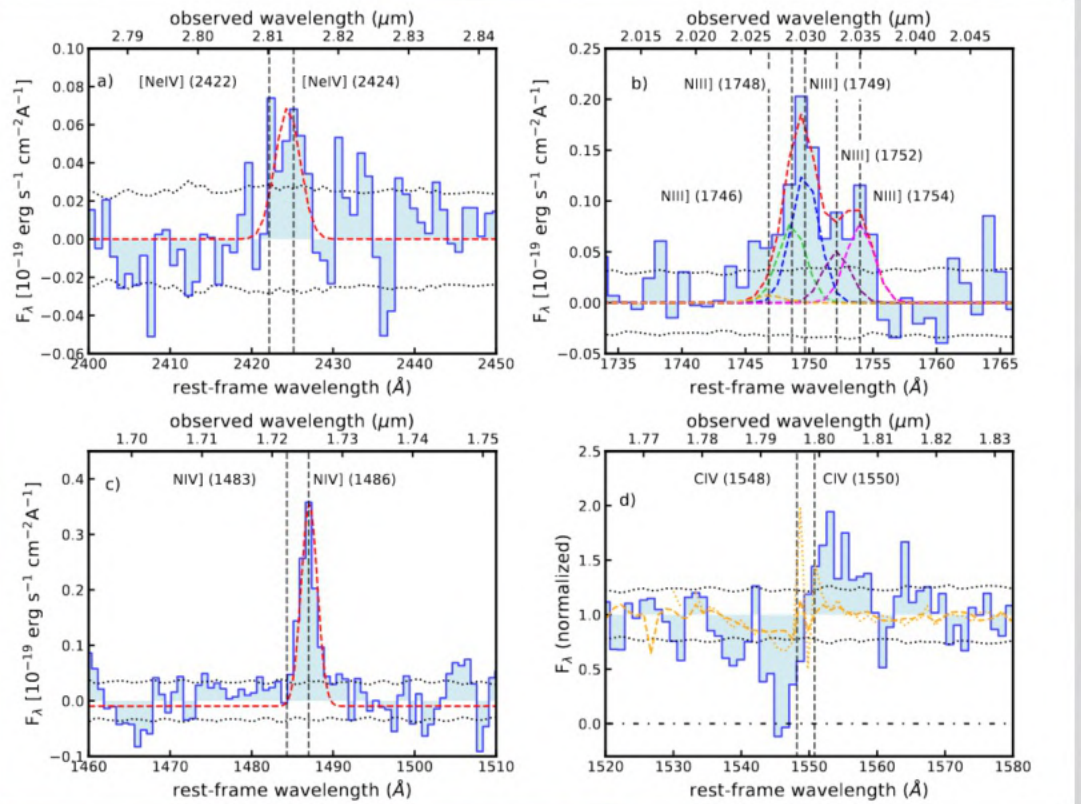



@ Roberto Maiolino et al.

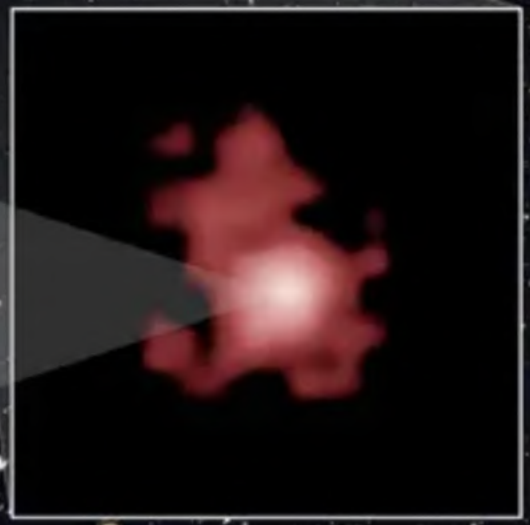
@ Roberto Maiolino et al.

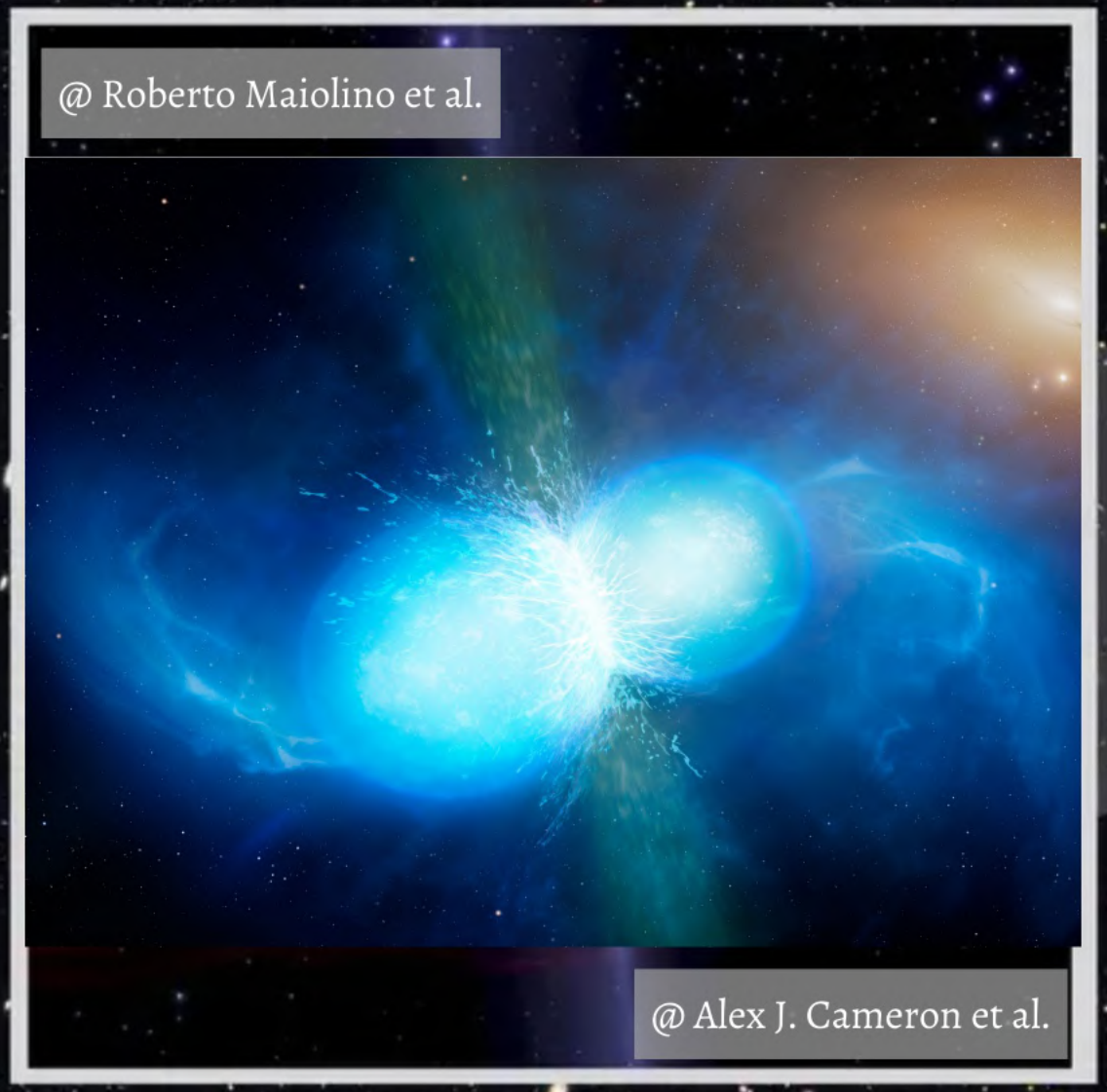


@ Roberto Maiolino et al.



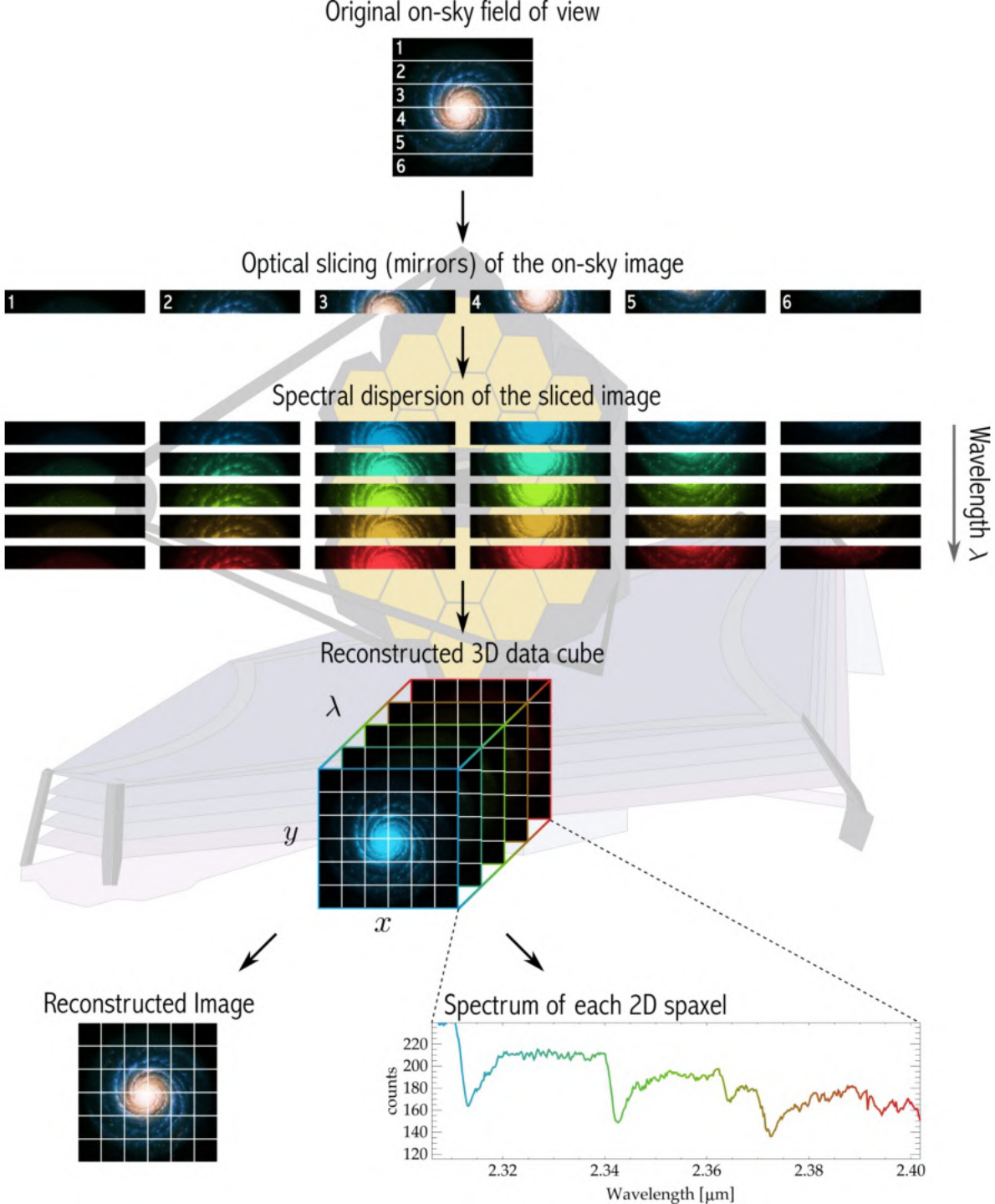
@ Alex J. Cameron et al.




@ Roberto Maiolino et al.
@ Alex J. Cameron et al.

