

# Theoretical modelling of optical and IR spectra of brown dwarfs and ultracool dwarfs.

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LOC & SOC of UCLMS

**Astronomy often progresses amoeba-like: the advance in one pseudopod may not move the animal very far, but permits other parts to advance in their turn and can reveal portions of the organism that are in danger of being left behind.**

V. Trimble, R.A. Bell, Q. J. I. R. astr. Soc. (1981), 22, 361-379

# **GENERAL PROBLEMS:**

- a) problems with line lists
- b) K and Na resonance  
lines profiles
- c) physics of the dust,  
dust opacities
- d) Model atmospheres

# Infrared spectra

$H_2O$  (AMES:1998, BT2: 2005)

$CO$  (Goorvitch, 1994)

Methane ???

...

# GJ 406:

**Sp ~**

**M6V**

**T<sub>eff</sub> =**

**2800 K**

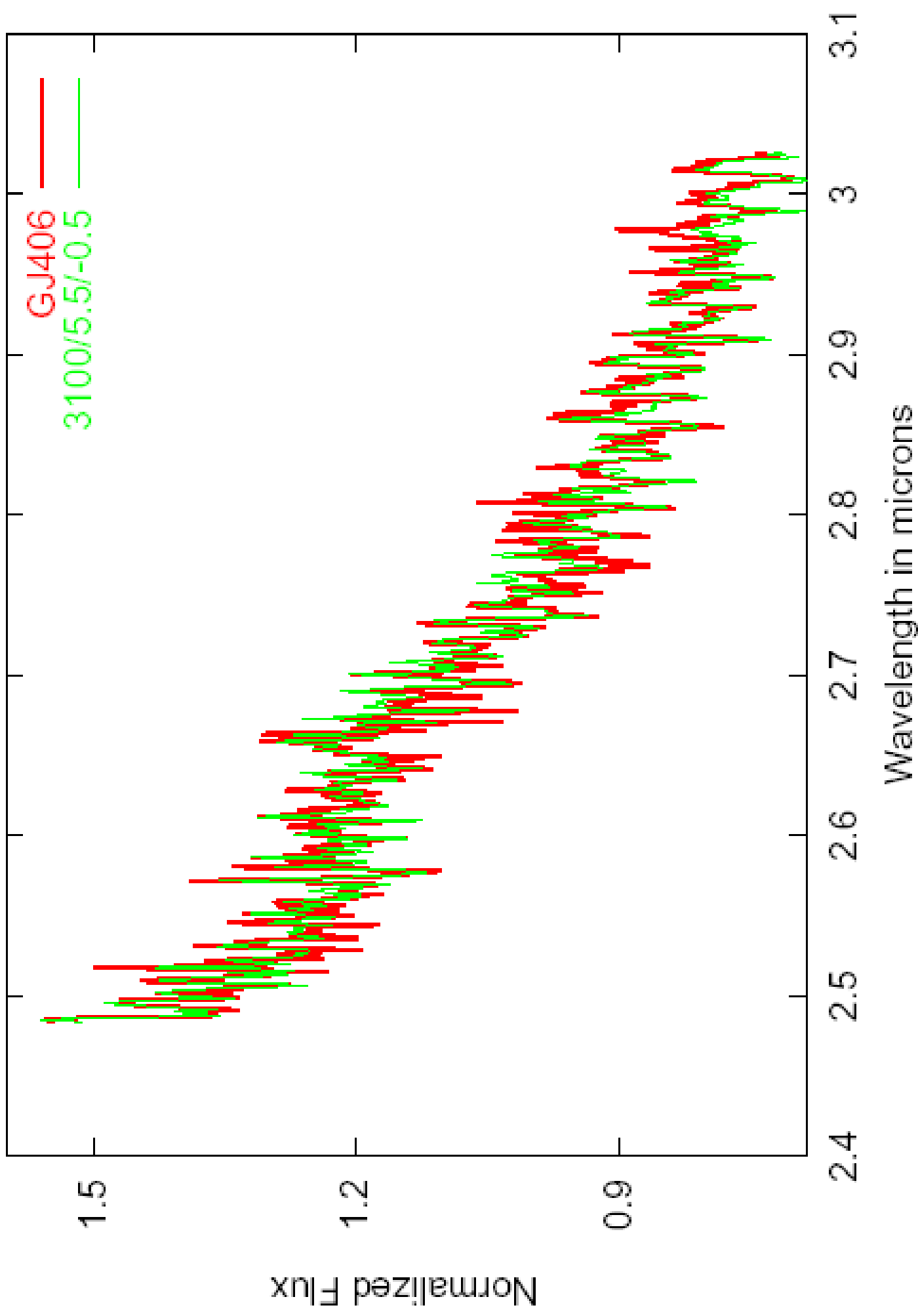
**log g =**

**5.0**

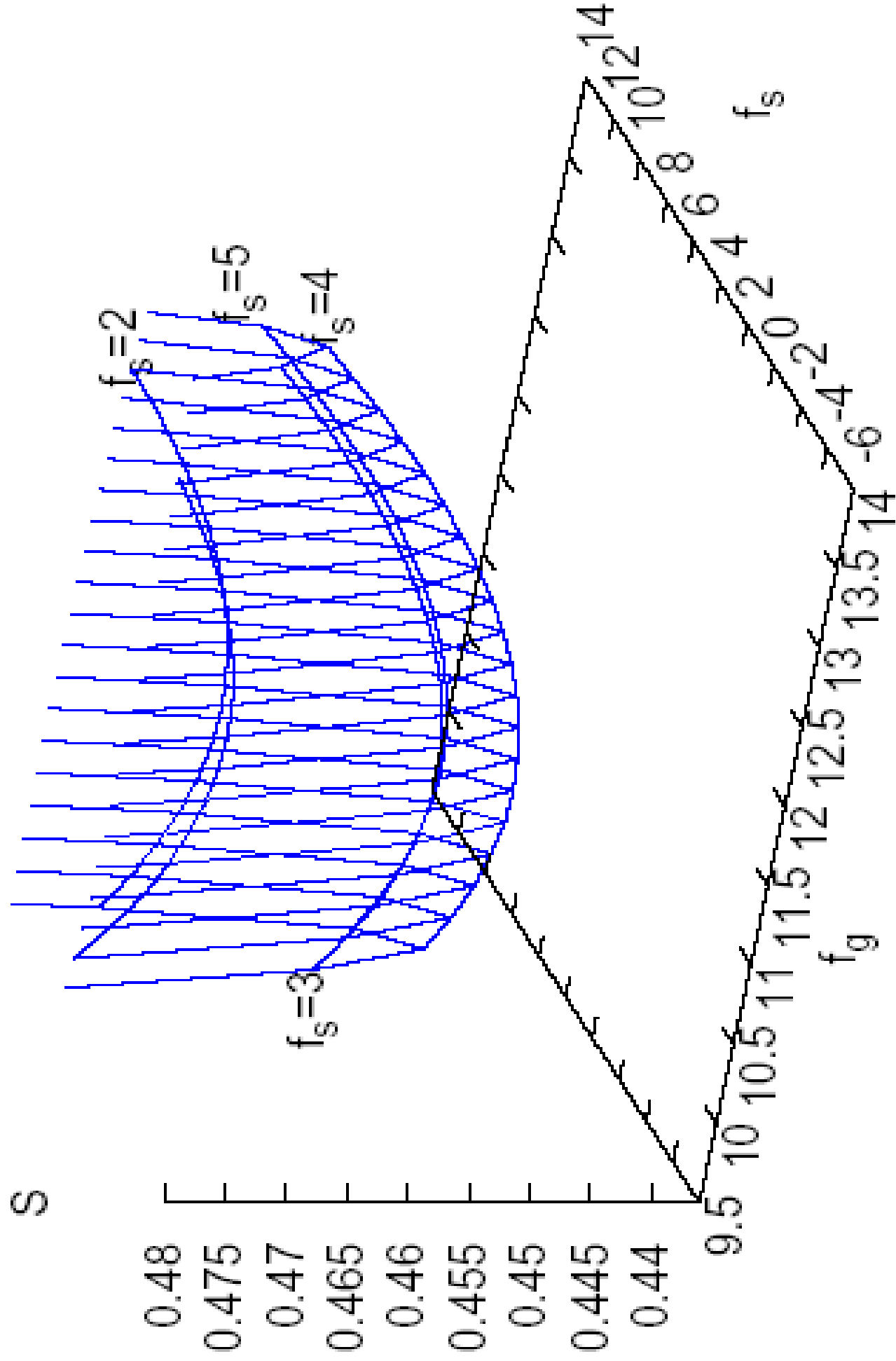
**L/L<sub>SUN</sub> =**

**-2.95+/-0.05**

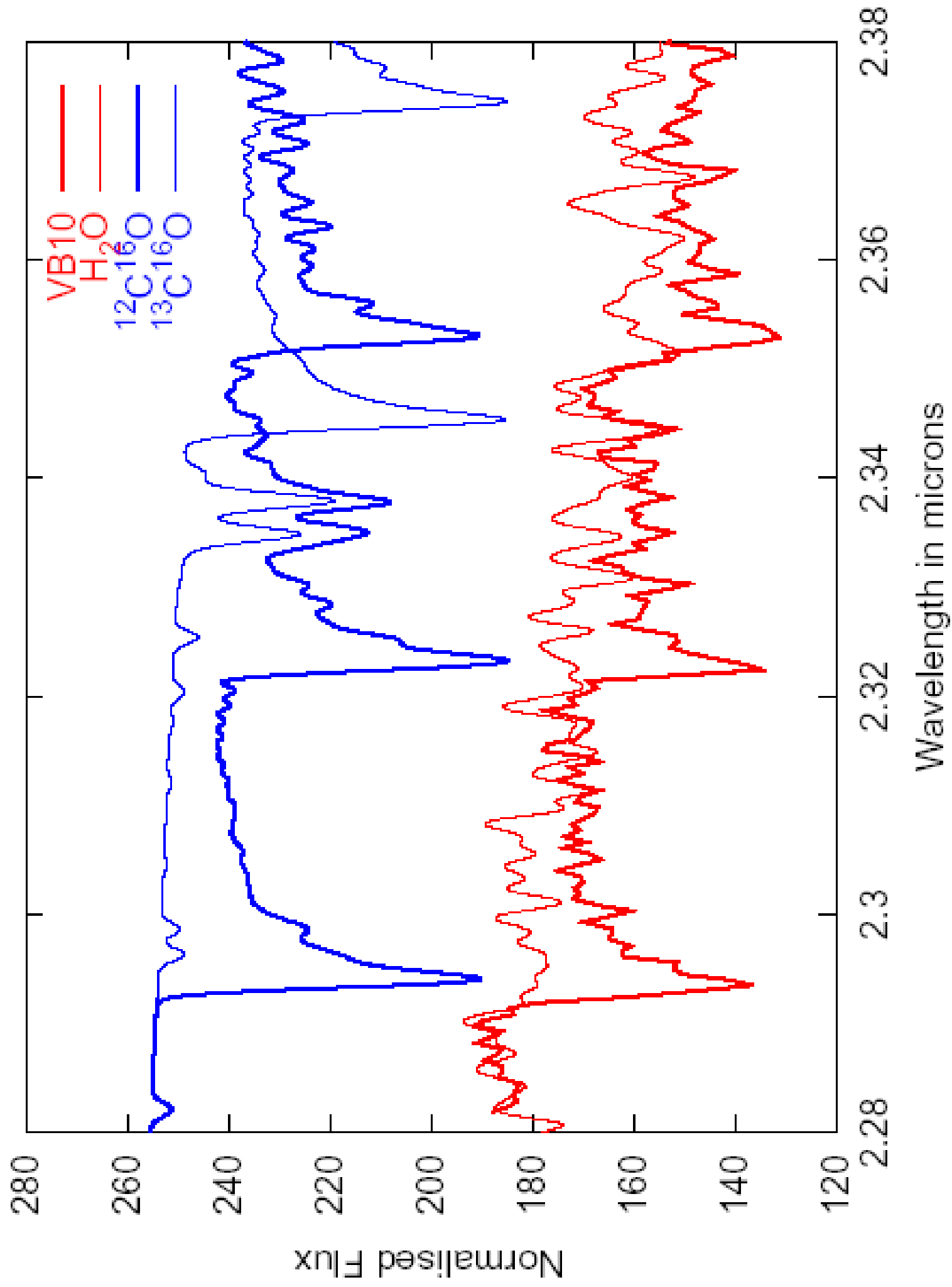
