



DIVISION OF ASTRONOMY AND ASTROPHYSICS

Faculty of Mathematics, Physics and Informatics
Comenius University
Bratislava



JWST

RNDr. Roman Nagy, PhD.



JAMES WEBB SPACE TELESCOPE



- Dlhá cesta časom a priestorom
- Ako James Webb pozoruje?
- Čo všetko nám chce objasniť a/alebo už ja stihol objasniť?



DLHÁ CESTA ČASOM

- 1996 – prvé projekty smerujúce k vesmírnemu ďalekohľadu novej generácie (let 2007, odhadovaná cena 1 mld. \$)
- Pôvodné plány – 8m zrkadlo
- 2002 – projekt premenovaný na James Webb Space Telescope
- Veľkosť zrkadla 6,5m



DLHÁ CESTA ČASOM



- 2003 – zmluva o výstavbe ďalekohľadu (let 2011,
odhadovaná cena 2.5 mld. \$)
- 2007 – spojenie súl NASA a ESA
- 2010 – Mission Critical Design Review MCDR



DLHÁ CESTA ČASOM

- Rozpočet 10 mld. \$



5

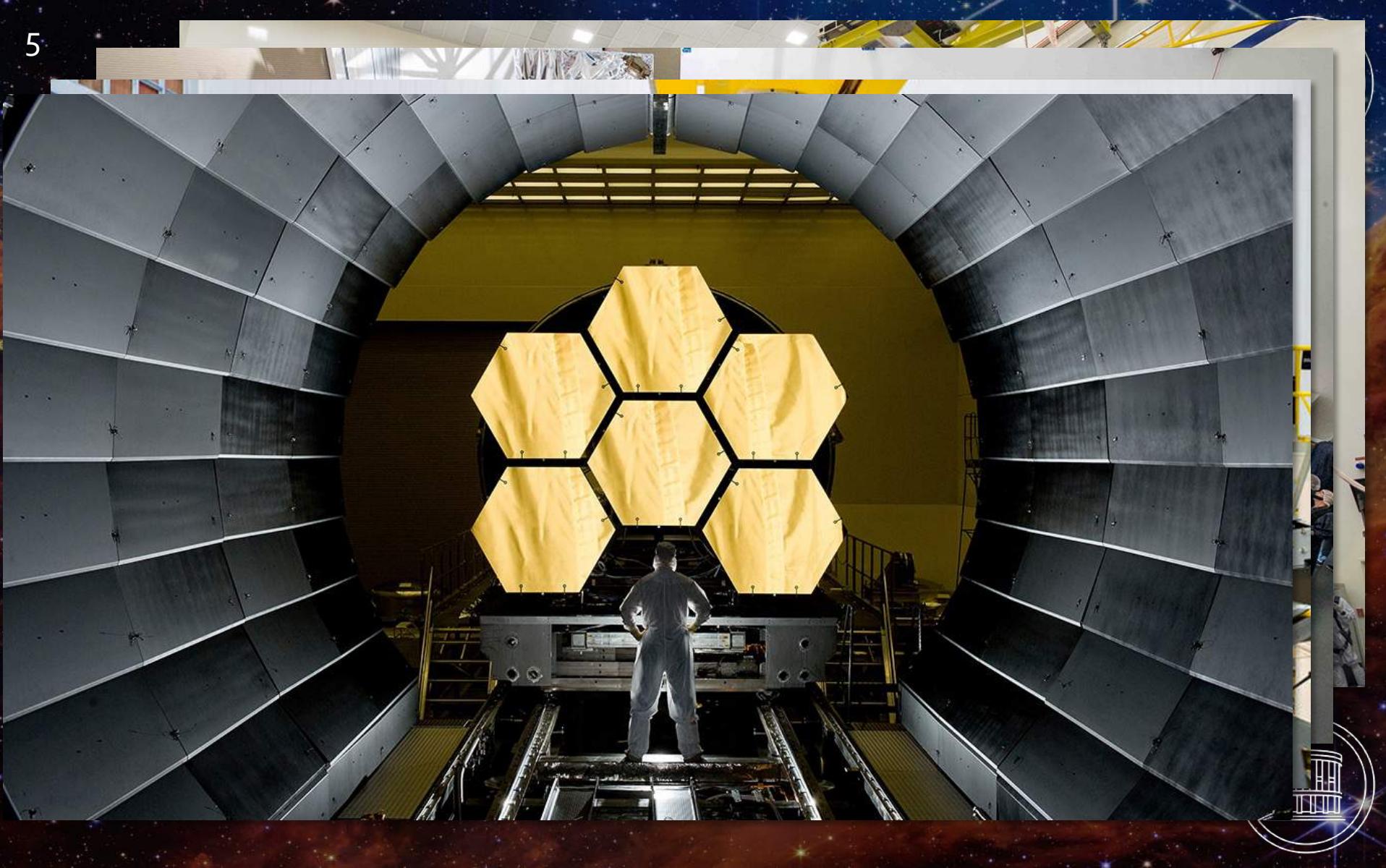
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DLHÁ CESTA ČASOM



○ 25.12.2021 – štart z Francúzskej Guyany

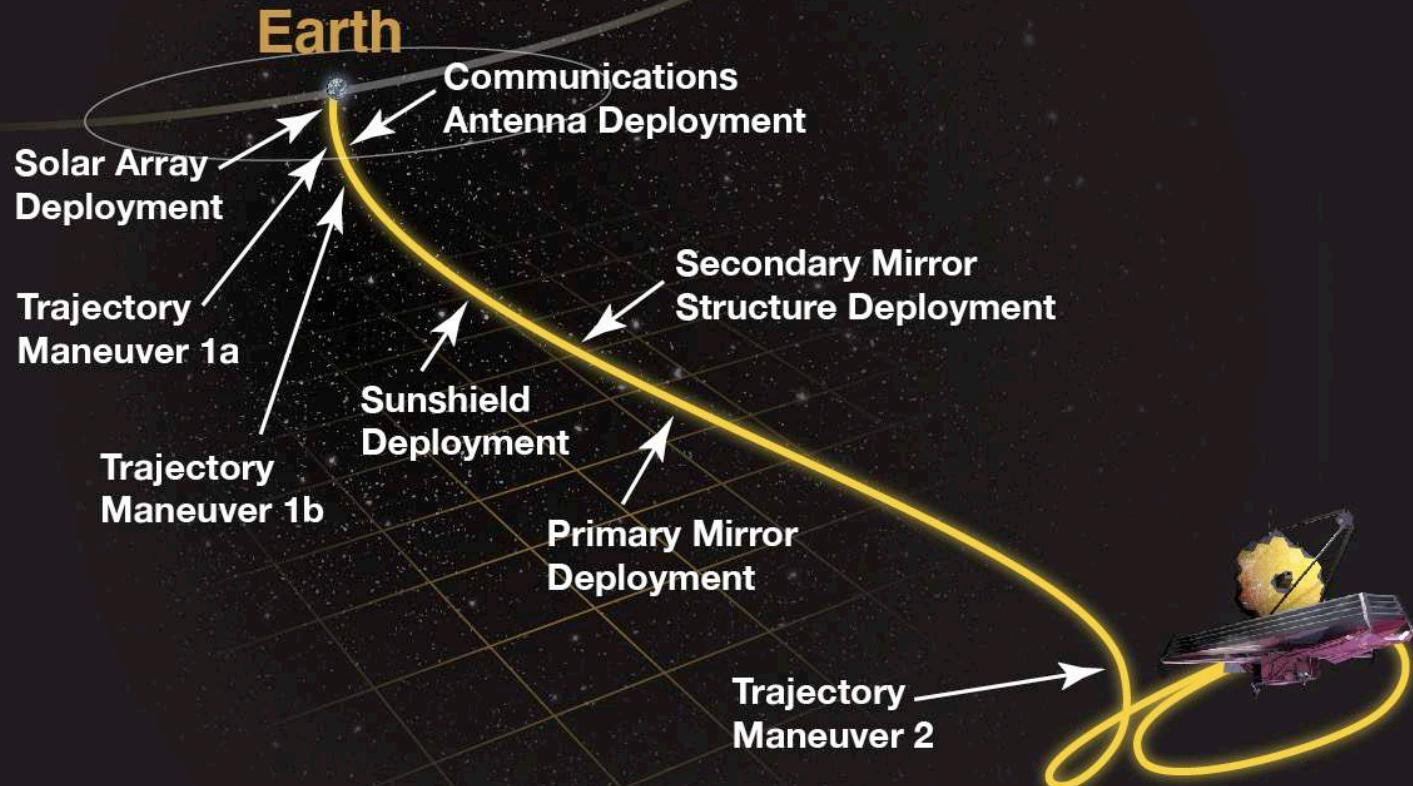


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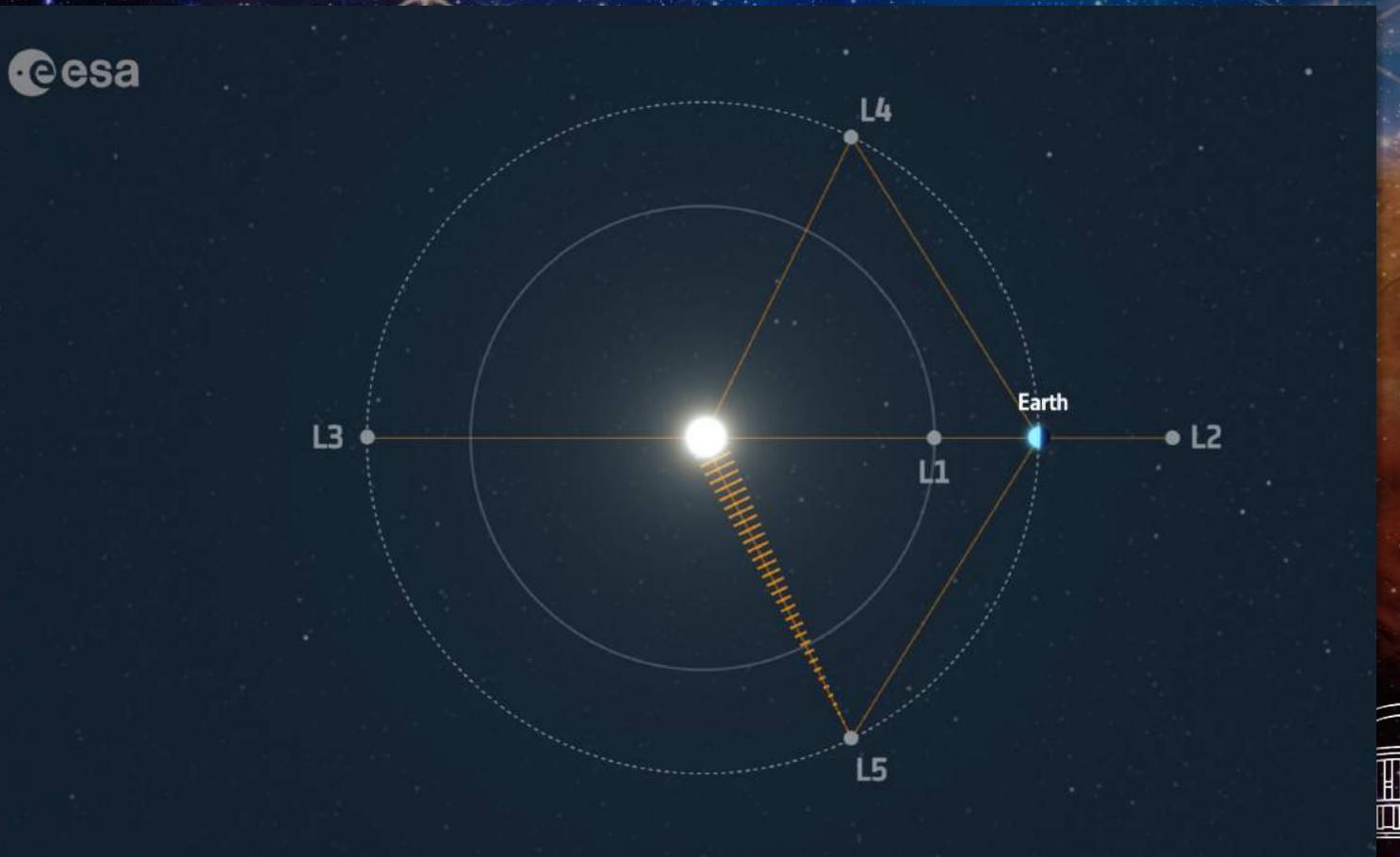
O 2



DLHÁ CESTA PRIESTOROM



A KAM TO VLASTNE IDE?



A KAM TO VLASTNE IDE?



esa

Hubble



384,400 km

Moon



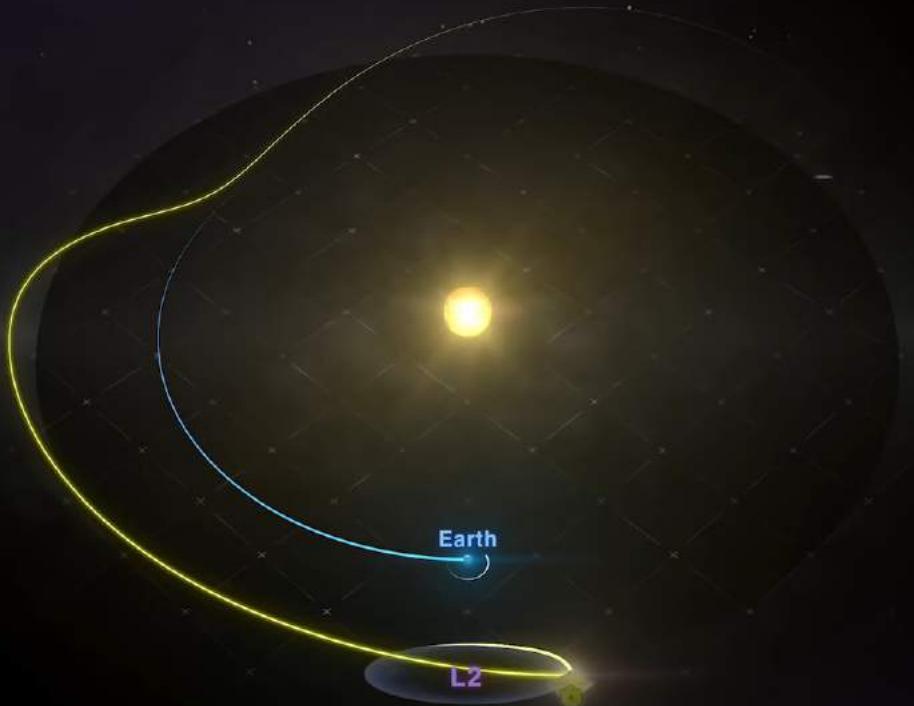
1.5 million km

Webb

L2







10





A ČO NA TO HOVORÍ STARÝ PÁN HUBBLE?

