Jupiter:
First Light Results with SOFIA

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DPS

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Outline

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Introduction

Introduction

- On May 26th 2010 UT SOFIA had its first light (Heat) with SOFIA in the air flying at 35,000 ft.
- The fight included images taken with FORCAST (Terry Herter, Cornell PI) of Jupiter at 5.4, 24.2 and 37.1 microns.
- The angular resolution was about 4 arcsec FWHM at all three wavelengths.
- At 37.1 microns, this was the best angular resolution on Jupiter since Galileo.
- The signal to noise was high at all three wavelengths >100

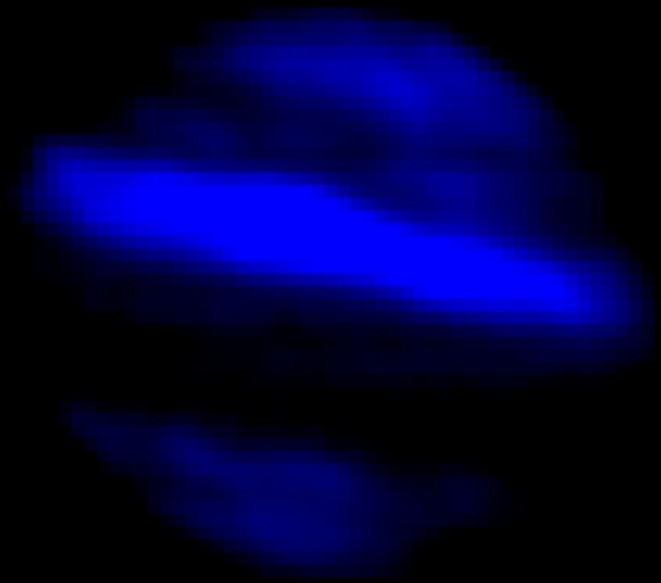
Results

Results 5.4 Microns

- At 5.4 microns the emission was concentrated in a band in the Northern Hemisphere at a latitude between 5 and 20 degrees, known as the North Equatorial Belt (NEB). The 5.4 micron brightness temperature in the NEB is over 200 K. The enhancement over the disk average is a factor of 5. The enhanced 5.4 micron region corresponds to a dark band in the optical image. Much weaker polar emission was also seen.

