

First results from EXES on SOFIA

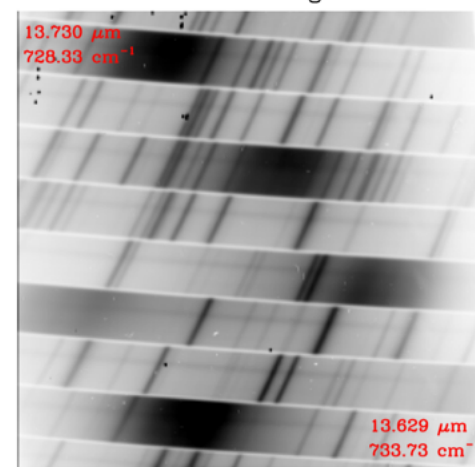


Matthew J Richter
UC Davis

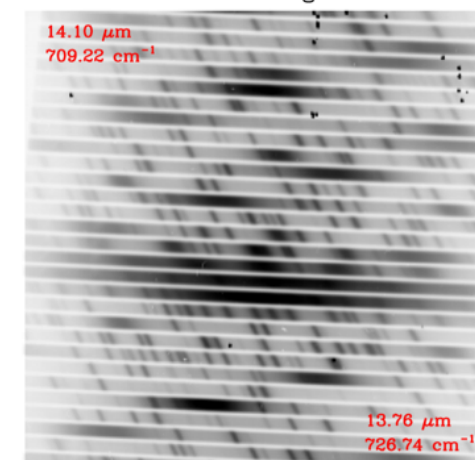
with Mark McKelvey, Mike
Case, and Curtis DeWitt

- EXES is a PI instrument optimized for high spectral resolution in mid-IR
- High resolution mode:
 - cross-dispersed with $R = 50,000$ to $110,000$ depending on slit width
 - single setting coverage of $\sim 0.8\%$ with 4-40" long slit or $\sim 4\%$ with >1 " long slit
- Other modes
 - Medium single order: $R \sim 5,000$ to $20,000$
 - Low single order: $R \sim 1500$ to 4000
 - limited focal plane and pupil imaging
- Wavelength range $\sim 4.5 \mu\text{m}$ to $\sim 28.3 \mu\text{m}$
 - includes H_2 J=2-0, although detector response fading at that wavelength
- Detector is a 1024×1024 pixel Si:As optimized for low background

