Science Case Studies - Instructions

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Introduction

- Simulate science cases with different observing modes
- Not everybody will get their favorite topic but the process is more important
- Will make use of things learned in previous sessions (Target Visibility Tool, ESASky, ETC, …)
- **Goal:** To have a fully planned observing strategy for your specific science case
- **ALL material (APT, ETC, Guides,…) will be available online after the workshop!**

Science Cases and Tables - Session 1 **(Day 2 - 14:35)**

1	2	**1.1** MIRI LRS slit observations high-z galaxy
3	4	**1.2** Metalicity gradients with NIRCam/NIRISS imaging
5	6	**1.3** Brown dwarfs with NIRSpec slit
7	8	**1.4** Pillars of creation/ star formation with MIRI IFU/Imaging

Science Cases and Tables - Session 2 **(Day 3 - 09:35)**

1	2
3	4
5	6
7	8

2.1 Search for high-redshift galaxies with NIRCam in pure parallel mode

2.2 Feeding and feedback of SMBHs with NIRSpec/MIRI IFU

2.3 TSO observations with NIRISS, NIRSpec and MIRI

2.4 Nearby galaxy photometry

Science Cases and Tables - Session 3 **(Day 3 - 11:35)**

1	2	**3.1** Brown dwarfs in SF clusters
3	4	**3.2** NIRSpec MOS of distant galaxies
5	6	**3.3** Deep NIRCam survey
7	8	**3.4** NIRISS lensed cluster observations

Science Cases and Tables

1	2	FS	IMA	MOS
3	4	IMA	IFS	MOS
5	6	FS	TSO	IMA
7	8	IFS	IMA	Slitless

1.1 High-z galaxy

Goal	This program aims at obtaining MIRI LRS spectra of SMMJ123616.15+621513.7, an **Ultra Luminous Infrared Galaxy at redshift 2.578**. The resulting spectra (5-12 microns) will measure the hot dust through PAH features such as those at 6.2, 7.7 and 8.6, and 11.3 μm
Methodology	Spectral extraction of MIR spectra, lines fitting and spectral templates fitting.
Observations	**MIRI LRS**
Source Type	Faint distant galaxy
Analysis Technique	Spectral extraction

1.2 Metalicity gradients

Goal	This program aims at deriving the **spatial metallicity gradient on M87**, one of the largest elliptical galaxies in the Virgo cluster, using NIR colors of stars as resolved with JWST NIRCam and NIRISS.
Methodology	Perform stellar photometry and construct NIR color-magnitude diagrams (CMDs). The CMDs will provide information on the metallicity of the stellar populations.
Observations	**NIRCam Imaging** (both channels) **NIRISS in parallel**
Source Type	Point sources (stars)
Analysis Technique	Photometry

1.3 Brown dwarfs

Goal	To obtain spectroscopic **observations of a Y dwarf across the entire JWST NIRSpec wavelength range** to understand whether these atmospheres are shaped by chemical disequilibrium driven by vertical transport or the formation of water clouds, and constrain the object's gravity, hence mass.
Methodology	Compare high-quality NIRSpec spectra in low (from 0.6 to 5.3 micron) and medium (from 2.87 to 5.27 micron) resolution, to models of cool atmospheres at different temperatures, gravity, degrees of turbulence, chemical equilibrium or disequilibrium driven by vertical transport, and clouds.
Observations	**NIRSpec fixed slit spectroscopy**
Source Type	Point source
Analysis Technique	Spectral extraction

1.4 Pillars of creation/star formation

Goal	**To spatially resolve the structure of a HII/PDR/Cloud interface in many atomic, molecular, PAH and dust features.**
Methodology	Integral Field Spectroscopy of an extended and bright Photo Dissociation Region. The rich MIR spectra will uncover a wealth of emission lines, dust features and warm dust continuum that will be used to diagnose UV flux and physical conditions. MIR imaging in a few selected PAH and warm dust emission filters will provide information to understand the environment.
Observations	**MIRI MRS** in all spectral bands and **MIRI imaging** in three filters
Source Type	Extended
Analysis Technique	Spectral analysis and modeling, photometry of extended sources.

