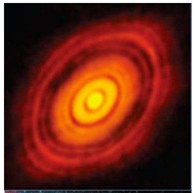
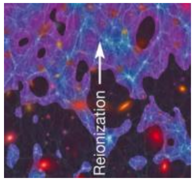
ORIGINS Space Telescope

How do I get involved?





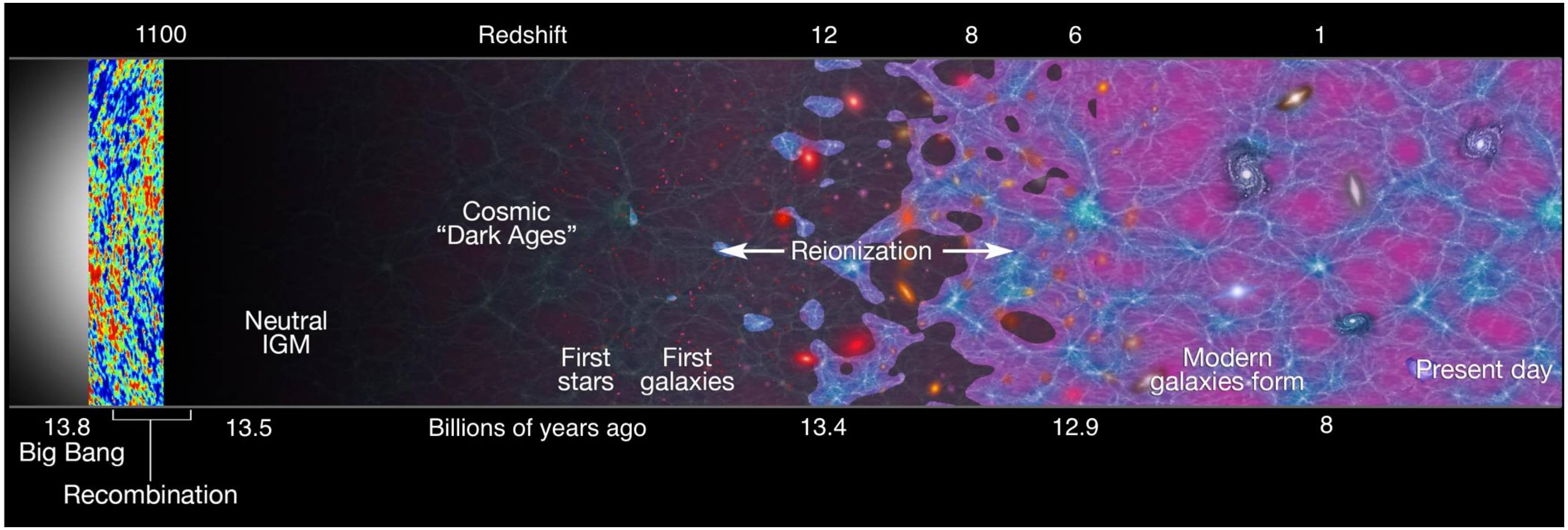
Send email to:

ost_info@lists.ipac.caltech.edu

Science coverage will be broad: highlight some of the goals

- First Billion Years:
    - Protogalaxies
    - Galaxy evolution
- Galaxy and blackhole Evolution
    - ISM probes for galaxies
    - Rise of metals
- Nearby Galaxies & Milky Way:
    - Polarization
    - Feedback in galaxies
    - Water transport
- Planetary systems: formation & exoplanets
    - Dust disks
    - Gas disks
    - Exoplanet atmospheres
- Solar systems
    - Small body census
    - Isotopes and origin of Earth water
    - Giant Planets

COSMIC DAWN - EARLY UNIVERSE - COSMOLOGY



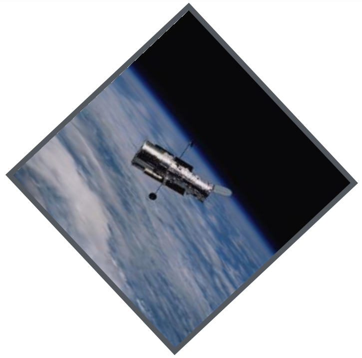
Big Picture topics already identified:

- Collapse to form first stars and proto-galaxies
  - Primordial cooling via H_2 rotational lines
  - seeds of super massive black holes
- Cosmic chemical evolution of the Universe
  - First dust, rise of heavy elements and building blocks of life
- Properties of reionizing galaxies
  - 3-D maps of the Universe
  - 3-D clustering revealing fine-structure line intensities -> metallicity, UV fields

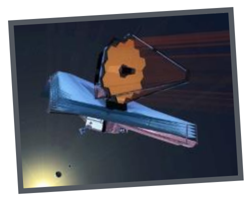
Vieira

Science Topics

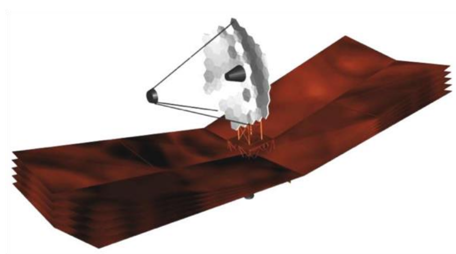
Hubble Space Telescope
- 1990—2025+
- 2.4 meter
- 0.1—2.4 µm
- 260 K

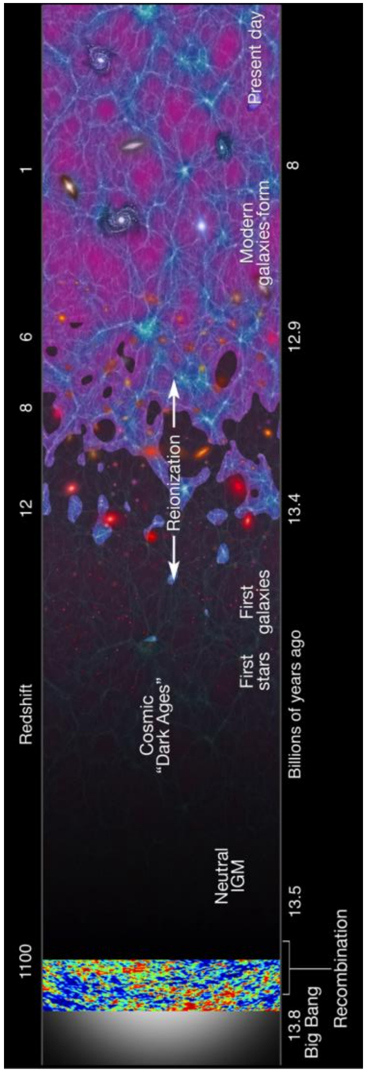


James Webb Space Telescope
- 2018—2028
- 6.5 meter
- 0.7—28.3 µm
- 50 K



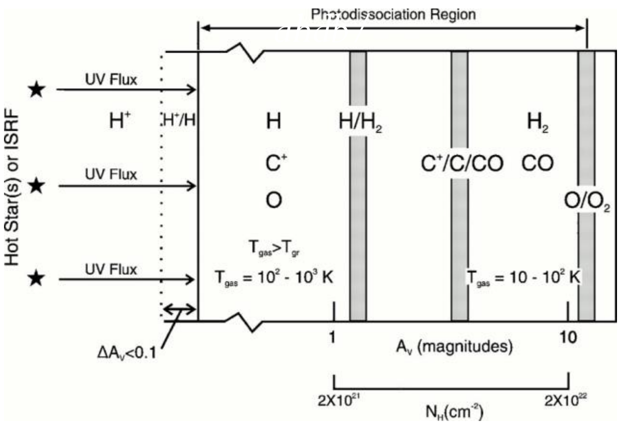
Origins Space Telescope
- 2020 Decadal
- 8-15 m single aperture
- 6—1000 µm (TBD)
- 4.5 K





Vieira

How do we probe the interstellar medium (gas and dust where stars are forming) in high redshift galaxies?