James Webb Űrtávcső
JWST




Original on-sky field of view
1
2
3
4
5
6
Optical slicing (mirrors) of the on-sky image
1
2
3
4
5
6
Spectral dispersion of the sliced image
Wavelength λ
Reconstructed 3D data cube
λ
y
x
Reconstructed Image
Spectrum of each 2D spaxel
220
200
180
160
140
120
counts
2.32
2.34
2.36
2.38
2.40
Wavelength [μm]

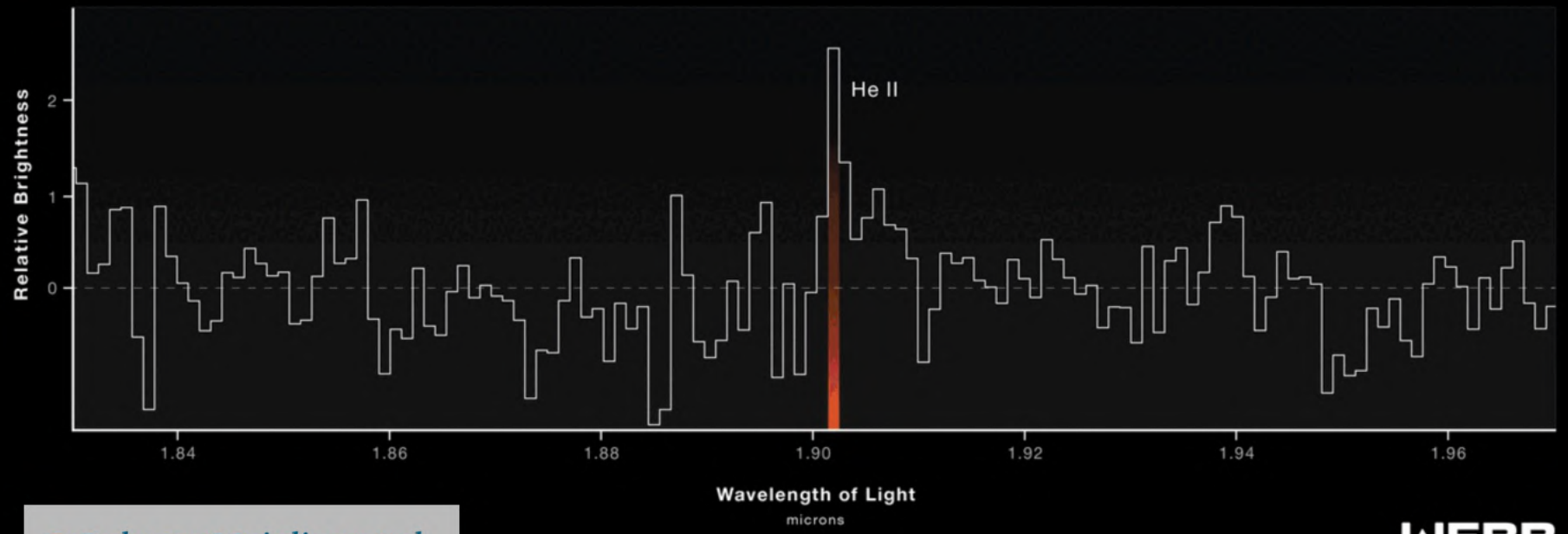
GALAXY GN - z11

PRISTINE GAS CLUMP NEAR GN - z11

NIRCam Imaging



NIRSpec Microshutter Array Spectroscopy

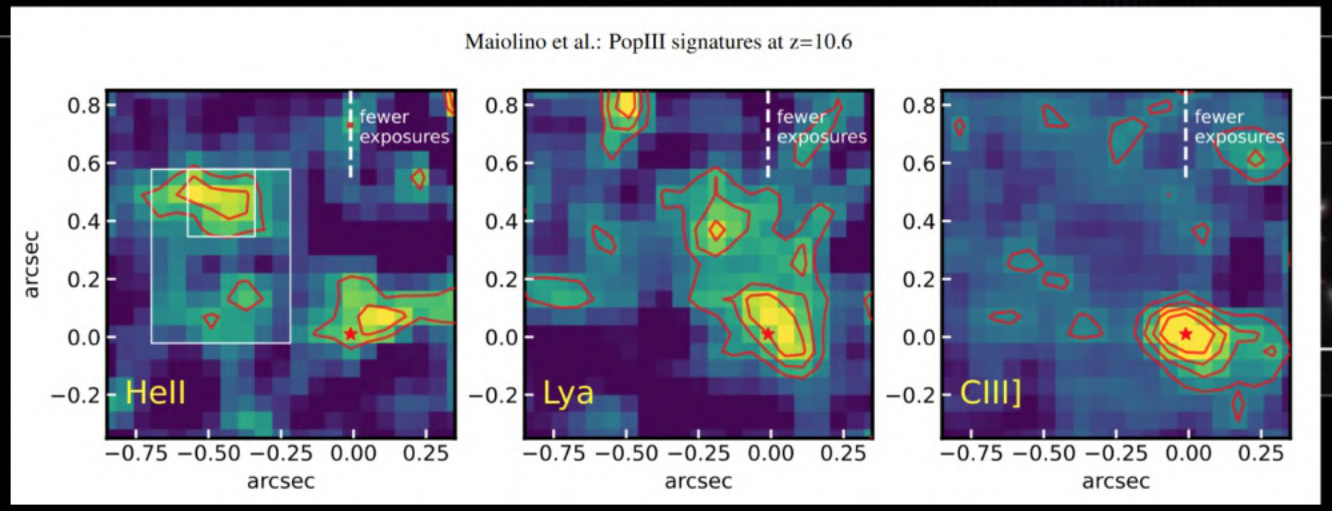


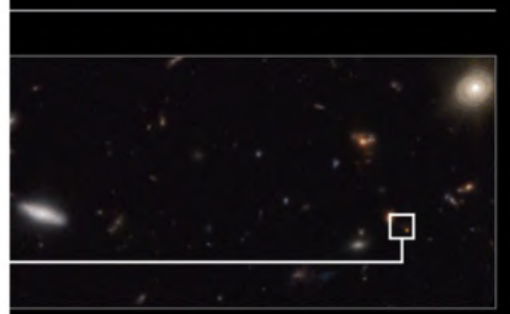
@ Roberto Maiolino et al.

WEBB
SPACE TELESCOPE

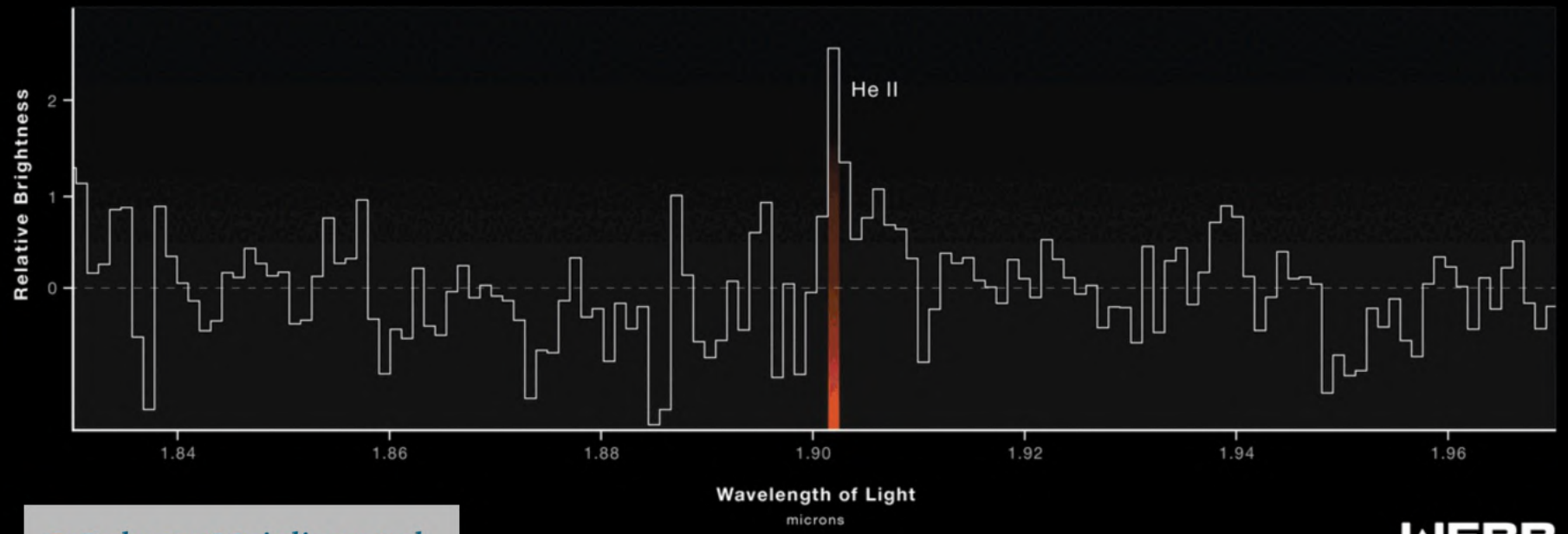
GALAXY GN - z11

PRISTINE GAS CLUMP NEAR GN - z11





NIRSpec Microshutter Array Spectroscopy



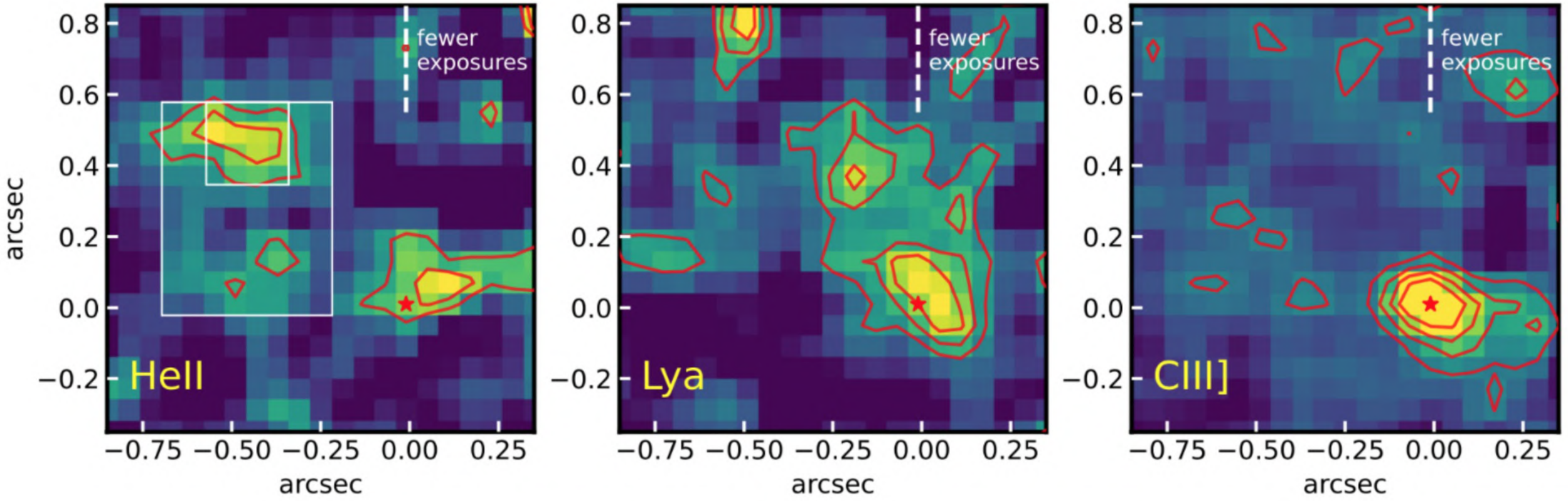
@ Roberto Maiolino et al.

WEBB SPACE TELESCOPE

GALAXY GN - z11

PRISTINE GAS CLUMP NEAR GN - z11

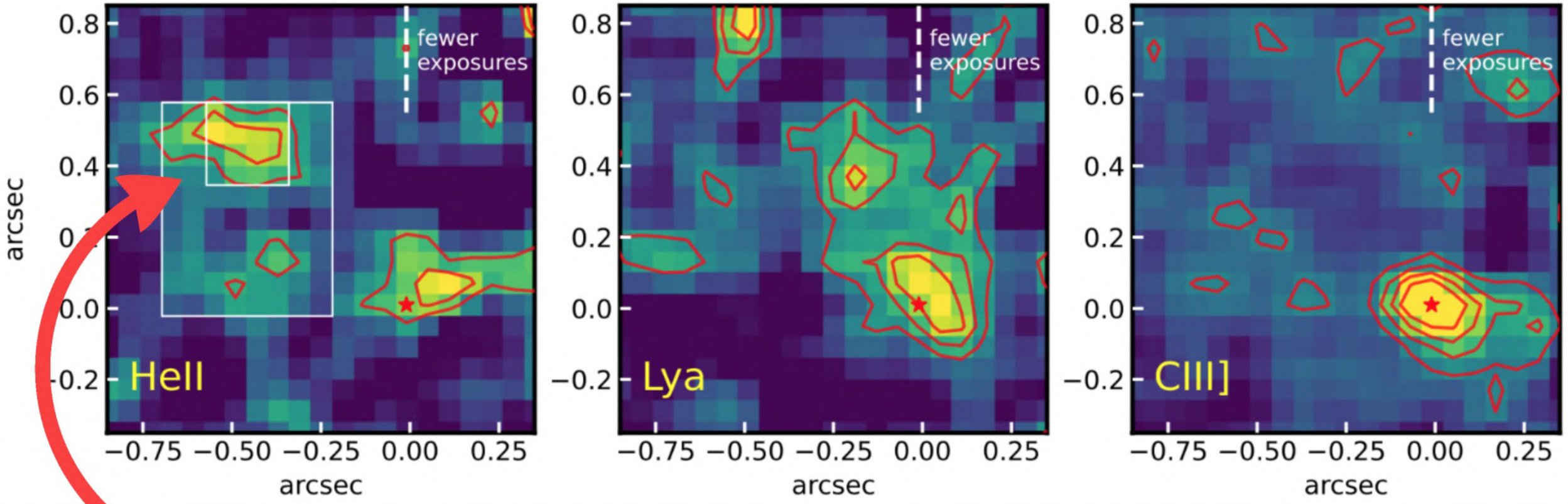
Maiolino et al.: PopIII signatures at z=10.6



