Special Topics in Observational Astrophysics

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General rationale

Borrowed from a similar course offered to GS in Princeton, the goals of this course are three-fold:

- Learn astrophysical topics beyond your own area of research.
- Improve your English, especially reading and speaking English.
- Develop and improve your skills for scientific presentation.

Introduced to THCA/DoA in 2017 Fall.

Became a formal course as part of the PhD curriculum since 2018 Fall.

Faculty rotate to teach this course, serving the same goal with varying formats.

Format

One main theme broken up into multiple topics (usually one topic per week), mainly contributed from DoA faculty, who will serve as your faculty contact.

Choose your topic (i.e., week) over the Tencent doc (other than your area of expertise), with typically 2-3 students per week forming a group.

The goal is to provide a review of the topic, with each student talking for 20 minutes + 10 minutes of Q&A (individual talks should be self-contained).

Start to prepare the talk in English 2+ weeks in advance! You, as a group, should be in touch with each other and the faculty contact over this period!

At the talk, the audience will provide feedback through a questionnaire.

Participation

All 2nd and 3rd yr graduate students should attend and give talks.

First year graduate students should attend the seminar. Also encouraged to give talks but not required.

Enrollment: the last time you attend this course (typically 3rd year)

Undergraduate students: if you enroll in this course, you must give a talk.

Elements to give a good talk

- Structure: make a story

  Provide enough research background with motivation: why this is interesting?

  Logic chain, take-home messages, back-up slides.

  Understand what you are talking: ask yourself questions as if you were in the audience.

- Individual slides: good visibility

  Good selection of figures (make sure the audience can read the axis!).

  Never put in too much text or equations (leave keywords, use your speech).

- Speech and gestures: be attractive

  Make pauses, make eye contact.

  Practice! Practice! Practice! (content, fluency, timing)

Suggested questionaire

	糟糕	凑合	一般	良好	优秀
提供了足够的背景知识介绍和充分的研究动机 逻辑清晰，结构合理 有明确的Take-home message 报告人对内容有充分的准备和理解 PPT图片选用合理，呈现清晰 PPT文字呈现得当 对PPT内容的讲解清晰 英语表达清晰流畅 擅用抑扬顿挫，体态得当，同听众有眼神交流 时间把控到位					
具体的意见/建议：					

Summary of your timeline

- 2+ weeks in before your talk: preliminary reading, coordinate with your teammates and faculty contact on individual talks.
- 1+ week in before your talk: construct a preliminary draft talk and start to iterate.
- 2-3 days in advance: present to the faculty contact for comments, so as to further polish/optimze the talk. Practice, practice, practice!
- Before your presentation: make the questionaire and attach the QR code to the final slide.

Special Topics in Observational Astrophysics, 2023/02/24

Science with JWST

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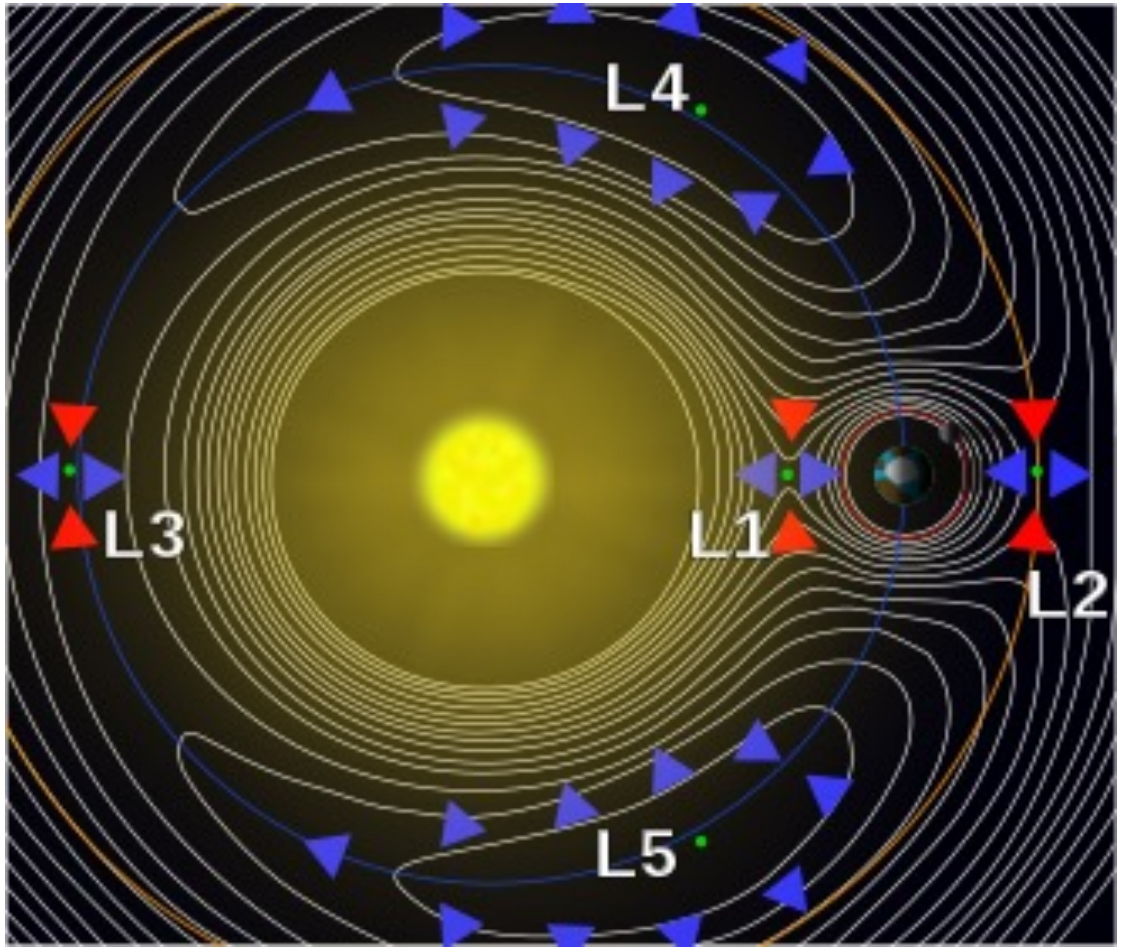
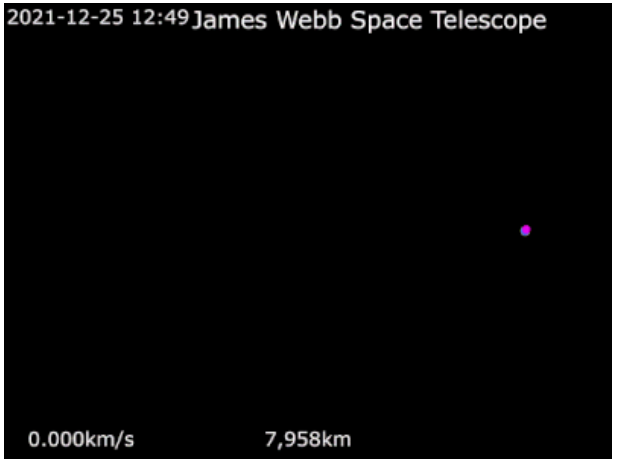
History

- Original mission concept in 1989, STScI workshop on *The Next Generation: A 10 m Class UV-Visible-IR Successor to HST*.
- 1990 Decadal survey: recommendation of 6m cooled space telescope as a successor to Hubble (Next-Generation Space Telescope, NGST).
- Idea of NGST further developed in the 1990s, around 8m flying to L2.
- Received highest ranking in the 2000 decadal survey, rescaled to 6.5m in 2001, named after James Webb in 2002.
- Construction started in 2003, passed major technical reviewsin 2007, 2010, assembled in 2016, launched on Oct. 12, 2021.