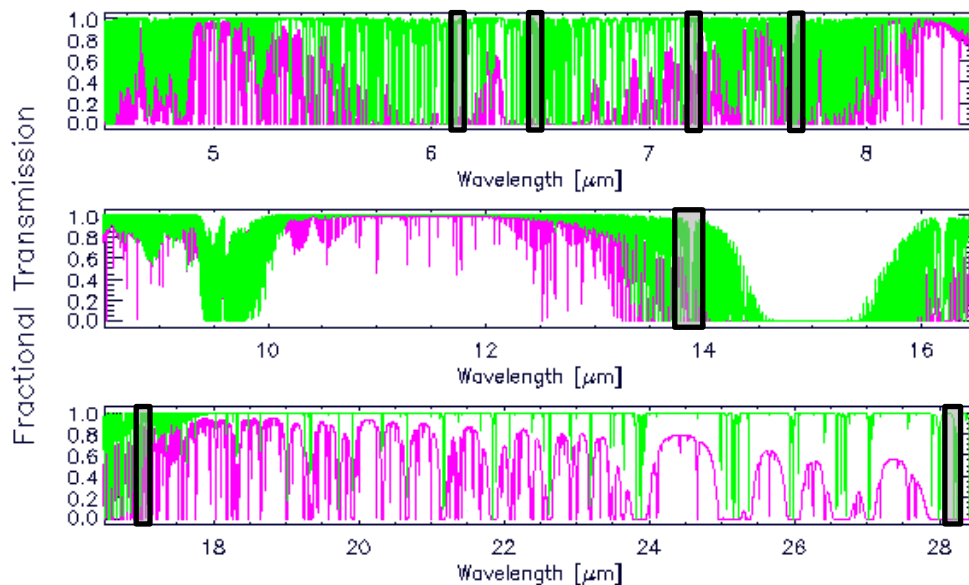
HIGH_MED Configuration



HIGH_LOW Configuration



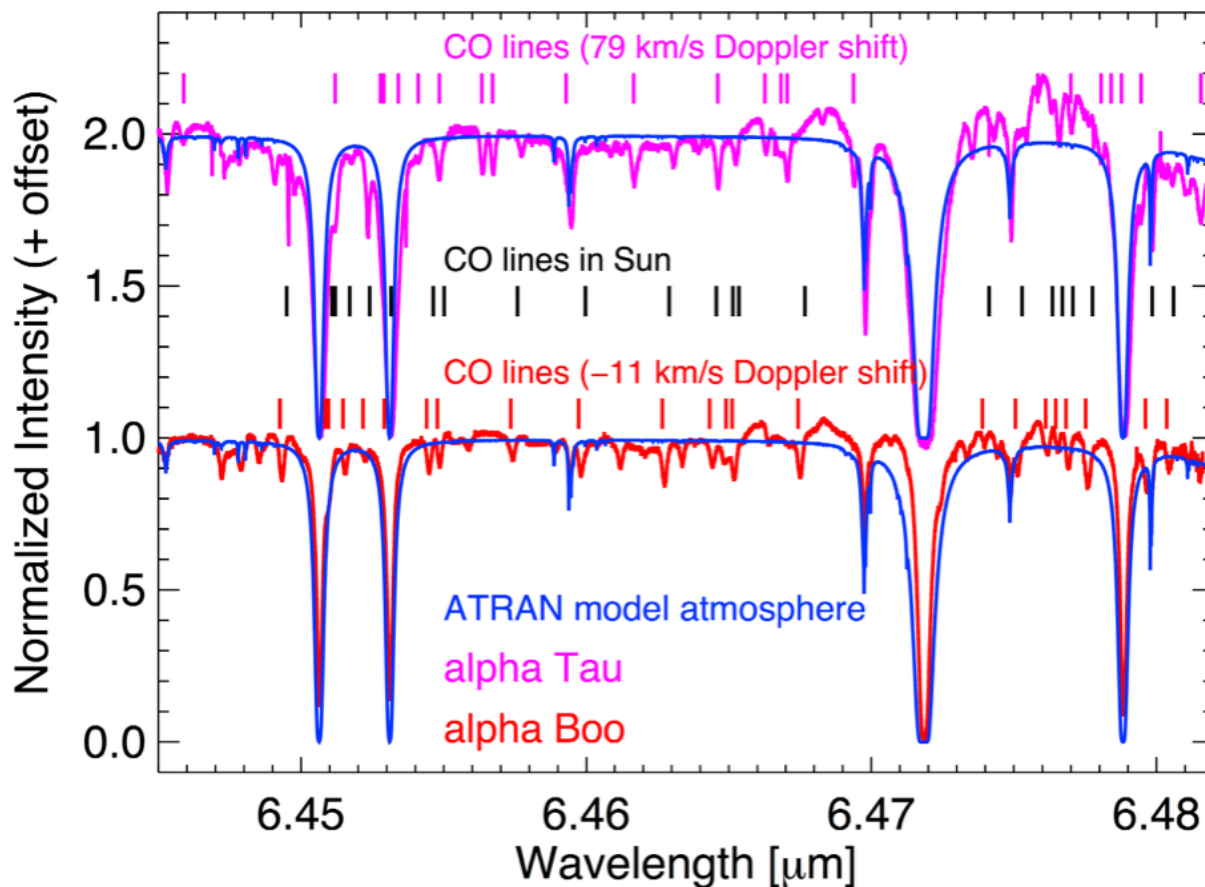
- 2 Flights in Apr 2014
 - 6 more flights in Feb/Mar 2015: 3 commissioning and 3 GI
- Nod and map observations
- Most observations in 6-8 micron range in high resolution mode
- Targets included standard stars, Mars, Jupiter, Ceres, and AFGL 2591