Pope

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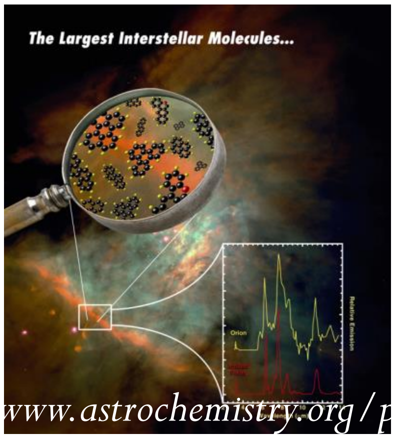

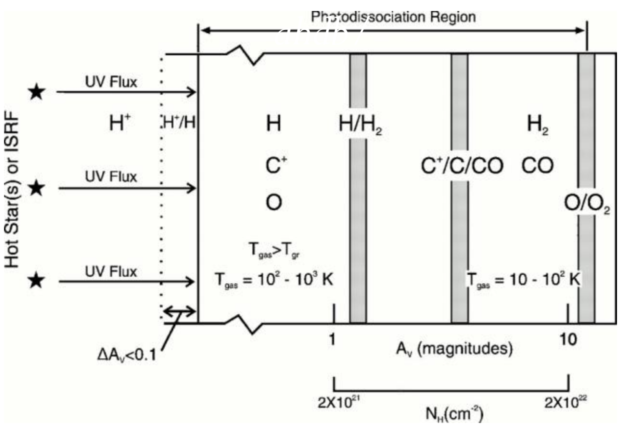

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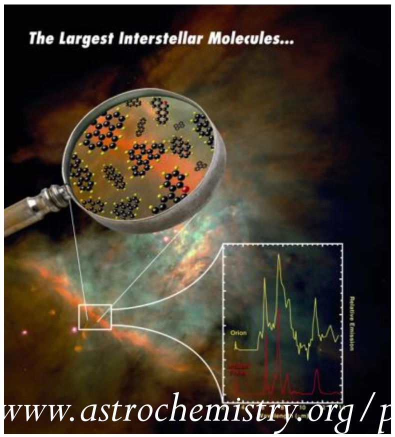
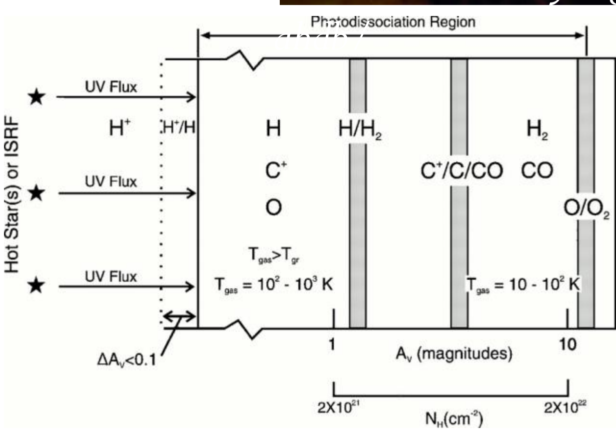
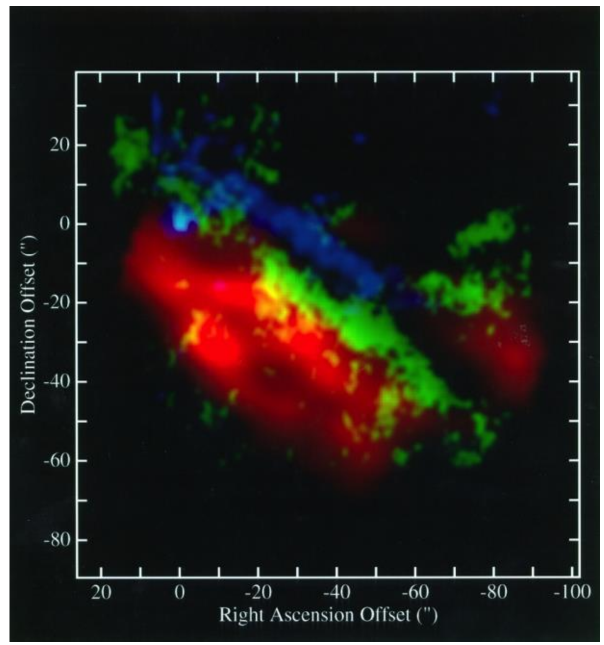