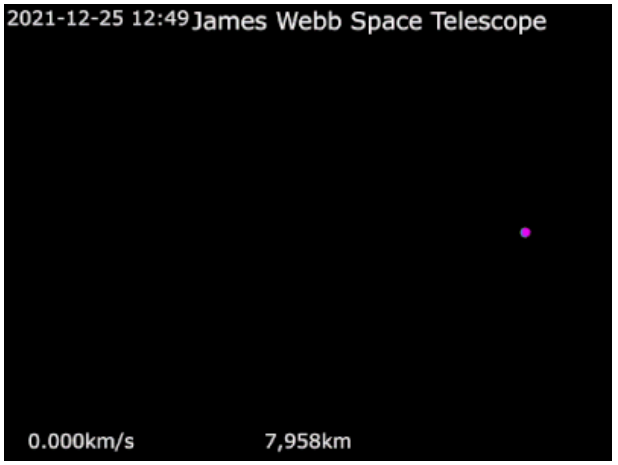
Orbit (Earth-Sun L2)



Source: wikipedia



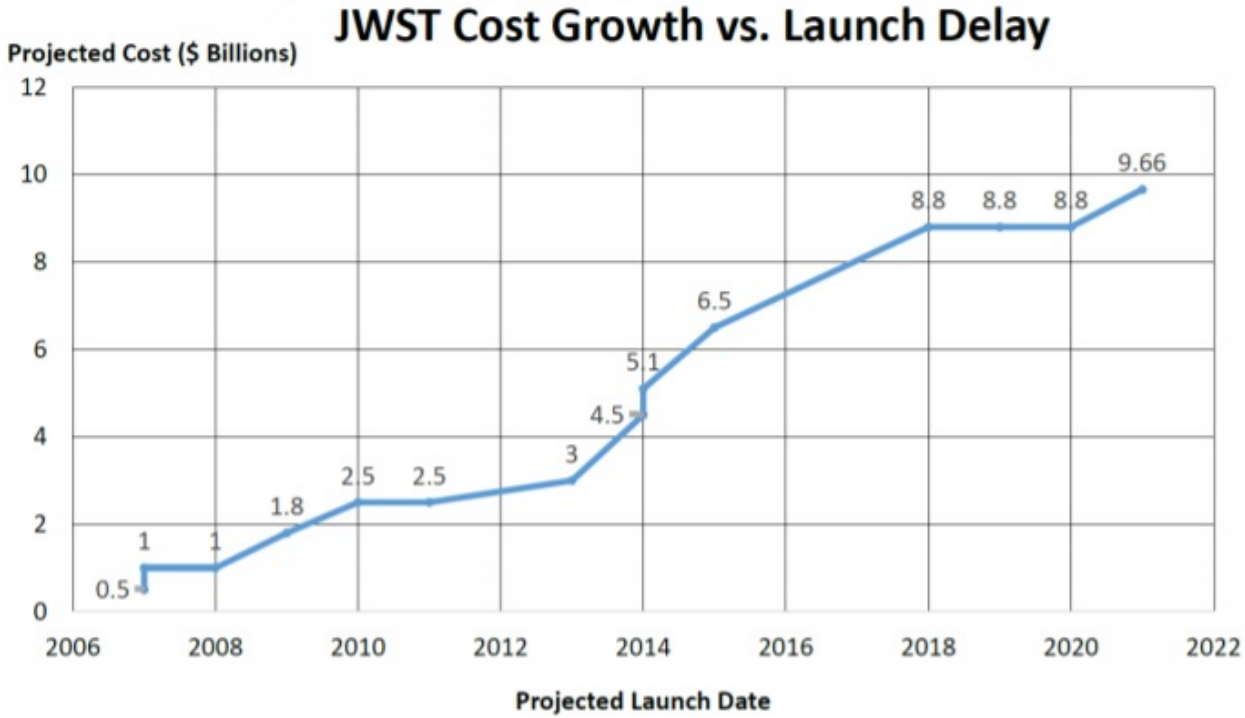
Top view



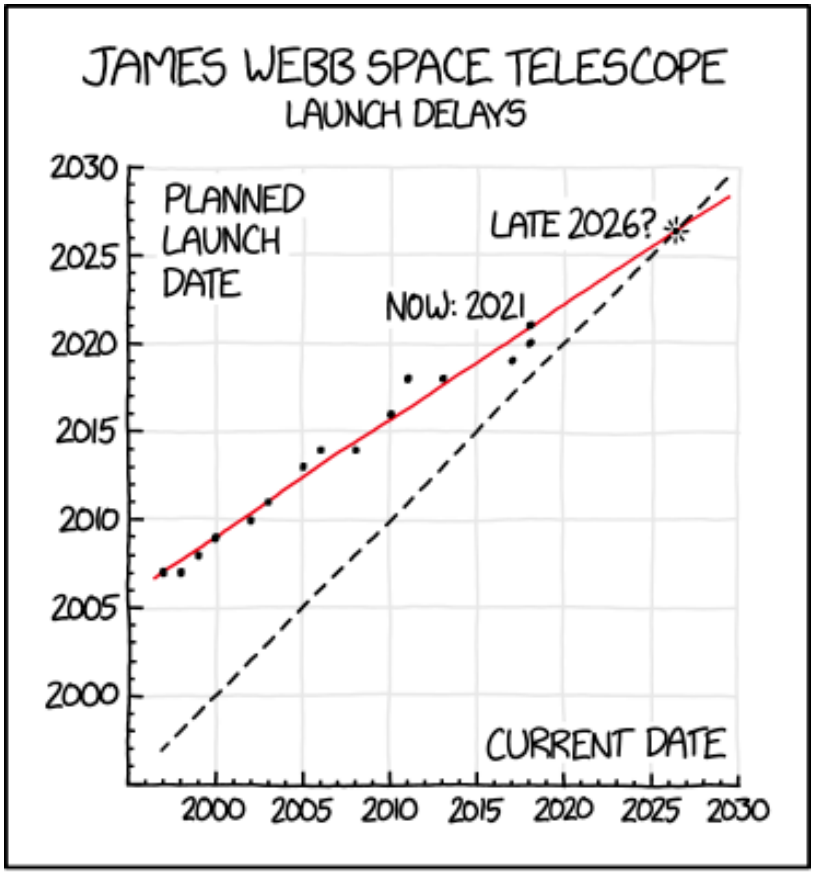
Side view

Budget and scheduling

[JWST cost and schedule delay chart]