Atmospheric models for:
SOFIA
Mauna Kea

Gray bars show
 commissioning settings

Standard Stars

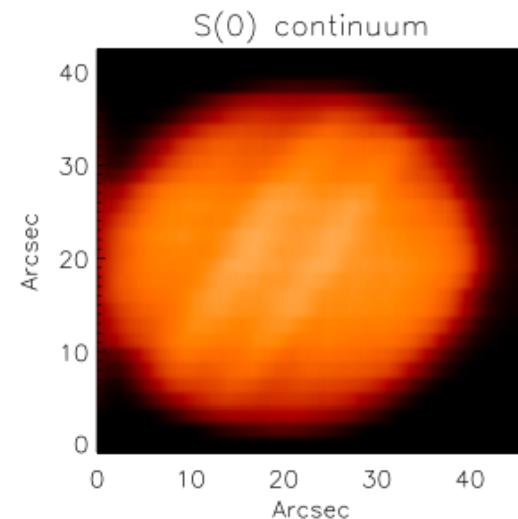
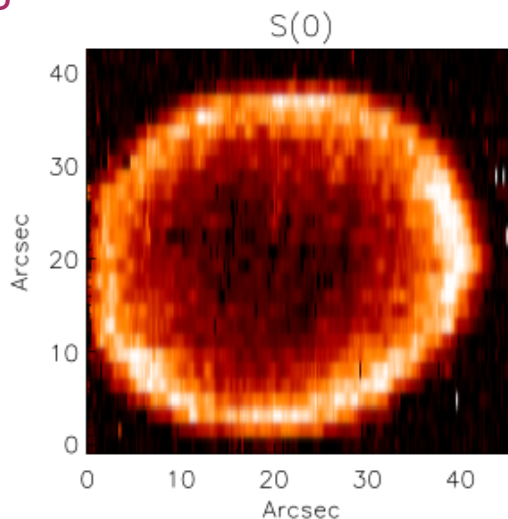
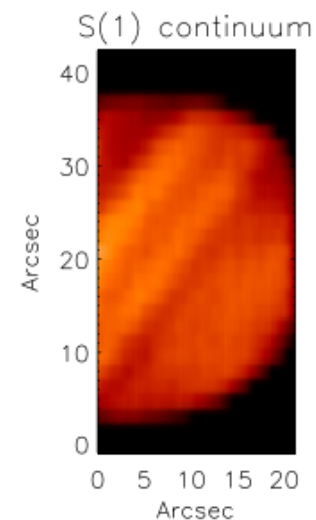
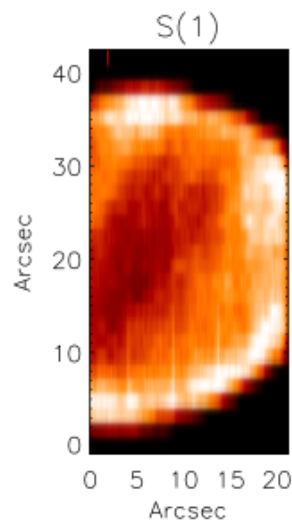


- H₂O lines in stars are weaker than expected based on 12 μm observations with TEXES
- First stars other than Sun explored at this wavelength range with this resolution