2.1 Search for high-redshift galaxies (pure parallel)

Goal	This program aims at **detecting high-redshift galaxies** with NIRCam taking advantage of the JWST **pure parallel** observing capabilities. Pure parallel observations are "part of distinct, separate programs that use parallel observing slots derived from separate accepted primary proposals." (find more details in JDocs)
Methodology	Perform deep photometry with several sets of NIRCam filters, sampling the blue and red sides of the Balmer break at different redshifts.
Observations	**NIRCam Imaging**
Source Type	Faint distant extended sources.
Analysis Technique	Photometry

2.2 Feeding of supermassive black holes

Goal	**To determine the physical conditions of the inflowing and outflowing gas.** Using NIRSpec and MIRI IFU observations will allow us to quantify mass accretion and mass outflows, and test how much mass will end up being available to fuel the
Methodology	Use rot-vib transition H_2 emission lines to trace the mass, temperature, and kinematics of the molecular gas within 100-200pc of a sample of nearby Seyfert AGN at different accretion efficiencies (Eddington ratios).
Observations	**MIRI IFU Mosaic, NIRSpec IFU Mosaic.**
Source Type	Extended
Analysis Technique	Spectral Analysis

2.3 TSO observations

Goal	**Obtain the transmission spectrum of the atmosphere** of WASP-107b from 0.6 to 12 μm. WASP-107b is a bloated "**Super-Neptune**" with twice the mass of Neptune, but almost the radius of Jupiter. Desired spectral resolution of at least 300 for wavelengths < 5 μm and at least 30 for > 5 μm.
Methodology	Perform time series observations of a transit of WASP-107b with NIRISS, NIRSpec and MIRI.
Observations	**NIRISS Slitless Spectroscopy,** **NIRSpec Bright Objects Time Series (BOTS)** **MIRI Single Object LRS**
Source Type	Exoplanet
Analysis Technique	Time Series

2.4 Nearby galaxy photometry

Goal

This program aims at obtaining NIR imaging data to perform accurate **multi-component galaxy model fitting**, measure surface brightness fluctuations and radial stellar population gradients. Mid-IR observations will detect the presence of a significant intermediate-age component or warm ISM. The program focuses on unresolved emission, as opposed to detecting individual stars.

Methodology

Obtain Near-IR and Mid-IR imaging of Arp220 using a set of filters that will allow studies of the stellar populations and ISM.

Observations

NIRCam and MIRI imaging in several filters.

Source Type

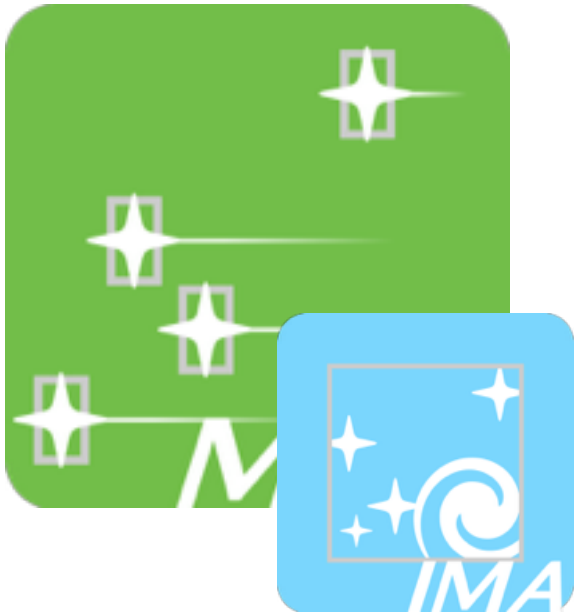
Extended

Analysis Technique

Photometry

3.1 Brown dwarfs in SF clusters

Goal	To improve constraints on the minimum mass of the IMF and search for a spectroscopic signature of formation mechanism by **obtaining near-IR spectra of known brown dwarfs** in the nearby star-forming cluster IC 348 in Perseus.
Methodology	Obtain NIRCam images of the center of IC 348 to identify new candidate planetary-mass brown dwarfs. Follow-up candidates by acquiring NIRSpec low-resolution spectra from 0.6 to 5.3μm to assess their (i) youth and membership to the cluster, (ii) surface gravity, (iii) temperature, and (iv) investigate the presence of heavy elements enrichment as a clue to the formation process.
Observations	**NIRSpec MOS** **NIRCam imaging**
Source Type	Point source (occasionally extended source)
Analysis Technique	Photometry and Spectroscopy