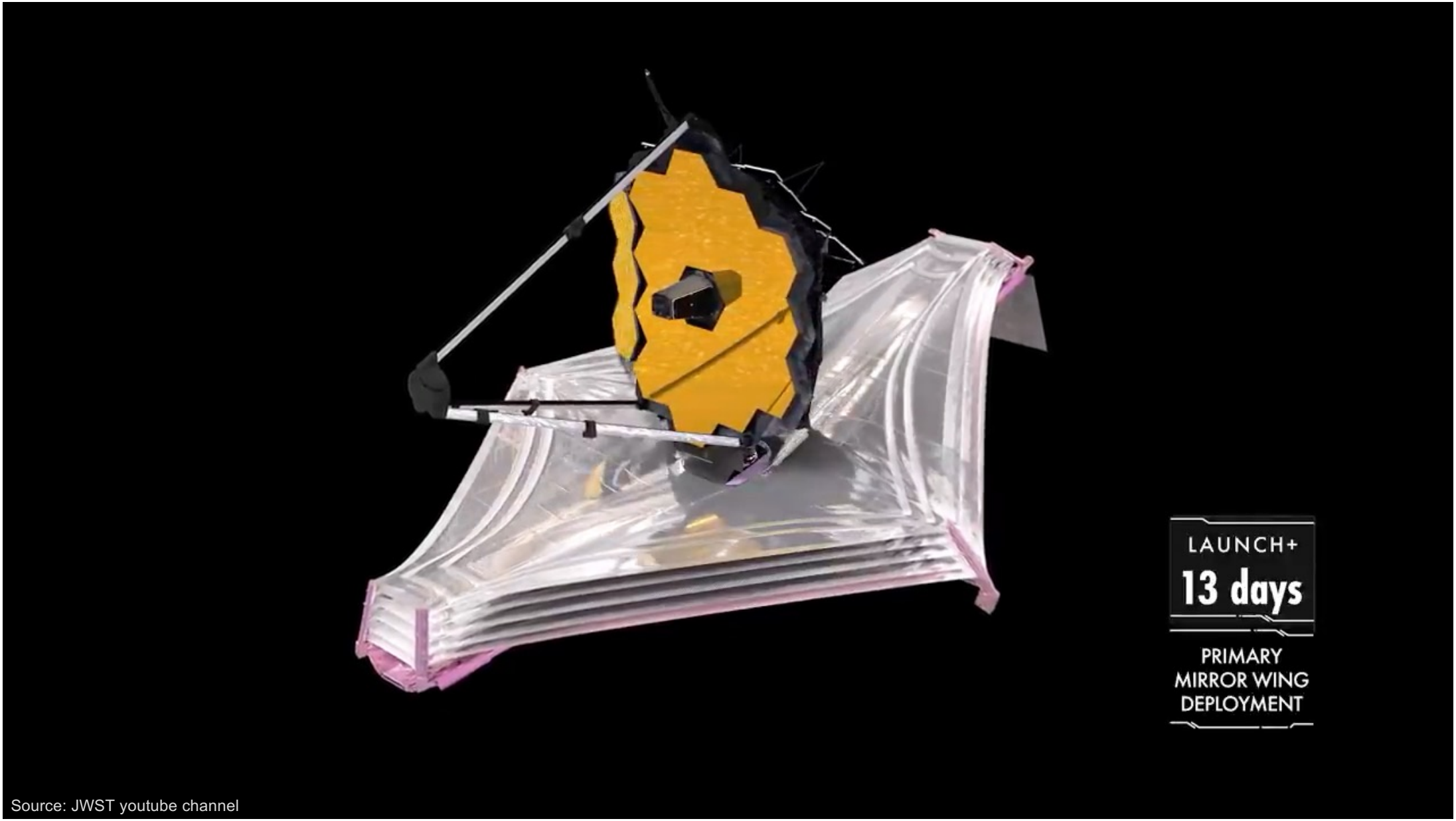


JWST swallows a good fraction of NASA astrophysics budget.

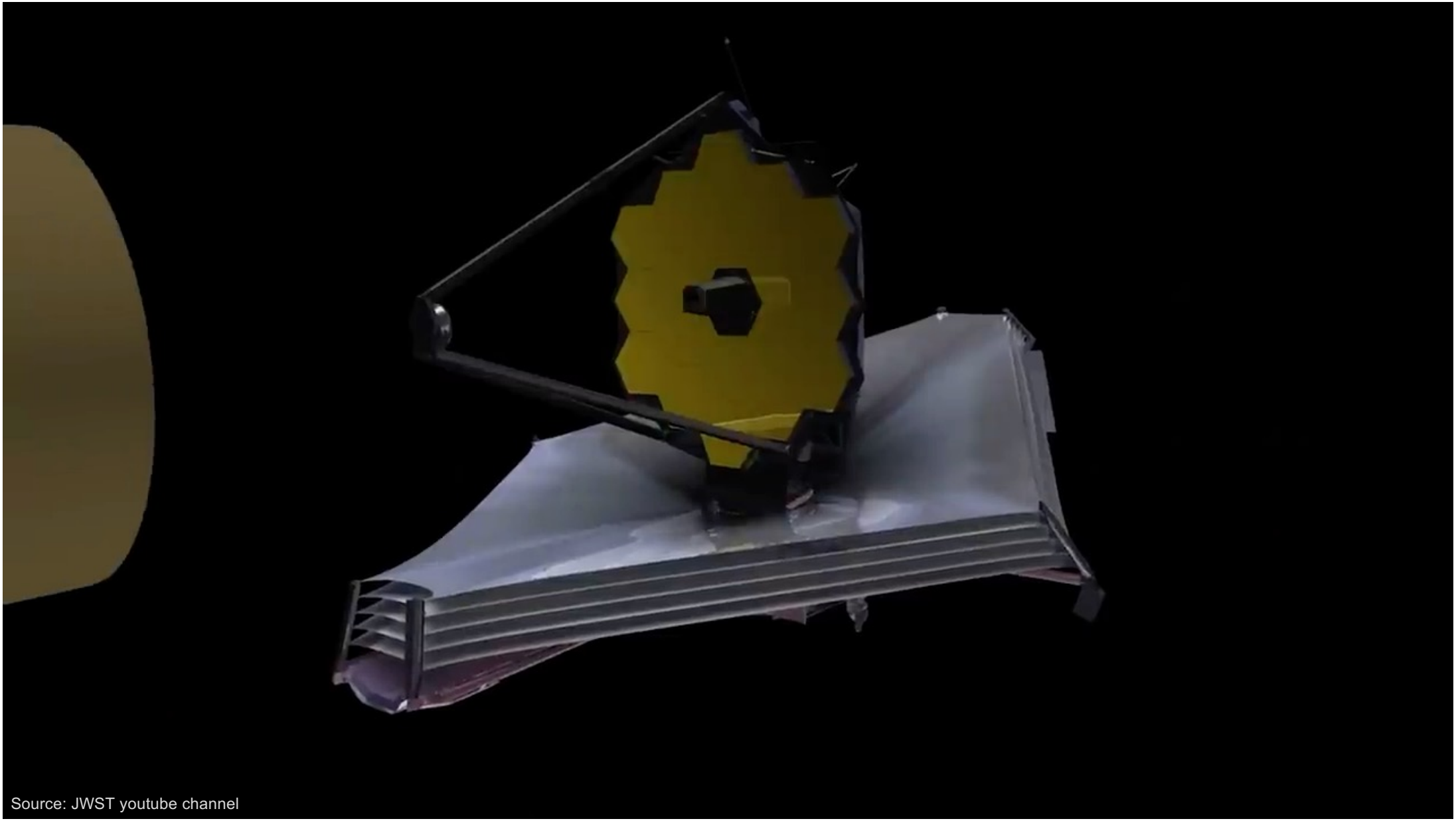


LOOK, AT LEAST THE SLOPE IS LESS THAN ONE.