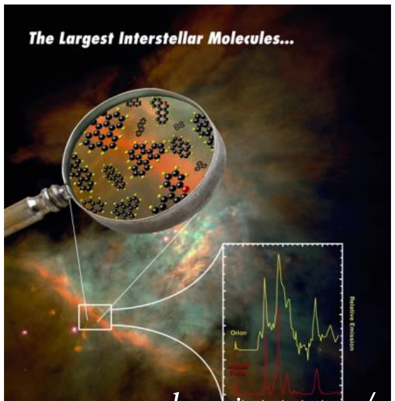
PAH

H_2

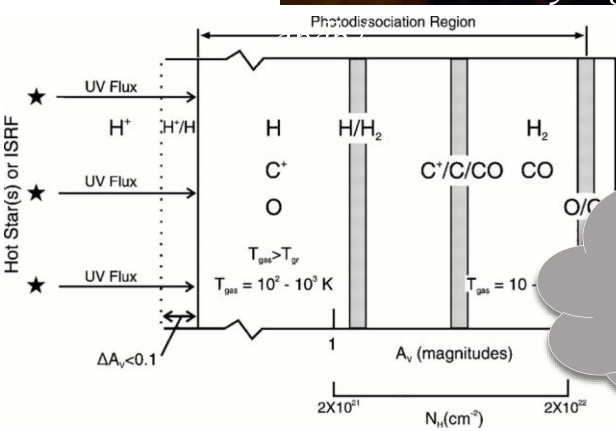
CO

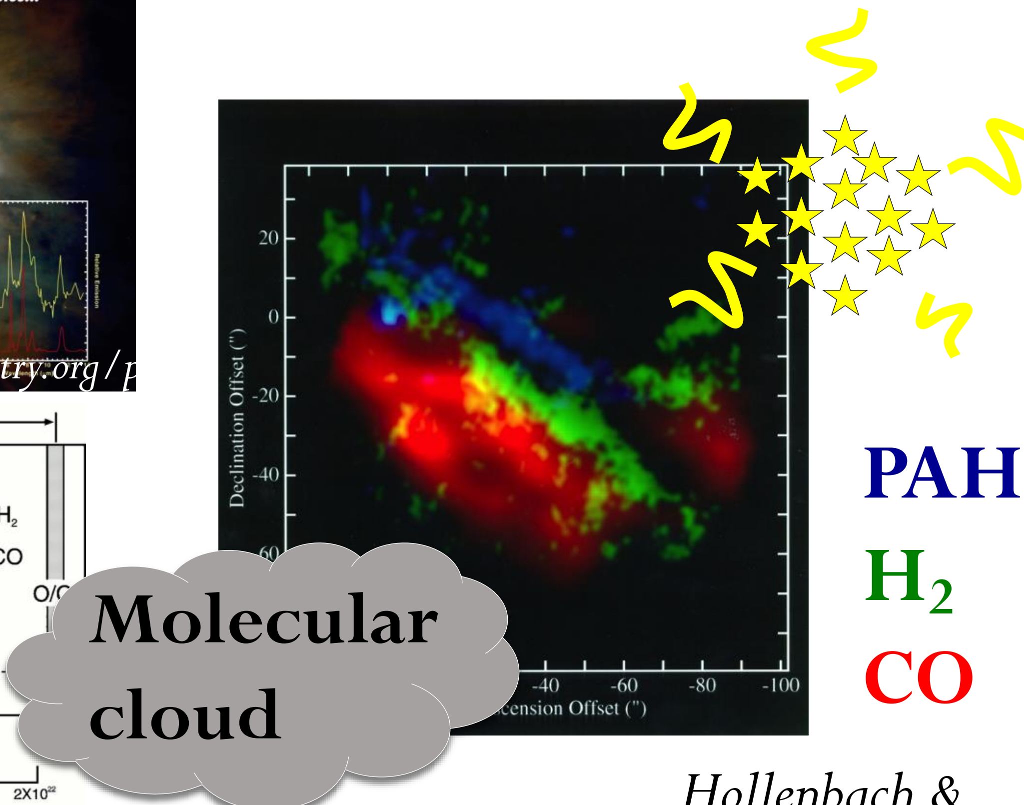
Hollenbach & Tielens 1997

How do we probe the interstellar medium (gas and dust where stars are forming) in high redshift galaxies?



www.astrochemistry.org/p





PAH
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Hollenbach & Tielens 1997

Pope

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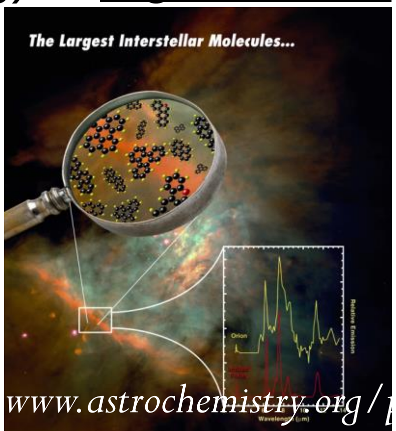
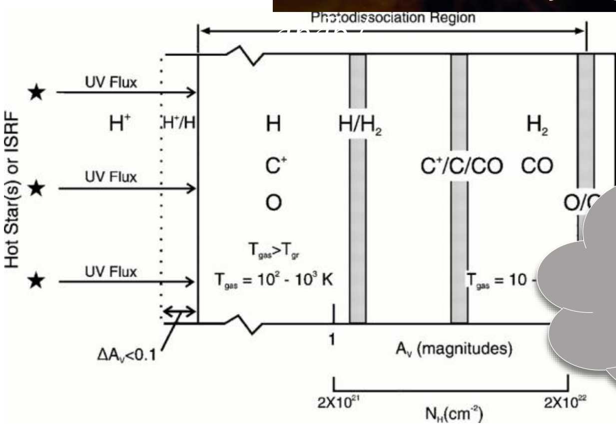
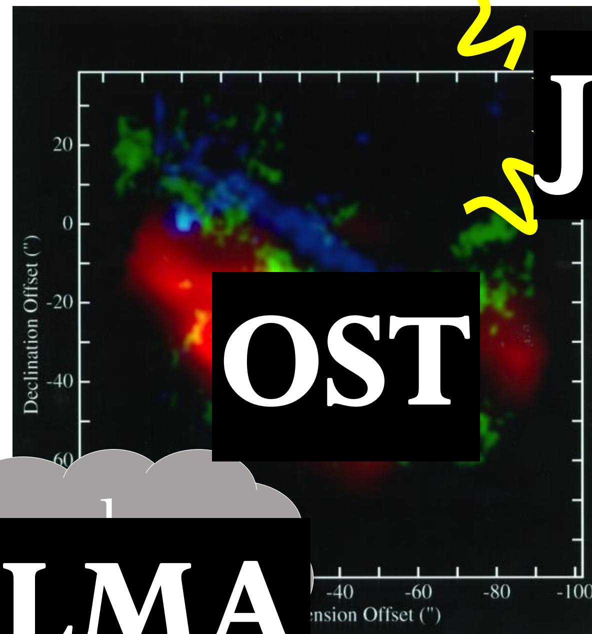