- 2,4m zrkadlo

- 6,5m zrkadlo

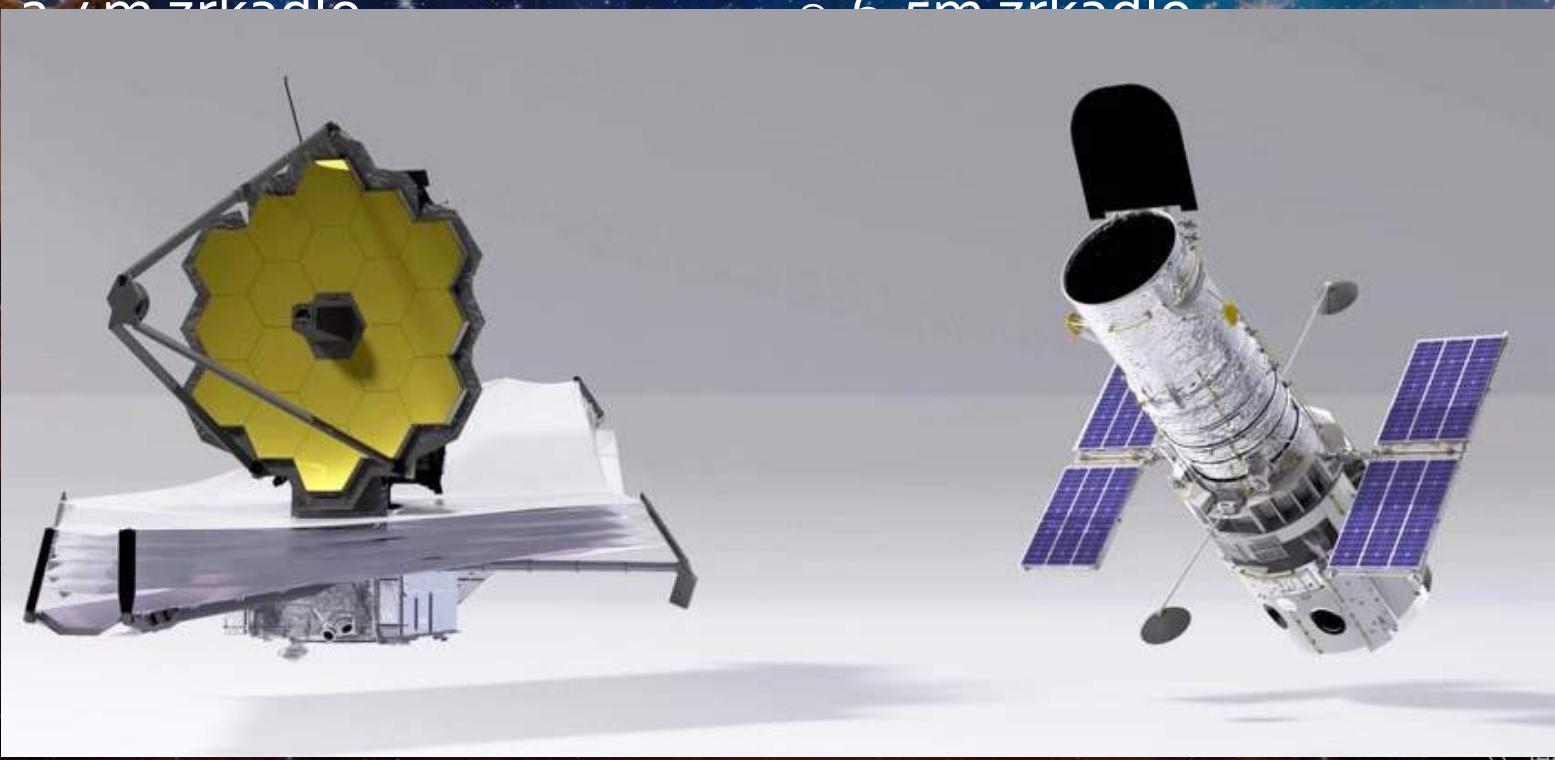




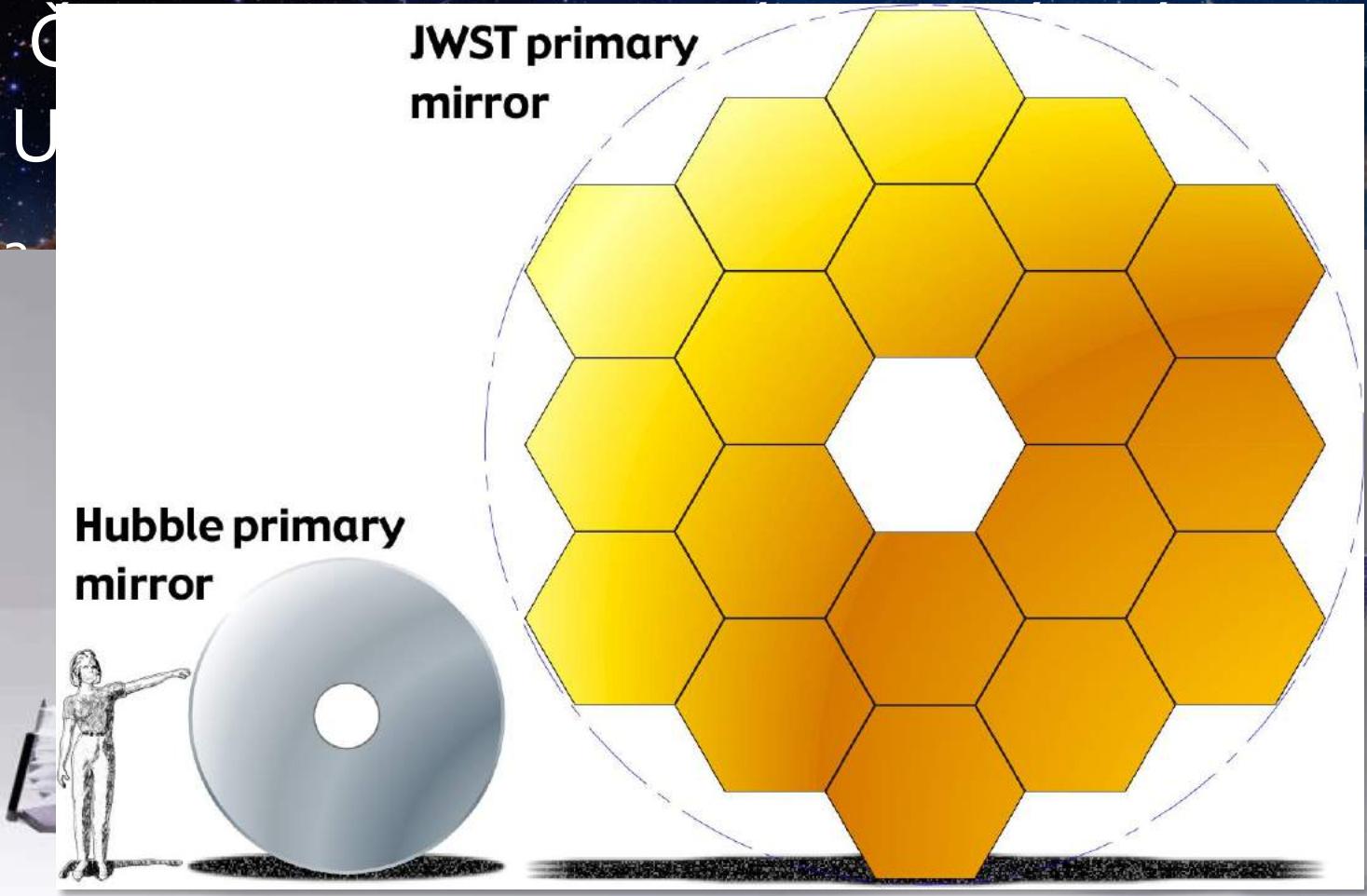
A ČO NA TO HOVORÍ STARÝ PÁN HUBBLE?

o 2,4 m zrkadlo

o 1,5 m zrkadlo



A C
HUB







A ČO NA TO HOVORÍ STARÝ PÁN HUBBLE?

- 2,4m zrkadlo
- 6,5m zrkadlo
- Viditeľná a UV oblast'
- Infračervená oblast'

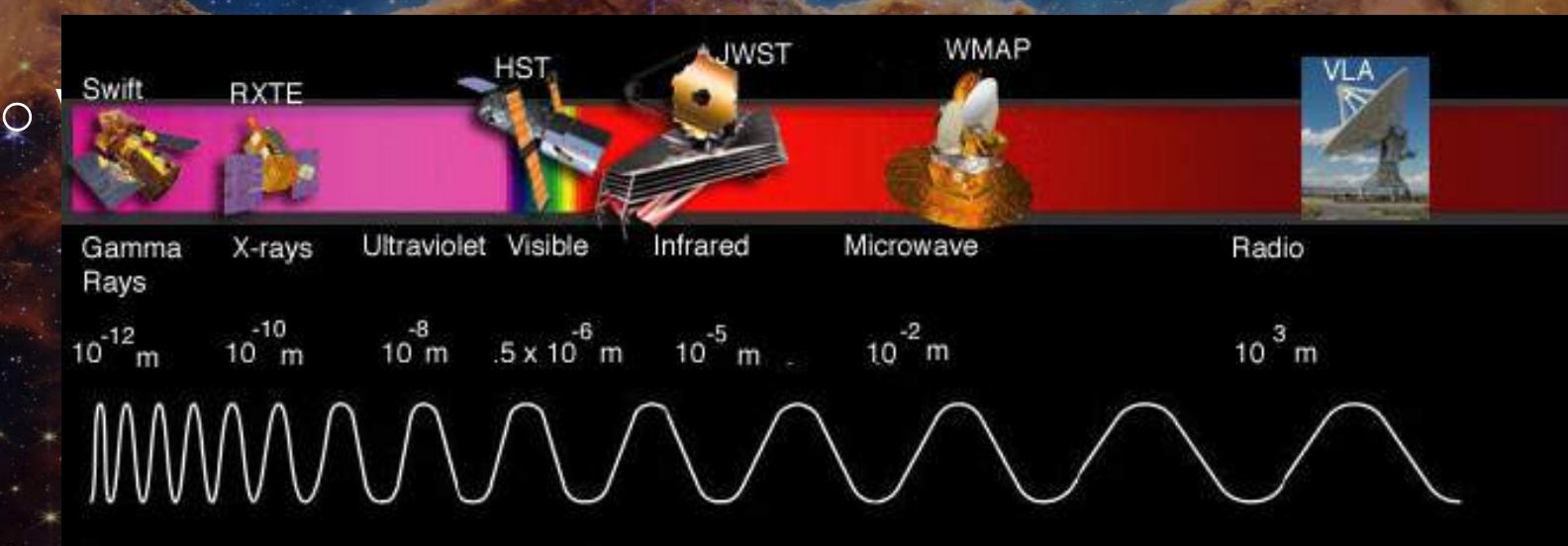




A ČO NA TO HOVORÍ STARÝ PÁN HUBBLE?

- 2,4m zrkadlo

- 6,5m zrkadlo



A ČO NA TO HOVORÍ STARÝ PÁN HIRRIE?



Visible ■ WFPC2 ■ 2001



Infrared ■ WFC3/IR ■ 2014



AČ
LINE



Visible ■ WFPC2 ■ 2001



Infrared ■ WFC3/IR ■ 2014





A PREČO PRÁVE IR?

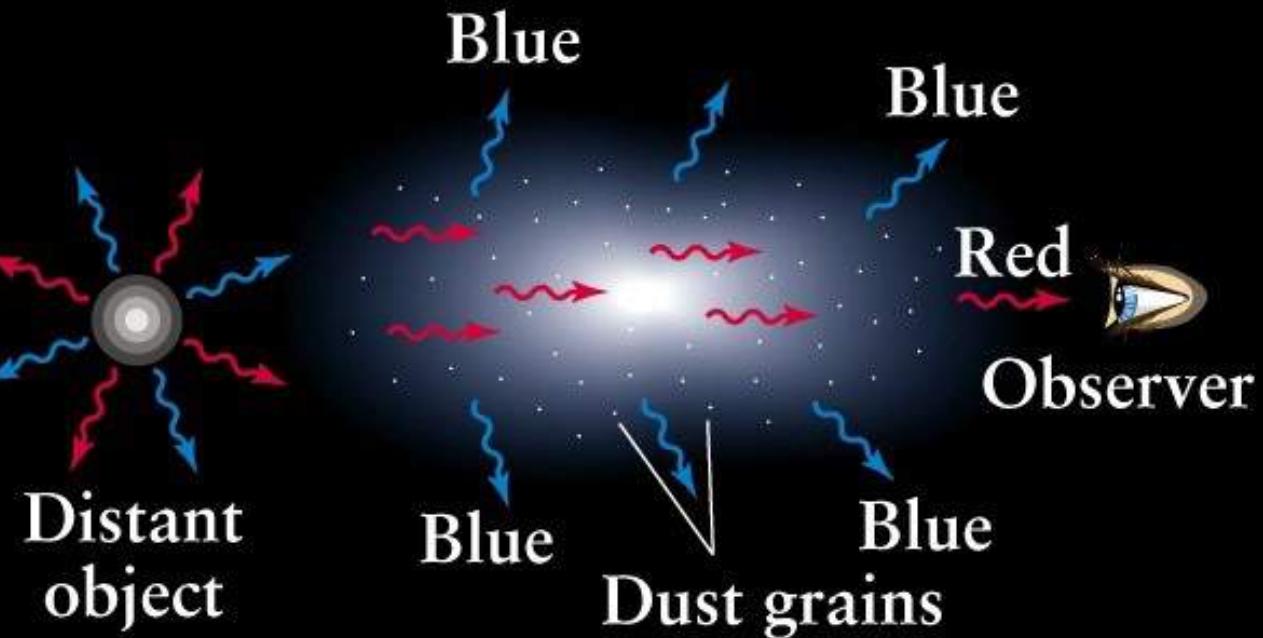
- Medzihviezdna a medzигalaktická absorpcia





A PREČO PRÁVE IR?

o Medzih



A PREČO PRÁVE IR?



- Medzihviezdna a medzигalaktická absorpcia
- Rozpínanie vesmíru



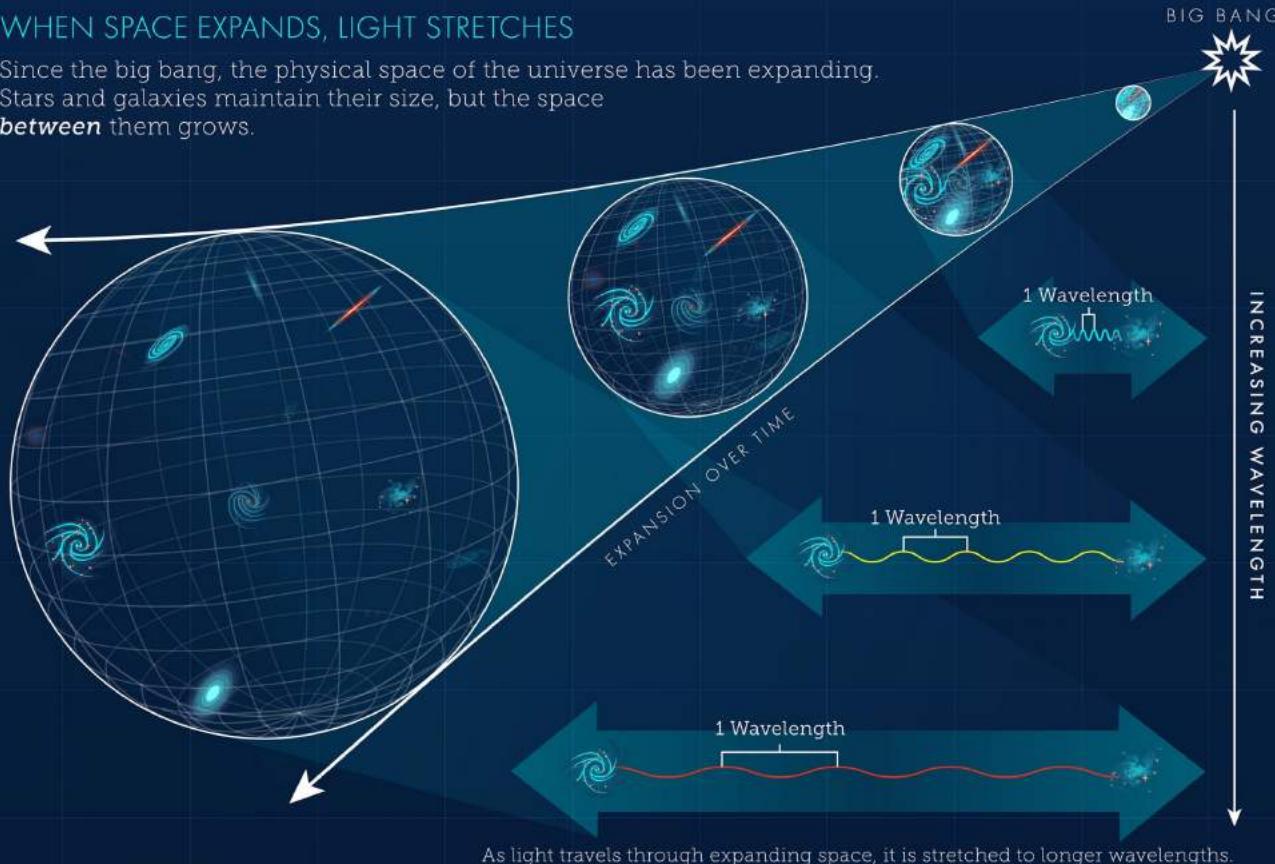
o Med

o Roz

WHAT IS COSMOLOGICAL REDSHIFT?

WHEN SPACE EXPANDS, LIGHT STRETCHES

Since the big bang, the physical space of the universe has been expanding. Stars and galaxies maintain their size, but the space **between** them grows.