GALAXY GN - z11

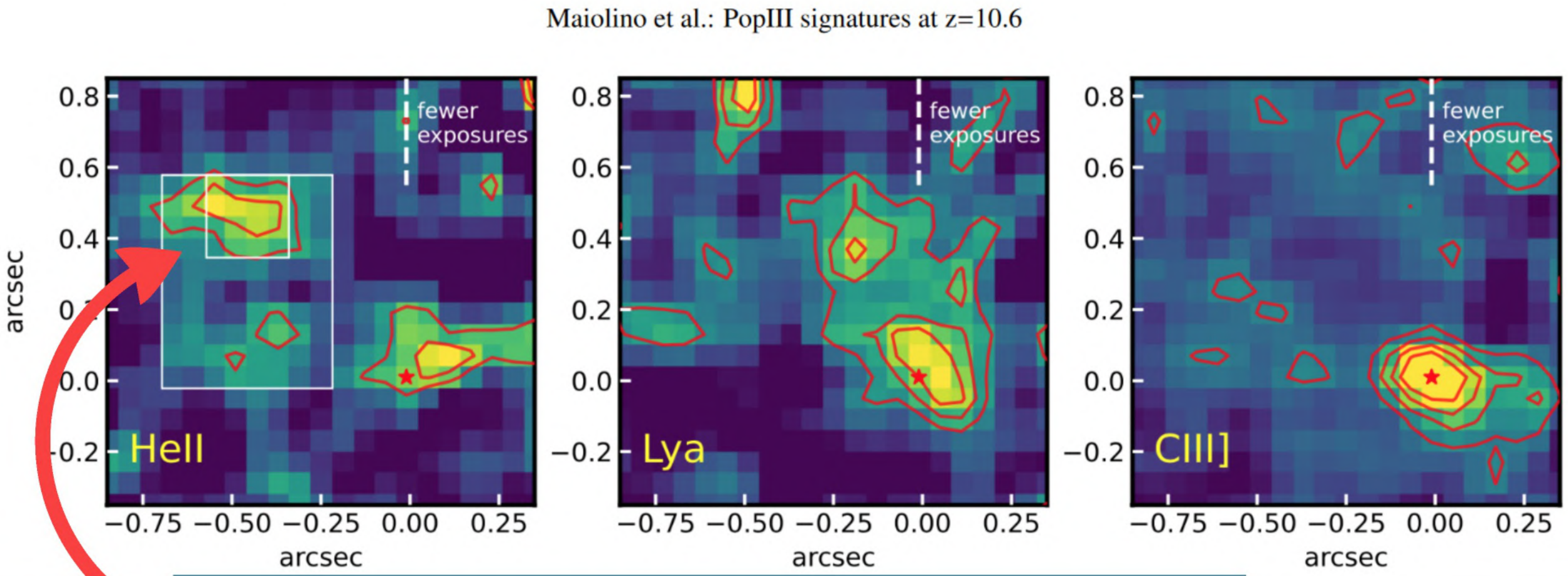
PRISTINE GAS CLUMP NEAR GN - z11

Maiolino et al.: PopIII signatures at z=10.6



GALAXY GN - z11

PRISTINE GAS CLUMP NEAR GN - z11



III. populációs csillagok ???

Az aktuális legtávolabbiak klubja

Az aktuális legtávolabbiak klubja



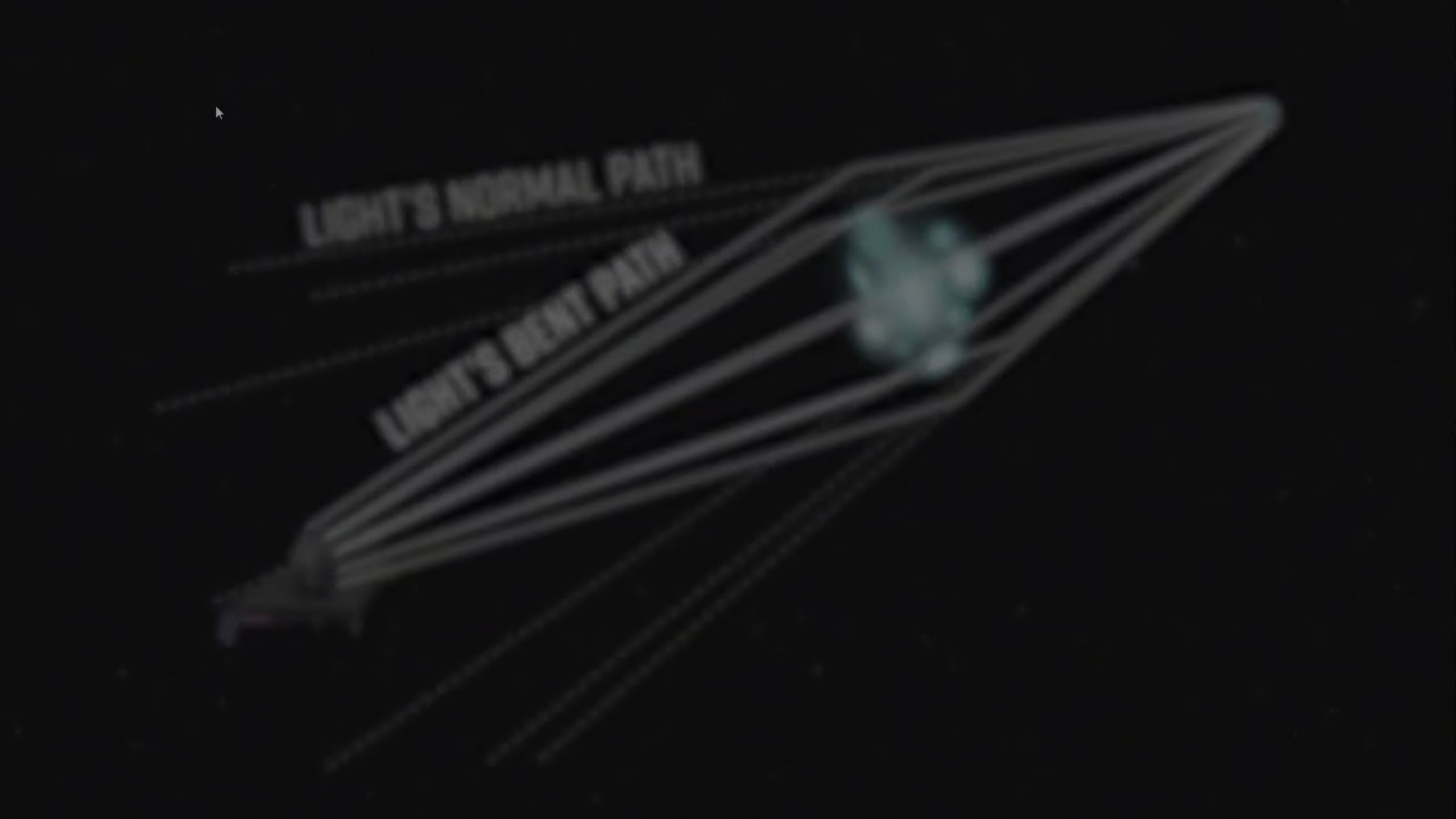
Az aktuális legtávolabbiak klubja



Az aktuális legtávolabbiak klubja

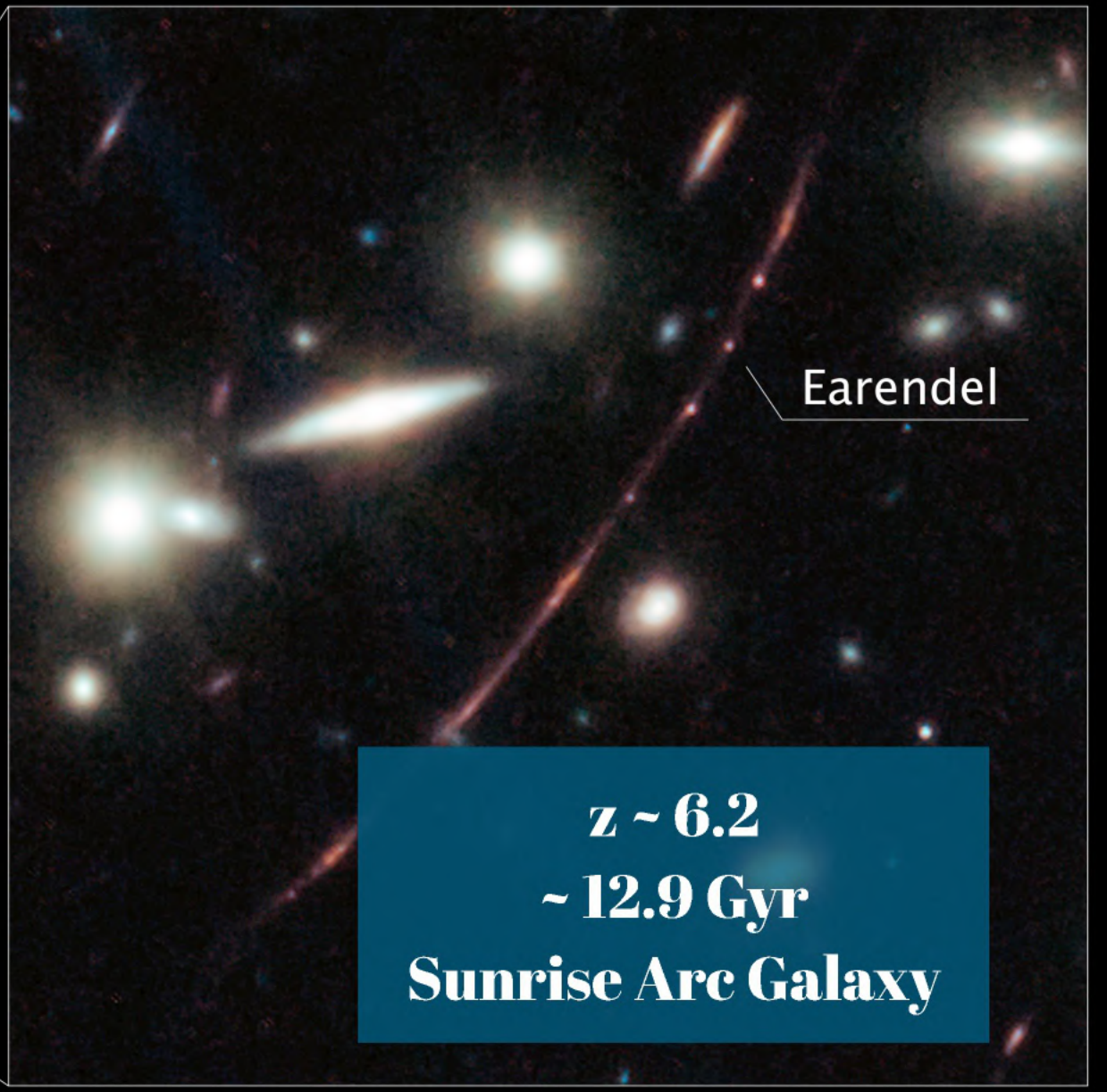
Earendel a csillag




LIGHT'S NORMAL PATH
LIGHT'S BENT PATH

@ Brian Welch et al.





