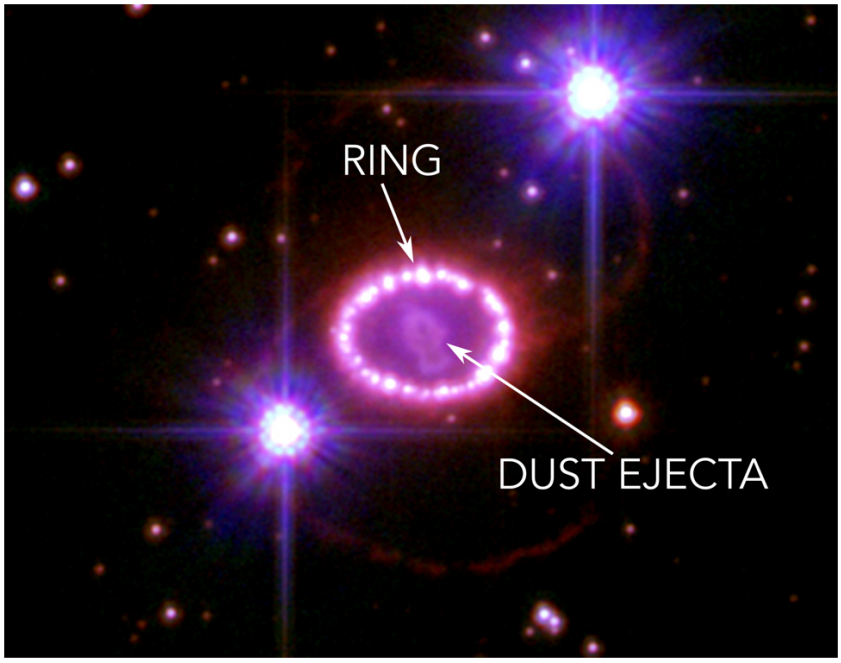
NIRSpec IFU Observations of SN1987A

1. Background

SN1987A is one of the best studied SN. It consists of a bright ring, enclosing the dust ejecta from the SNa. One challenge is to detect the ejecta without saturating the ring.

- Ring diameter ~ 1.1 arcsec, with thickness ~0.2 arcsec (the NIRSpec IFU covers a 3"x3" FOV)
- Total emitting area ~ 1.7 arcsec^2.
- Ejecta occupy approx. 4 pixels, i.e. just-resolved.



2. ETC (20min)

GOAL: Create an ETC workbook that estimates the exposure time needed to observe the SN ejecta and ring using the NIRSpec IFU.

Scenes and Sources:

In the "Scene and Sources" you can create different sources and combine them to make an astronomical scene. Design two sources:

Source 1: Ejecta-alone: a point source centred at (0,0) with BB of 100K normalised to 0.1 b mJy at 10 μm .

Source 2: The ring alone: An extended flat-profile source, radius 0.638", with BB spectrum of 400K, normalised to 80 mJy at 10 microns.

Create a scene that contains both sources.

Calculations:

1) IFU Verification Image

   - Use the ring + ejecta scene
   - Select the NIRSpec IFU Verification Image mode
   - Find a filter that gives you for 30 groups and NRSIRS2RAPID a reasonable S/N (without saturating)
     - Look at the pixel S/N in the 2D image rather than the one reported in the plot

2) G235M/F170LP setting (medium resolution)

   - Use the ring + ejecta scene
   - Pick 2.12 μm in the strategy tab, representing the H2 line. We don't actually have the line strength, so for line observations the SNR may be higher.
   - Choose readout mode NRSIRS2 (more information in JDox), 4 exposures of 30 groups 1 integration. The number of exposures will be equivalent to the number of dither positions in APT.
   - Think about your background subtraction strategy[1]: do you need an off-source background? In-scene background subtraction? Use the same detector configuration to cover the NIRSpec wavelength range using:
     - G140M/F100LP
     - G235M/F170LP
     - G395M/F290LP

[1] Look at the recommended strategies for background observations with NIRSpec on Jdox: https://jwst-docs.stsci.edu/near-infrared-spectrograph/nirspec-observing-strategies/nirspec-background-recommended-strategies

3. APT (20min)

Create New JWST Proposal

- File → New → New JWST Proposal
- Investigate the Proposal Information Tab (you can leave this for the end and focus on the more technical part of the proposal first)
- Under the Targets Tab add a "fixed target" and search for SN1987A. Fill in the information about the target. Pay attention to the "Extended" target field.
- Then specify a background target[2]:
  - RA: 05 35 28.3900
  - DEC -69 16 15.6025
- Go back to the SN1987A target. Click on the box "Observation Requires companion background obs." Select the background Target.

Define Target Observations

- Under the Observations tab: Create a New Observation Folder. This will be always needed for each set of instruments/observing modes/configurations.
- When submitting your proposal, the observation summary should be filled in. For the sake of this exercise that step is not needed.
- Click on the Observation and fill in all the information:
  - Instrument, template to use, target.
  - TA method: VERIFY ONLY
  - Select the science parameters (gratings, filters, readout pattern, dithers and exposure times should be consistent with those defined in the ETC exercise).
  - Duplicate each grating/filter combination and flag it as Leakcal. This takes an exposure with the MSA closed. It is done to correct for the MSA leakage that, in the presence of extended sources, affects the IFU data.
- Use the Aladin visualization tool with the NIRSpec footprint

Define Background Observations

- The Background observation folder can be created by duplicating the science target observation folder, and changing the target. Click on the Observation and fill in all the information.
- Think about whether you want to dither the background observations.
- Also, think about whether the background observations needs extra leakage observations? How much more overheads would that bring?
- Go to the Special Requirements tab and add a Time Constraint Explicit Requirement. Link the SN1987A and SN1987A background observations to be executed in a **non-interruptible sequence** (if you get an error on this you probably

[2] Feel free to specify your own background region by investigating with the Aladin visualization or ESASky

have not selected "sequence"). This is to ensure data are taken in the exact same conditions.

Constraints and Observability

Special requirements: Constrain the position angle so the SN1987A can be observed avoiding the bright star in the FOV (see figure in page 1). Check adequate PA range with Aladin and add a special requirement. Use the provided HST (*10m_APT02-04_SN1987A_HST.fits*) image to display in APT.

⇒ **Hint:** Verify whether you may want to modify the telescope pointing to optimize your strategy.

Visit planner: Highlight the Observation folders and run the Visit Planner. Verify the schedulability of the program. Go to the visit planner menu and run smart accounting to remove potential unnecessary overheads.

Review the program: Do you have errors or warnings? If yes, are they expected? Can you "fix" any?