dating 2018



Source: JWST youtube channel


Source: JWST youtube channel

The JWST instruments

Installed in the “Integrated Science Instrument Module” (ISIM), including:

- Near-Infrared Camera, or NIRCam (0.6-5 micron, two 2.2’x2.2’ FoV)

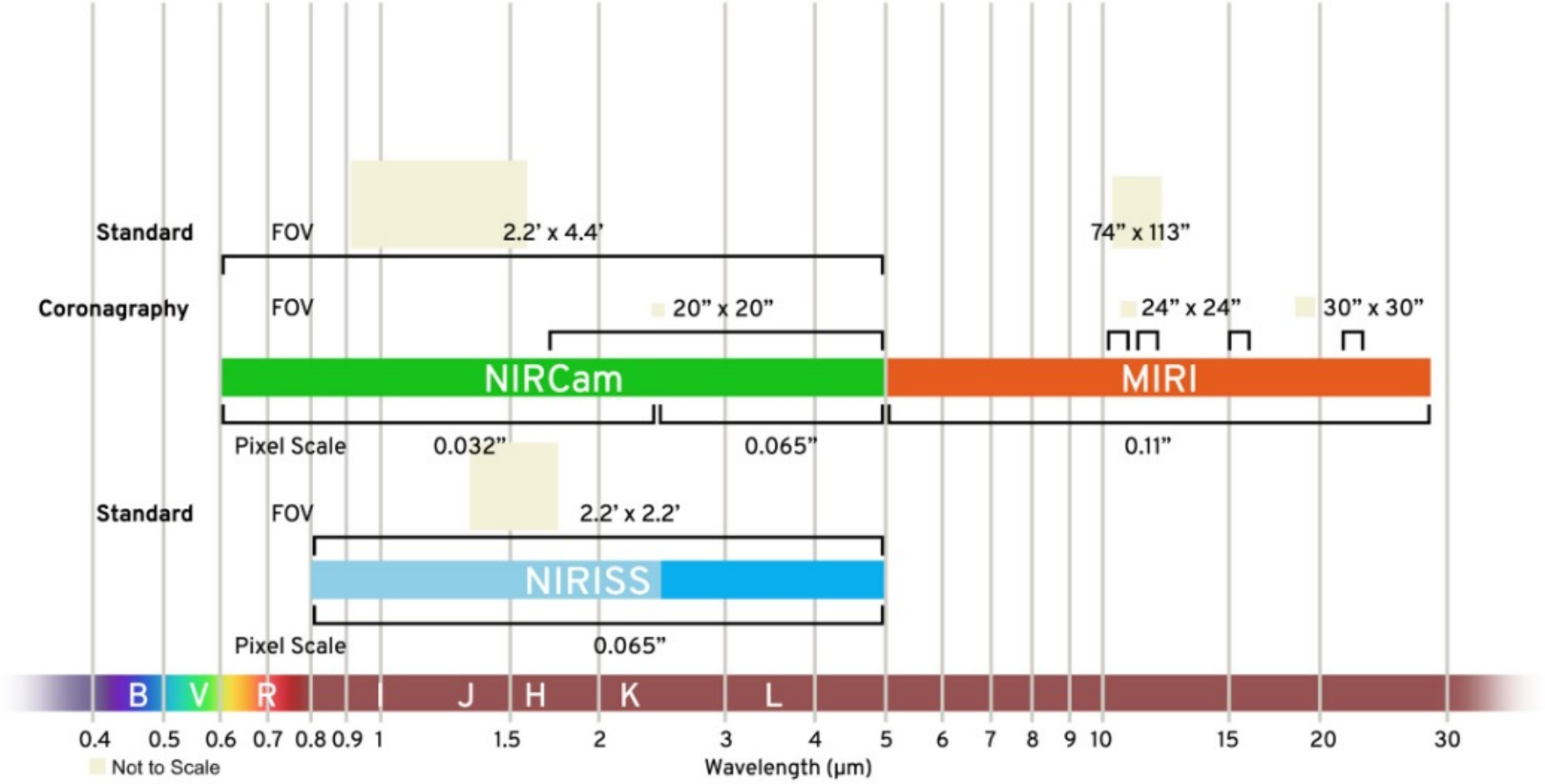
  Two Cams, can also do slitless spectroscopy and coronalgraphy
- Near-Infrared Spectrograph, or NIRSpec (0.6-5.3 micron, 3.6’x3.4’ FoV)

  Single-slit, integral field, and multi-object, resolution R=100, 1000, 2700
- Near Infrared Imager and Slitless Spectrograph, or NIRISS (0.6-5 micron, 2.2’x2.2’ FoV)

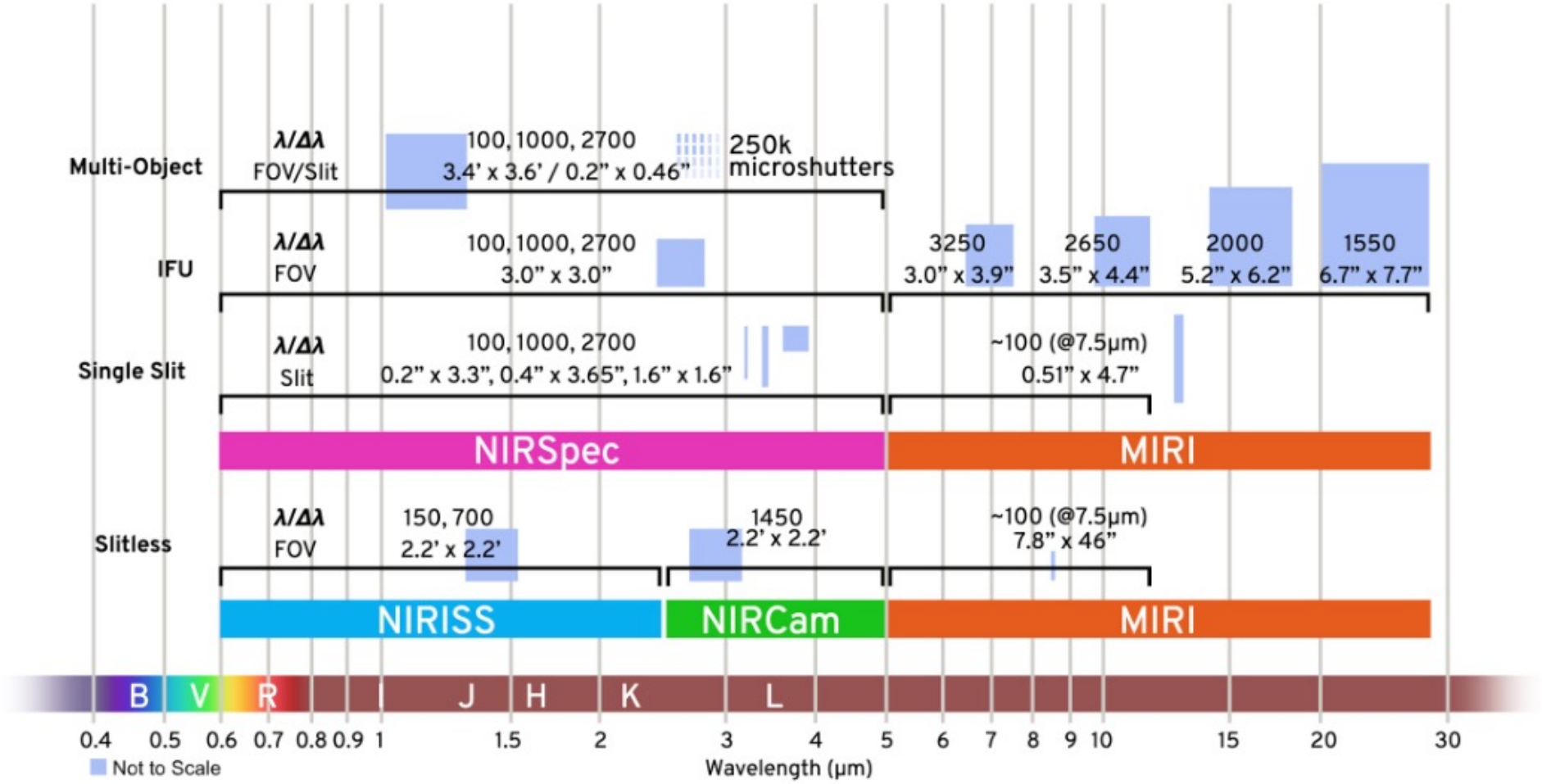
  Single-object mode and wide-field slitless mode
- Mid-Infrared Instrument, or MIRI (5.0-27.5 micron, 1.23’x1.88’ FoV)