z ~ 6.2
~ 12.9 Gyr
Sunrise Arc Galaxy

Az aktuális legtávolabbiak klubja

Earendel a csillag



Az aktuális legtávolabbiak klubja

Earendel a csillag





Az aktuális legtávolabbiak klubja

Earendel a csillag





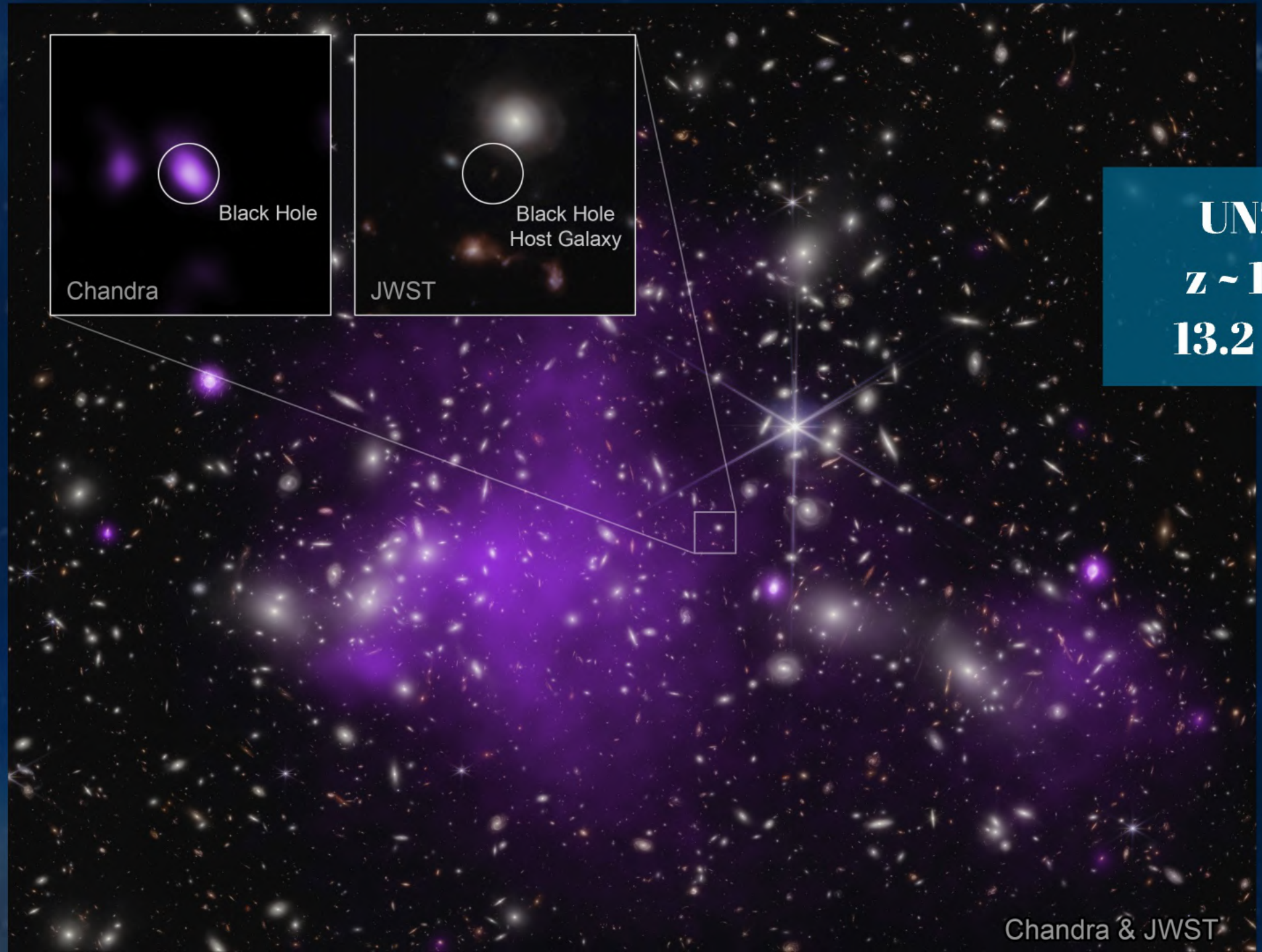
Az aktuális legtávolabbiak klubja

Earendel a csillag



UHZ 1 a kvazár

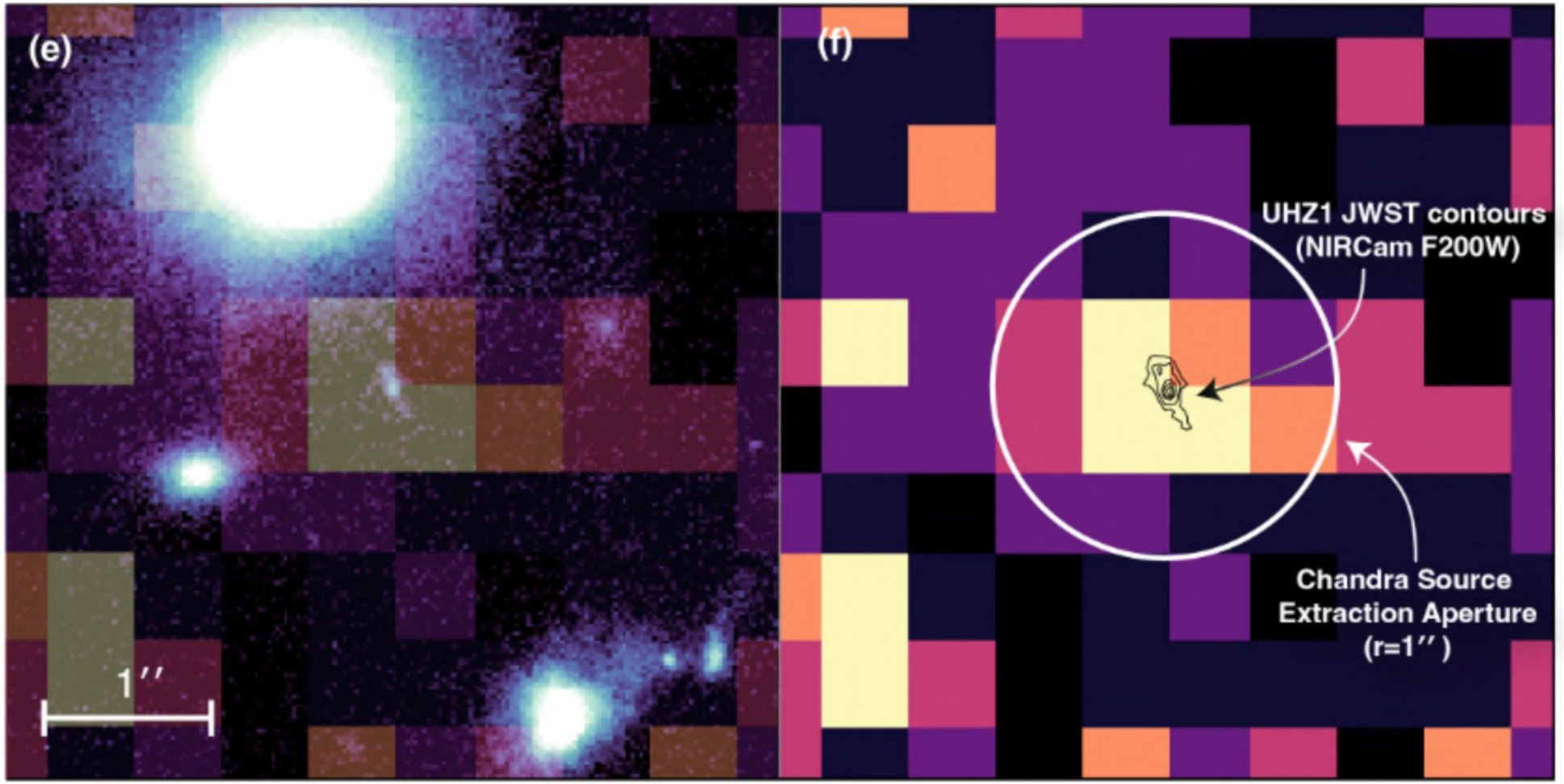



Black Hole
Chandra
Black Hole
Host Galaxy
JWST
UNZ 1
z ~ 10.1
13.2 Gyr
Chandra & JWST