5.4 Microns

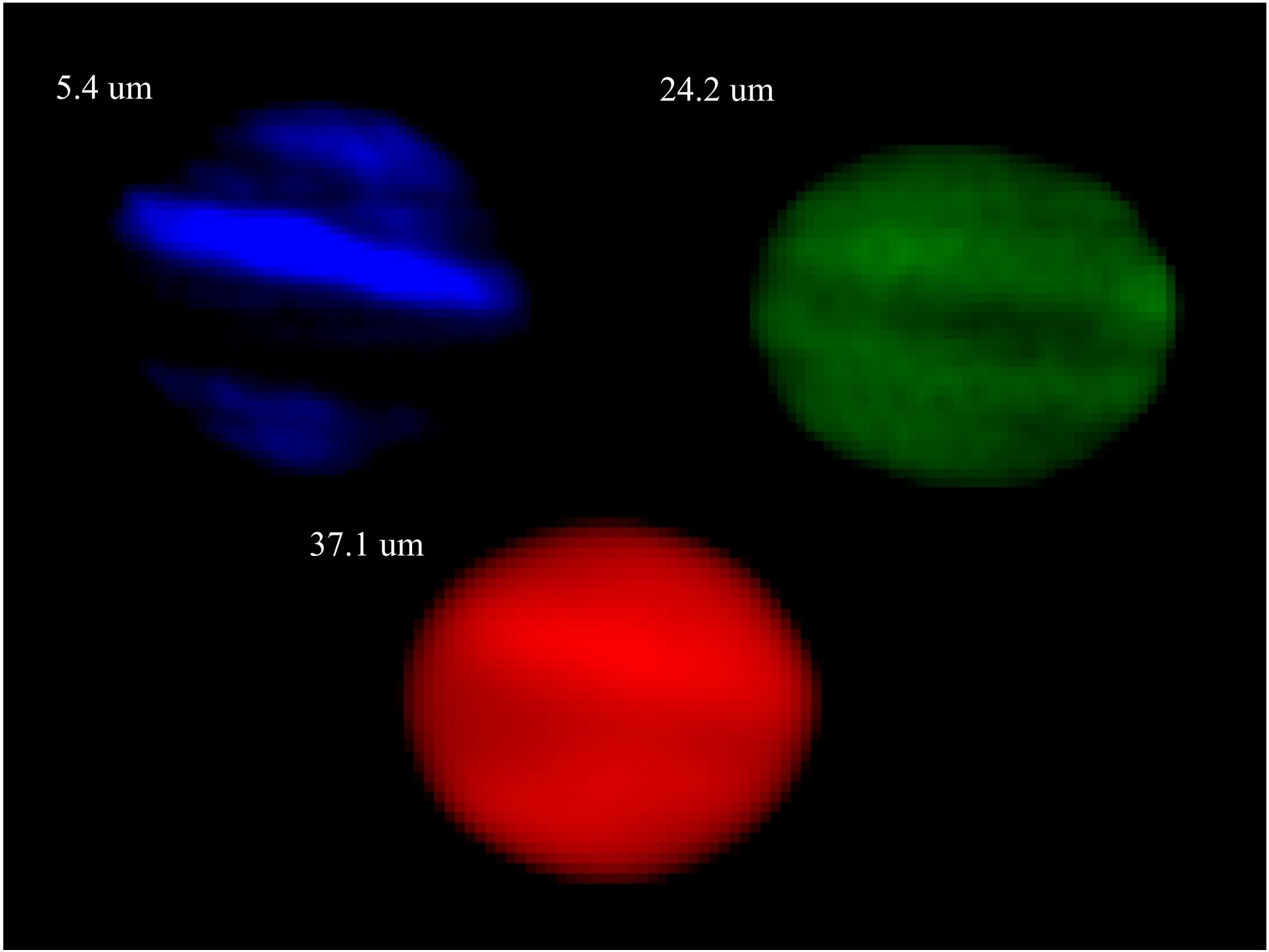
Optical



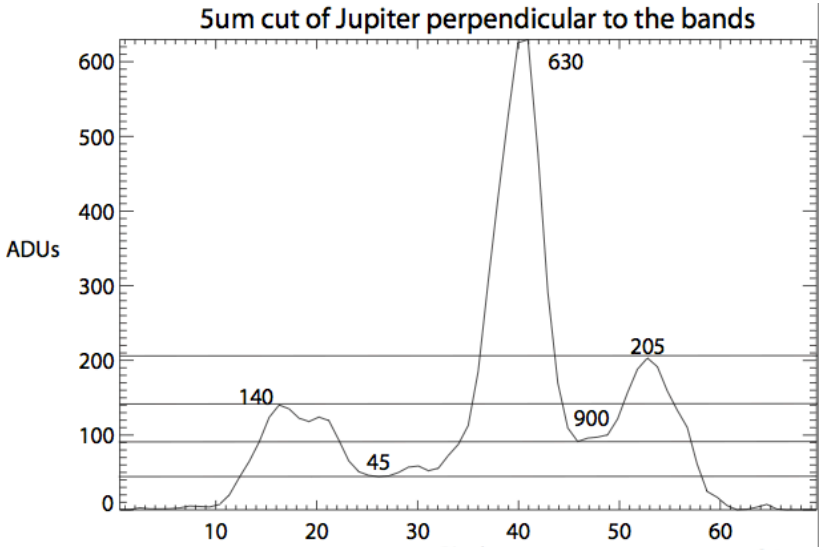
Optical Image:Anthony Wesley

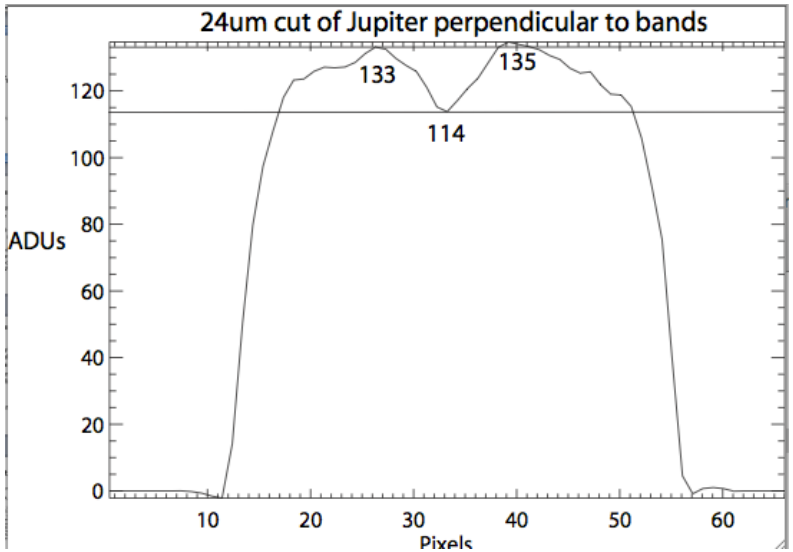
Results 24.2 and 37.1 Microns

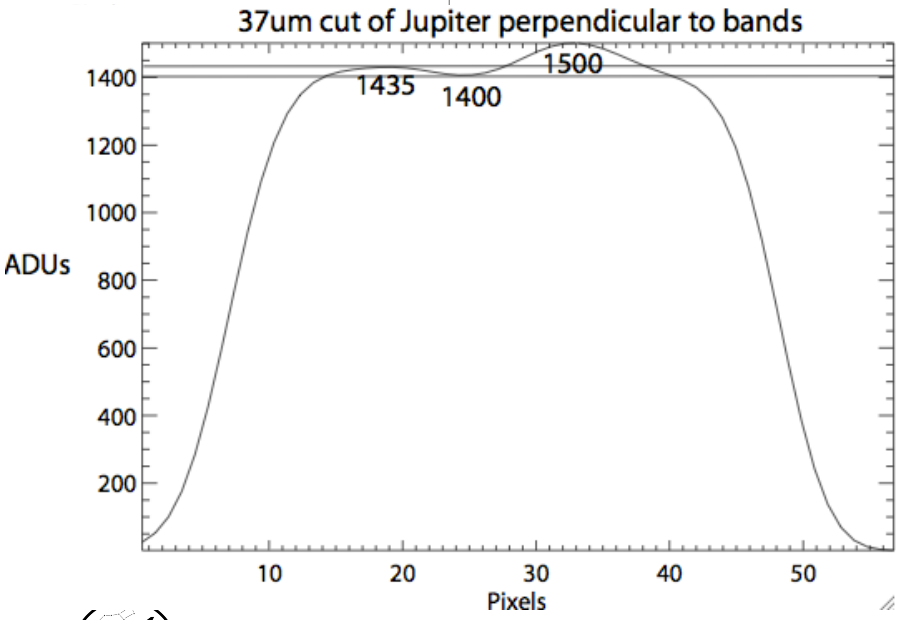
- The emission at 24.2 and 37.1 microns is much more uniform, with bands of enhanced emission at the same region of the dark optical band in the north (the NEB), and a symmetric region in the south, the South Equatorial Belt (SEB) The enhancement relative to the disk average is about 20% at 24.2 microns and 7% at 37.1 microns.


5.4 um
24.2 um
37.1 um

Line Scans


5um cut of Jupiter perpendicular to the bands
ADUs
630
205
140
900
45


24um cut of Jupiter perpendicular to bands
ADUs
133
135
114
Pixels


37um cut of Jupiter perpendicular to bands
ADUs
1435
1500
1400
Pixels

What it Means

What it Means: 5.4 Microns

- Extreme 5 micron Jupiter emission over that expected from reflected light was first discovered by Gillett and Stein and characterized by Westphal. (1969 ApJ Letters 157 L63)