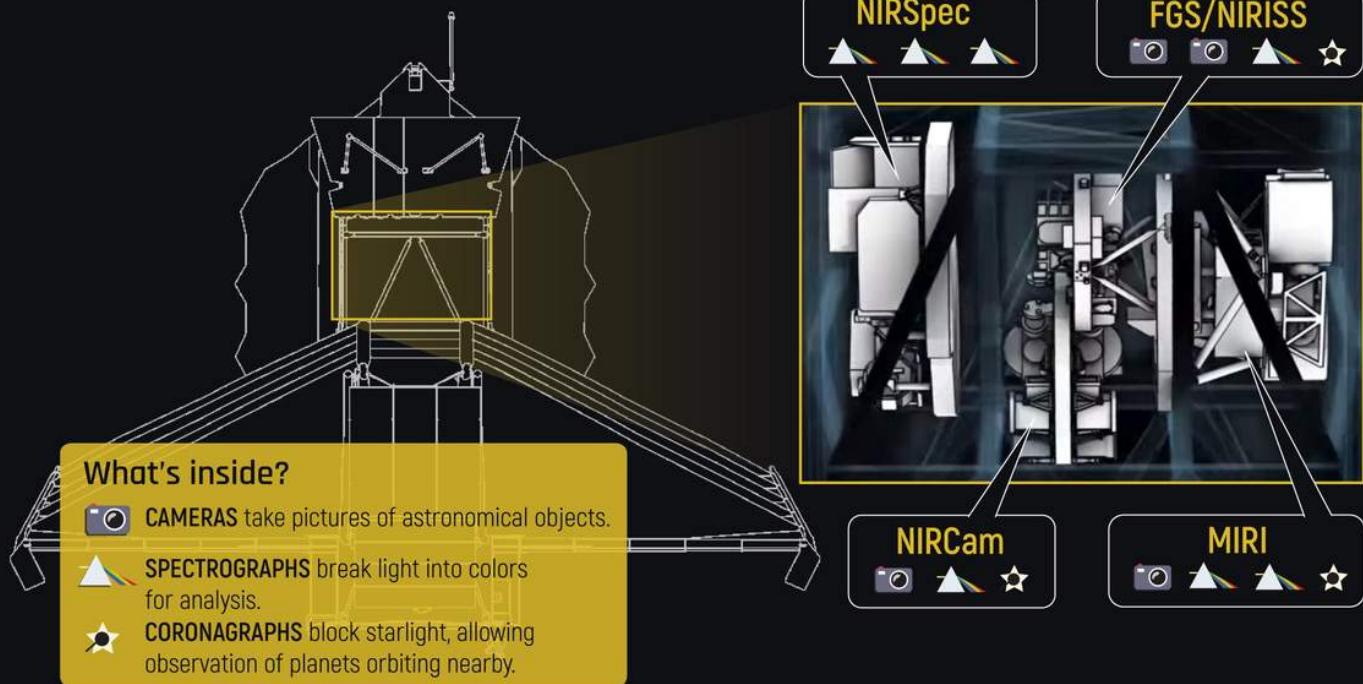


As light travels through expanding space, it is stretched to longer wavelengths.

A AKO WEBB POZORUJE?



Webb's Science Instruments





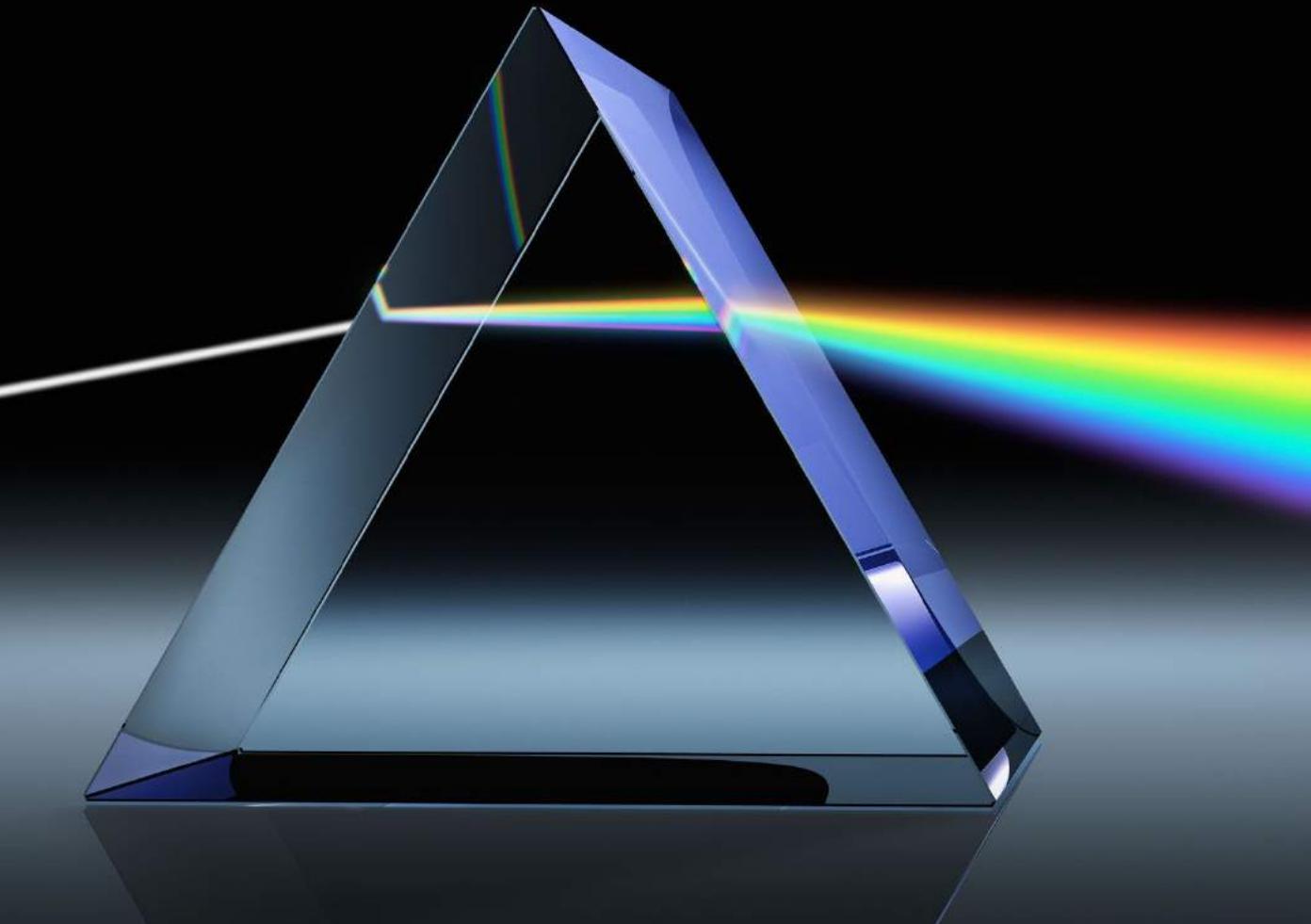
A AKO WEBB POZORUJE?

- NIRSpec - Near-Infrared Spectrograph
- FGS – Fine Guiding Sensor
- NIRISS - The Near Infrared Imager and Slitless Spectrograph
- NIRCam - Near-Infrared Camera
- MIRI - Mid-Infrared Instrument



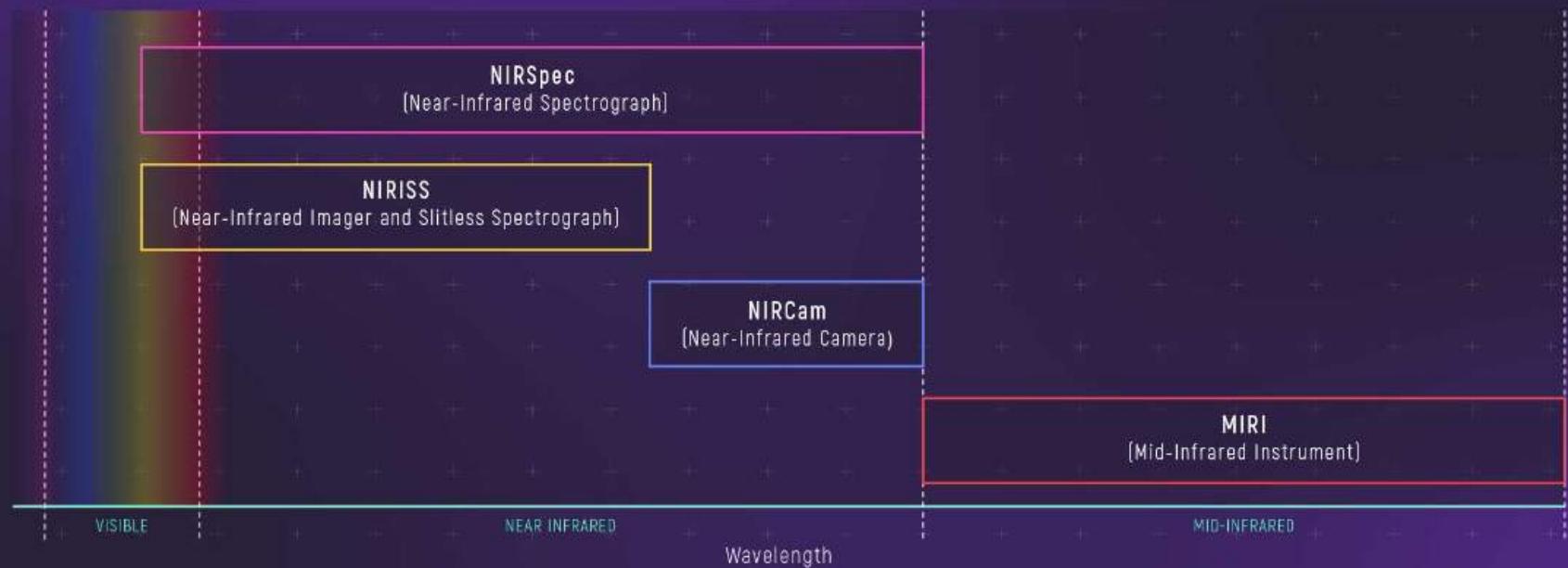
AAk

- NIR
- FGS
- NIR
- NIR
- MIR

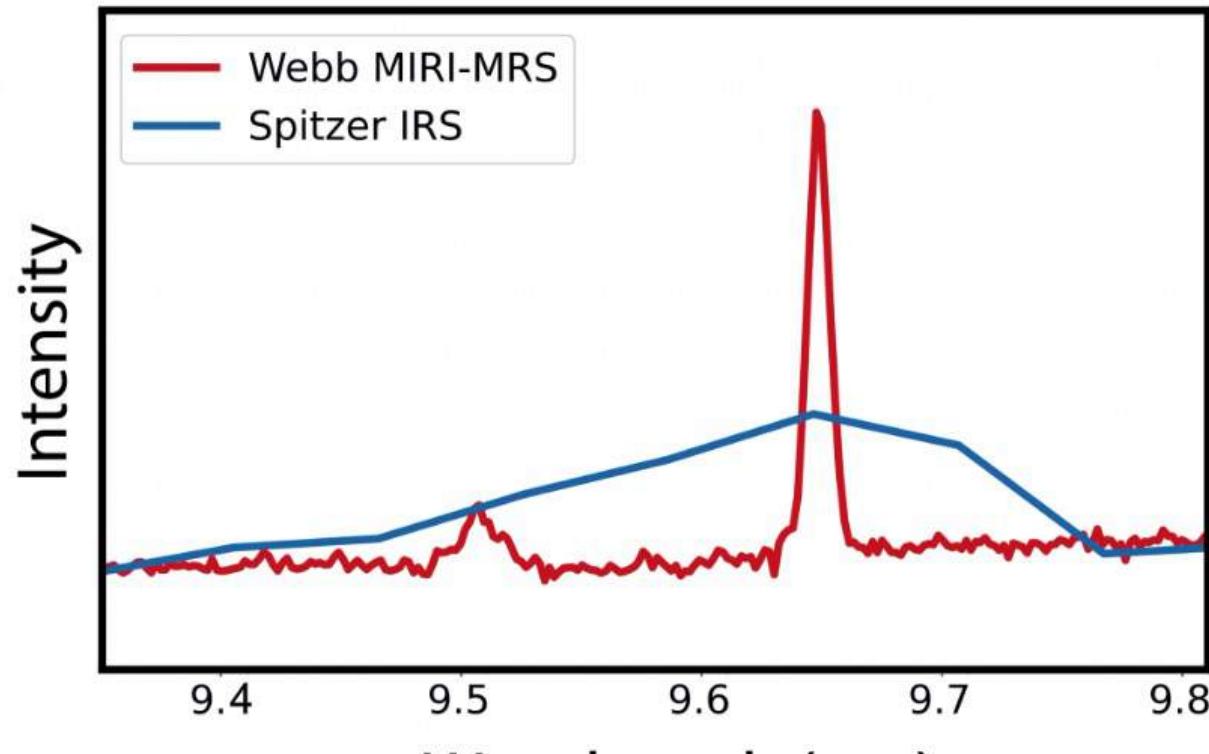
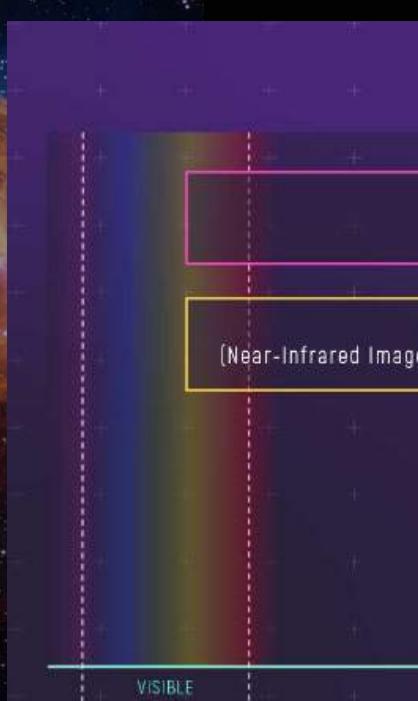




WAVELENGTH RANGE OF WEBB'S SPECTROSCOPIC INSTRUMENTS



AAk



NEAR INFRARED

Wavelength

MID-INFRARED



The Two Sides of the Webb Telescope



Hot side

185° Fahrenheit
(85° Celsius)

SOLAR PANEL

COMMUNICATIONS
ANTENNA

COMPUTER

STEERING:
REACTION WHEELS & JETS

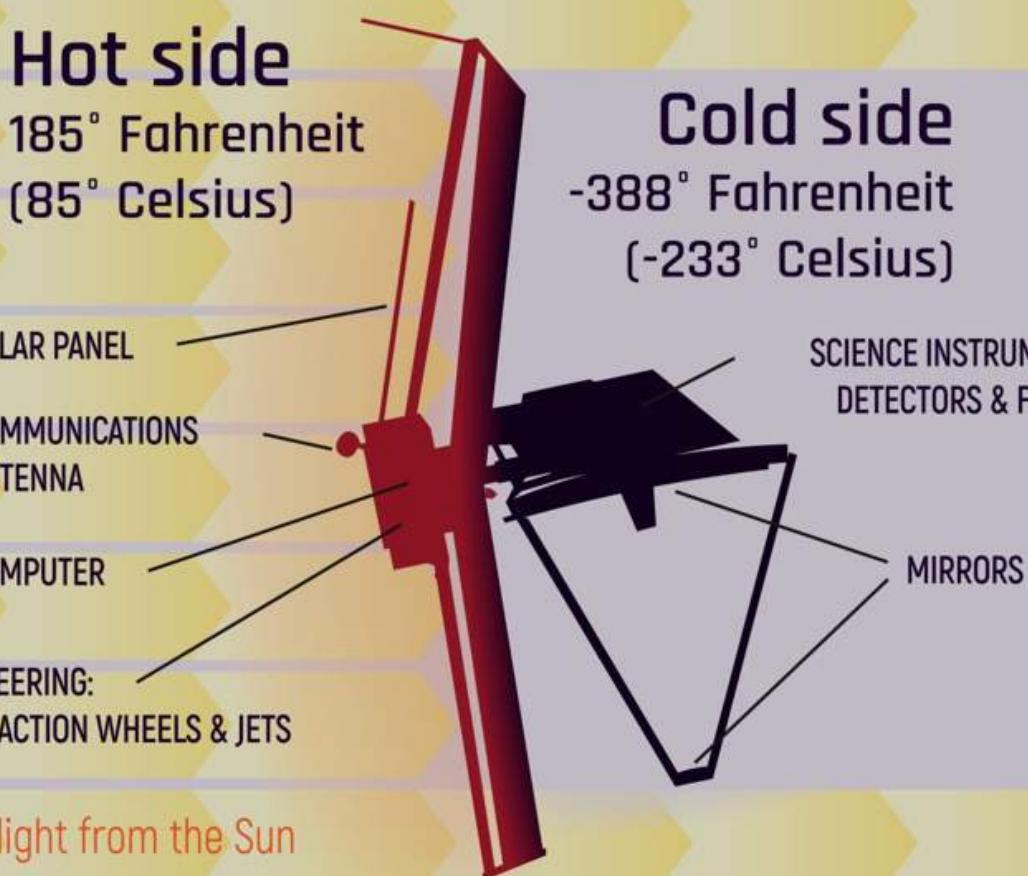
light from the Sun

Cold side

-388° Fahrenheit
(-233° Celsius)

SCIENCE INSTRUMENTS:
DETECTORS & FILTERS

MIRRORS





The Two Sides

Hot Side

185° F
(85° C)

SOLAR PANEL

COMMUNICATION
ANTENNA

COMPUTER

STEERING:
REACTION WHEELS & JETS

light from the Sun

Cross-Section of Webb's Five-Layer Sunshield

Light and heat from the Sun hits the shield, heating it up.