JWST NIRCam UHZ1 images



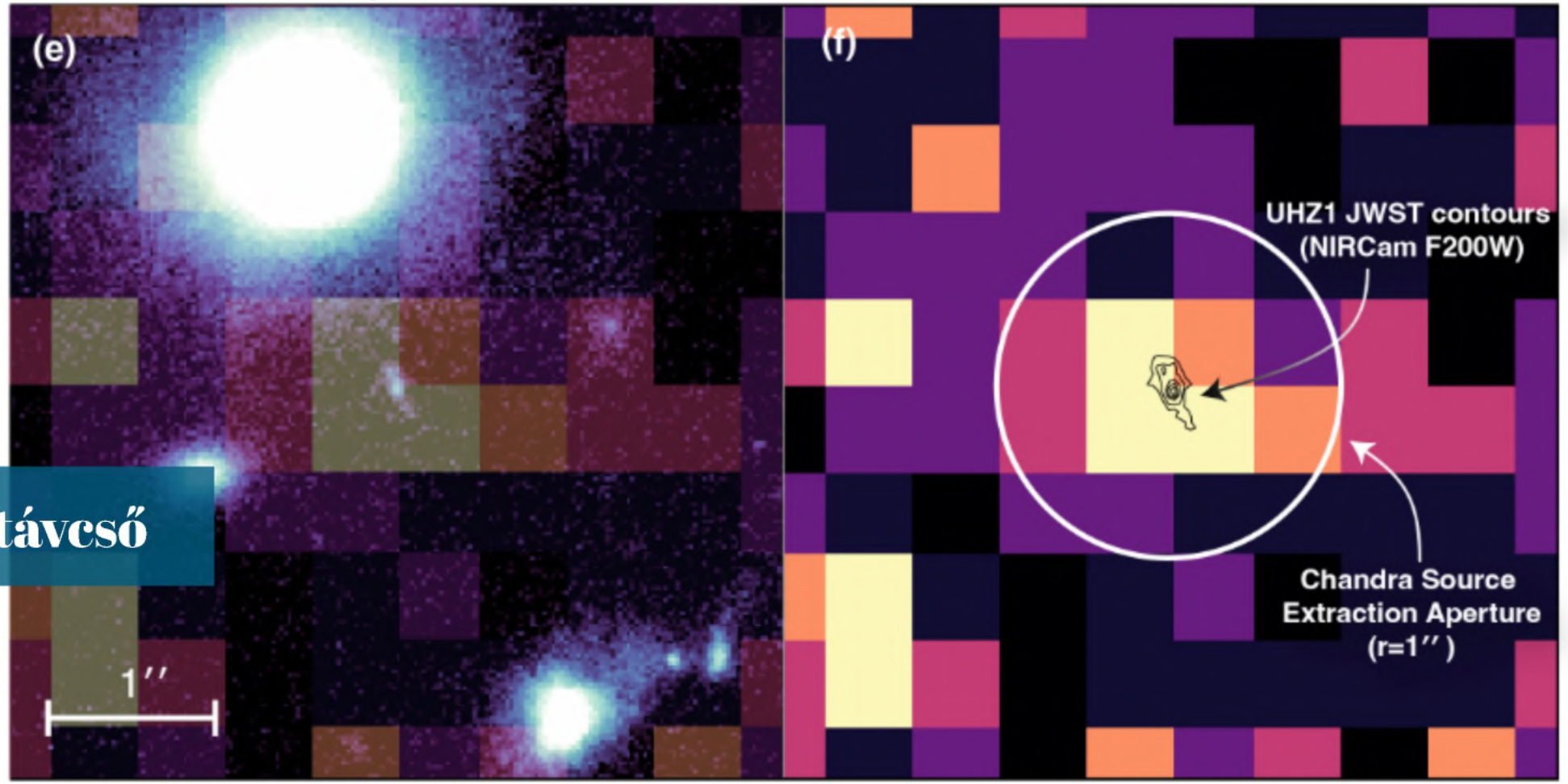
JWST / **Chandra** overlays of UHZ1



JWST NIRCam UHZ1 images



JWST / Chandra overlays of UHZ1



Chandra Űrtávcső

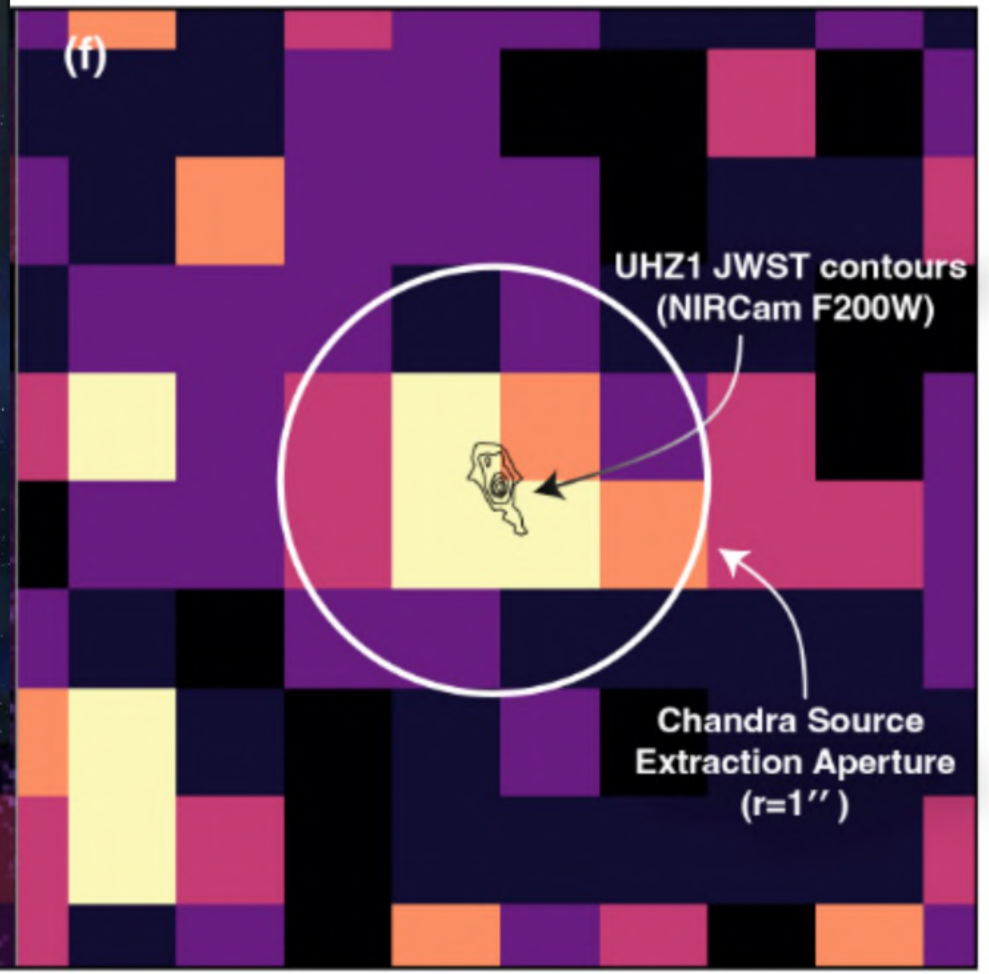
JWST NIRCam UHZ1 images





Chandra Űrtávcső

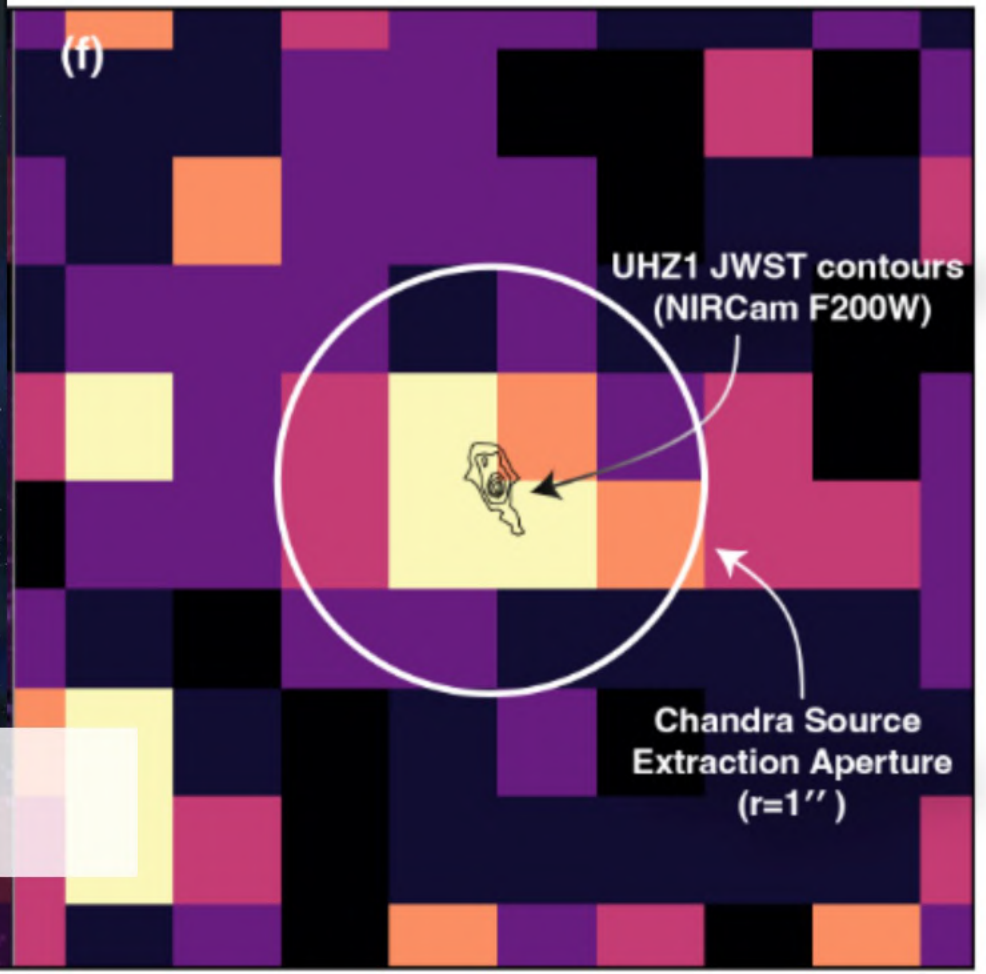








Chandra Űrtávcső

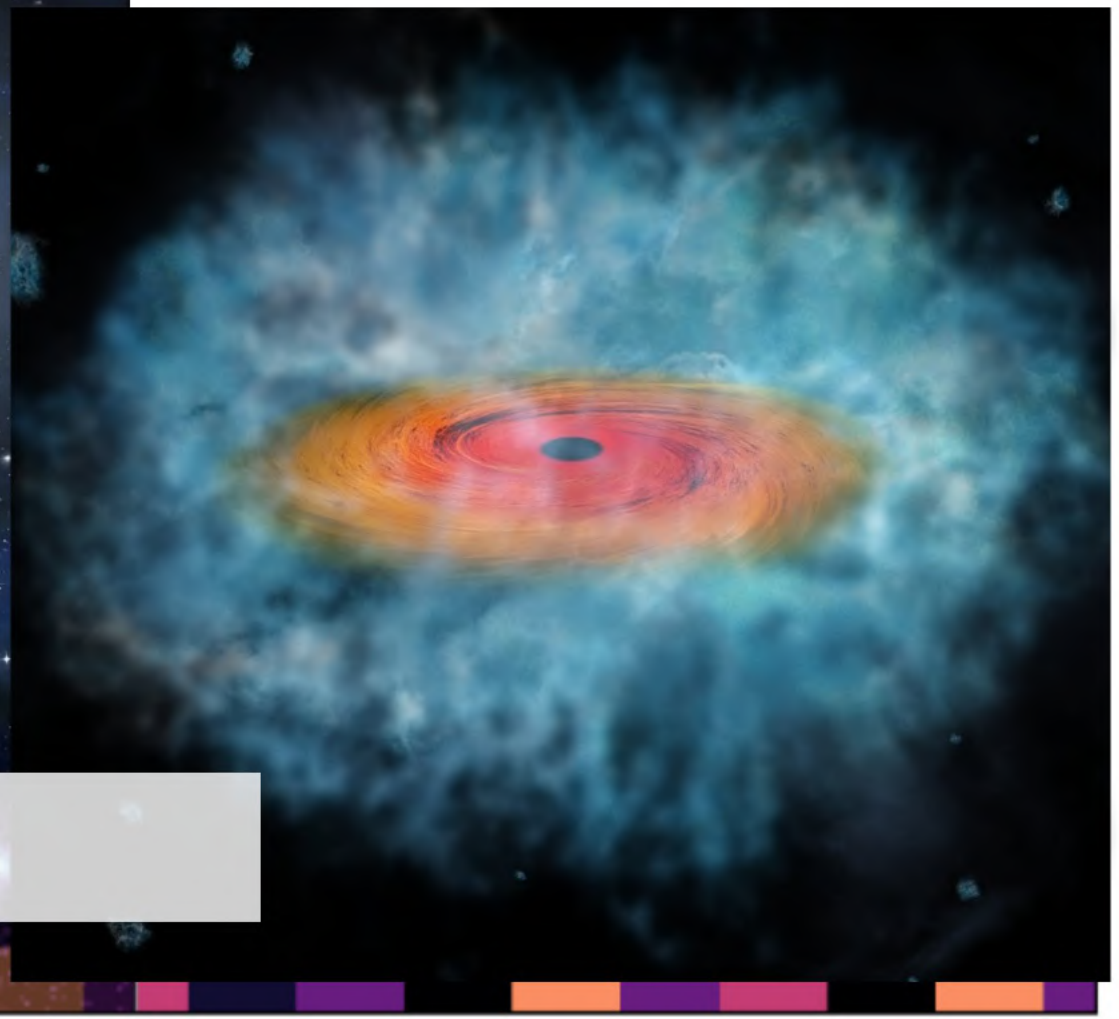


@ Bogdán Ákos et al.





Chandra Űrtávcső



@ Bogdán Ákos et al.

Az aktuális legtávolabbiak klubja

Earendel a csillag



UHZ 1 a kvazár



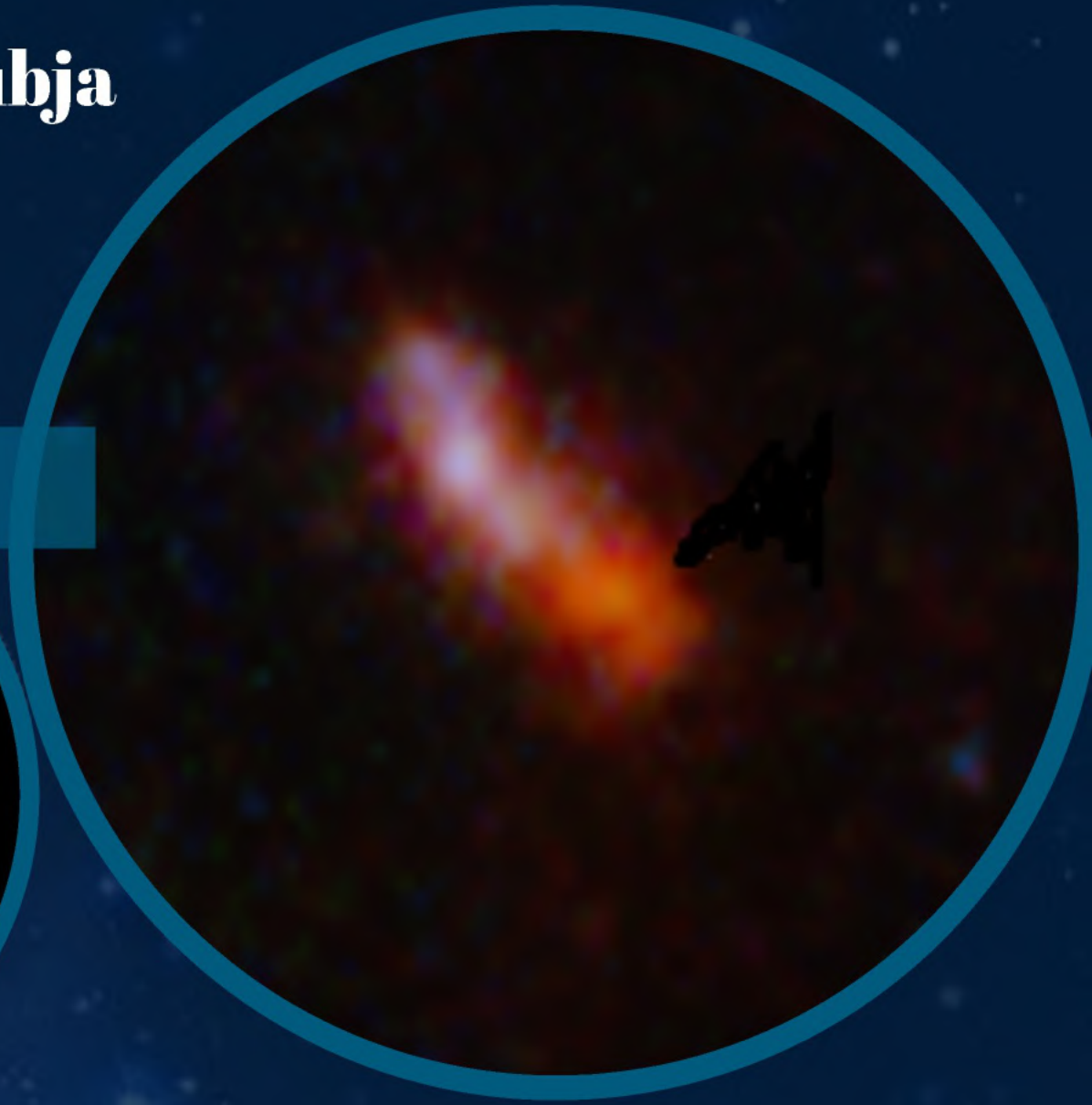
Az aktuális legtávolabbiak klubja

Earendel a csillag



UHZ 1 a kvazár





Az aktuális legtávolabbiak klubja

Earendel a csillag



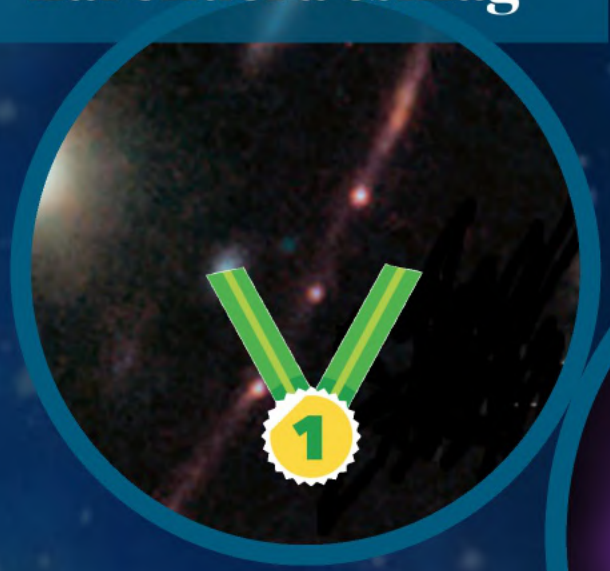
UHZ 1 a kvazár





Az aktuális legtávolabbiak klubja

Earendel a csillag



UHZ 1 a kvazár



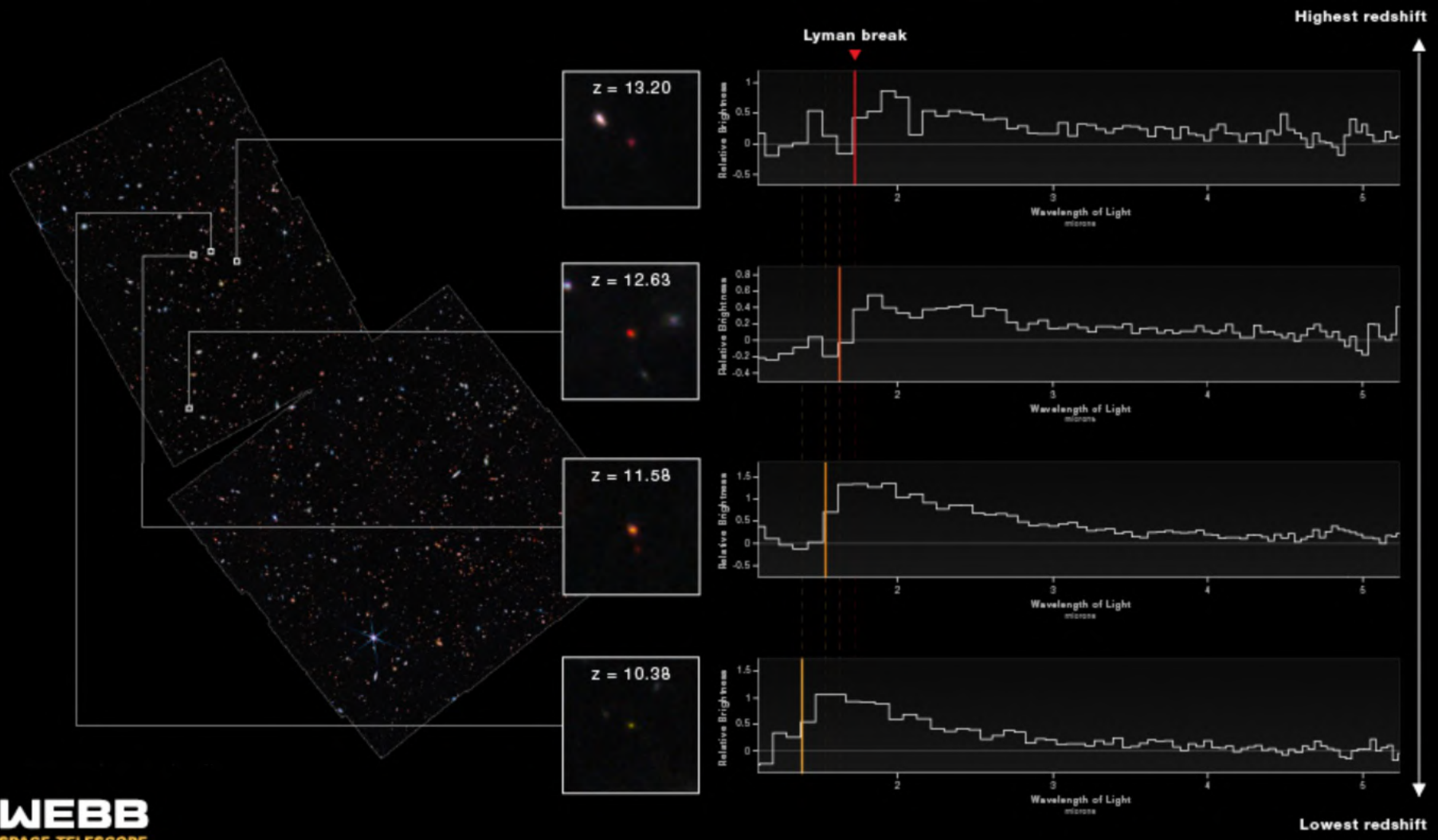
GS-z14-0 a galaxis



JWST ADVANCED DEEP EXTRAGALACTIC SURVEY (JADES)

WEBB SPECTRA REACH NEW MILESTONE IN REDSHIFT FRONTIER

@ Emma Curtis-Lake et al.