  Versatile, can do imaging, low-res slit/slitless spectroscopy, coronography

Imaging mode



Spectroscopic mode

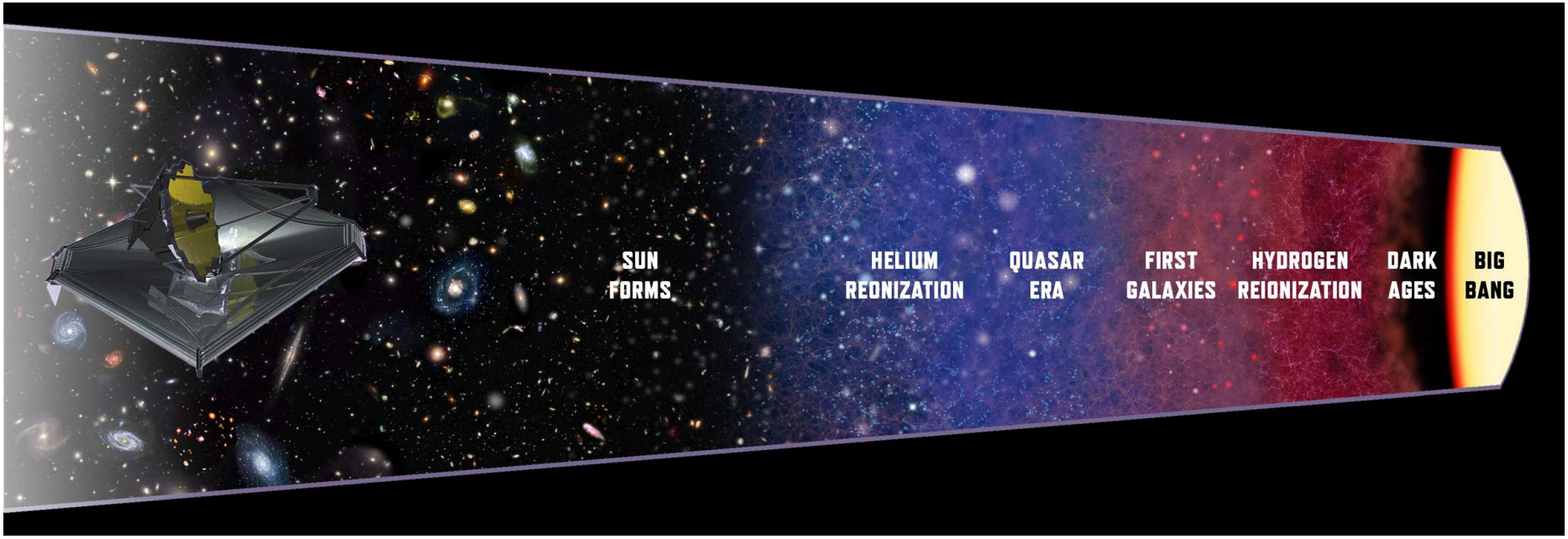


Comparison with other telescopes

Telescope	Years active	Aperture (m)	Wavelength (micron)	Cooling
Hubble	1990-	2.4	0.1-1.7	Passive and thermoelectric
Spitzer	2003-2020 (warm mission in 2009+)	0.85	3-180 (<4.5 after 2009)	Helium and later passive
Herschel	2009-2013	3.5	55-672	Helium
JWST	2021-	6.5	0.6-28.5	Passive and cyrocooler (MIRI)


Credit: NASA's Goddard Spaceflight Center
Source: Launch Pad Astronomy youtube channel.