JWST

OST

ALMA

PAH
H_2
CO

Hollenbach & Tielens 1997

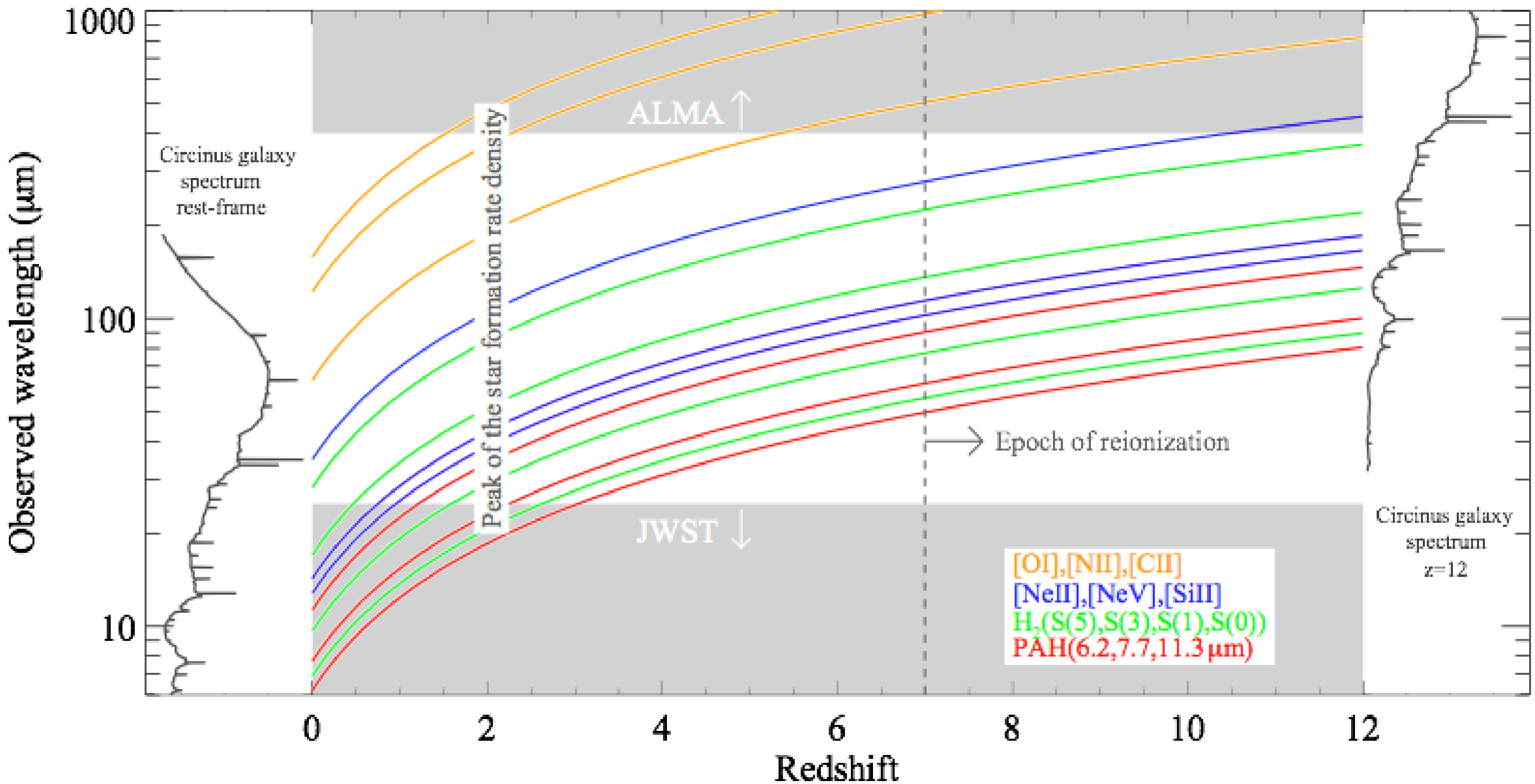
Pope

Spectral probes from 10 – 500 μm

Species	Wavelength [μm]	f (M82)	f (Arp220)	Diagnostic Utility
		Ionized Gas Fine Structure Lines		
Ne V	24.3			Unambiguously AGN
O IV	25.9, 54.9			Primarily AGN
S IV	10.5	2.1 (-5)		
Ne II	12.3	1.2 (-3)	7.5 (-5)	Probes gas density and
Ne III	15.6, 36.0	2.05 (-4)		UV field hardness in
S III	18.7, 33.5	1.0 (-3)	7.3 (-5)	star formation HII
Ar III	21.83	9.1 (-6)		regions.
O III	51.8, 88.4	1.3 (-3)		
N III	57.3	4.2 (-4)		
N II	122, 205	2.1 (-4)		Diffuse HII regions
		Neutral Gas Fine Structure Lines		
Fe II	26.0			Density and temperature probes
Si II	34.8	1.1 (-3)	7.7 (-5)	of photodissociated-neutral
O I	63.1, 145	2.2 (-3)	6.8 (-5) (abs)	gas interface between HII
C II	158	1.6 (-3)	1.3 (-4)	regions and molecular clouds.
		Molecular Lines		
H_2	9.66, 12.3, 17.0, 28.2	2 (-5)	3 (-5)	Coolants of first collapse
CH	149		4 (-5)	Ground state absorbtion:
OH	34.6, 53.3, 79.1, 119	2 (-6)	2 (-4) (abs)	gives column and abundance.
OH	98.7, 163		5 (-5)	Emission: gas coolants, constrain
H_2O	73.5, 90, 101, 107, 180		5 (-5)	temperature, density of warm
CO	325, 372, 434, 520	3 (-6)	1 (-5)	($50K < T < 500 K$) mol. gas

Viera

OST provides the crucial link in wavelength coverage between JWST and ALMA to complete our view of the evolution of the universe.