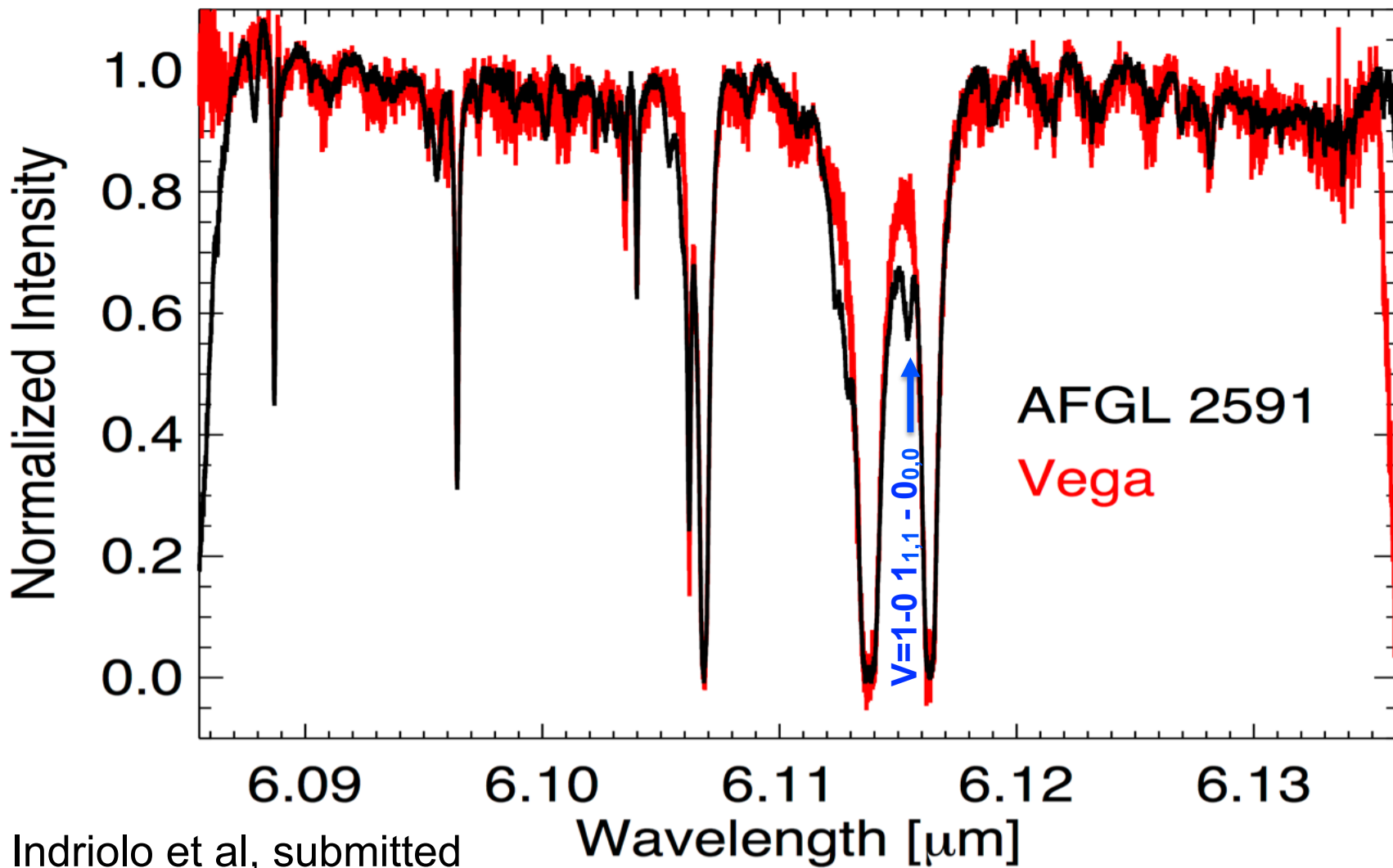
Ryde et al (in prep)

Jupiter H₂

- Use H₂ ortho-para ratio to study dynamics
 - Only possible with EXES/SOFIA
- EXES/SOFIA can produce data cubes
 - slit stepped across Jupiter
 - both maps done in single leg



H₂ maps of Jupiter and continuum at 17.03 microns (top) and 28.22 microns (bottom)