Each layer of material blocks some heat, deflects the rest harmlessly out the sides.



PLÁNY, VEĽKÉ PLÁNY



- Formovanie prvých hviezd a galaxií
- Evolúcia galaxií
- Exosystémy a ich planéty
- Analýza povrchov a atmosfér objektov slnečnej sústavy
- A (dúfajme) mnoho ďalších neočakávaných objavov





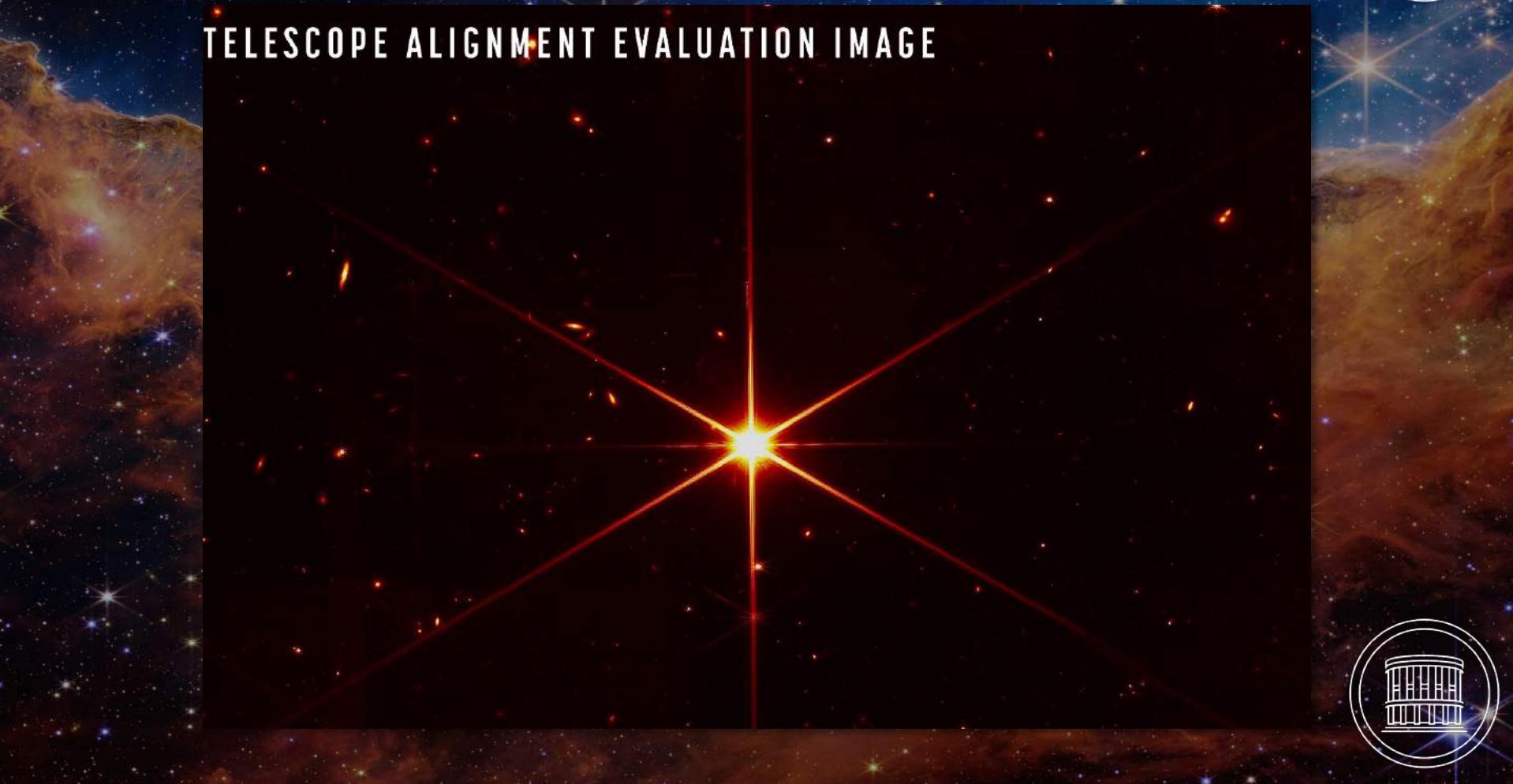
ALE POĎME PO
PORIADKU ... |



PRVÝ KALIBRAČNÝ ZÁBER – 11.3.2022



TELESCOPE ALIGNMENT EVALUATION IMAGE



VEĽKÁ HMLOVINA V ORIONE





VĚÍKA HMI OVINA V ORIONE

Hubble (color)



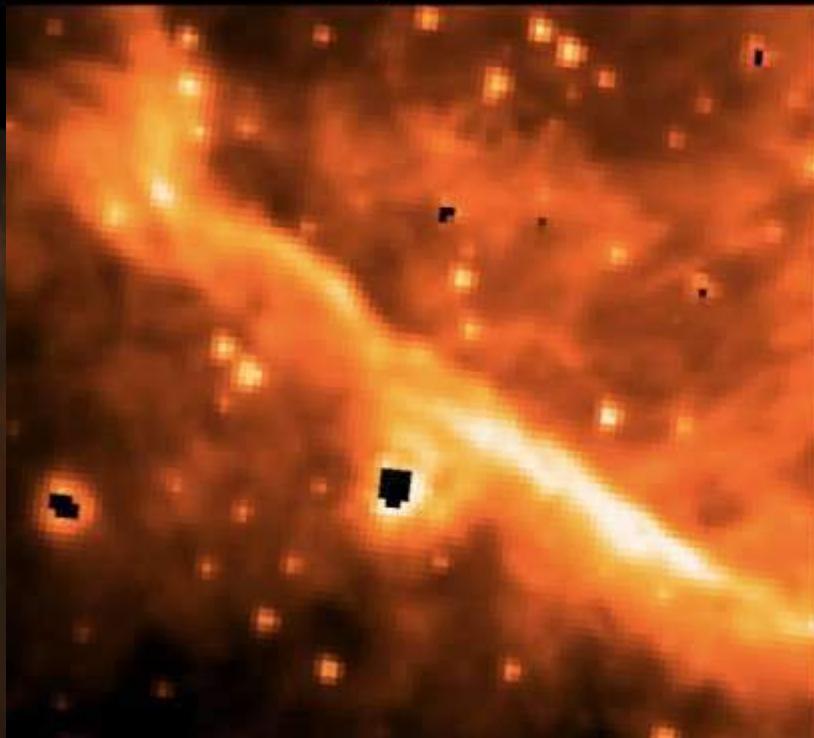
JWST (color)



V E I'

Spitzer

JWST

IRAC / 3.6 μm

Credits : NASA / IPG-Garching/ESO Magellan

NIRCam / 3.35 μm

Credits : NASA / CSA / CSA and PDBeKAO team

Credits : NASA, C.R. O'Dell and S.K. Wong [Rice University]

Credits : NASA / CSA / CSA / PDBeKAO team S. Pottawat



Credits : NASA / CSA / CSA / PDBeKAO team S. Pottawat

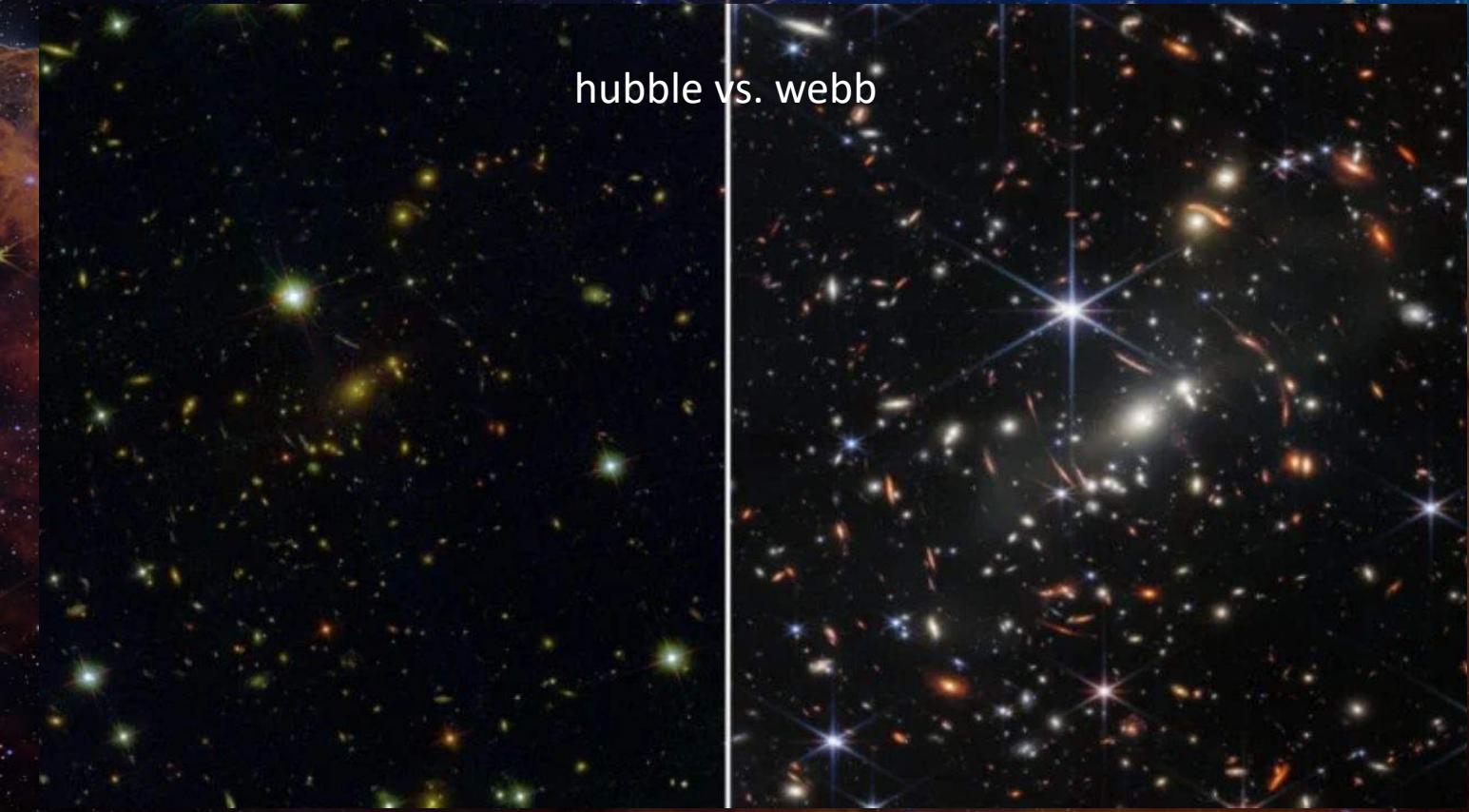
WEBB DEEP FIELD (NIRCAM)



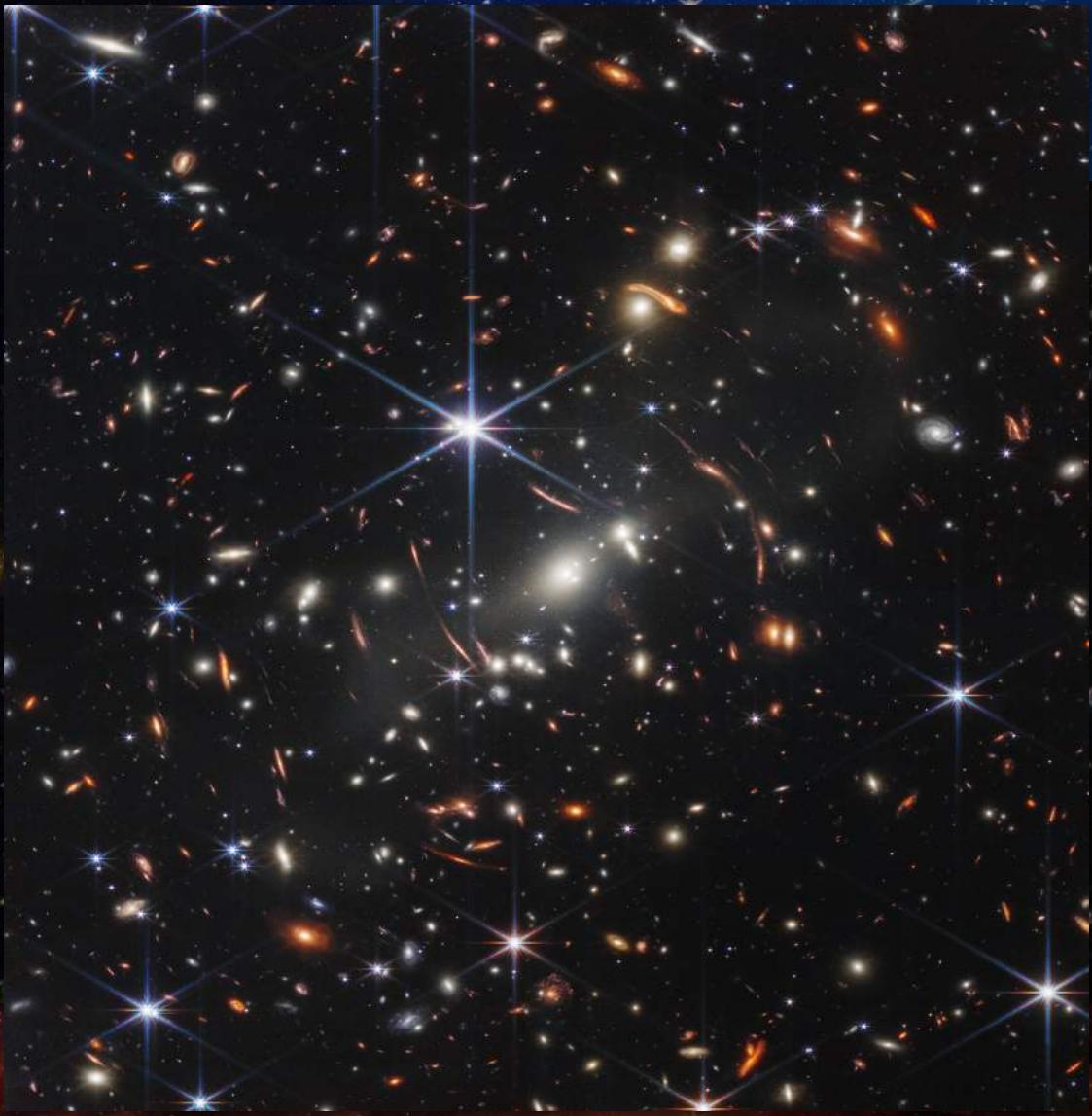
WEBB DEEP FIELD (NIRCAM)