The end of the dark ages: First light & reionization

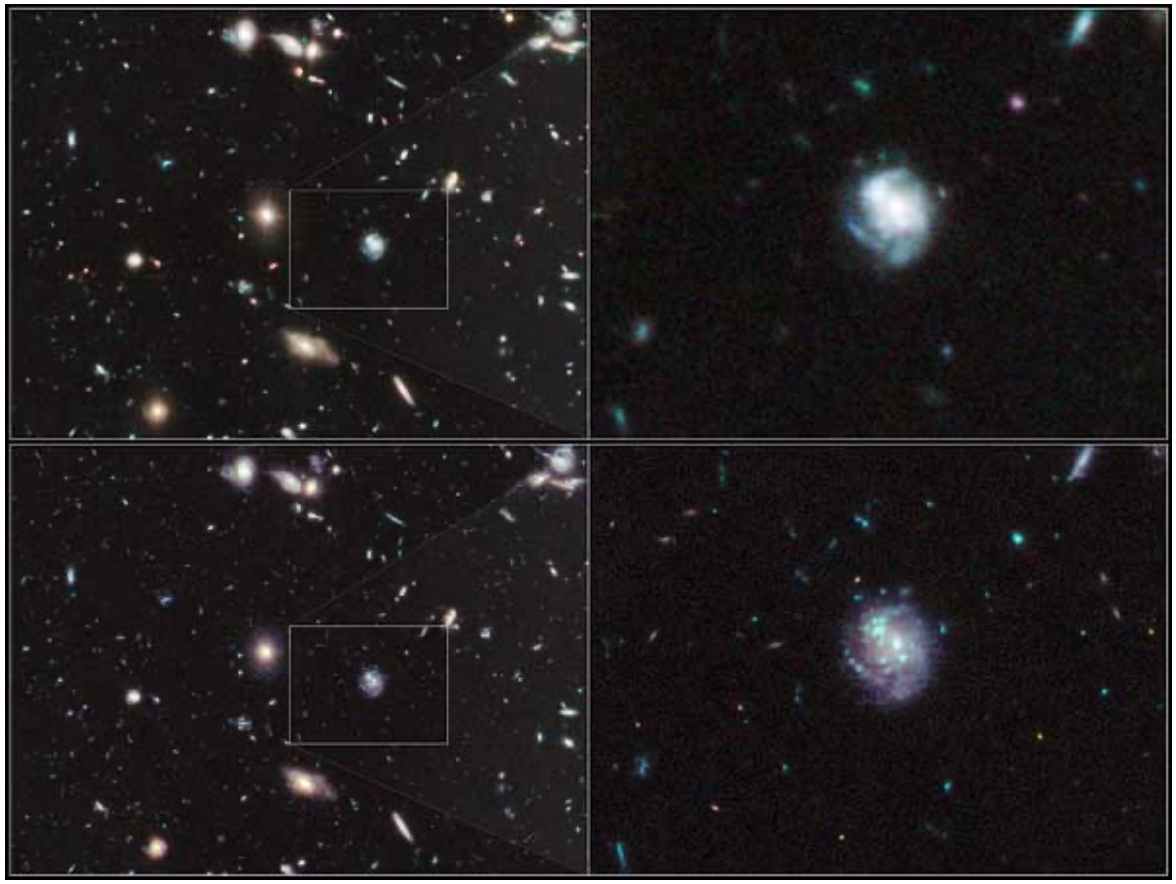


When and how did first stars and the first AGNs form? Weeks 3,4,12,16

What are the first galaxies?

When and how did reionization occur, and what caused reionization?

Assembly of galaxies



Hubble (top) and (simulated) JWST images (bottom)

How exactly are galaxies formed?

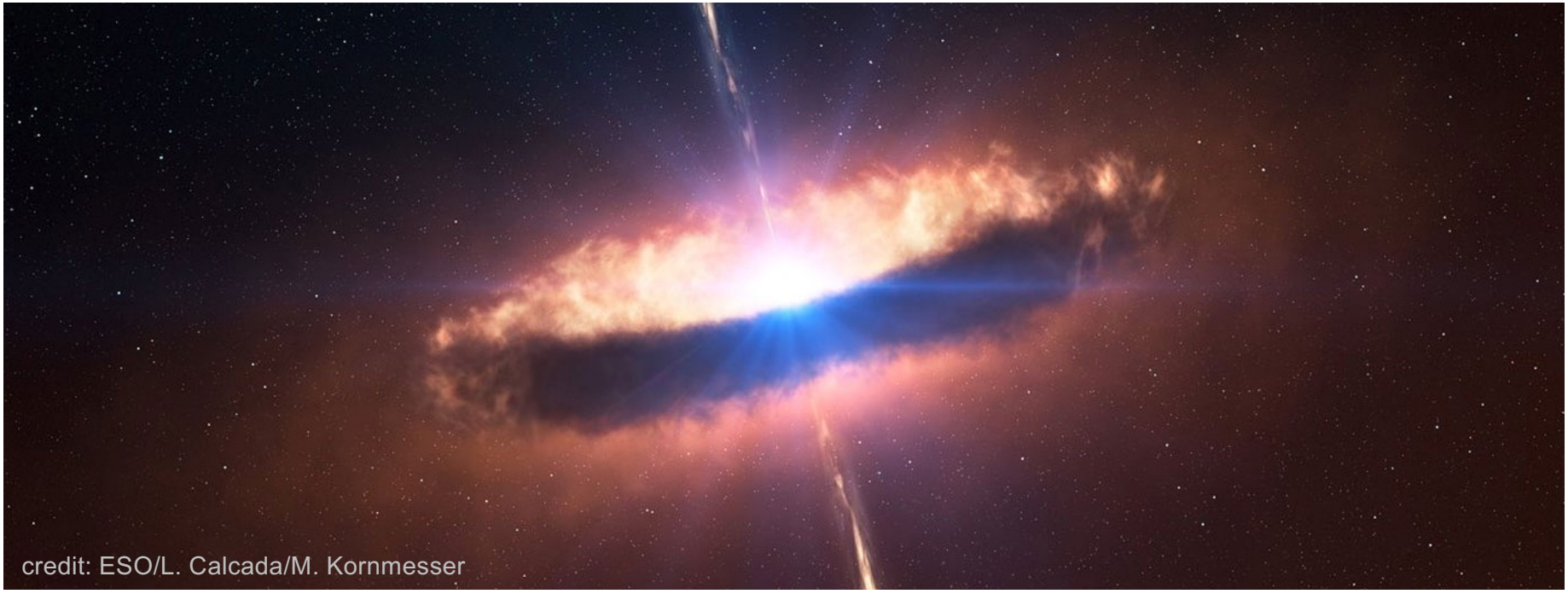
What makes them form stars?

How chemical elements are generated and redistributed?

What are the role of the central black hole, and global environments?