GS-z13-0

GS-z12-0

GS-z11-0

GS-z10-0

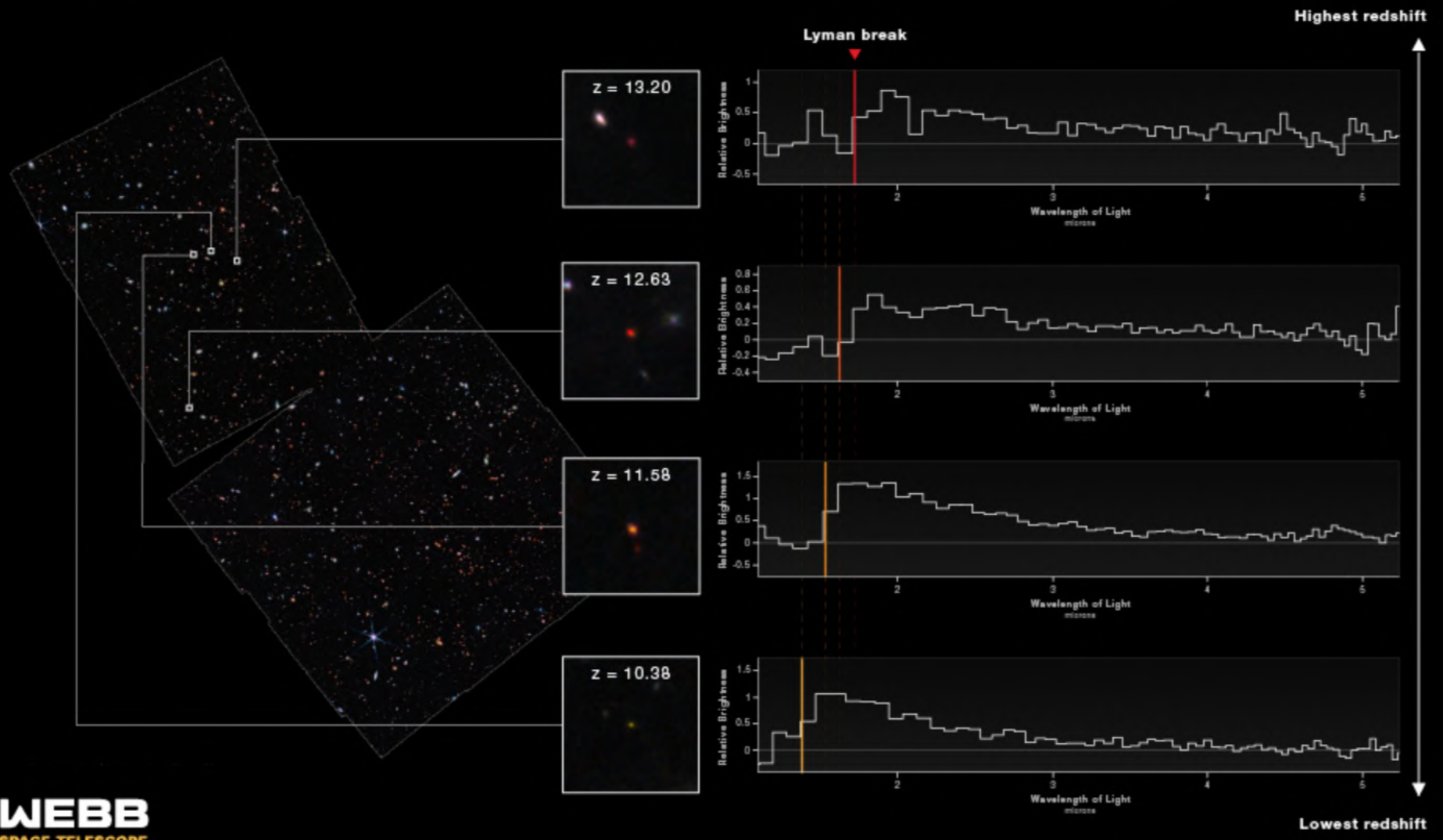
WEBB
SPACE TELESCOPE


JADES-GS-z14-0
z ~ 14.32
~ 13.5 milliárd évet
utazott a fénye
~ 33.9 milliárd fényév a
jelenlegi távolsága
@ Stefano Carniani et al.

JWST ADVANCED DEEP EXTRAGALACTIC SURVEY (JADES)

WEBB SPECTRA REACH NEW MILESTONE IN REDSHIFT FRONTIER

@ Emma Curtis-Lake et al.



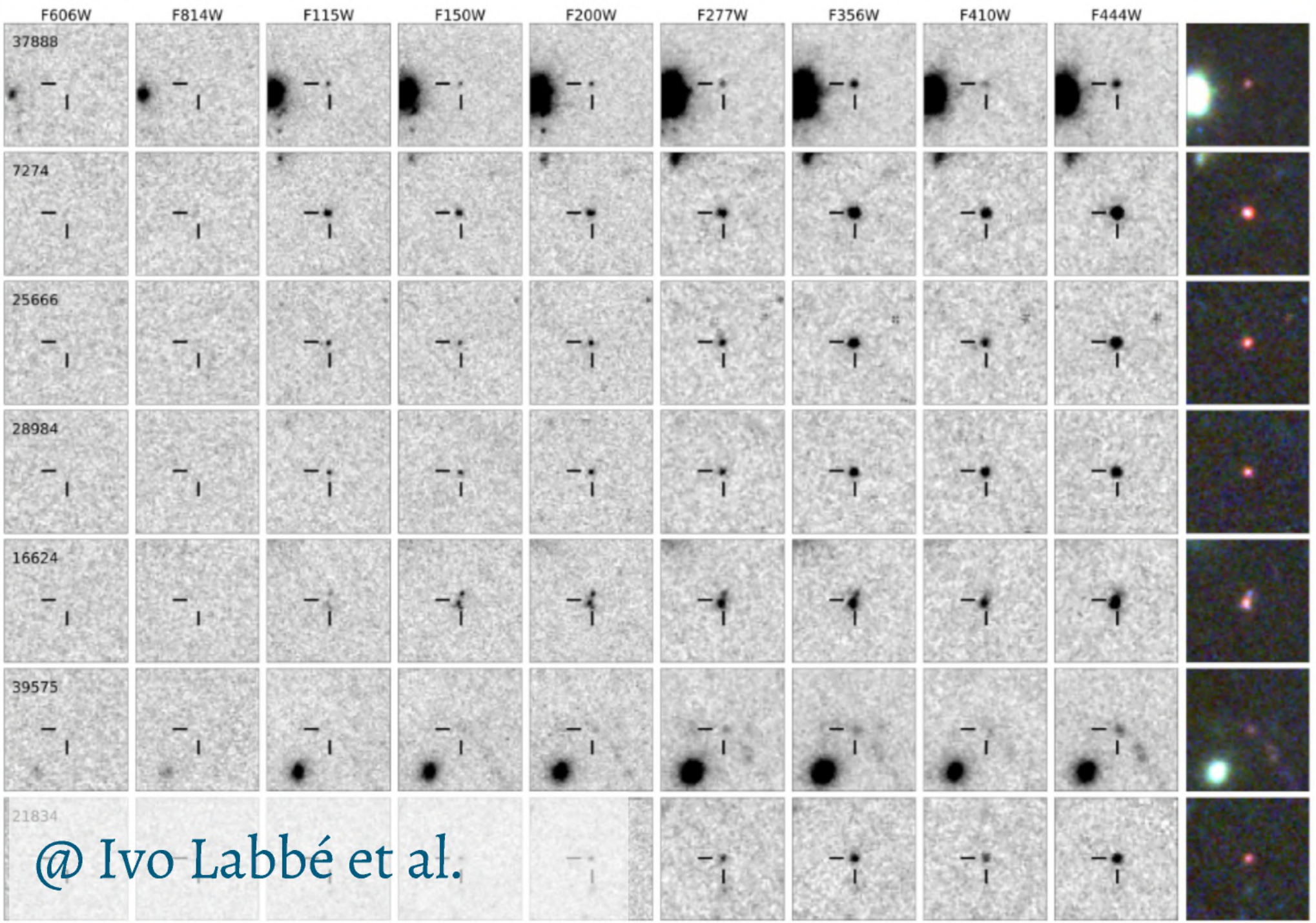
GS-z13-0

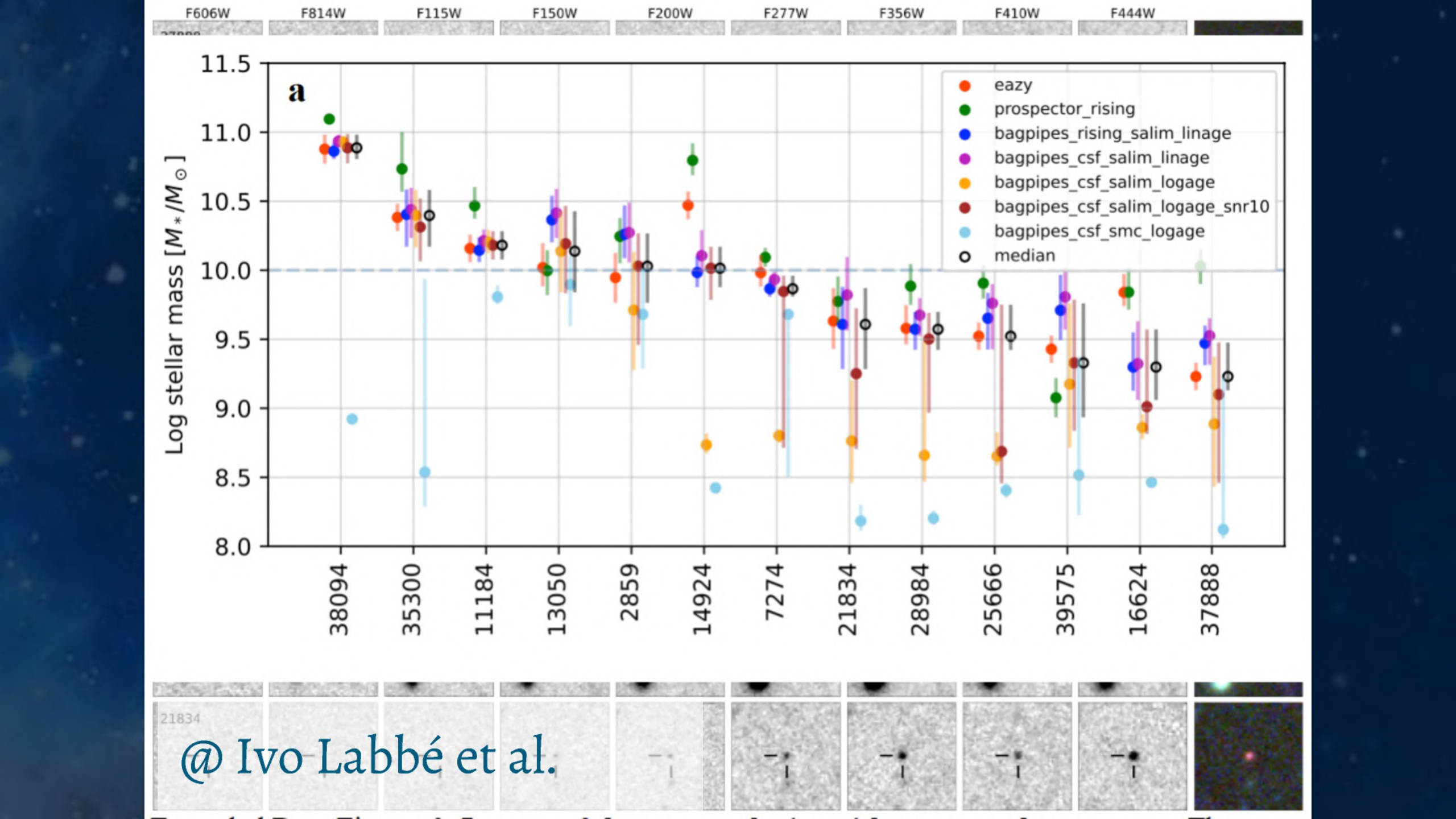
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GS-z11-0