3.2 NIRSpec MOS of distant galaxies

Goal	This program aims at **studying the evolution of galaxies** from its first steps (z>10), through the end of the dark ages (z=7-9) and down to the epoch of galaxy assembly (z=2-6).
Methodology	An in-depth program of this type would combine deep imaging (NIRCam) and follow-up spectroscopy (NIRSpec MOS) like the NIRCam-NIRSpec GTO galaxy assembly survey. This will be simplified to a single "pointing" using an input source catalog derived from existing HST imaging.
Observations	**NIRSpec MOS**
Source Type	Compact Objects (Galaxies)
Analysis Technique	Spectroscopy

3.3 Deep NIRCam survey

Goal

This program will image the **GOODS-S** field to **study galaxy evolution** from the first steps ($z > 10$) through the end of the dark ages ($7 < z < 9$) and the epoch of galaxy assembly ($2 < z < 6$). This survey will construct luminosity functions at the highest redshifts to test galaxy formation models as well as measure the galaxy characteristics (metallicity, star formation, morphology).

Methodology

Image portions of the GOODS-S field with NIRCam and MIRI in parallel with several filters. The survey will cover about 25 sq. arcmin at 30 – 50 ksec depth.

Observations

NIRCam imaging
MIRI imaging in parallel

Source Type

Deep Field

Analysis Technique

Photometry

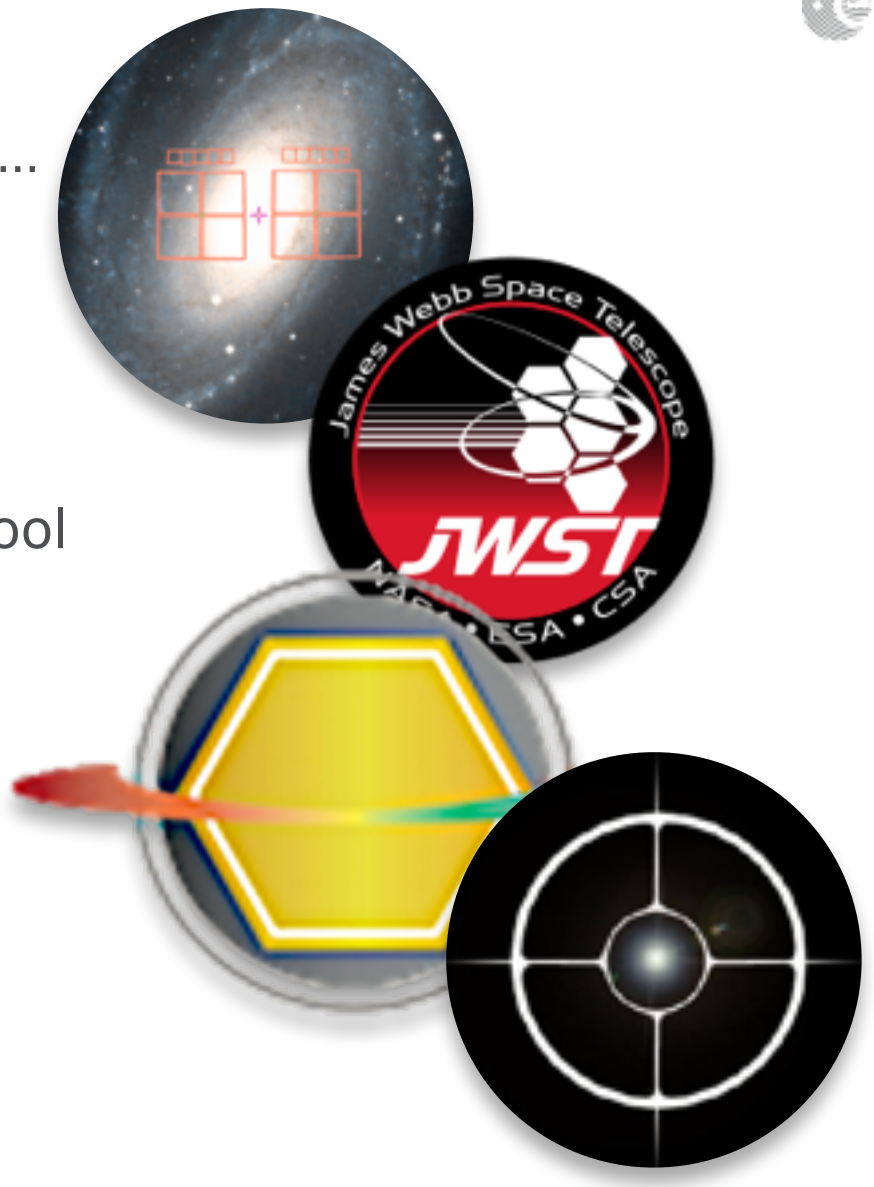
3.4 NIRISS lensed cluster observations

Goal	Using the NIRISS Wide Field Slitless Spectroscopy, its very high multiplexing factor and capability to spatially resolve emission lines, the **Canadian NIRISS Unbiased Cluster Survey (CANUCS)** will achieve several Science Goals: • Detection and Characterization of galaxies within the reionization epoch. • Evolution of low-mass galaxies across cosmic time. • Resolved emission-line maps and line ratios for galaxies in the cosmic noon.
Methodology	The plan is to observe five strong-lensing galaxy cluster fields at $0.37<z<0.55$.
Observations	**NIRISS Slitless Spectroscopy** **NIRCam imaging**
Source Type	Compact Objects (Galaxies)
Analysis Technique	Spectroscopy and Photometry