Weeks 2,8,9,10,13,15

Birth of stars and protoplanetary systems

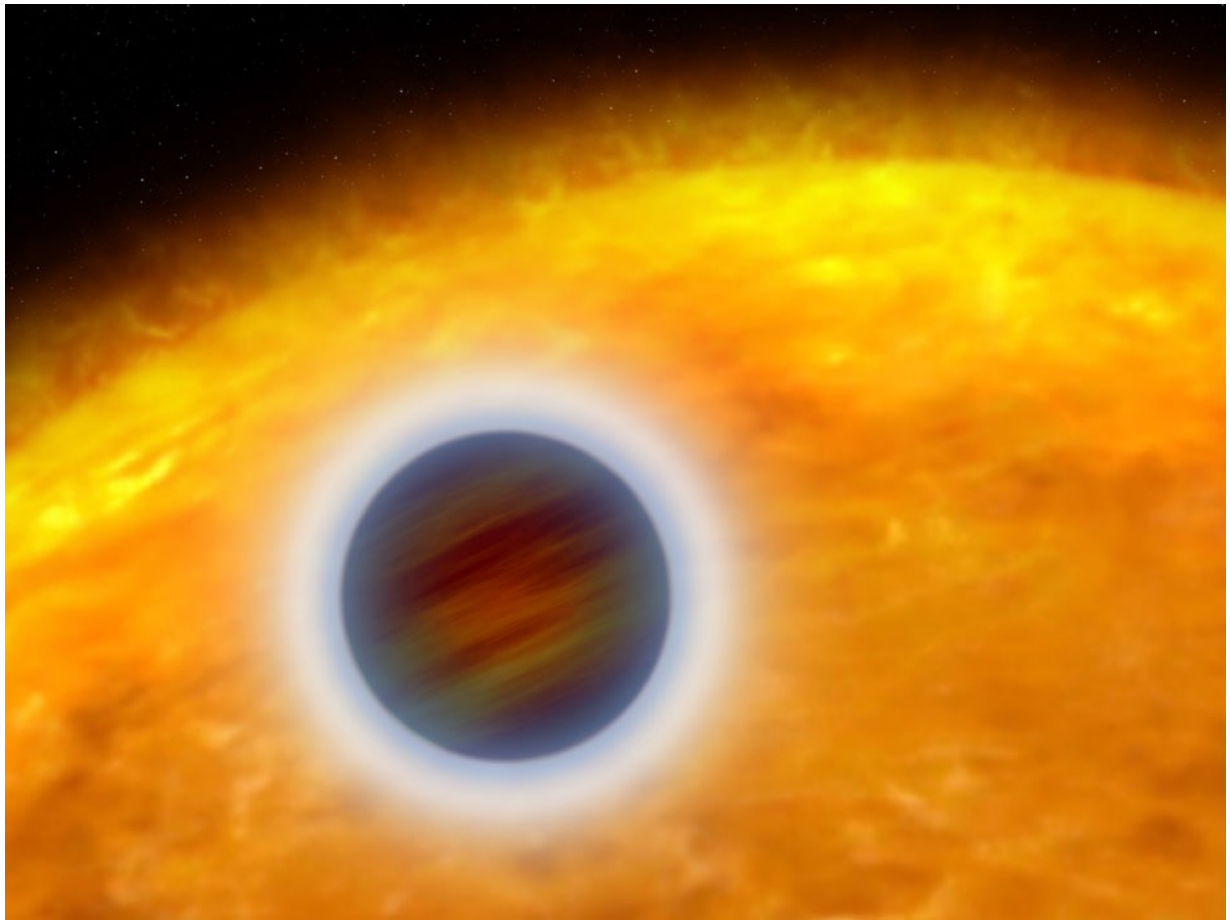


How exactly do stars and disks form from molecular clouds?

What are the structure, compostion and kinematics of protoplanetary disks?

What are the properties of forming planets? Week 6

Planetary systems and origins of life



What is the giant planet population at the outer planetary system?

What are the composition of planetary atmospheres?

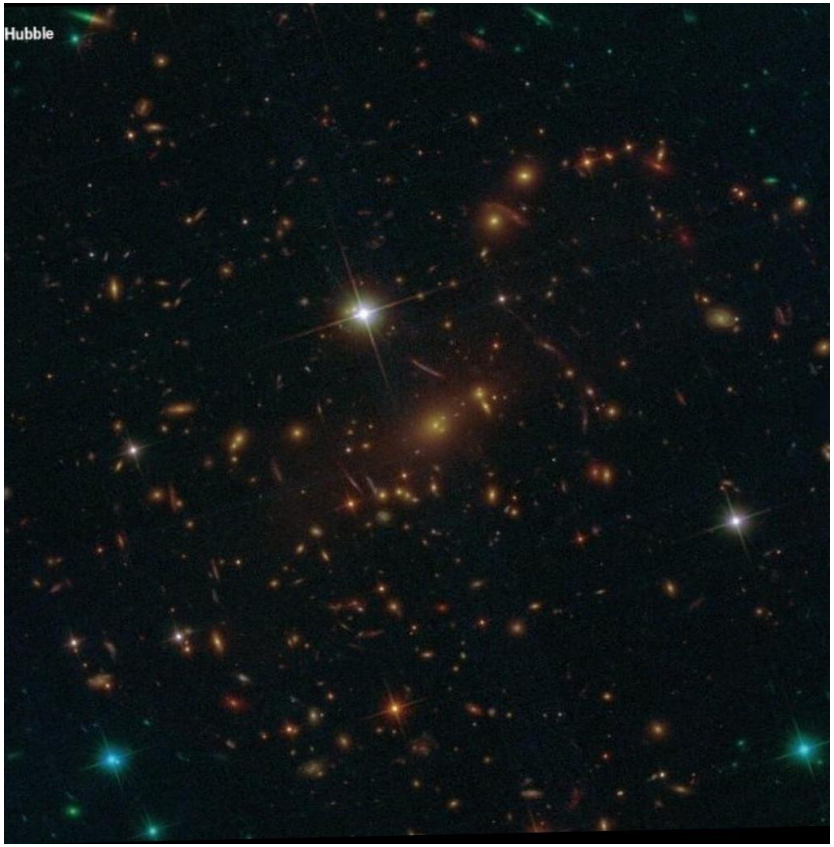
Can we find bio-signatures among Earth-like planets?

Weeks 5,7

JWST first deep field

Galaxy cluster SMACS J0723.3-7327 at z=0.39

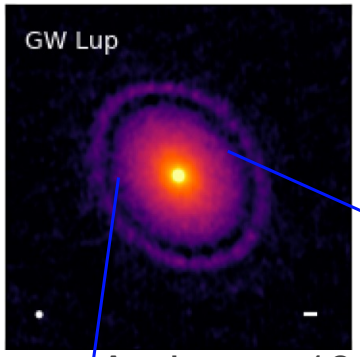
z=16 galaxy in the background?