**No lithium.**

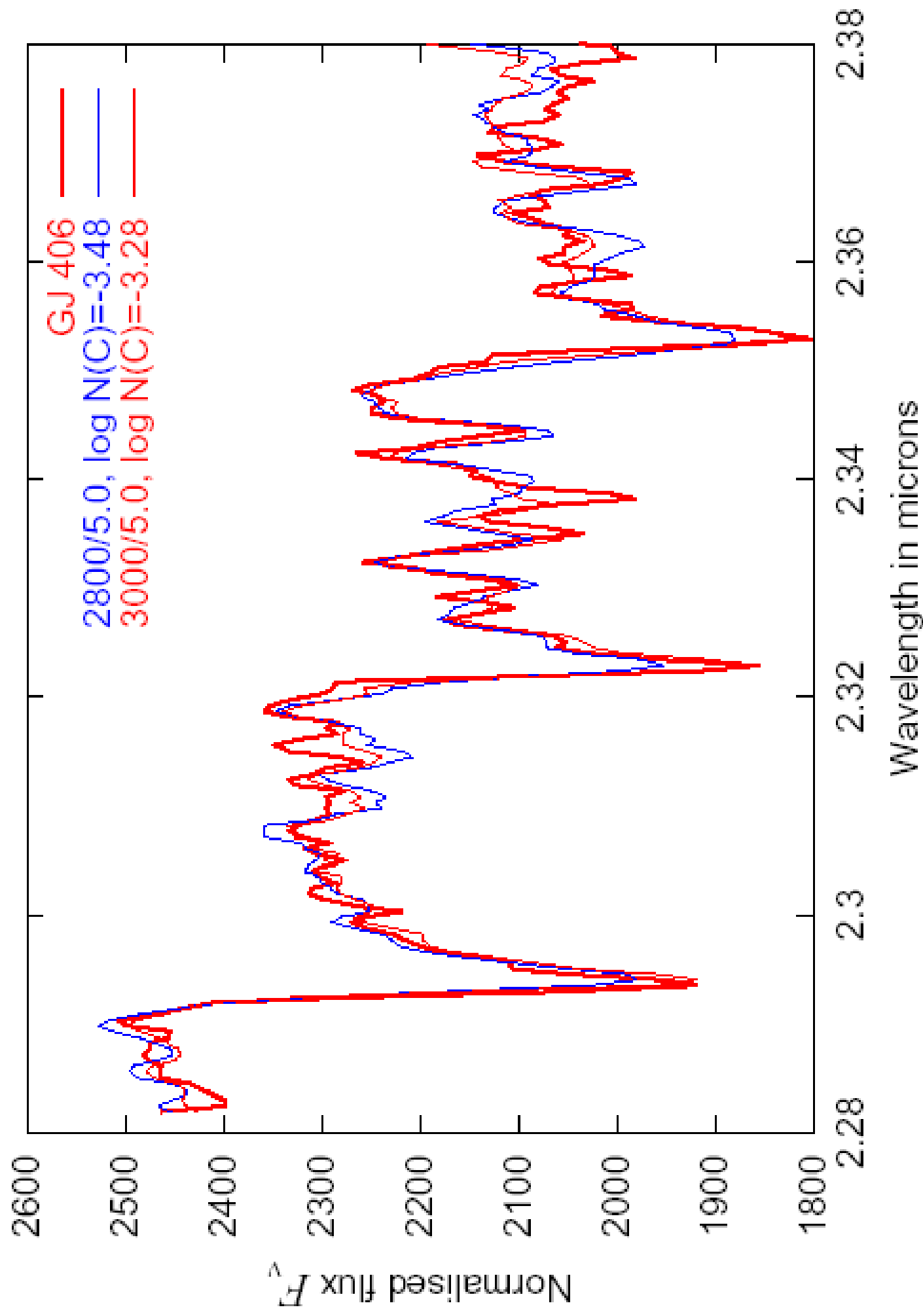


GJ 406, 3100/5.5,  $D_0=0$ ,  $f_h=0.88$



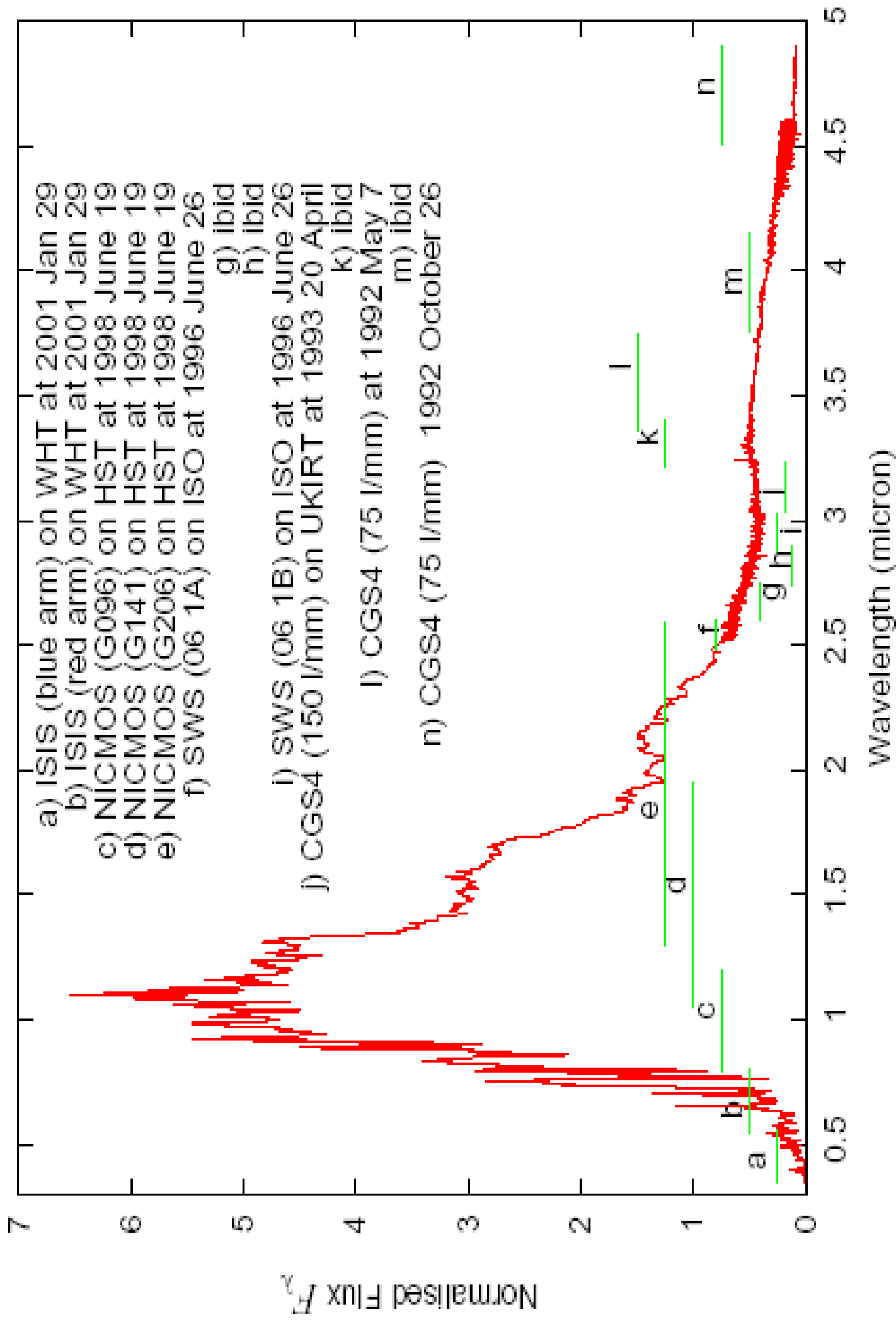


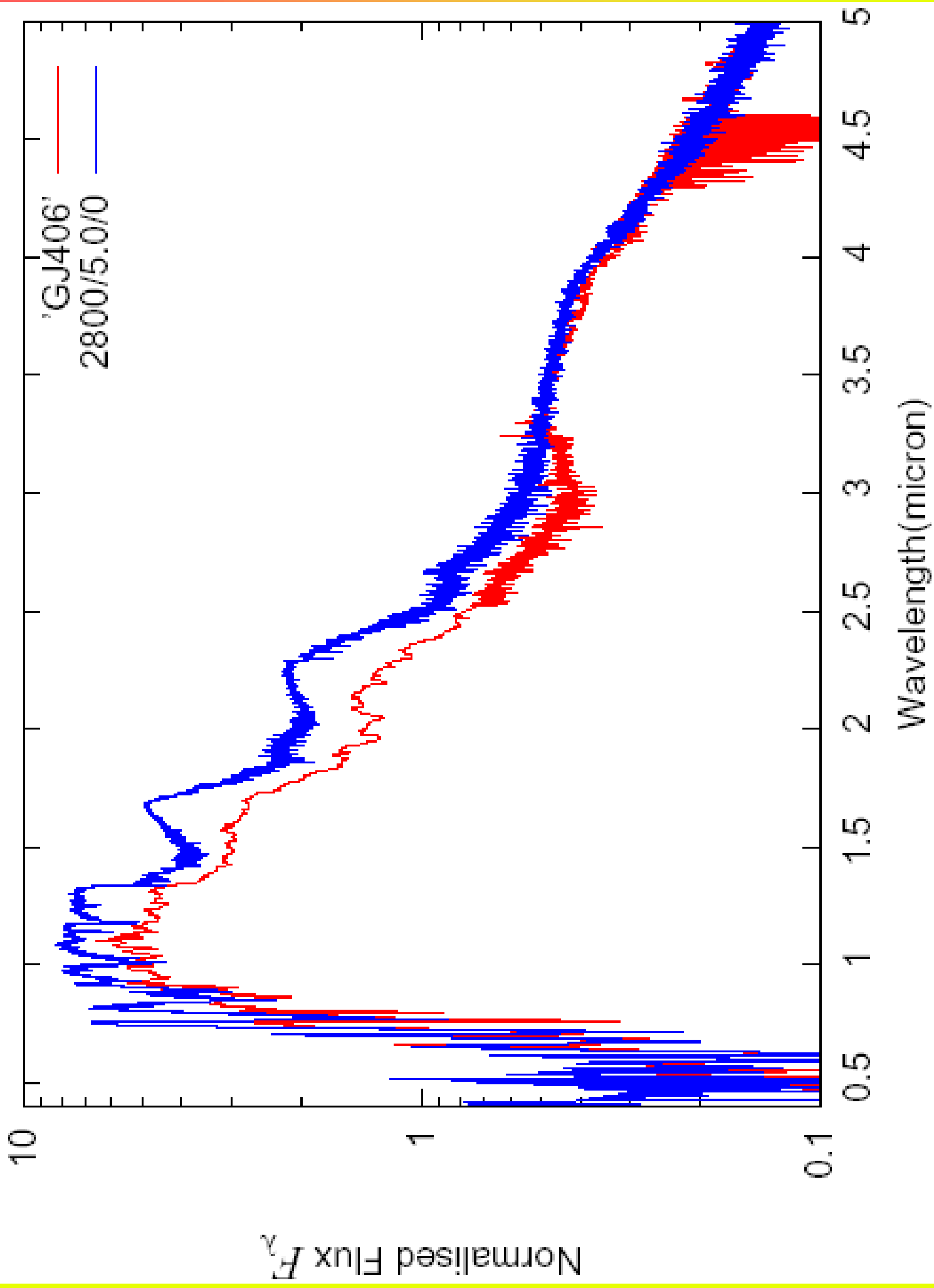




... but 😞:

**We cannot fit to  
the observed  
SEDs of late M- and L-  
dwarfs across all  
spectral regions.**





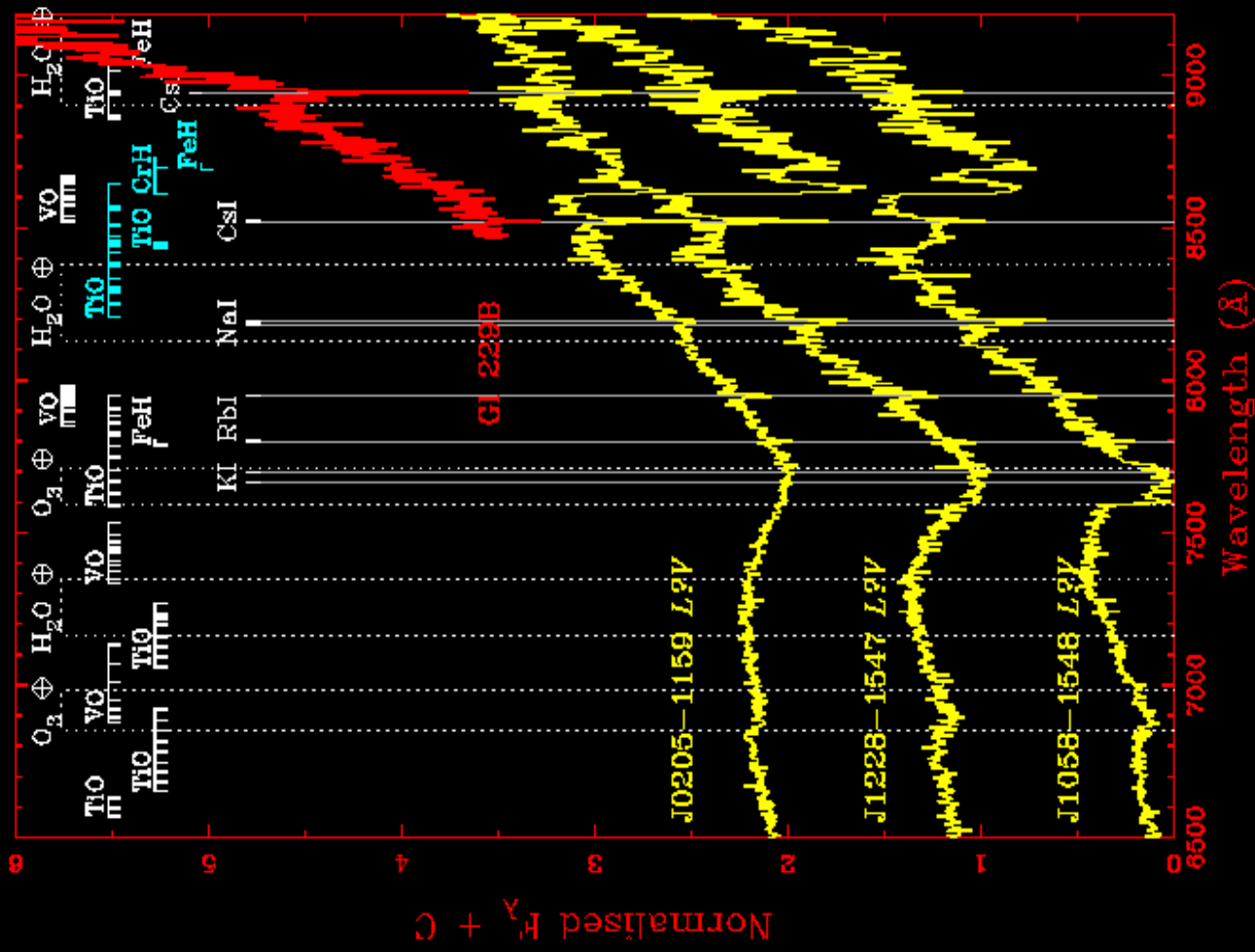
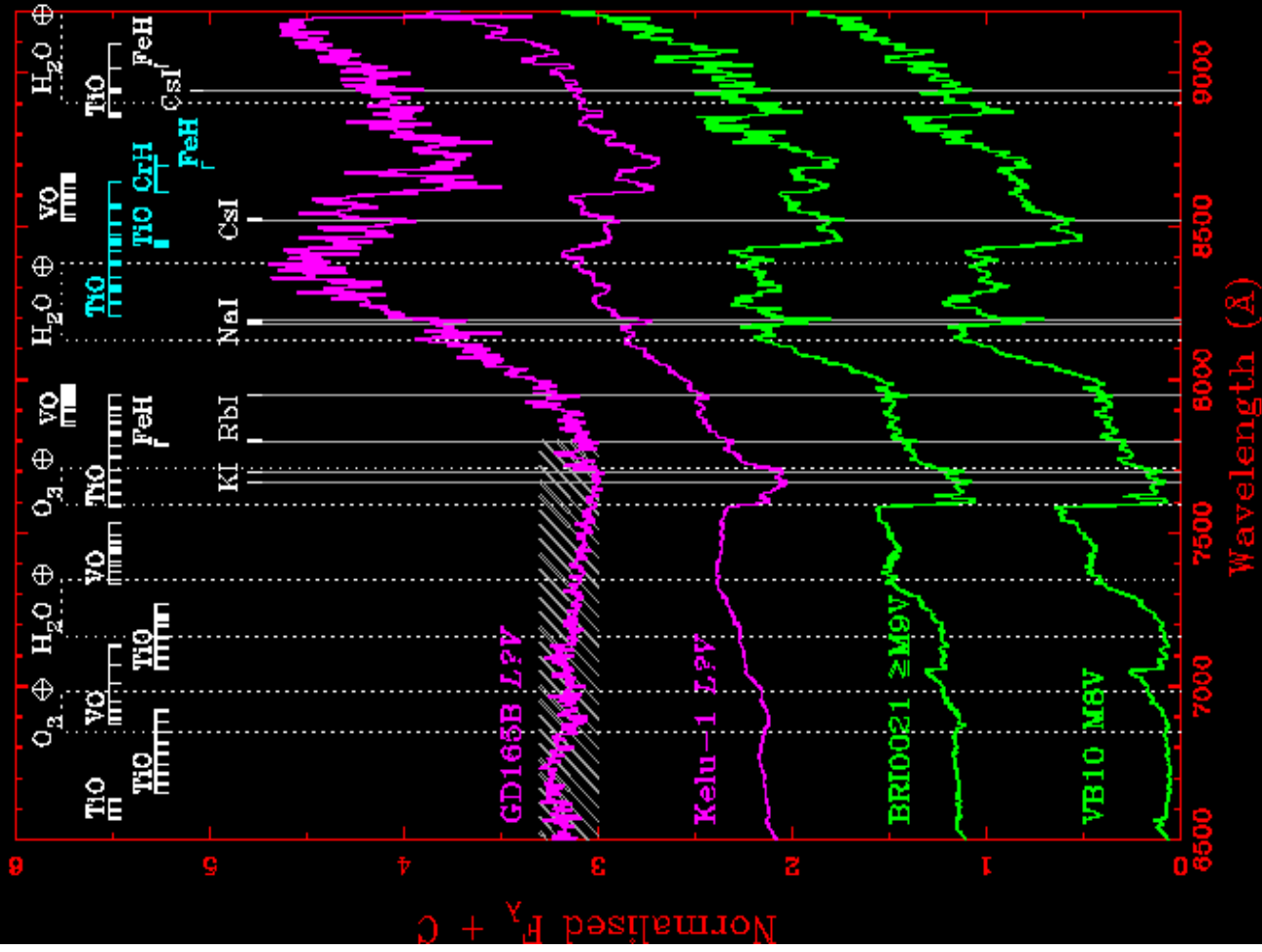
# ”Optical” spectra