Strategy

Remember previous sessions …

1. ESASky
2. Target Visibility Tool
3. ETC
4. APT



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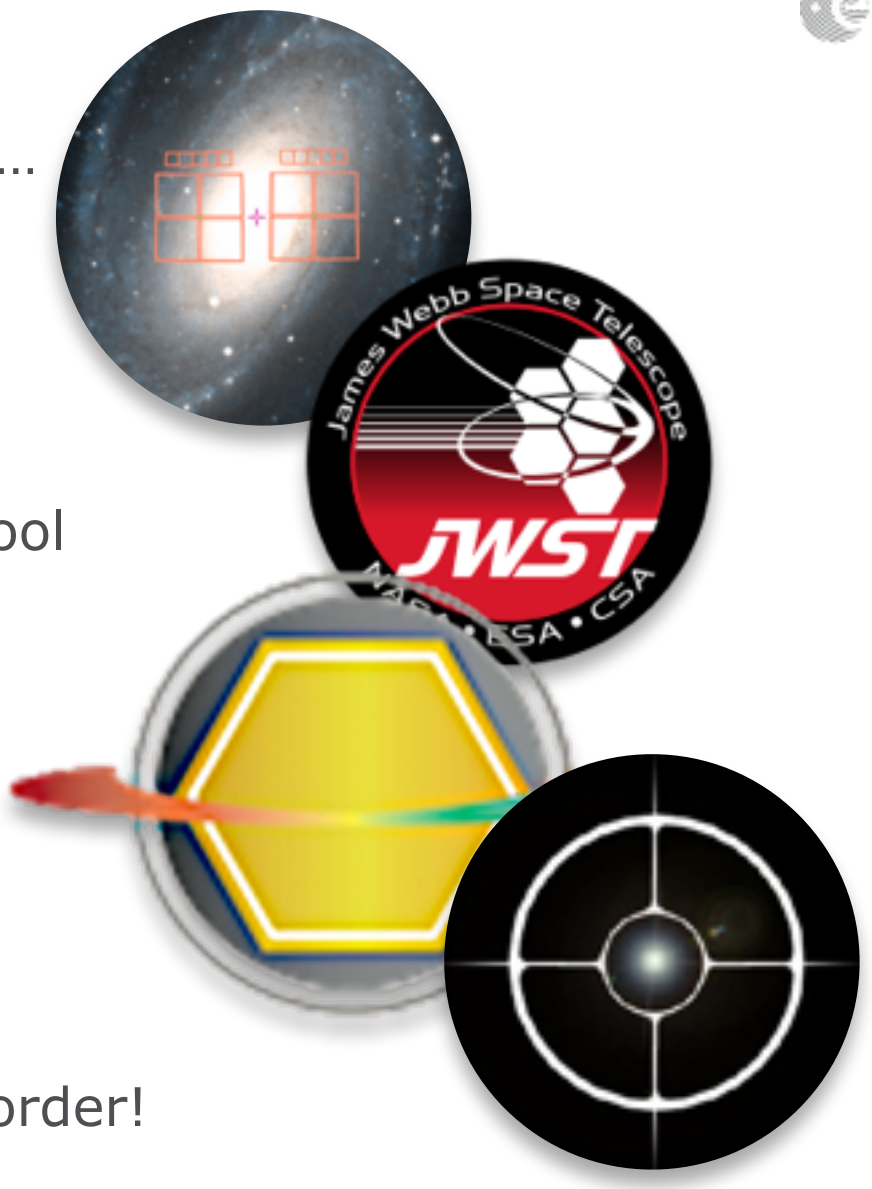
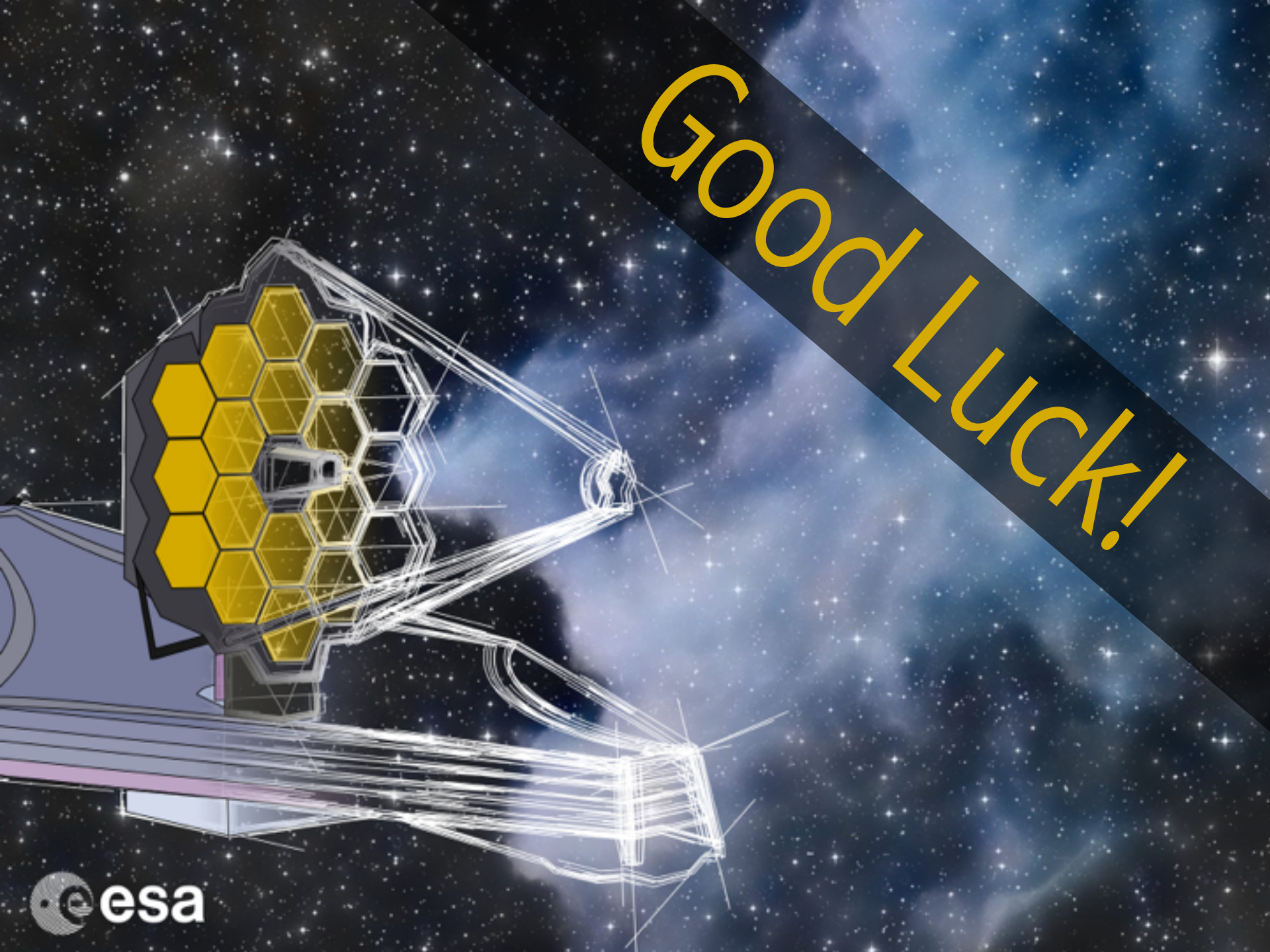


… but does not have to be in order!

Help

- Experts on the tables + floaters in the room
- JDocs (https://jwst-docs.stsci.edu/)
- Science Case Guides


Good Luck!
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