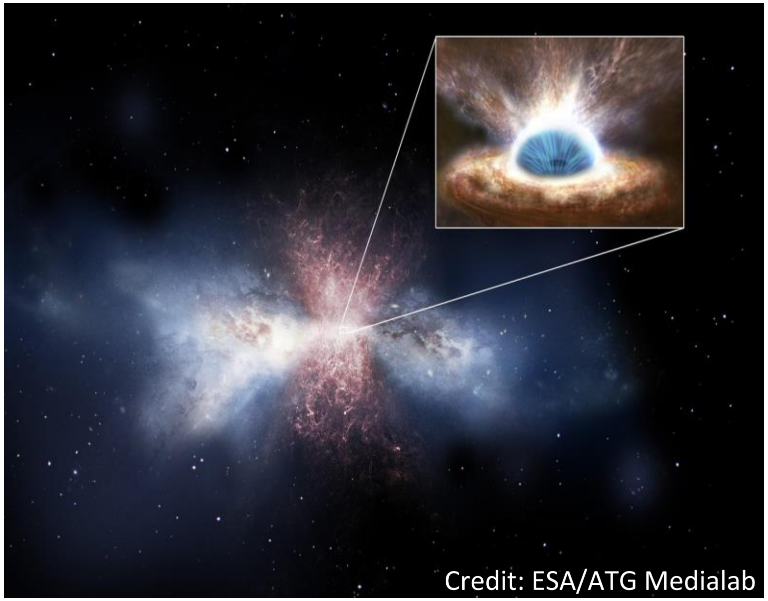


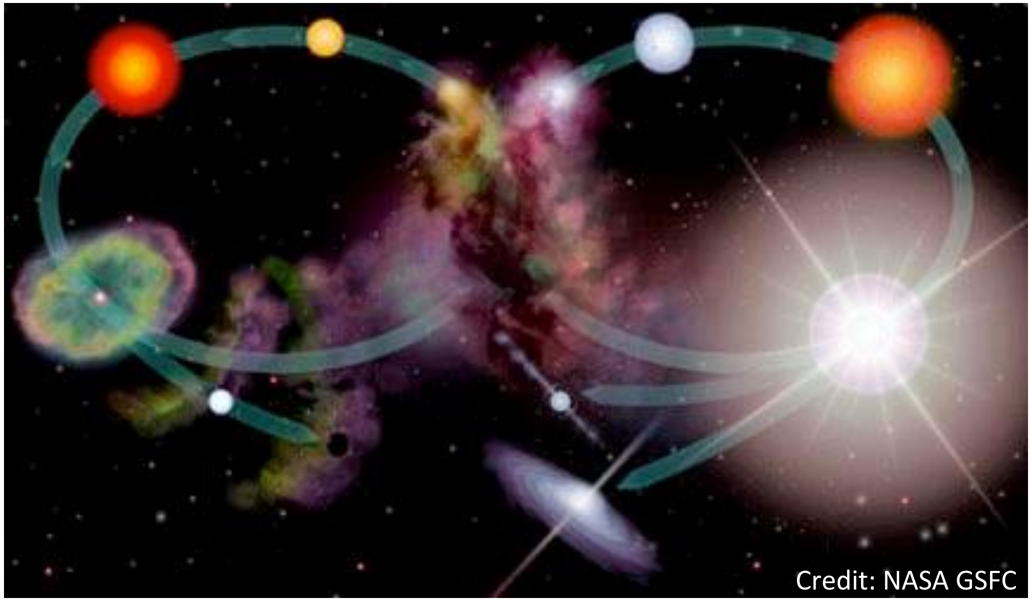
ALMA

JWST

Pope

Milky Way, Interstellar Medium, and Nearby Galaxies


Credit: ESA/ATG Medialab


Credit: NASA GSFC

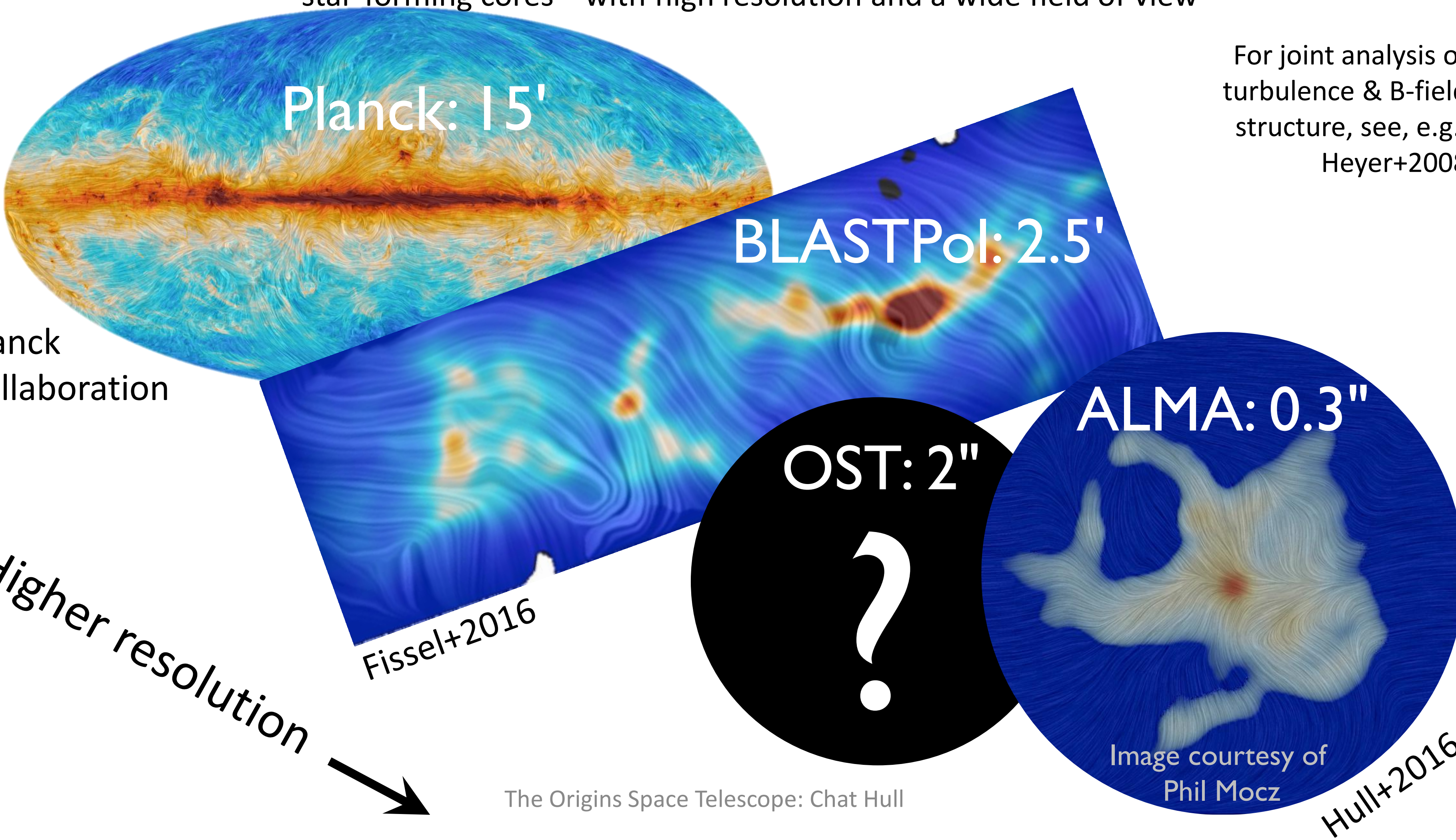
Reveal the connection between **Black Hole growth** and **star formation**.

Trace the **dust and metal enrichment** history of the Universe.

Magnetic fields and turbulence

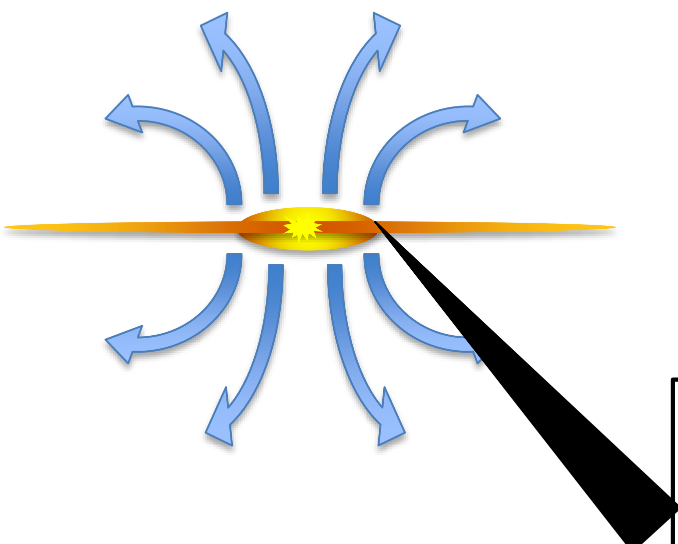
The Origins Space Telescope will characterize magnetic fields and turbulence from molecular clouds to star-forming cores—with high resolution and a wide field of view

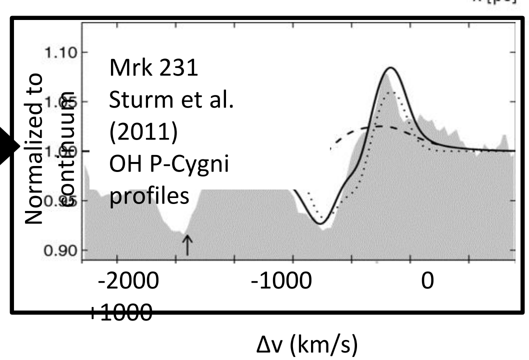
For joint analysis of turbulence & B-field structure, see, e.g., Heyer+2008

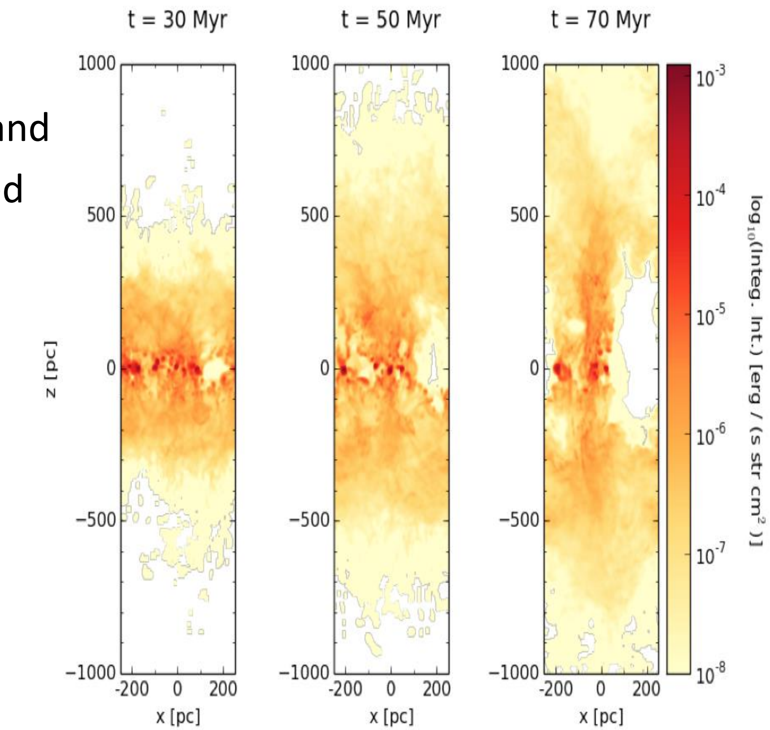


Galaxy Feedback Mechanisms at z<1

Science Goal: Characterize the mechanisms of feedback from AGN/star formation across the spectrum of galaxy masses and types and quantify the amount of material recycled/expelled from galaxies at z<1.