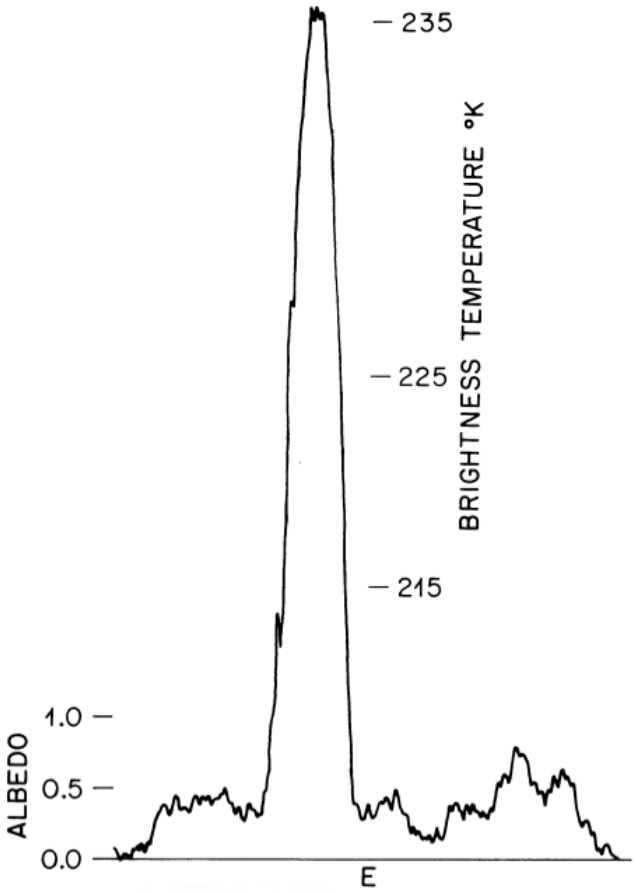
- It has been explained as cloud free regions where you see deep into the Jovian atmosphere. 5 micron temperatures in excess of 300K have been reported. (Westphal 1969, Westphal etal 1974, ApJ Letters 188 L111)

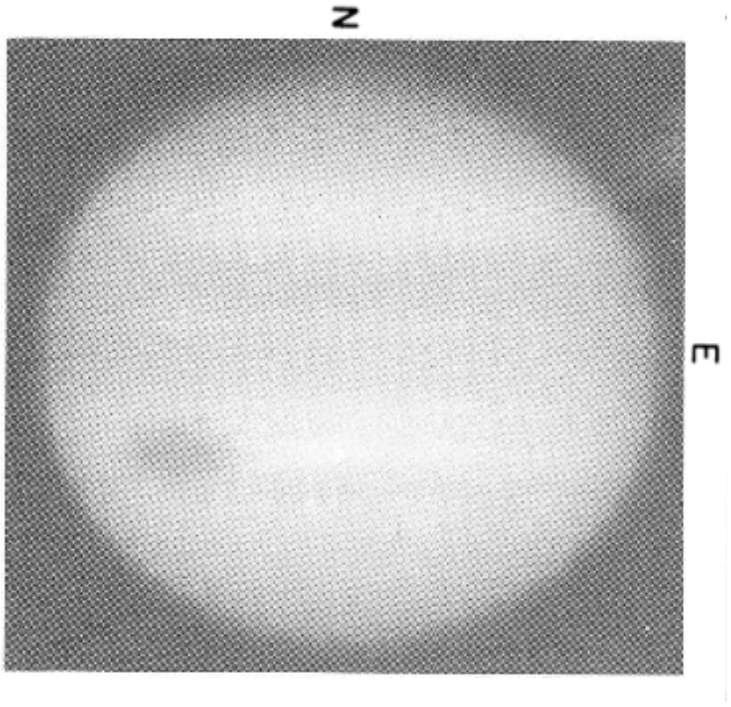
- Similar explanations are used to explain the high near-IR brightness temperatures in low-temperature brown dwarfs.

- The correlation with the optically dark region was first pointed out by Westphal 1969.

- At most times there is also enhanced 5 micron emission in the southern hemisphere. However, the dark band in the SEB disappeared over the last year along with enhanced 5-micron emission. A similar situation was seen by Westphal in 1969.

Jupiter on April 22, 1969 (Westphal ApJ157 L63)





What it Means: 24 and 37 Microns

- At 24.2 and 37.1 microns, the enhanced emission arises from the relatively warm temperatures in the upper troposphere (0.1-0.4 bars) of the NEB. These warm temperatures correspond to regions of prevailing downwelling, dry winds where enhanced 5.4 micron emission indicates the presence of a relatively clear atmosphere. However, the warm temperatures and enhanced emission in the SEB do not correlate with the 5.4 micron emission. The atmosphere is as cloudy as the adjacent visibly white "zones"