Indriolo et al, submitted

- 10 lines detected

- ground state of para-H₂O
- 1 H₂¹⁸O
- 2 2-1 lines

- Line profiles

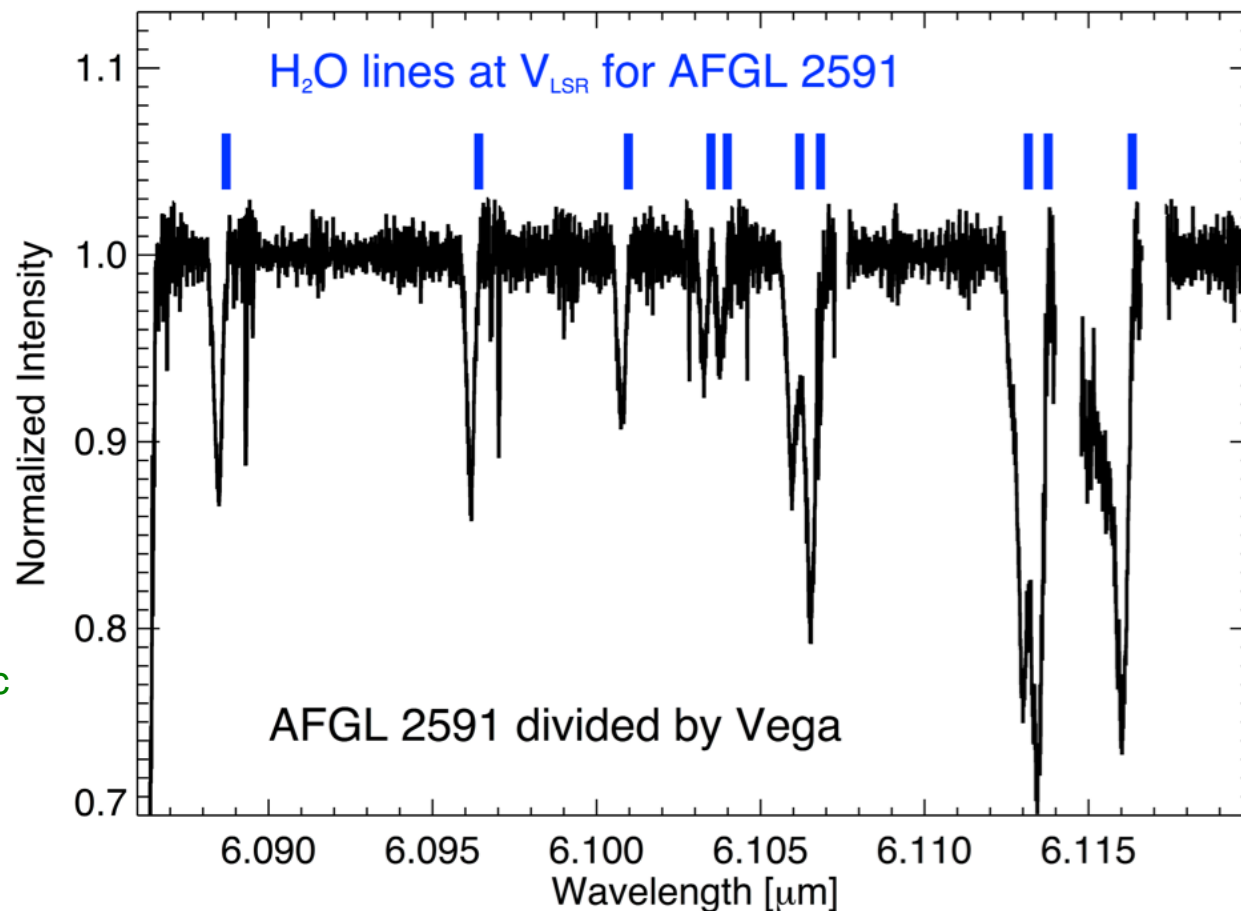
- FWHM ~14 km/s
- blue-shifted

- T = 700 K

- N = 10¹⁹ cm⁻²

- EXES/SOFIA can separate target lines from strong atmospheric lines

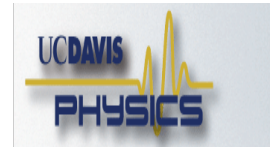
- EXES/SOFIA can study absorption from the coldest H₂O gas



Indriolo et al, submitted



EXES Summary



- EXES on SOFIA producing new science data
 - unseen combination of sensitivity and spectral resolution at wavelengths blocked from the ground
- Able to separate astrophysical lines from Earth's atmospheric lines with moderate Doppler shift
- Basic observing modes work
 - Still lots of work to be done....

Looking forward to 3x more time on the SOFIA come Feb/Mar