hubble vs. webb



WEBB

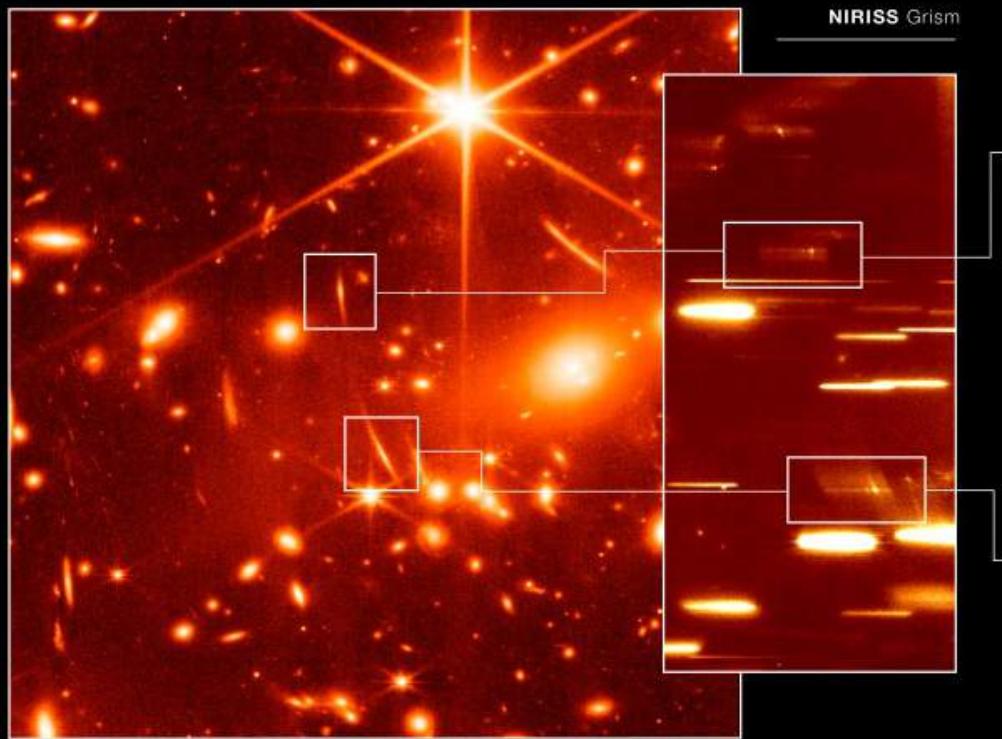




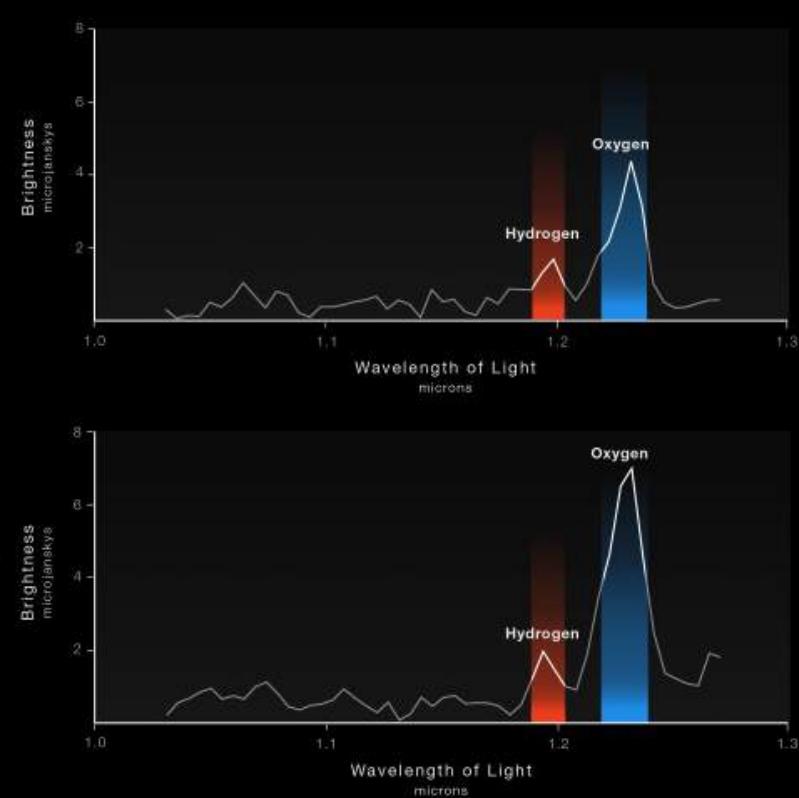
GALAXY CLUSTER SMACS 0723

WEBB SPECTRA CONFIRM TWO ARCS ARE THE SAME GALAXY

NIRISS Imaging



NIRISS Wide Field Slitless Spectroscopy



DISTANT GALAXY BEHIND SMACS 0723

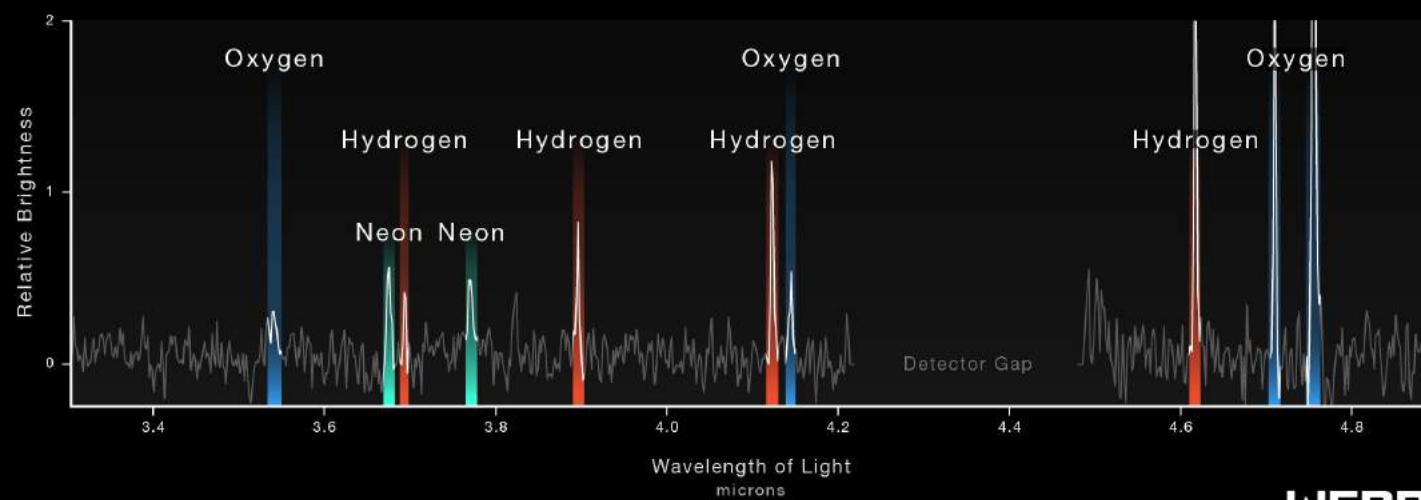
WEBB SPECTRUM SHOWCASES GALAXY'S COMPOSITION



NIRCam Imaging



NIRSpec Microshutter Array Spectroscopy



WEBB
SPACE TELESCOPE



DISTANT
WEBB

GALAXY CLUSTER SMACS 0723

WEBB SPECTRA IDENTIFY GALAXIES IN THE VERY EARLY UNIVERSE



NIRCam

NIRCam Imaging



11.3 billion years

12.6 billion years

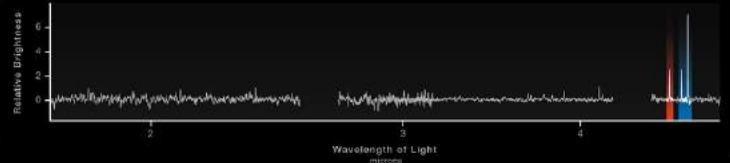
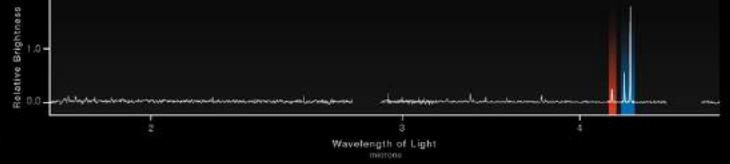
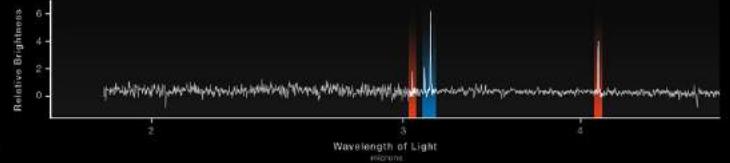
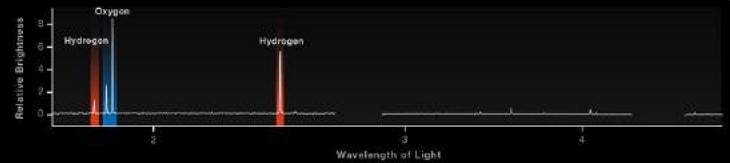
13.0 billion years

13.1 billion years



NIRSpec Microshutter Array Spectroscopy

Lowest redshift



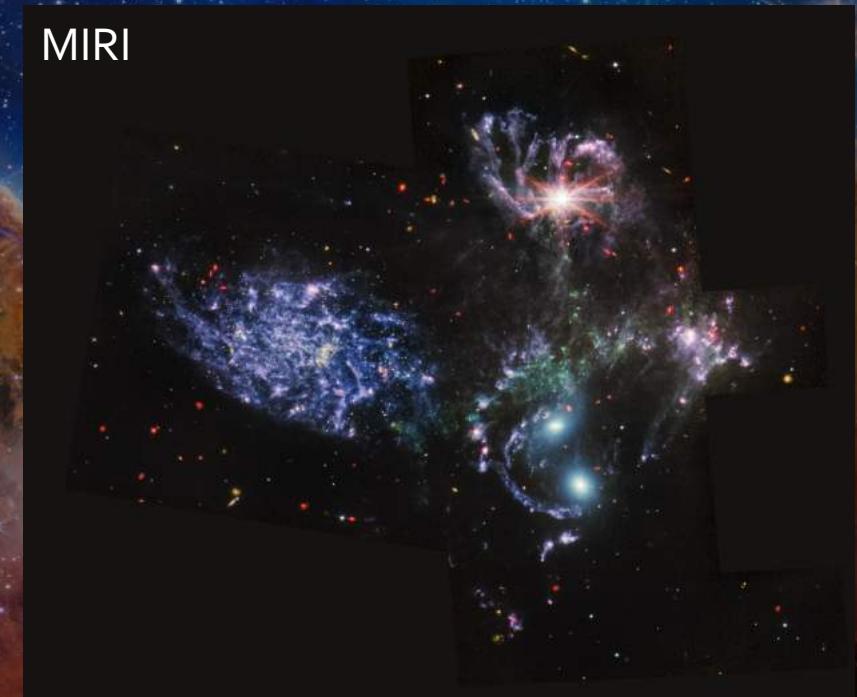
Highest redshift

WEBB
SPACE TELESCOPE

STEPHAN'S QUINTET



MIRI





STEPHAN'S QUINTET

hubble vs. webb

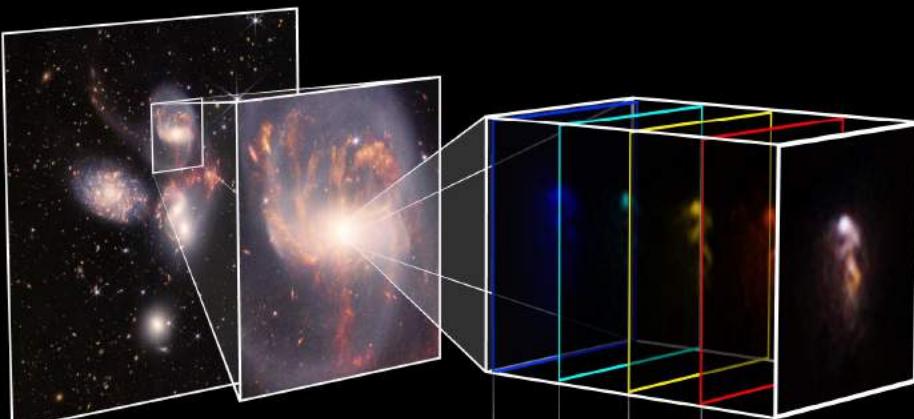


INTERACTING GALAXIES | STEPHAN'S QUINTET

COMPOSITION OF GAS AROUND ACTIVE BLACK HOLE

NIRCam and MIRI Imaging

NIRSpec IFU Spectroscopy



Atomic Hydrogen

0.656 microns
Wavelength of Light

Iron Ions

1.64 microns
Wavelength of Light

Atomic Hydrogen

1.87 microns
Wavelength of Light

Molecular Hydrogen

4.7 microns
Wavelength of Light

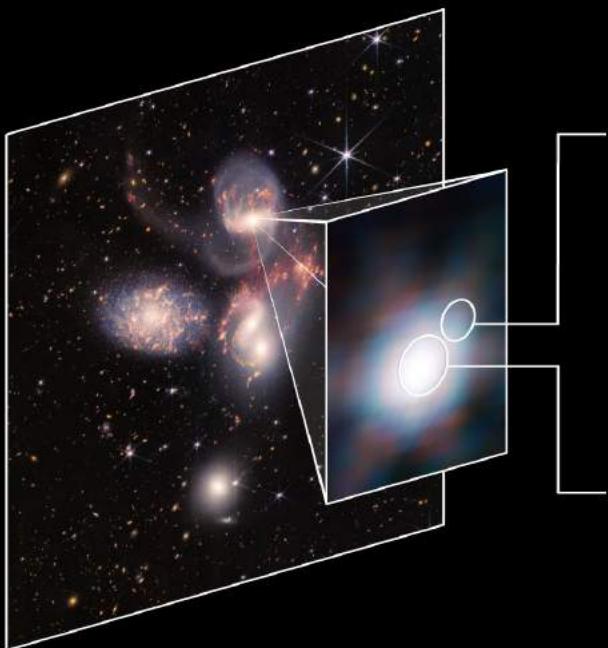
WEBB
SPACE TELESCOPE



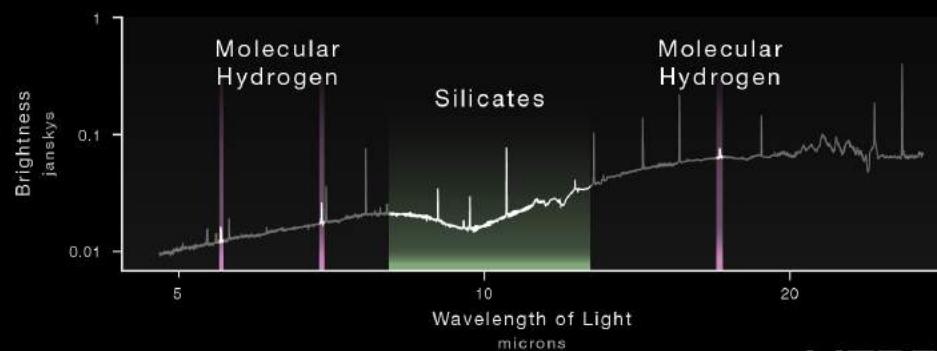
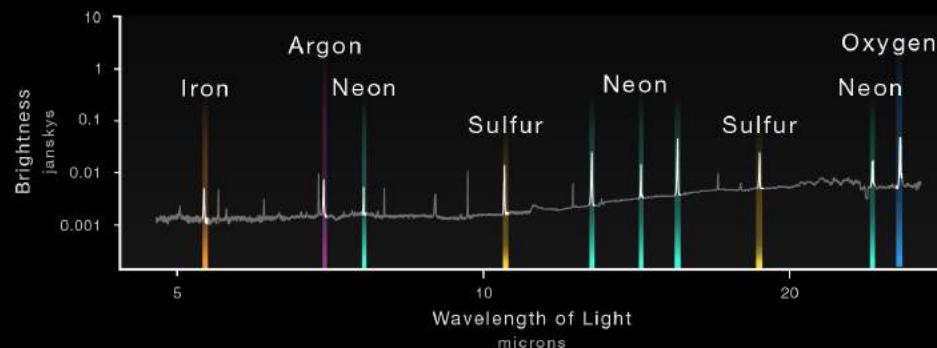
INTERACTING GALAXIES | STEPHAN'S QUINTET

