ALMA - JWST Synergy:
Disk Structure and Chemistry in 2013
Alycia J. Weinberger
Carnegie / DTM
Some JWST Basics

- **Telescope**
  - 18 Be Segments, Au coated
  - 6.5 m diameter
  - 150 K primary mirror temperature
  - Located at L2

- **4 Science Instruments**
  - Fine Guidance Sensor - Tunable Filter Modules (FGS-TS)
  - Near Infrared Camera (NIRCam)
  - Near Infrared Spectrograph (NIRSpec)
  - Mid Infrared Instrument (MIRI)

Launch: Scheduled for 2013
The Successor

HST

And

Spitzer
**JWST-Spitzer Comparison**

**Beam Size at 8 \( \mu m \):**
- *Spitzer*: 2"
- **JWST**: 0.25"

Graph showing point source 5-sigma in 100 s vs. wavelength (microns) with data points for Spitzer and JWST.
MIRI Background

The graph depicts the background flux in photons per second per micron per pixel as a function of wavelength in microns. The graph shows three distinct curves labeled 'Mirrors', 'Sunshade', and 'Zodiacal Light'. The background flux is shown on a logarithmic scale on the y-axis, ranging from 1 to 100,000, while the wavelength is on a linear scale from 5 to 30 microns on the x-axis.
MIRI (http://ircamera.as.arizona.edu/MIRI)

- Imaging 5-27 μm with 1.3x1.7' FOV
- Coronagraphs at 10.65, 11.4, 15.5, 23 μm

ALMA at 450 μm can be < 0.1''; JWST 24 μm resolution is 0.8''

7.5'' resol. 5.8'' resol. 0.05'' resol; 
Holland et al. 2003 Stapelfeldt et al. 2003 Kalas et al.2005
MIRI Spectroscopy

- $R \approx 100$ at 5-10 $\mu$m
- $R \approx 3000$ 5-28.3 $\mu$m (in 3 portions)

Track the CO:H$_2$ ratio in disks over time


Note: Spitzer IRS has $R \approx 600$
Observe disks at a range of inclinations

Line of sight toward T Tau N

Line of sight toward RNO 91

Line of sight toward HL Tau

Line of sight toward T Tau S

Rettig et al. 2006
Beta Pic Gas Composition

No Debris Disks have (yet) detections of submm gas emission

\[ \text{C:O} = 18 \times \text{solar} \]
NIRCam (http://ircamera.as.arizona.edu/nircam)

- Two Channels: 0.6-2.4 µm and 2.5-5 µm
- Nyquist sampled at 2 and 4 µm
- Field of View: 2.2 x 4.4 arcmin
- Coronagraphy
FGS-TFI

- 1.2 - 2.4 μm and 2.4 - 4.8 μm
- 2.2 x 2.2 arcmin FOV
- Selectable R~100
- Coronagraphs for 20x20” FOV
FGS-TFI Contrast at 4.5 $\mu$m

Planet and Disk Imaging

Doyon et al. 2004
Contrast Similar to HST

HR 4796: NICMOS/STIS
Contrast $\sim 10^{-4}$ at 0.5"

Image: Color composite at 0.5 - 2.2 $\mu$m

(Debes, Weinberger & Schneider, in prep)
Imaging in Scattered Light

- Coronagraphy in FGS-TF and NIRCam

![Graph showing limiting surface brightness](image)

Green et al. 2005
Scattering Albedo: Silicates, Ices and Organics
0.6 - 5 μm
R=100, 1000, 3000
FOV 3.4 x 3.4 arcmin
Microshutter array
Contrast (open/closed) ~3000
Color same as star: largeish grains, as expected

Inner Warp?

Roberge et al. 2005

Debes et al. in prep

0.5 - 2 µm
Blue color in inner-most disk: collision dominated?

Roberge et al. 2005
My Combo Wish List

- Spatially resolved gas:dust ratios and depletion in transitional disks
- Prevalence of organics on surfaces and in gas phase of disks
- Ice lines; volatile gradients in disks
- Disk morphologies and evidence for planets
More about JWST

Space Science Reviews Paper on JWST Capabilities by Gardner et al.:

Space Telescope Science Institute JWST Site:
http://jwstsite.stsci.edu/