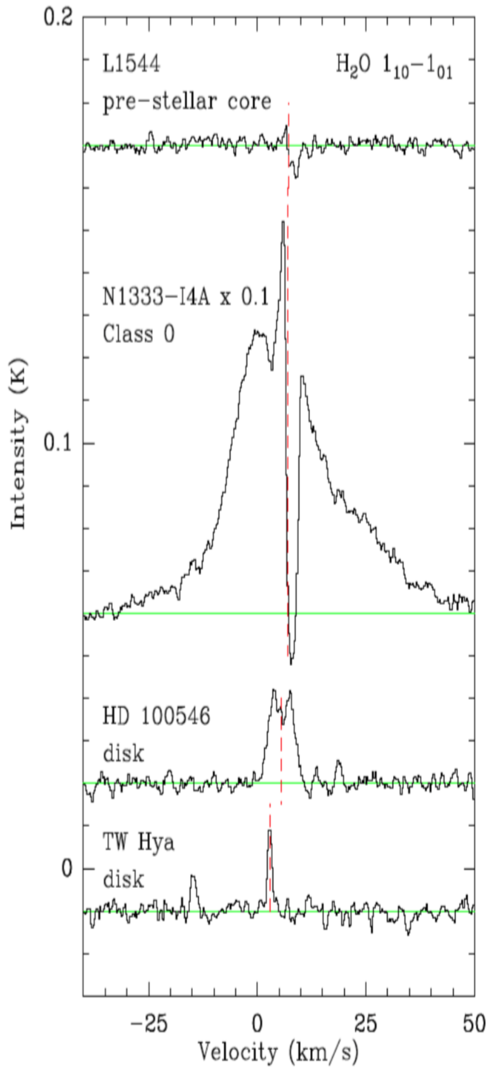


ORIGINS Space Telescope

Science Topics

Water Transport to Terrestrial Planetary Zone

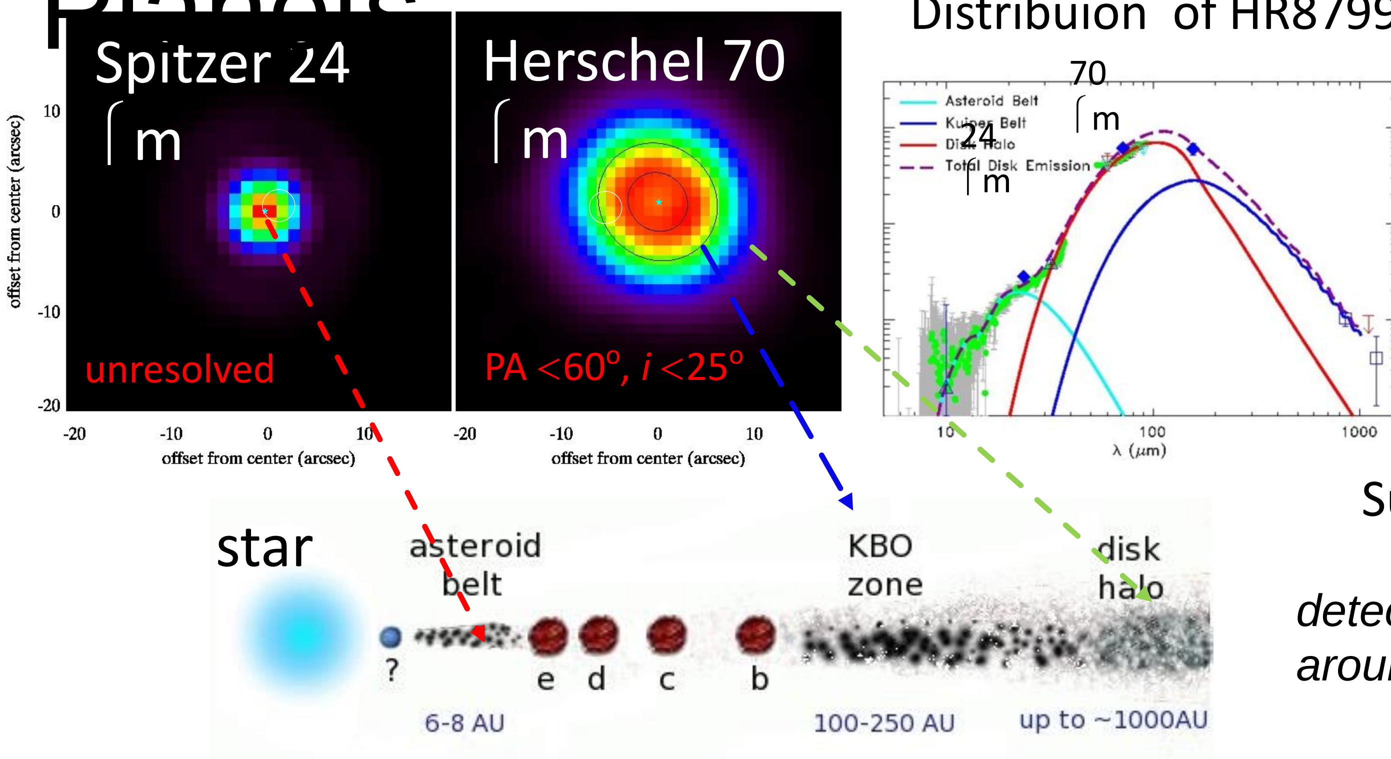
Science Goal: Observe gas-phase water in interstellar clouds and dense star-forming cores to probe critical processes related to formation and transport of water to the terrestrial planet zone, as a key input to habitability.



Debris Disks and Giant Planets

Su+ 2009 Matthews+ 2013

Spectral Energy Distribuion of HR8799



Su et al. 2009

detect Oort clouds around nearby stars

Marios+2008, 2010

Pontoppidan

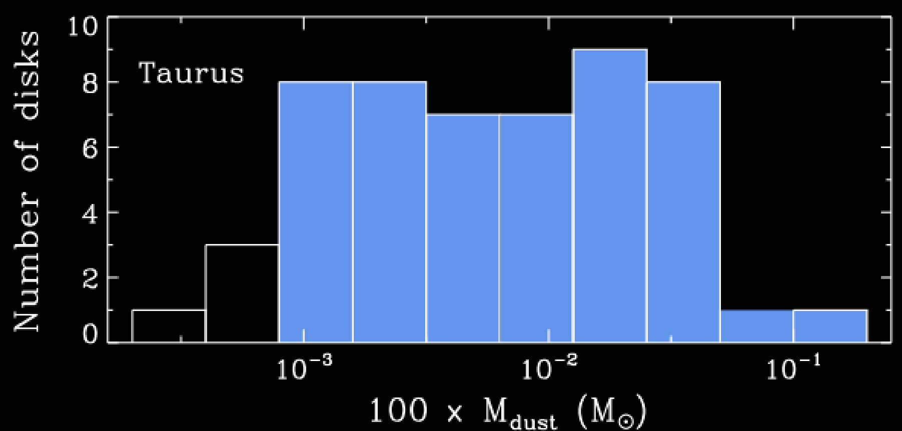
WHAT ARE PROTOPLANETARY DISK GAS MASSES?