GS-z10-0

WEBB
SPACE TELESCOPE

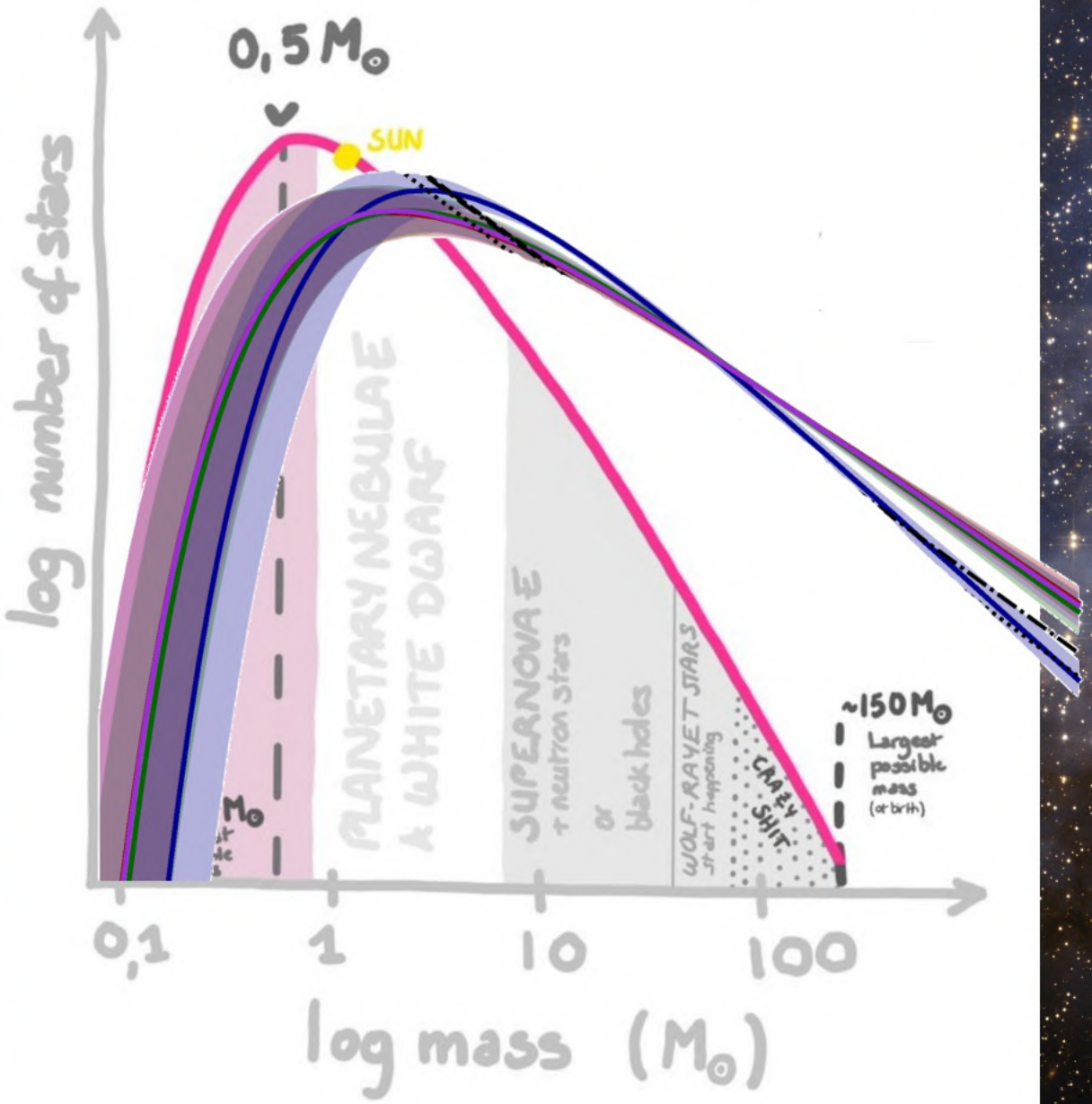

F606W
F814W
F115W
F150W
F200W
F277W
F356W
F410W
F444W
37888
7274
25666
28984
16624
39575
21834
@ Ivo Labbé et al.


F606W
F814W
F115W
F150W
F200W
F277W
F356W
F410W
F444W
a
eazy
prospector_rising
bagpipes_rising_salim_linage
bagpipes_csf_salim_linage
bagpipes_csf_salim_logage
bagpipes_csf_salim_logage_snr10
bagpipes_csf_smc_logage
median
Log stellar mass [$M_*/M_\odot$]
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
38094
35300
11184
13050
2859
14924
7274
21834
28984
25666
39575
16624
37888
21834
@ Ivo Labbé et al.

BAD INITIAL MASS FUNCTION

by @Sydonahi

(and how stars die)





Sötét csillagok?

@ Katherine Freese et al.

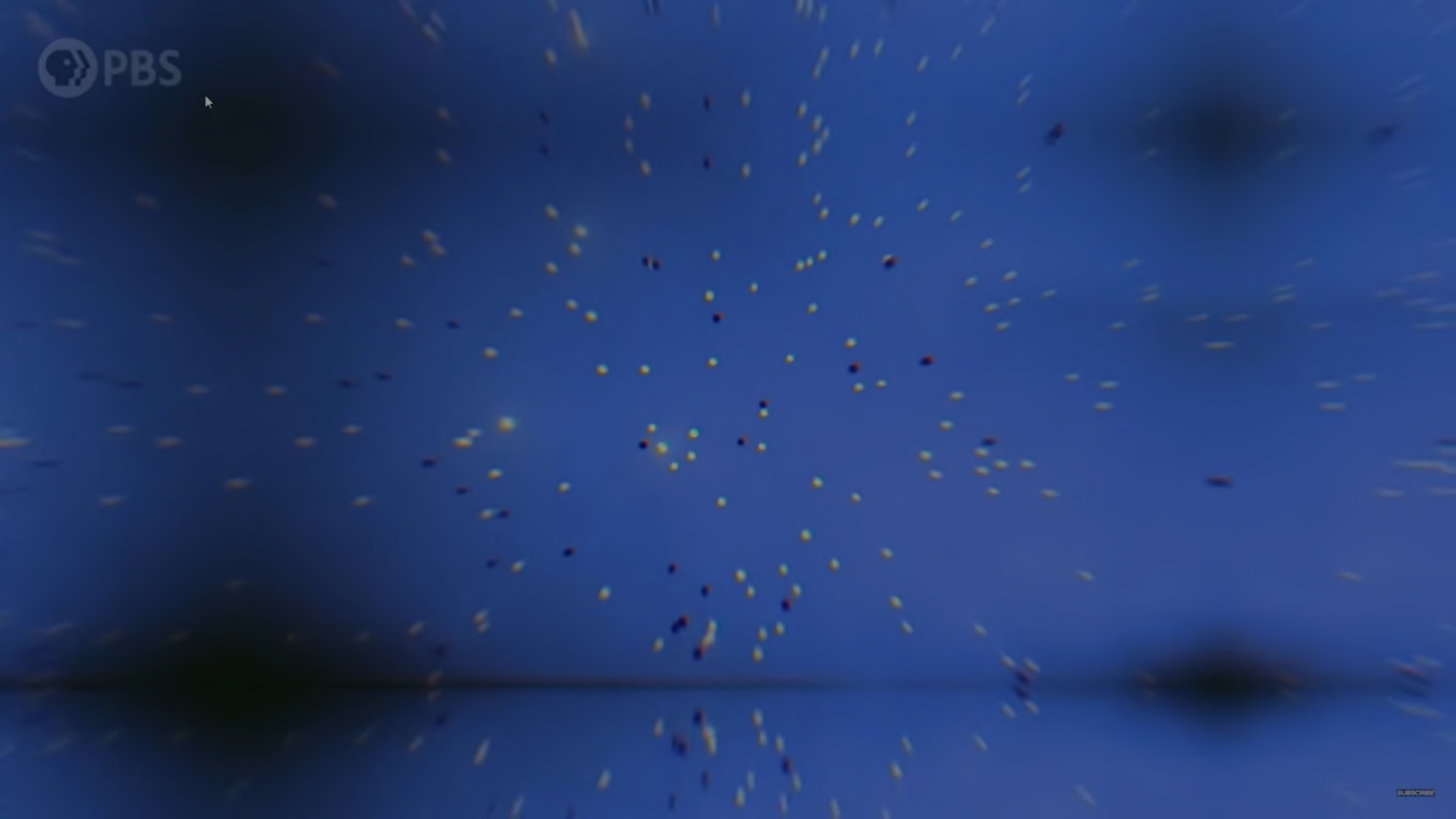


Sötét anyag



@ ESO / L. Calcada

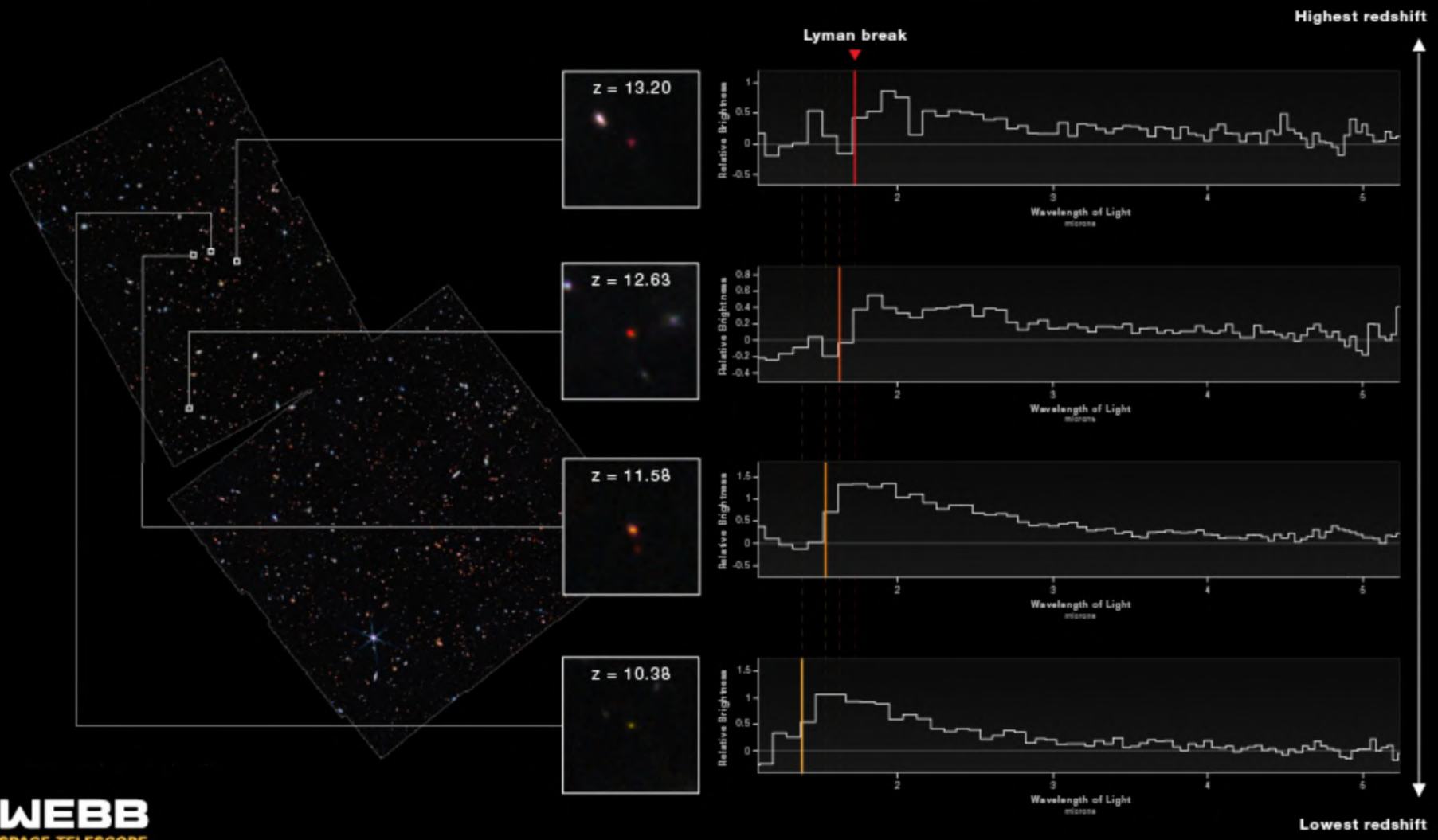

ANIMATED WITH
blender


PBS
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JWST ADVANCED DEEP EXTRAGALACTIC SURVEY (JADES)

WEBB SPECTRA REACH NEW MILESTONE IN REDSHIFT FRONTIER

@ Emma Curtis-Lake et al.