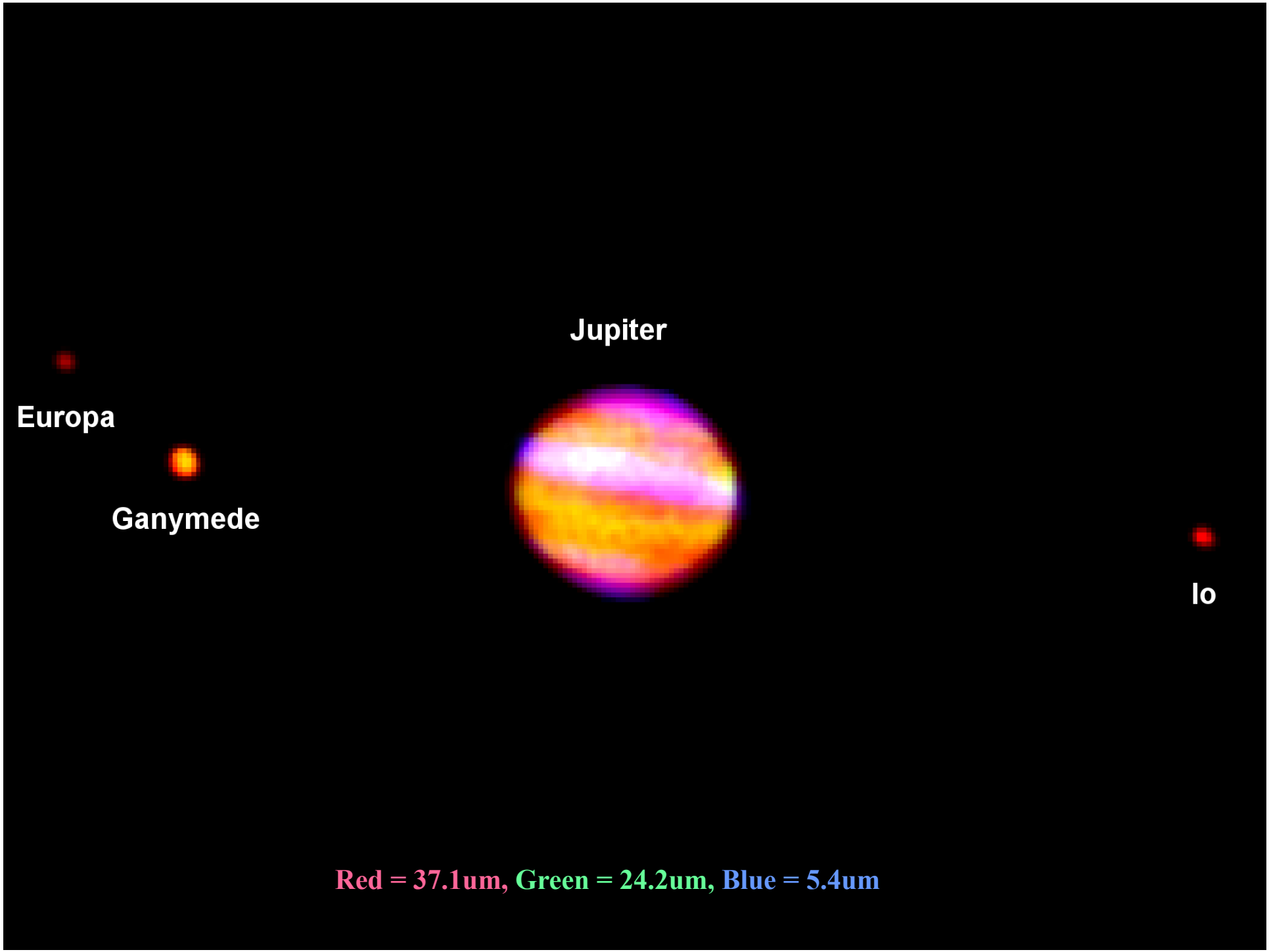
- It has been reported in the SOFIA Science Vision by Orton that the ortho to para ratio of molecular hydrogen can be determined from the 24 and 37 micron emission if the calibration is better than 5%. Preliminary calibration of Jupiter using Ganymede indicates that this might be possible.

Summary

Summary

- We have obtained 5.4, 24.2 and 37.1 high signal to noise images of Jupiter using FORCAST on SOFIA. The angular resolution was about 3 to 4 arcsec FWHM. At the 37.1 microns wavelength, this is the highest angular resolution reported since the Galileo spacecraft.

- The results indicate a good potential for atmospheric studies of Jupiter in the future.


Jupiter
Europa
Ganymede
Io
Red = 37.1um, Green = 24.2um, Blue = 5.4um