- HD is a million times more emissive than H_2 at T ~ 20 K.
- Atomic D/H ratio inside the local bubble is well characterized (~1.5 x 10^{-5})
- HD will follow H_2 in the gas

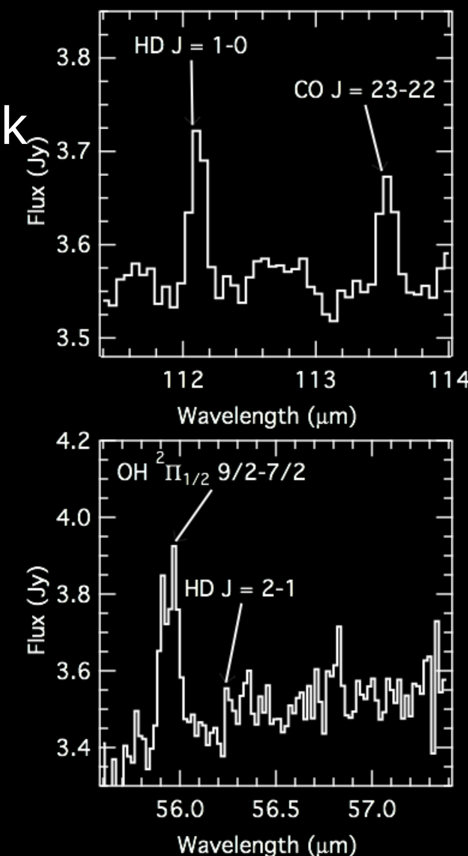
- TW Hya disk mass

M_{disk} ~ 0.05 $M_\odot$

Williams and Cieza 2011



Bergin+ 2013



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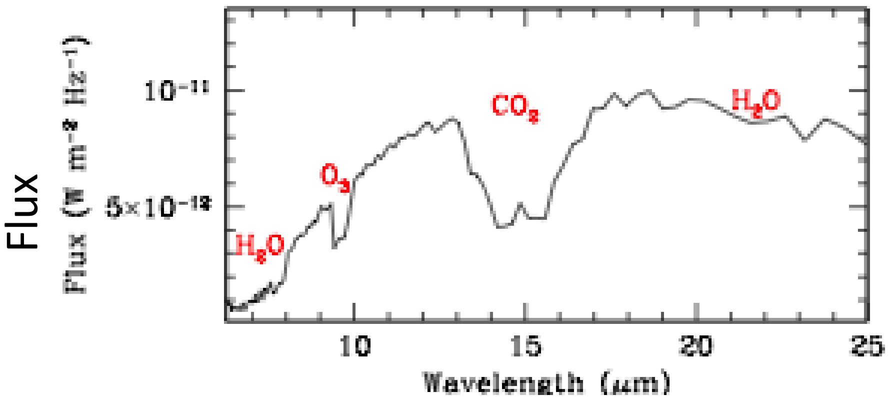
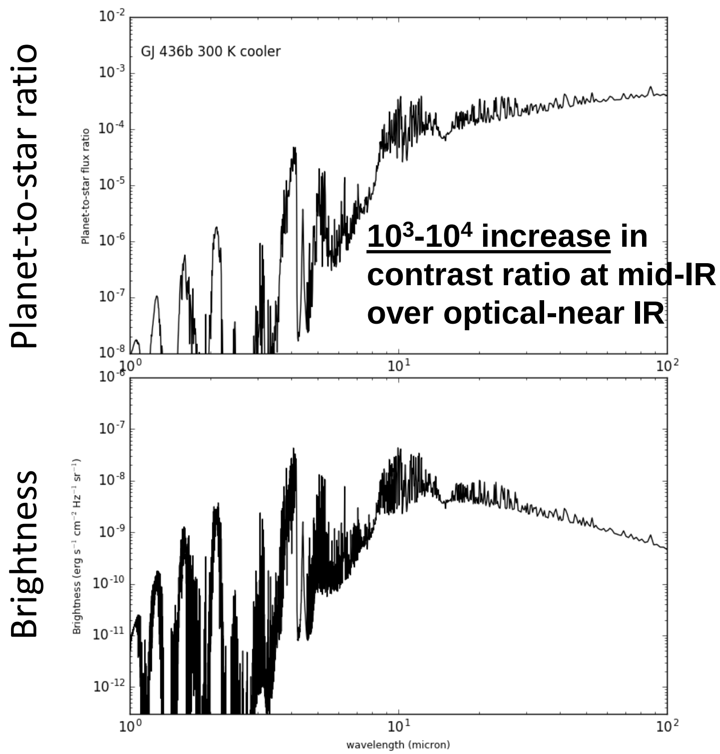
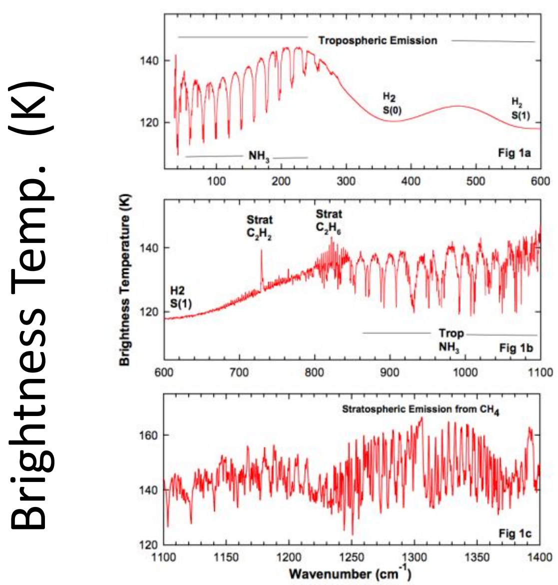
POTENTIAL FOR TRANSITING HABITABLE PLANETS AROUND M DWARFS?





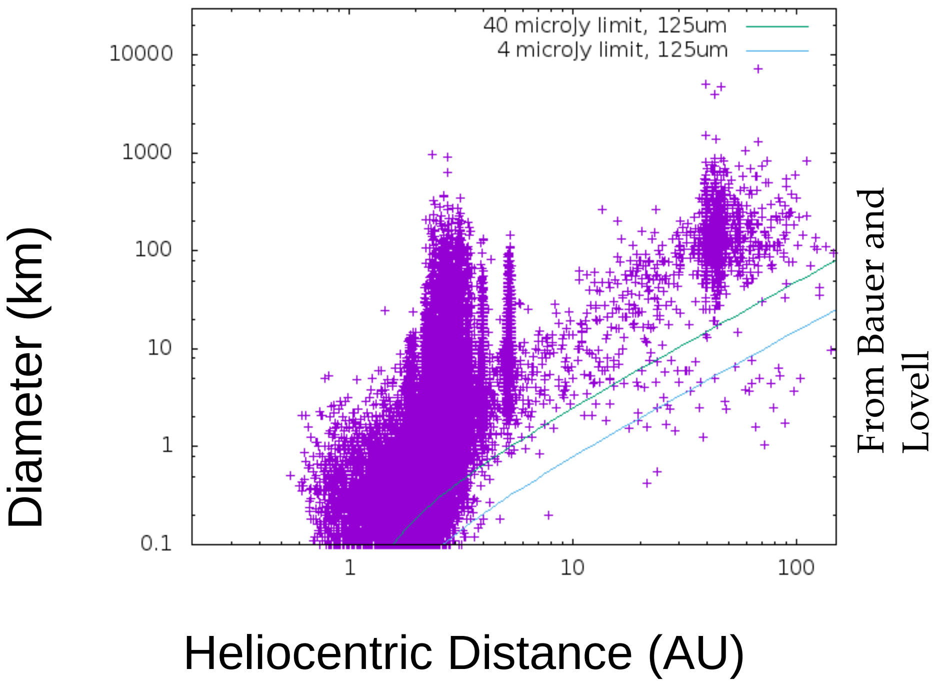


Jupiters around M-dwarf stars via transits.
Direct imaging of Jupiters at Jupiter distances with a coronagraph.