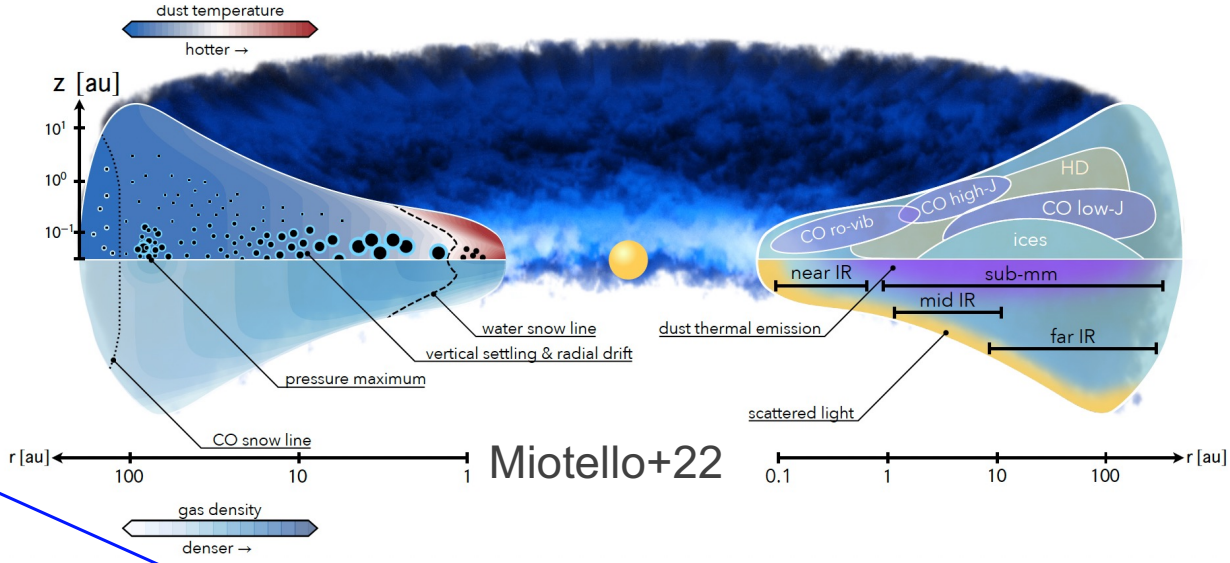
Hubble deep feeld, 2 weeks

JWST NIRCam 12.5h

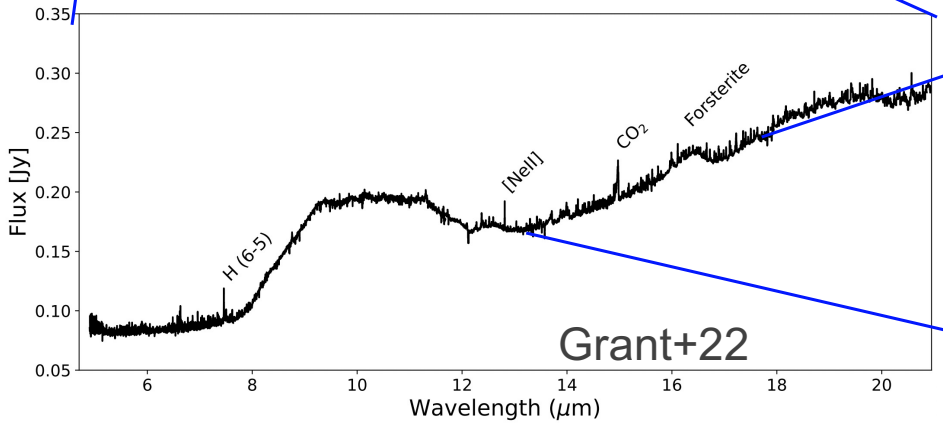
Molecular lines from protoplanetary disks



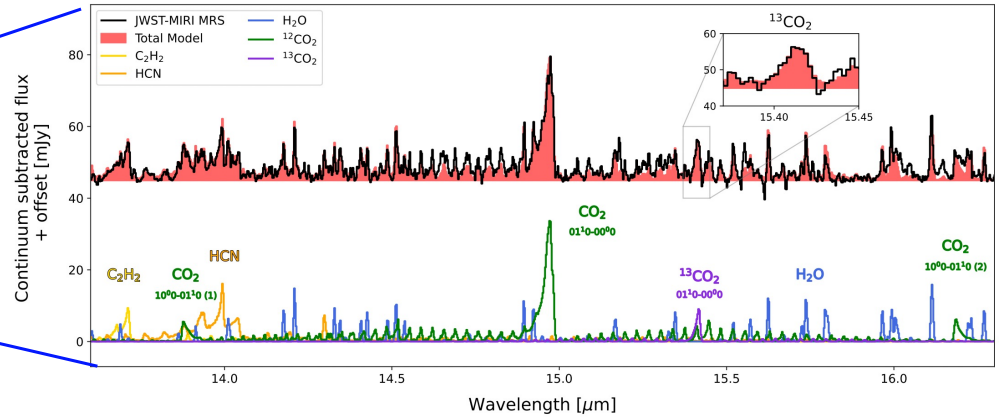
Andrews+18



Miotello+22



Grant+22

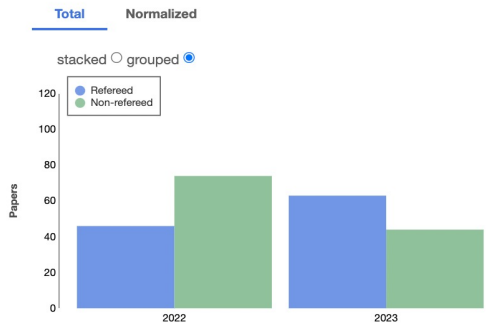


JWST papers

JWST papers on galaxy observations:

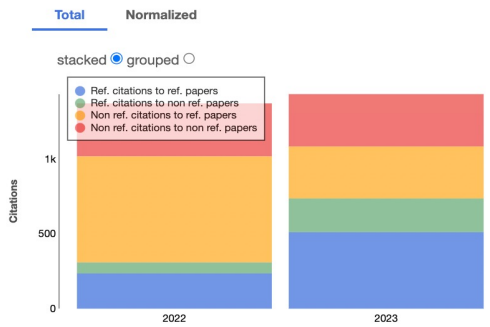
Papers

	Totals	Refereed
Number of papers	227	109
Normalized paper count	23.8	12.5



Citations

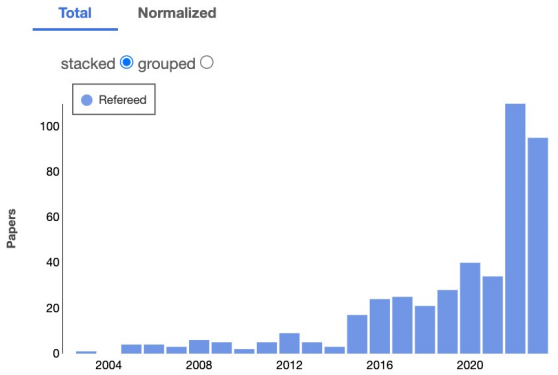
	Totals	Refereed
Number of citing papers	429	388
Total citations	2810	1806
Number of self-citations	1886	1187
Average citations	12.4	16.6
Median citations	5	7
Normalized citations	307.1	161.1
Refereed citations	1048	748
Average refereed citations	4.6	6.9
Median refereed citations	2	4
Normalized refereed citations	110.1	63.9



All papers with “JWST” in the title:

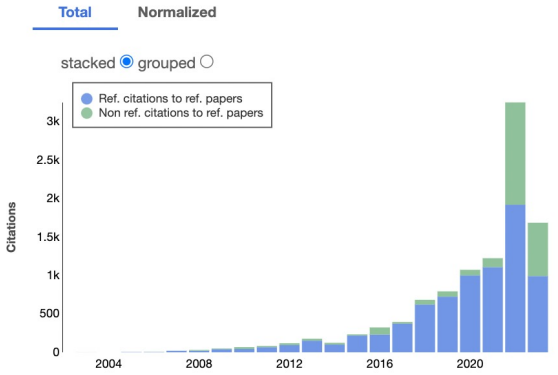
Papers

	Totals	Refereed
Number of papers	441	441
Normalized paper count	94.9	94.9



Citations

	Totals	Refereed
Number of citing papers	4745	4745
Total citations	10328	10328
Number of self-citations	2064	2064
Average citations	23.4	23.4
Median citations	9	9
Normalized citations	1579.2	1579.2
Refereed citations	7708	7708
Average refereed citations	17.5	17.5
Median refereed citations	5	5



Any problem with my talk?

提供了足够的背景知识介绍和充分的研究动机
逻辑清晰，结构合理
有明确的Take-home message
报告人对内容有充分的准备和理解

PPT图片选用合理，呈现清晰
PPT文字呈现得当
对PPT内容的讲解清晰

英语表达清晰流畅
擅用抑扬顿挫，体态得当，同听众有眼神交流
时间把控到位

Sample feedback form

Finally, let's decide on the schedule

Guiding principles:

- 1. Ensure every week is filled by at least 2 students.
- 2. Respect the students' preferences.
- 3. Priority goes to those who sign up early.

Algorithm:

1. If there are only two students or less available for one topic, they are all set.
2. If your first choice is within the first two blocks of a topic, you are all set.
3. Once a student is set, remove his/her other choices, and move others up.
4. Repeat the above until getting stuck. Then go for 2nd choice and repeat.
5. The last couple students without assignment should fill the gaps.