COMPOSITION OF GAS AROUND ACTIVE BLACK HOLE

NIRCam and MIRI Imaging



MIRI IFU Medium Resolution Spectroscopy



WEBB
SPACE TELESCOPE

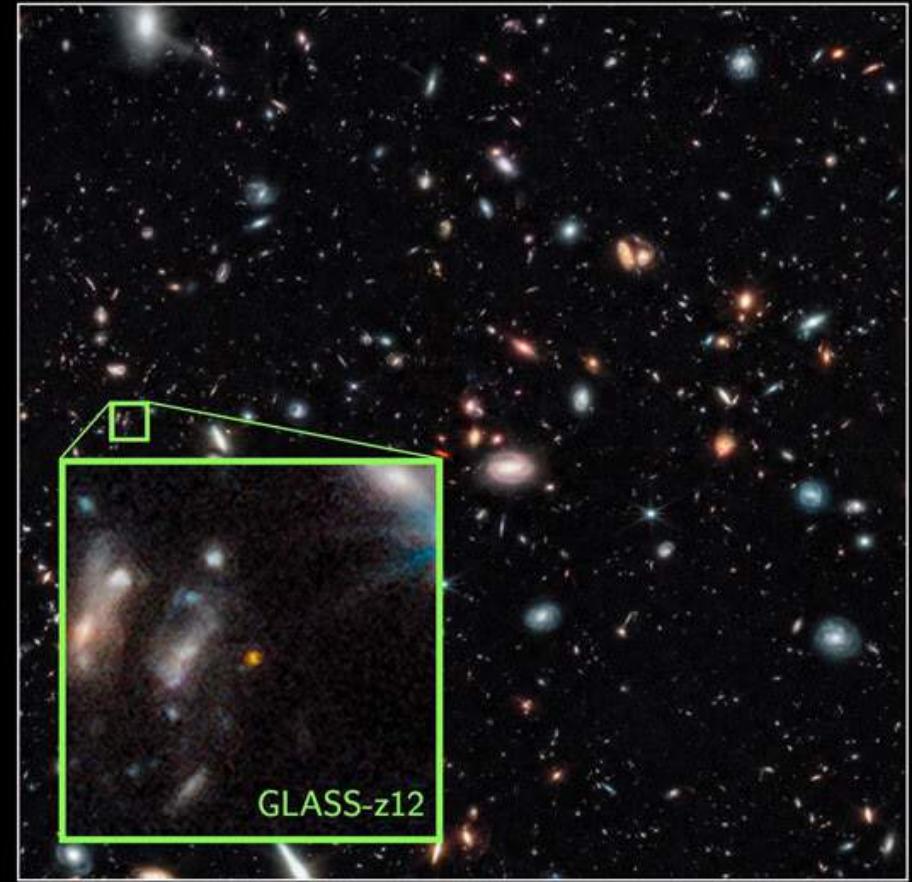
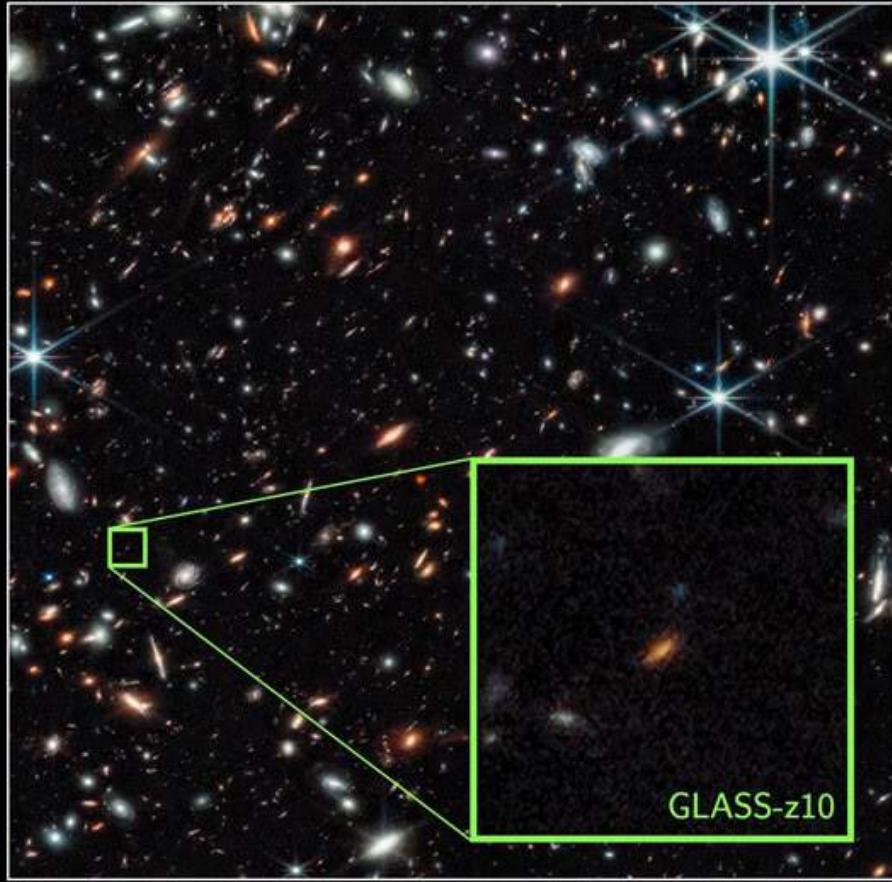