Pontoppidan

REVEALING THE SOLAR SYSTEM IN THE FAR-IR

History and Evolution of the Solar System (SS):

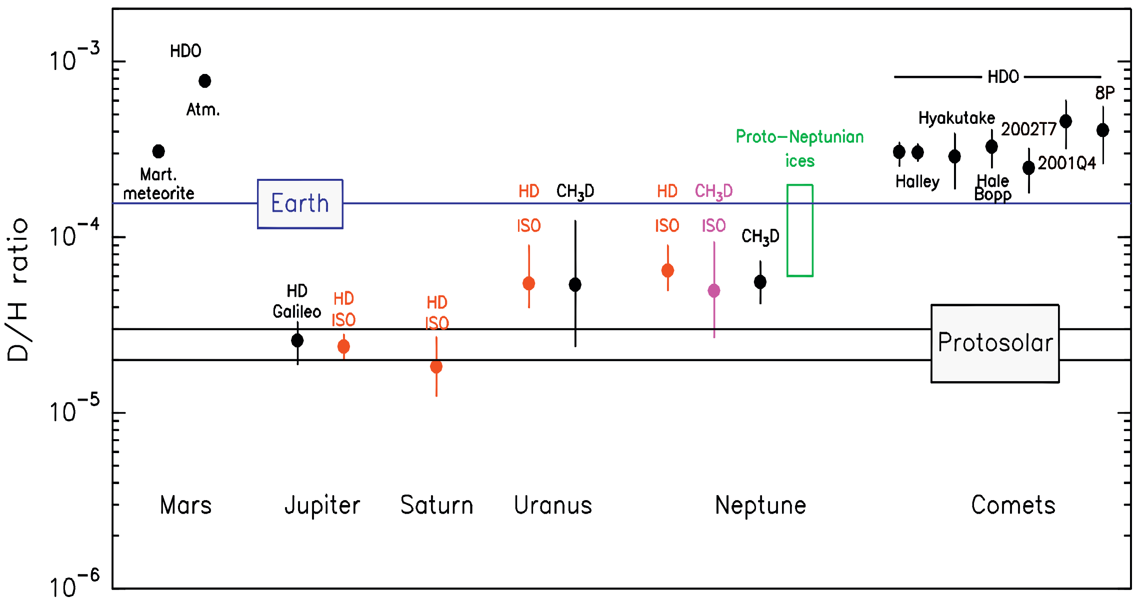


- Measure the thermal emission (via Far-IR imaging) of small bodies in outer SS – 1000's of targets
- Volatile isotope measurements (HCNO) across the SS
- Constrain the Thermal History/Evolution of the Solar System – He/H_2 measurements.
- Moving Targets Not limited by confusion.

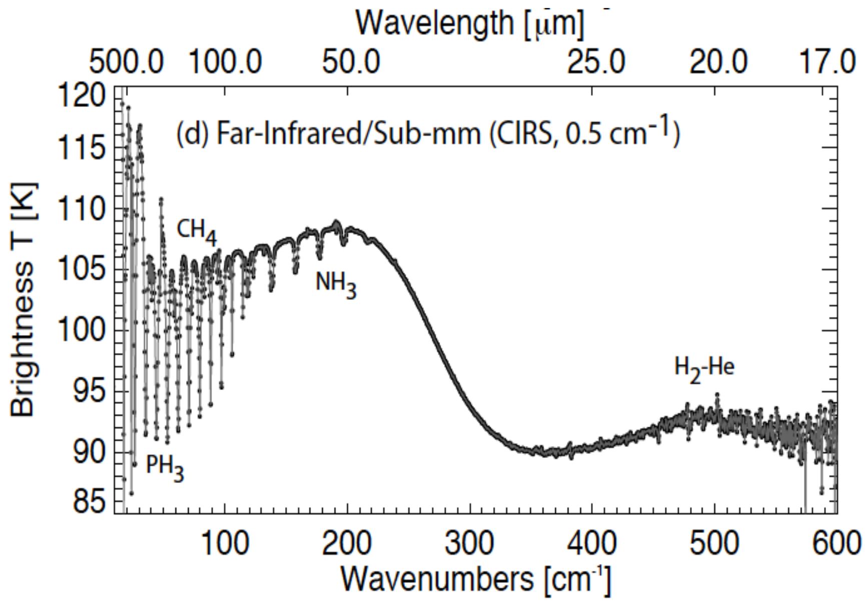
Milam

Planetary Origins and Evolution of the Solar System

- **Goal:** *To measure accurate isotopic ratios and abundances of trace gases, to constrain models and inform understanding of solar system origin and evolution.*



Comparative Climate and Thermal Evolution of Giant Planets



Far-IR spectra of Saturn as measured by Cassini/CIRS, showing the lines and the collision-induced continuum that allows temperature, windshear, aerosol, para-H2 and helium sounding.

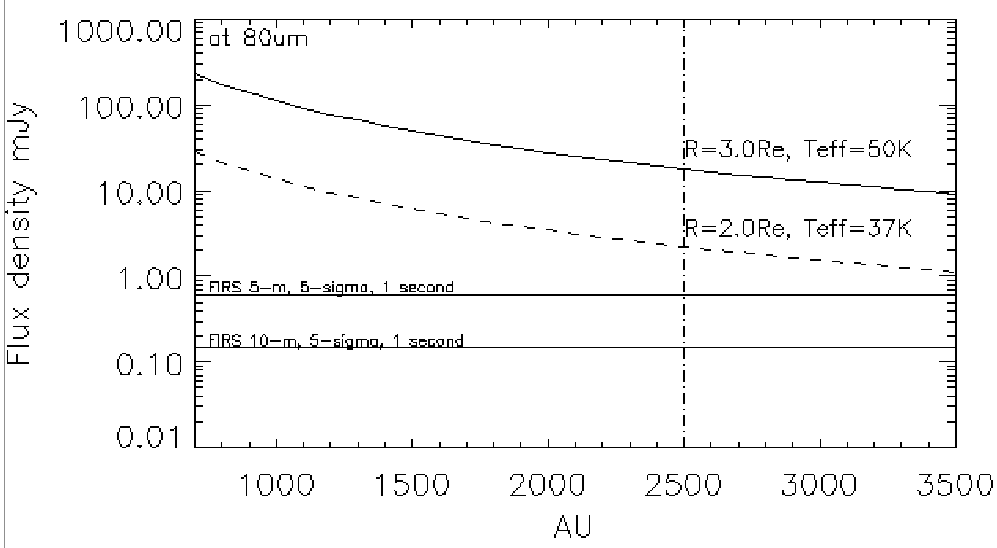
- **Goal:** *Explore the thermal history, present-day climate and circulation patterns of the four Giant Planets as archetypes for brown dwarf and exoplanetary atmospheres.*

ORIGINS Space Telescope

Science Topics:

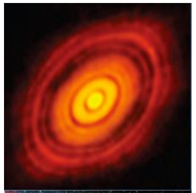
Find Planet IX

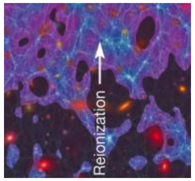
- **Goal:** *Do we really understand our outer backyard?: Find Planet Nine (from Outer Space!)*



Even a 2 Earth Radius Planet 9, with Teff=37K has ~4 mJy flux at 80um is detectable with a 5 meter OST architecture. OST 5 meter (10 meter), 5-sigma, 1second sensitivity at 80um as 0.6 (0.15) mJy.

How do I get involved?





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Secret word:

Universe