GS-z13-0

GS-z12-0

GS-z11-0

GS-z10-0

WEBB
SPACE TELESCOPE

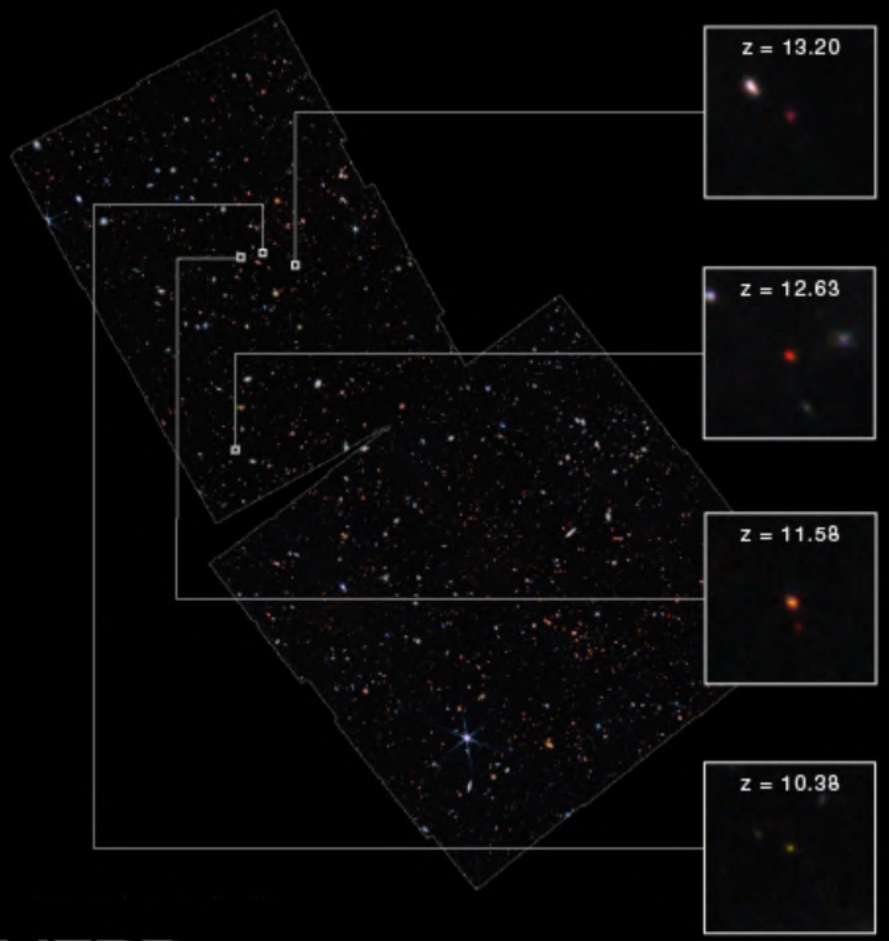
JWST ADVANCED DEEP EXTRAGALACTIC SURVEY (JADES)

WEBB SPECTRA REACH NEW MILESTONE IN REDSHIFT FRONTIER

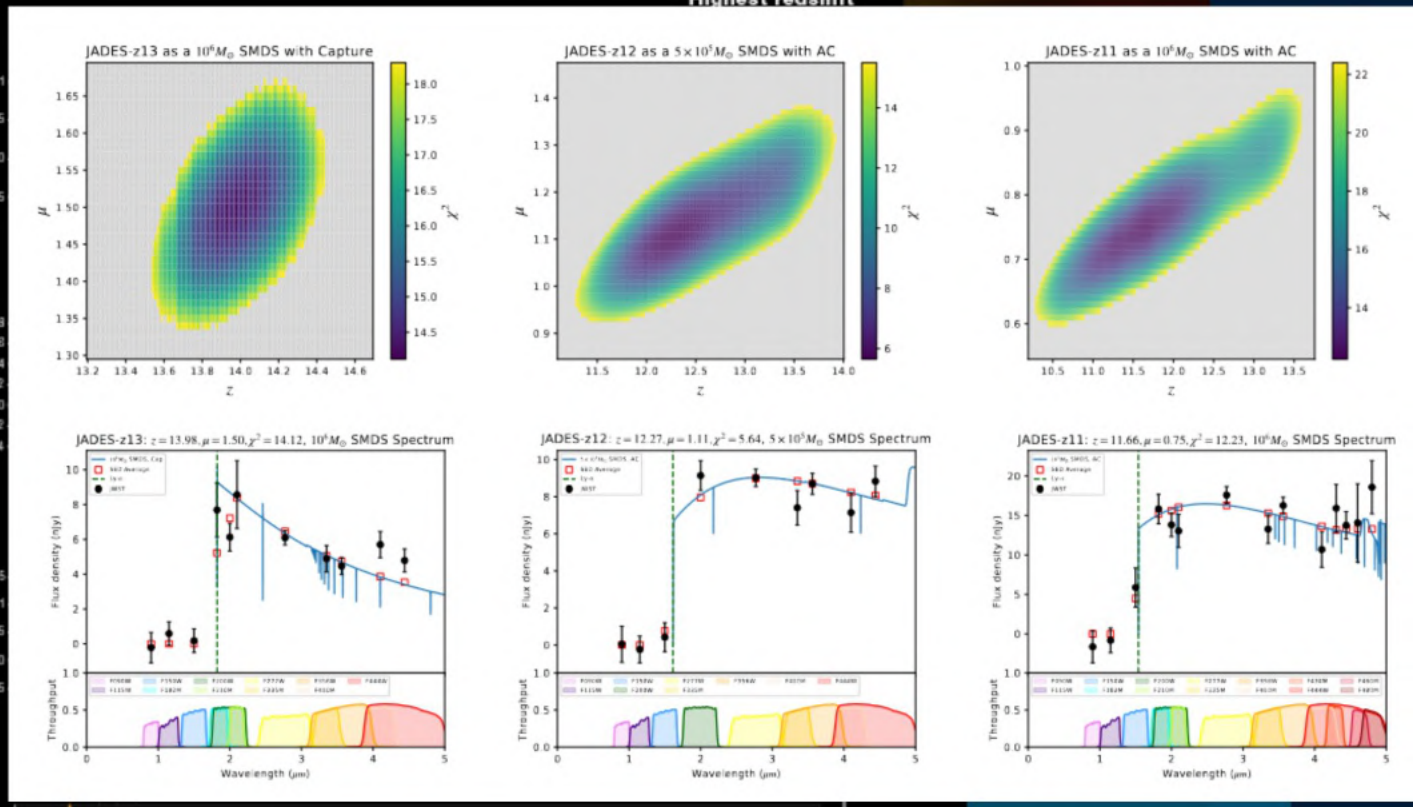
@ Emma Curtis-Lake et al.

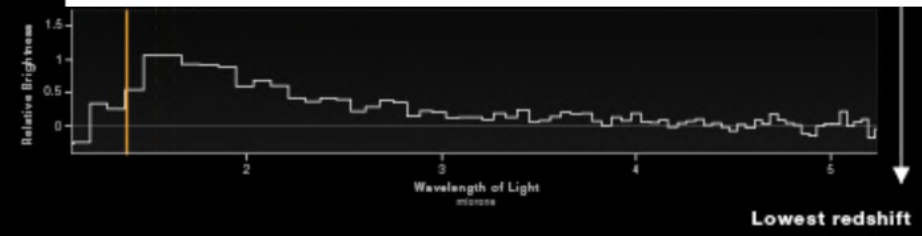
NIRCam Imaging

NIRSpec Microshutter Array Spectroscopy



Highest redshift





Lowest redshift

GS-z10-0

WEBB SPACE TELESCOPE

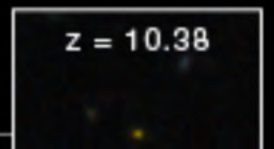
NIRSpec Microshutter Array Spectroscopy

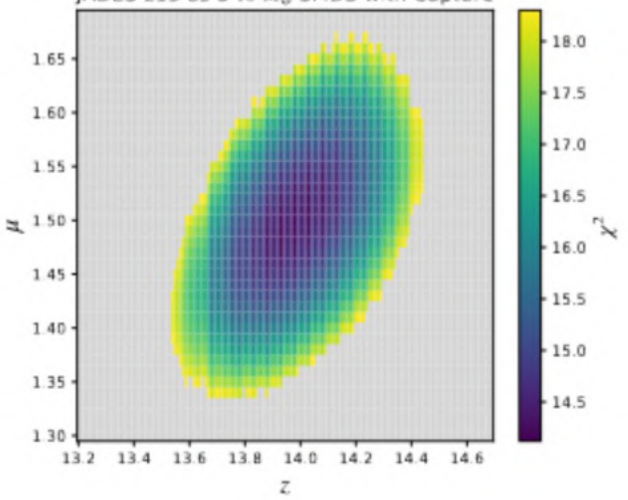
Highest redshift

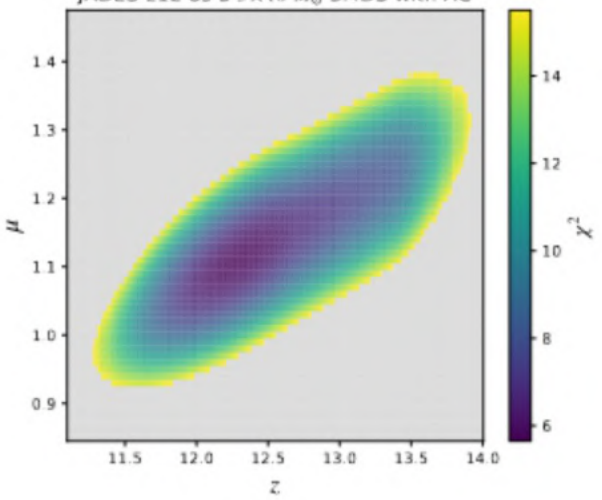


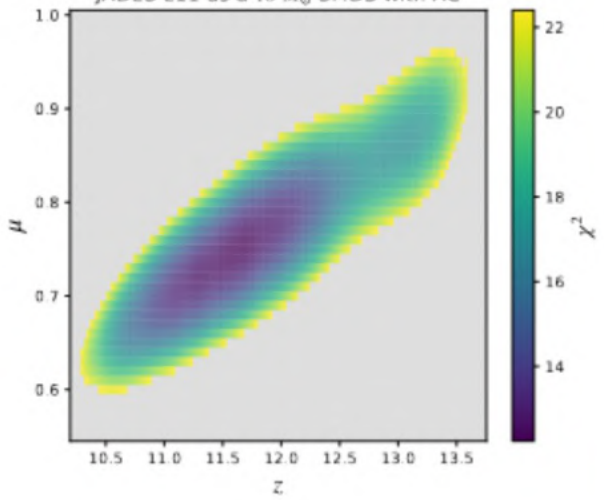


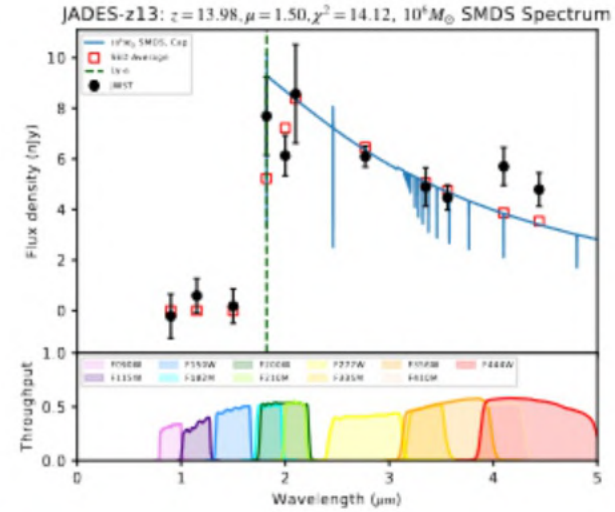


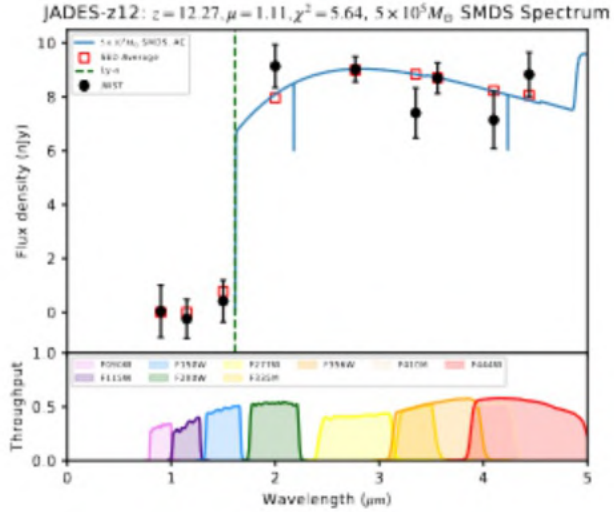


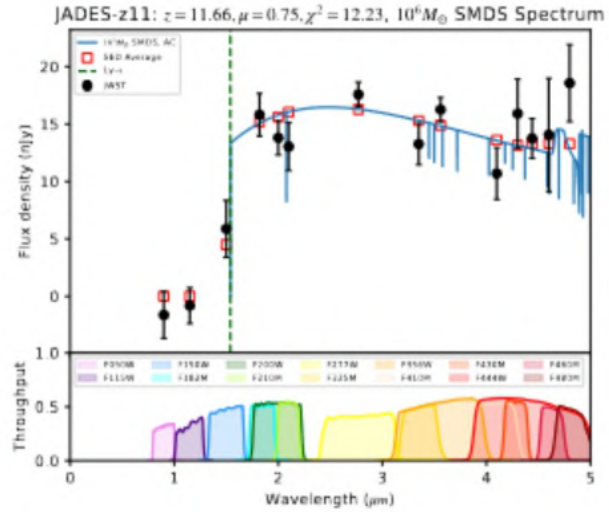














GS-z10-0

Sötét csillagok?

@ Katherine Freese et al.



Sötét csillagok?

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Terítéken a távoli világűr

Kis-Tóth Ágnes * Atomcsill 20 24 10 24




@ Starforge