NAJVZDIALENEJŠIA JWST GALAXIA



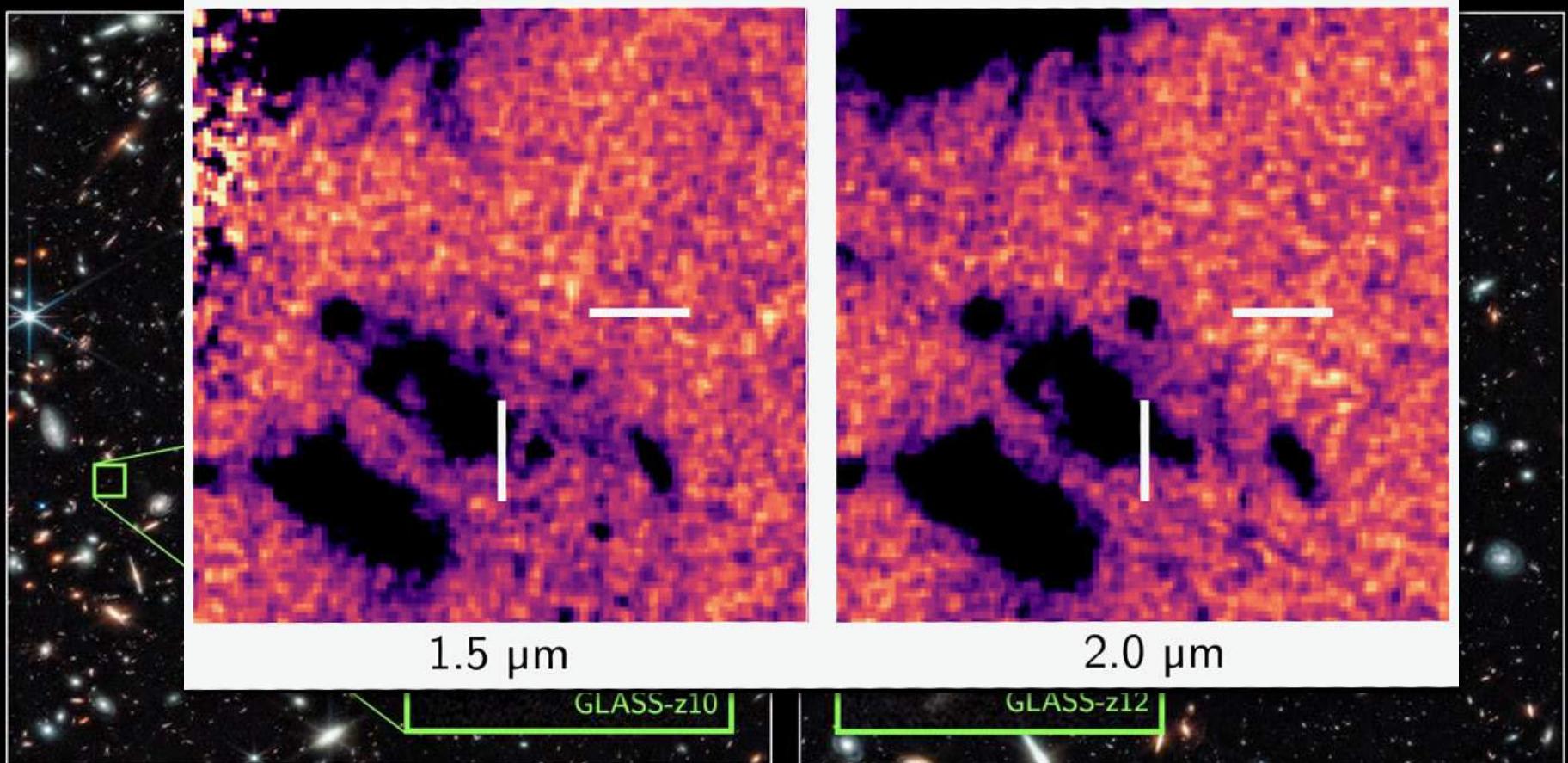


NAJVZDIALENEJŠIA JWST GALAXIA





NAJVZDIALENEJŠIA JWST GALAXIA



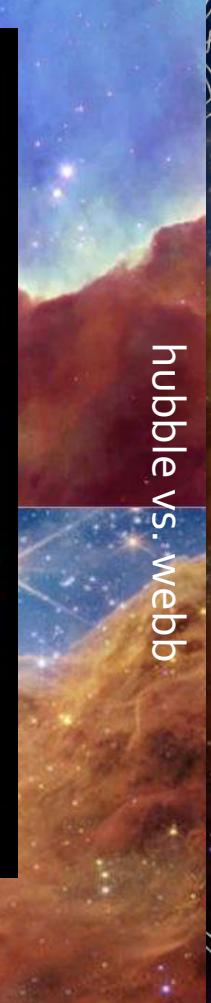
Hmlovina Carina





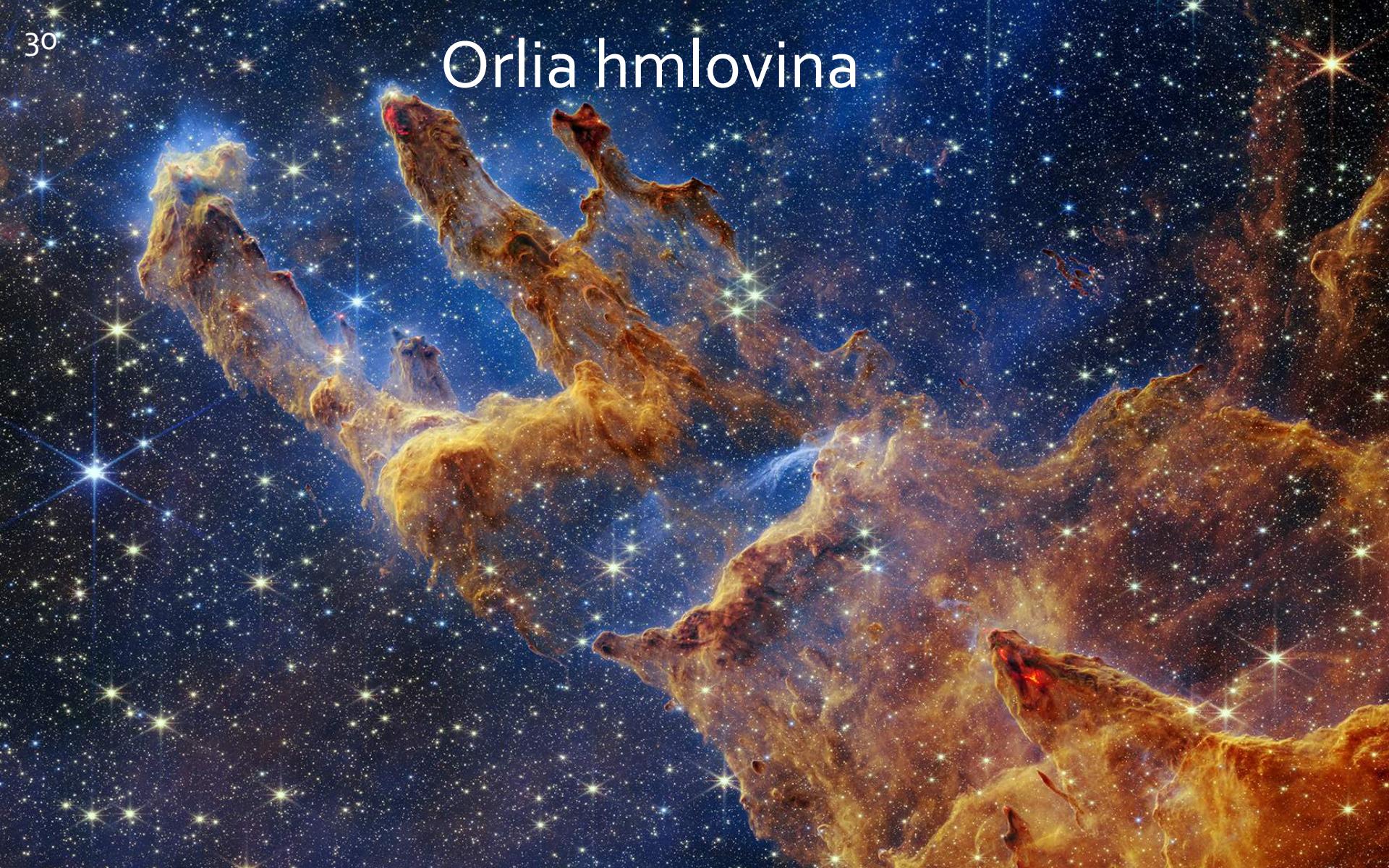
hubble vs. webb





30

Orlia hmlovina



Orlia hmlovina



Orlia hmlovina



JUŽNÁ PRSTENCOVÁ HLMOVINA



NIRCam



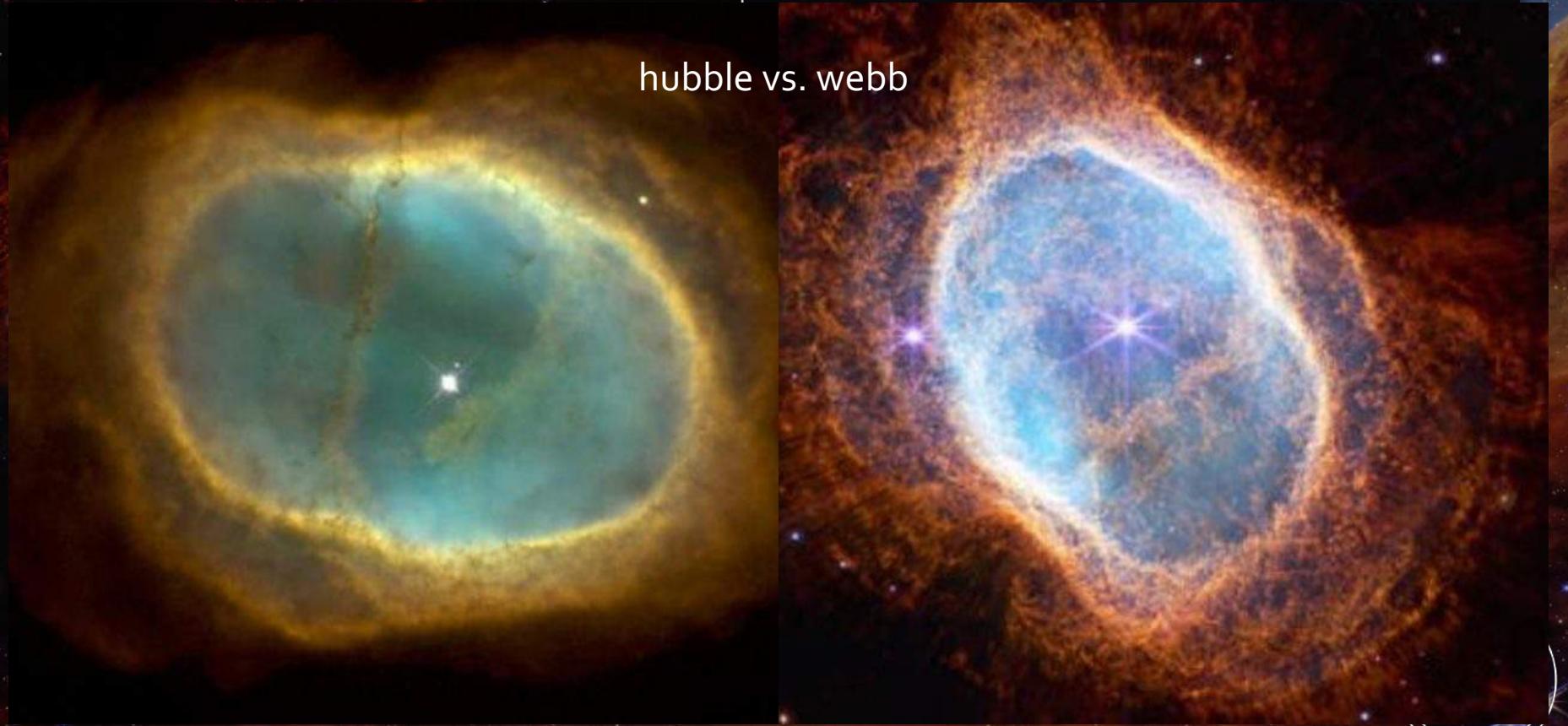
MIRI



JUŽNÁ PRSTENCOVÁ HLMOVINA



hubble vs. webb



ĎALŠIE WEBBOVE ZÁZRAKY



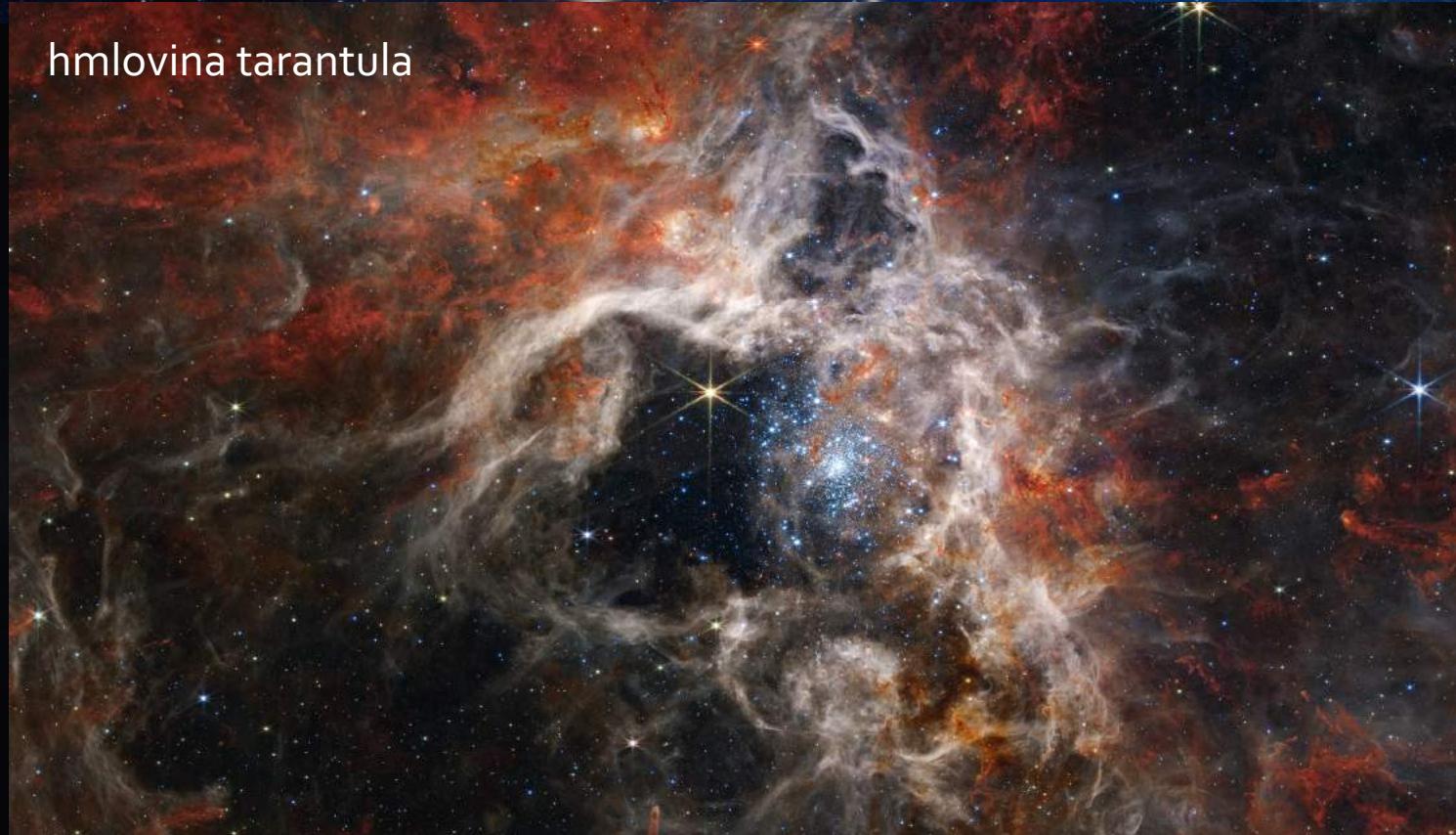
NIRCam



ĎALŠIE WEBBOVE ZÁZRAKY



hmlovina tarantula



ĎALŠI

Cartwheel Galaxy

hmlovin



ĎALŠ

Cartwhee

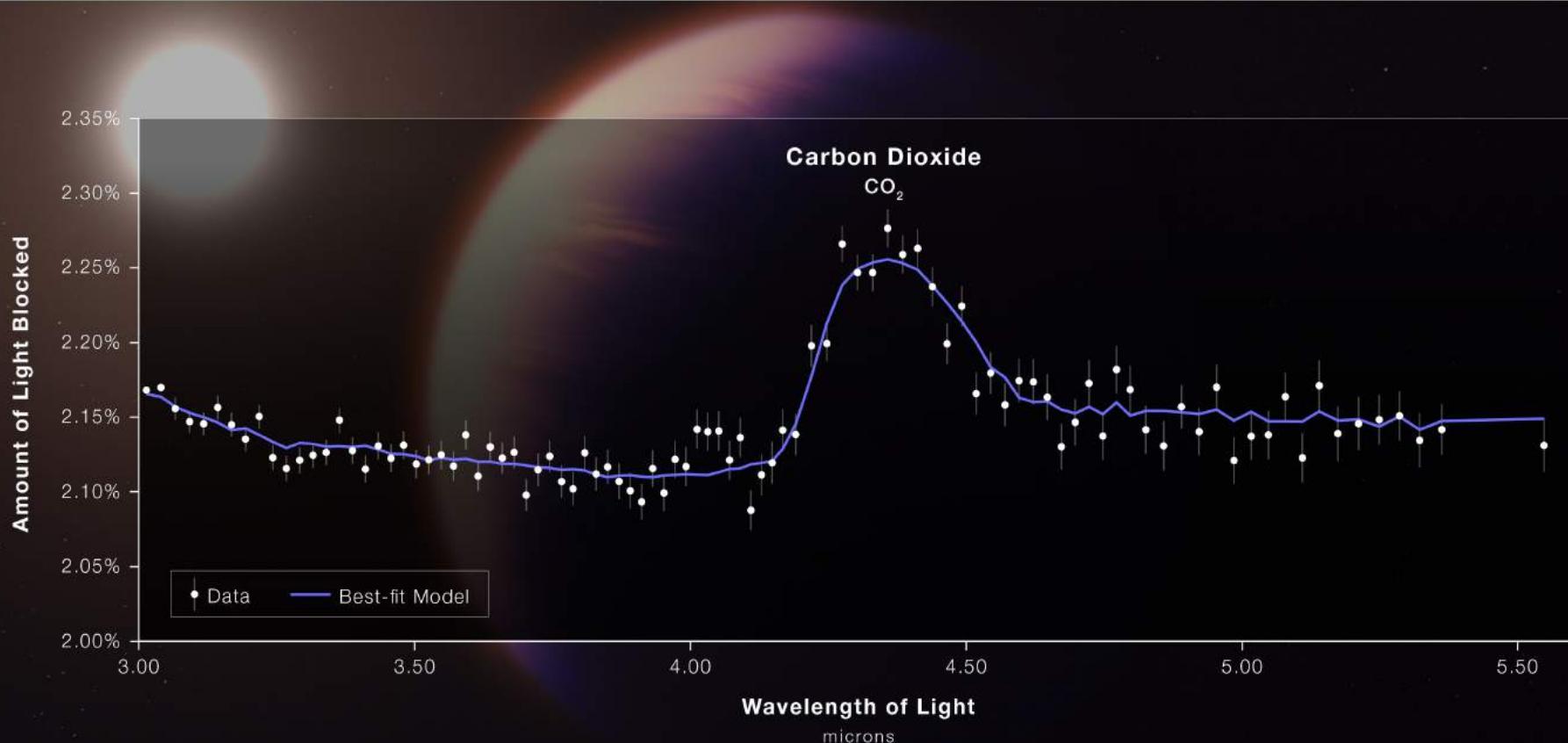
Arp 220 – zrážka galaxií



hmlovina



ATMOSPHERE COMPOSITION



HOT GAS GIANT EXOPLANET WASP-39 b

ATMOSPHERE COMPOSITION

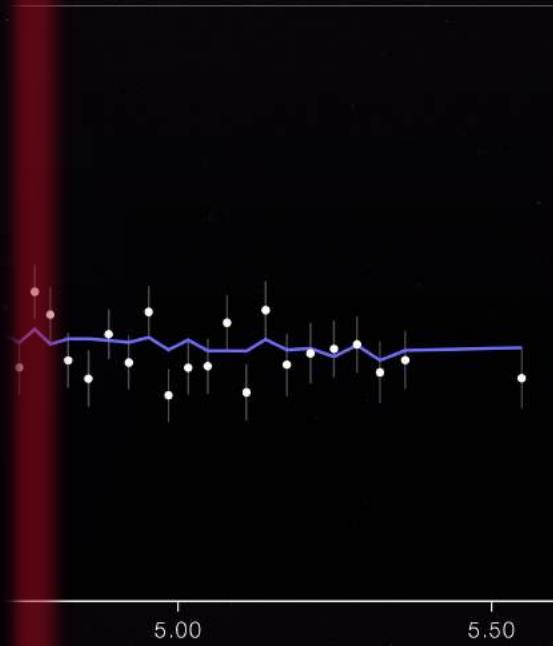
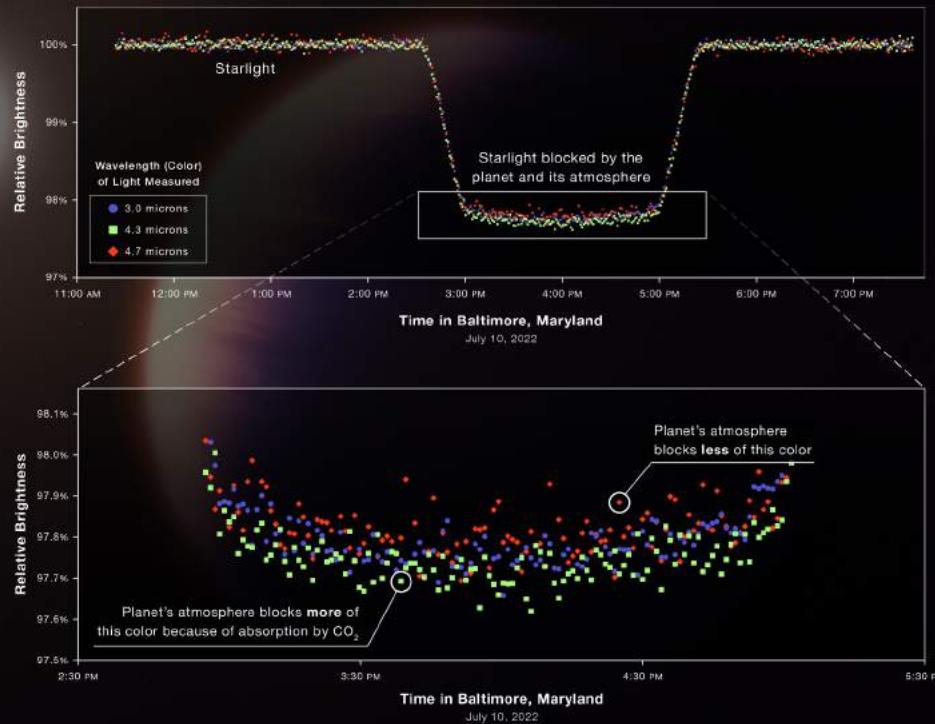
HOT GAS GIANT EXOPLANET WASP-39 b

TRANSIT LIGHT CURVE

NIRSpec

| Bright Object Time-Series Spectroscopy

NIRSpec | Bright Object Time-Series Spectroscopy



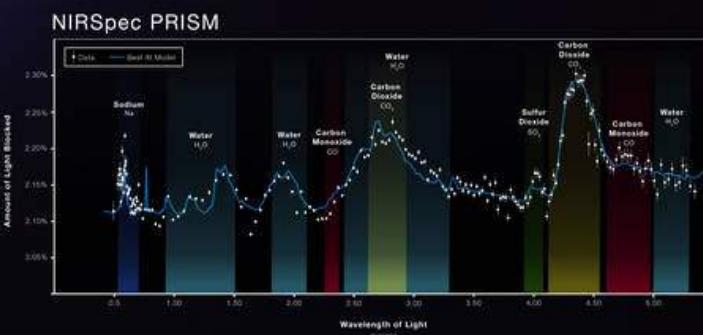
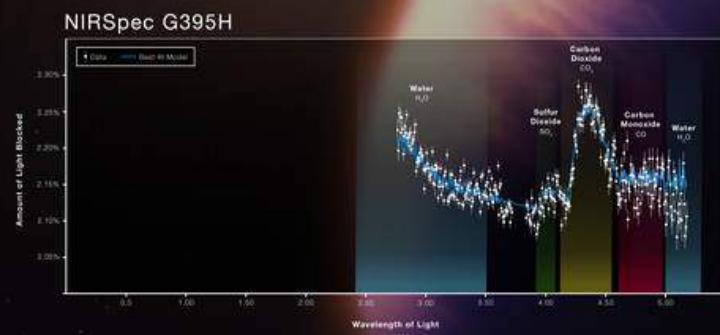
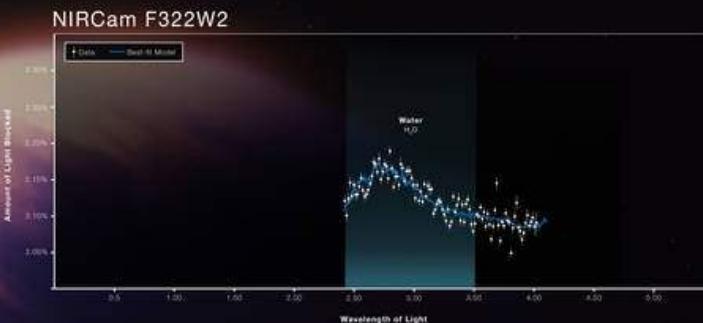
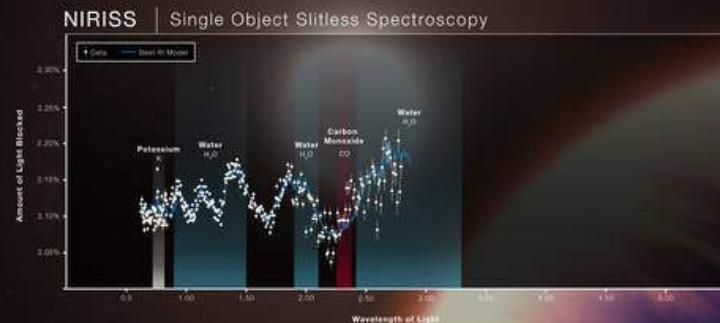
WEBB
SPACE TELESCOPE

WEBB
SPACE TELESCOPE

HOT GAS GIANT EXOPLANET WASP-39 b

ATMOS
HOT GAS
TRAN

HOT GAS GIANT EXOPLANET WASP-39 b ATMOSPHERE COMPOSITION

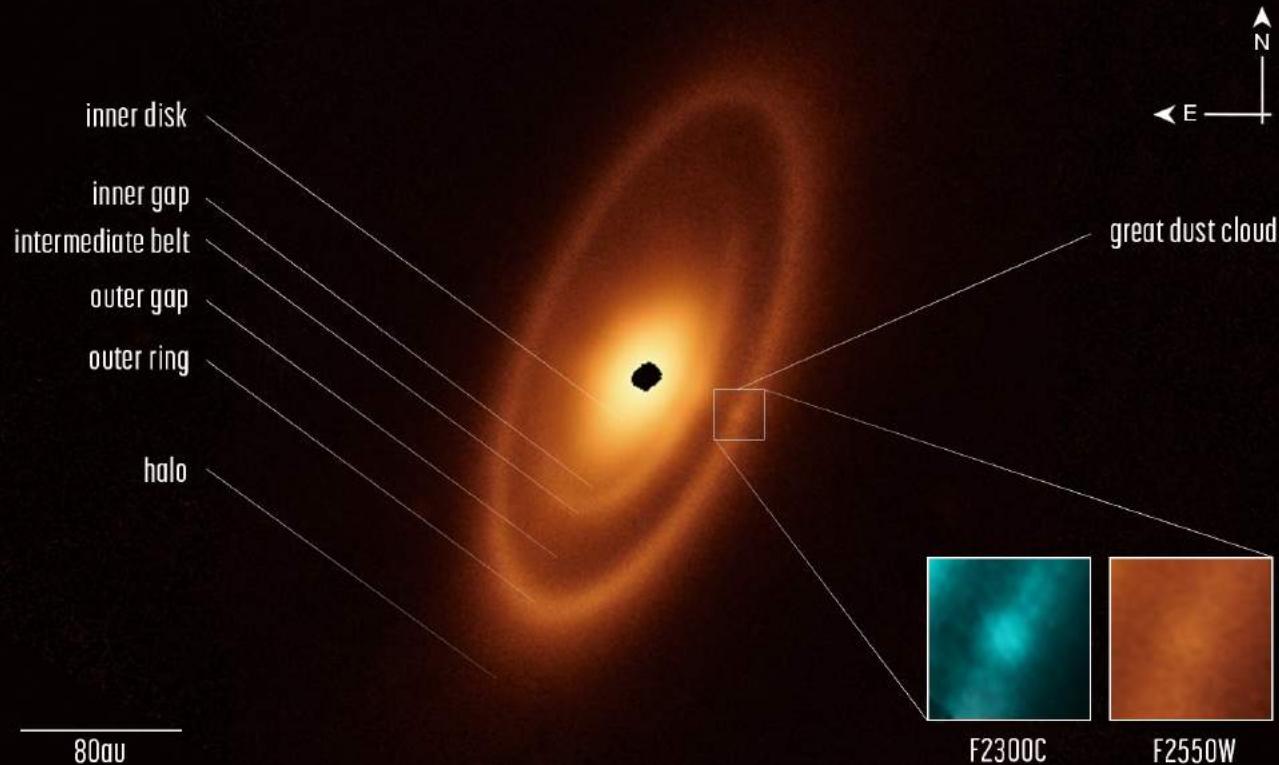


Spectroscopy

WEBB
SPACE TELESCOPE

WEBB
SPACE TELESCOPE

JAMES WEBB SPACE TELESCOPE
FOMALHAUT



MIRI Filters

F2550W



3

JAMES

FON

NGC 1433

interme

8

MIRI Filters

F2550W



3

JAMES

FON

interme

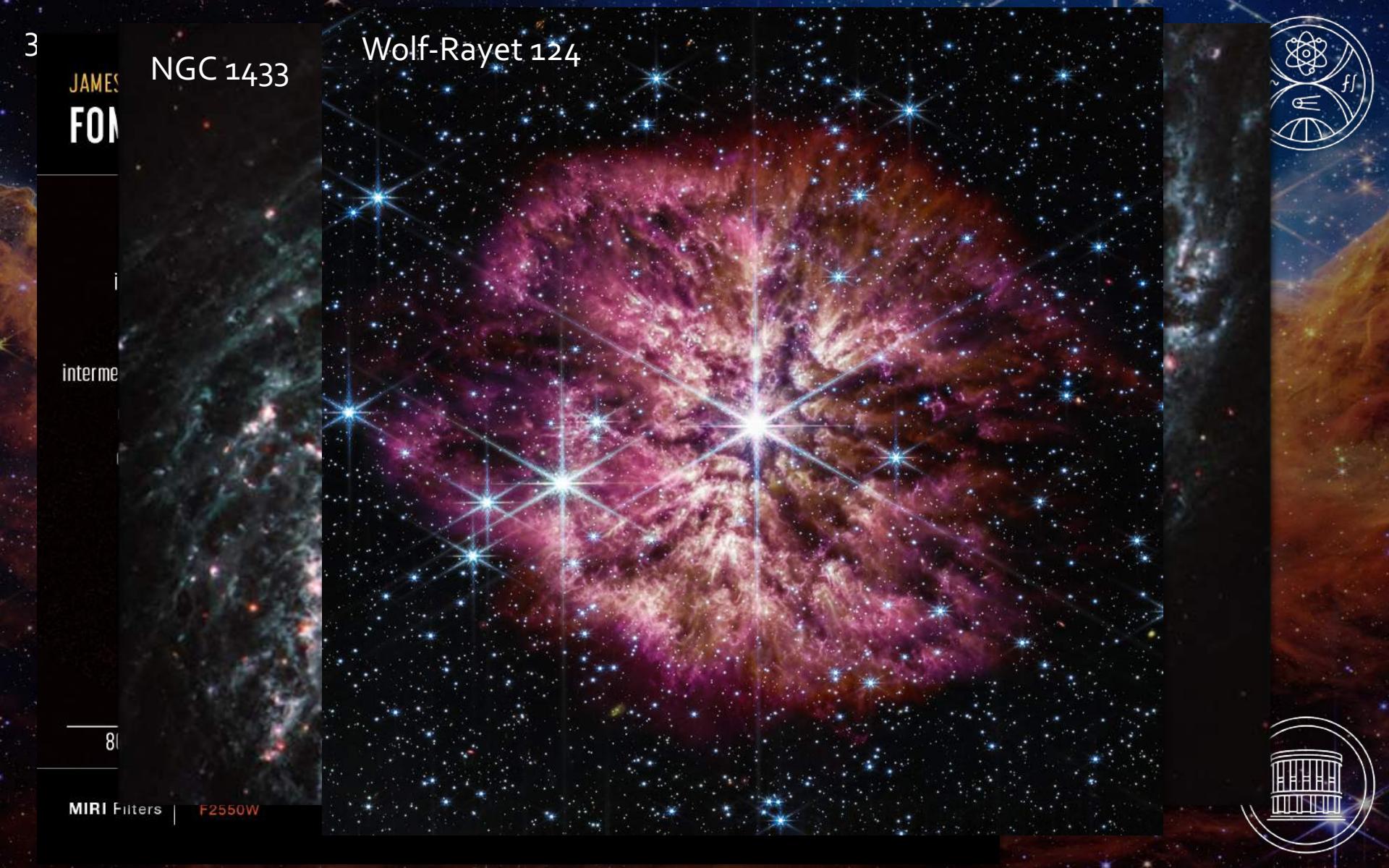
81

MIRI Filters

F2550W

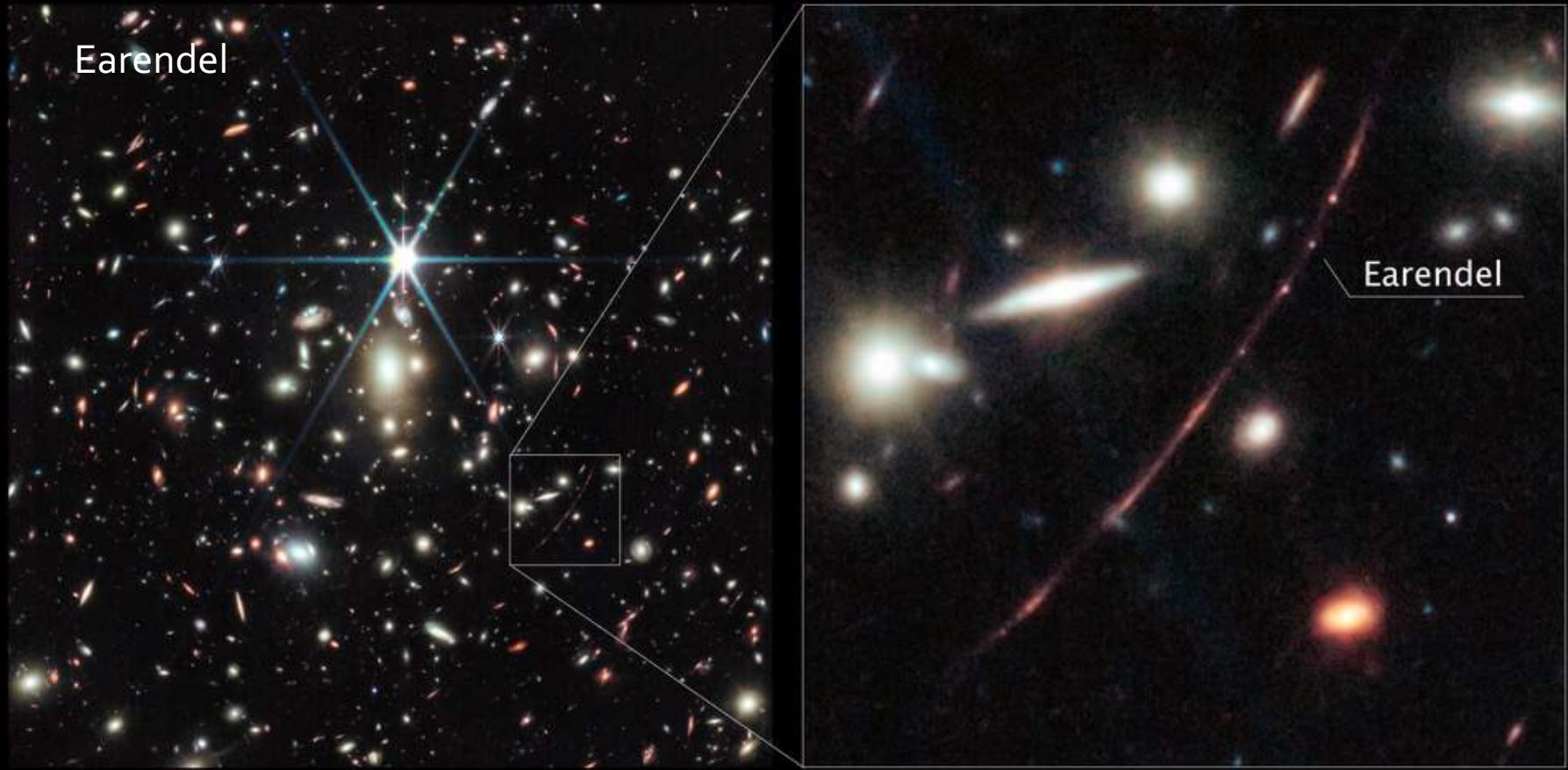
Wolf-Rayet 124

NGC 1433





Earendel



35

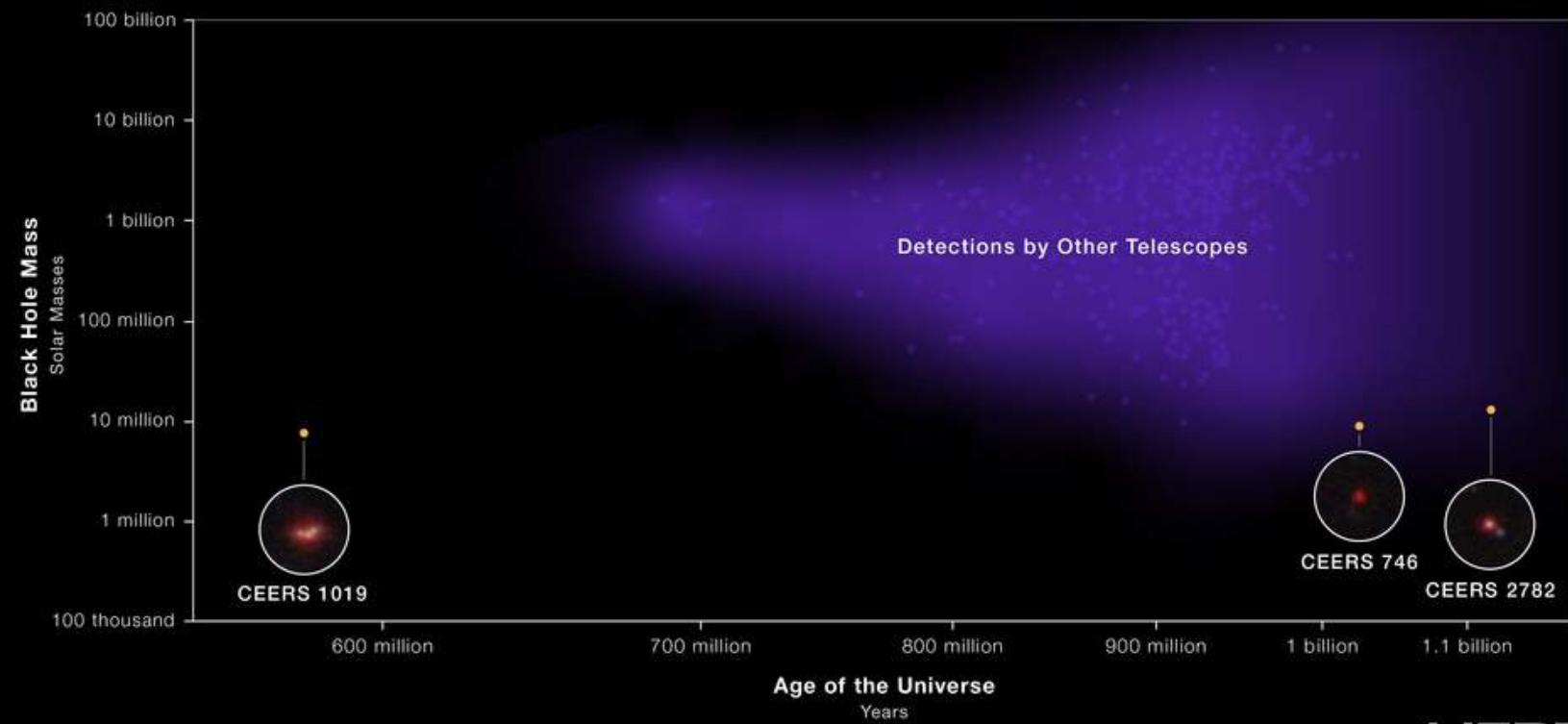
1st anniversary

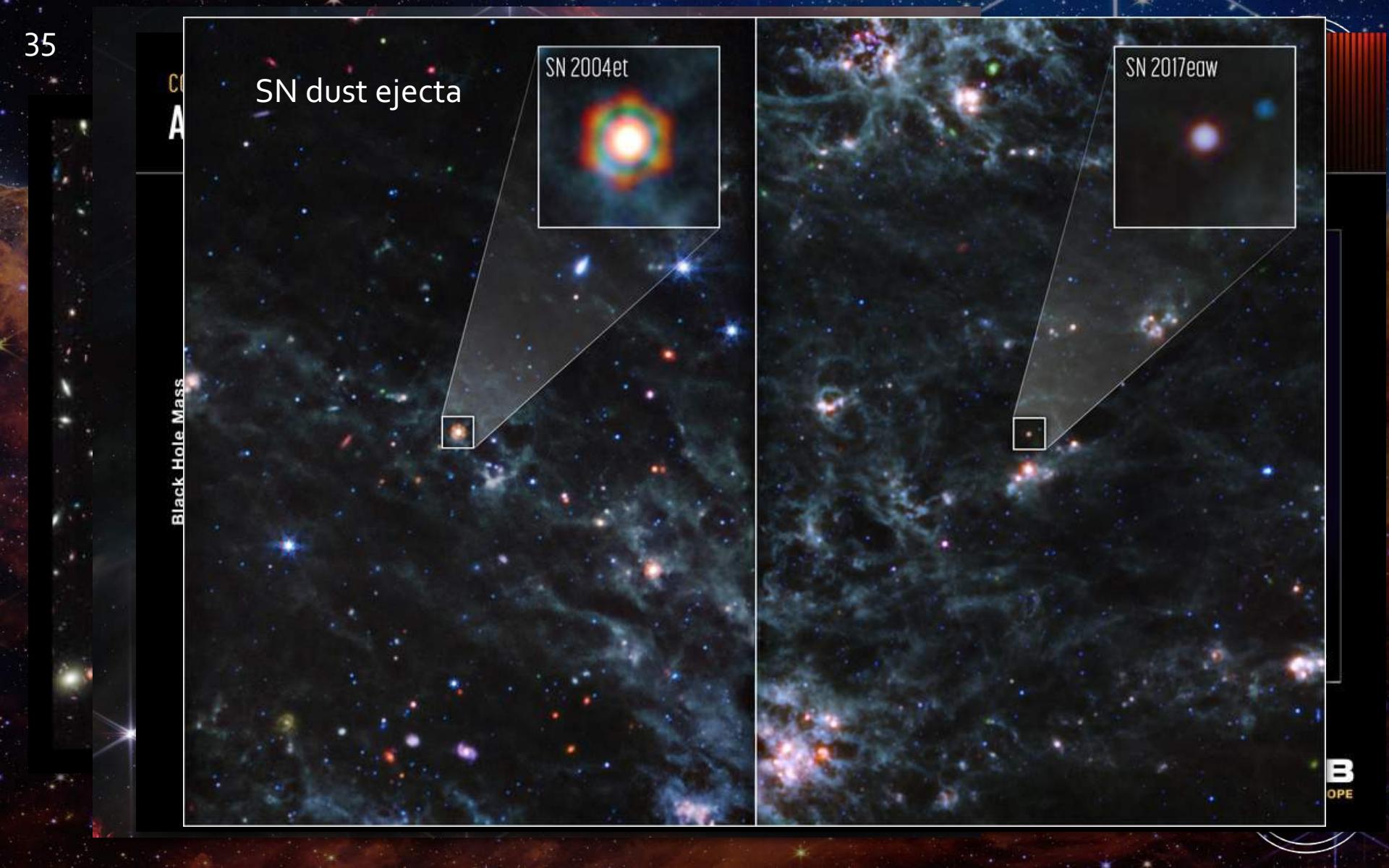


COSMIC EVOLUTION EARLY RELEASE SCIENCE (CEERS) SURVEY

ACTIVE SUPERMASSIVE BLACK HOLES ACROSS COSMIC TIME

AGNs

**WEBB**
SPACE TELESCOPE



NGC 346



NGC 1672



M74



M16





DIVISION OF ASTRONOMY AND ASTROPHYSICS

Faculty of Mathematics, Physics and Informatics
Comenius University
Bratislava



ďakujem za pozornosť

roman.nagy@fmph.uniba.sk



European Collaborating Astronomer Projects: Espana-Czechia-Slovakia – Erasmus + Key Action 2

- Štúdium štruktúry galaxie Mliečna cesta pomocou GAIA dát a testovanie teórií gravitácie v galaktickom disku – VEGA 1/0761/21

@roman.nagy33