Low resolution spectra – fits

High resolution spectra

LR+HIRES spectra analysis

# Resonance lines of potassium and sodium





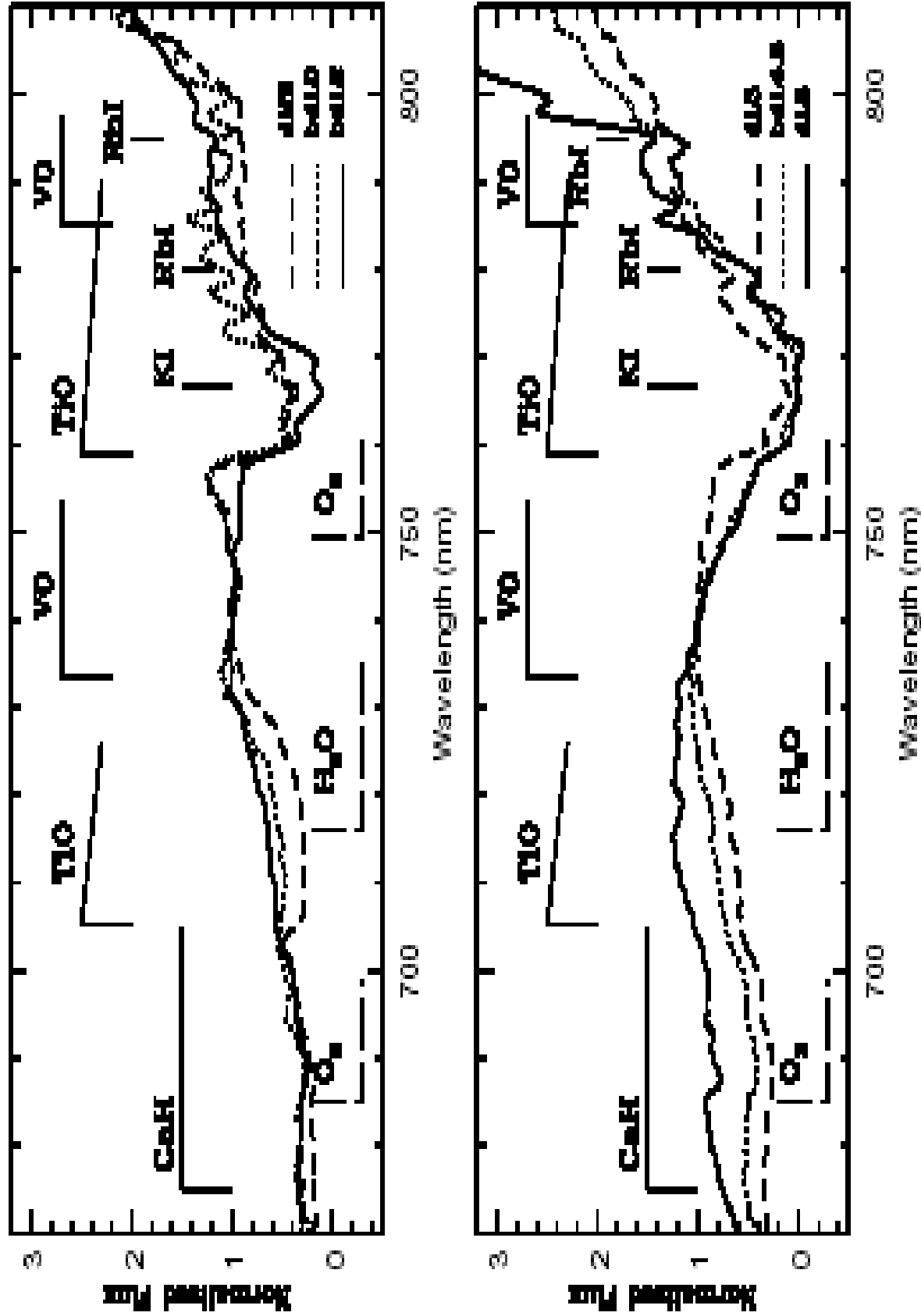
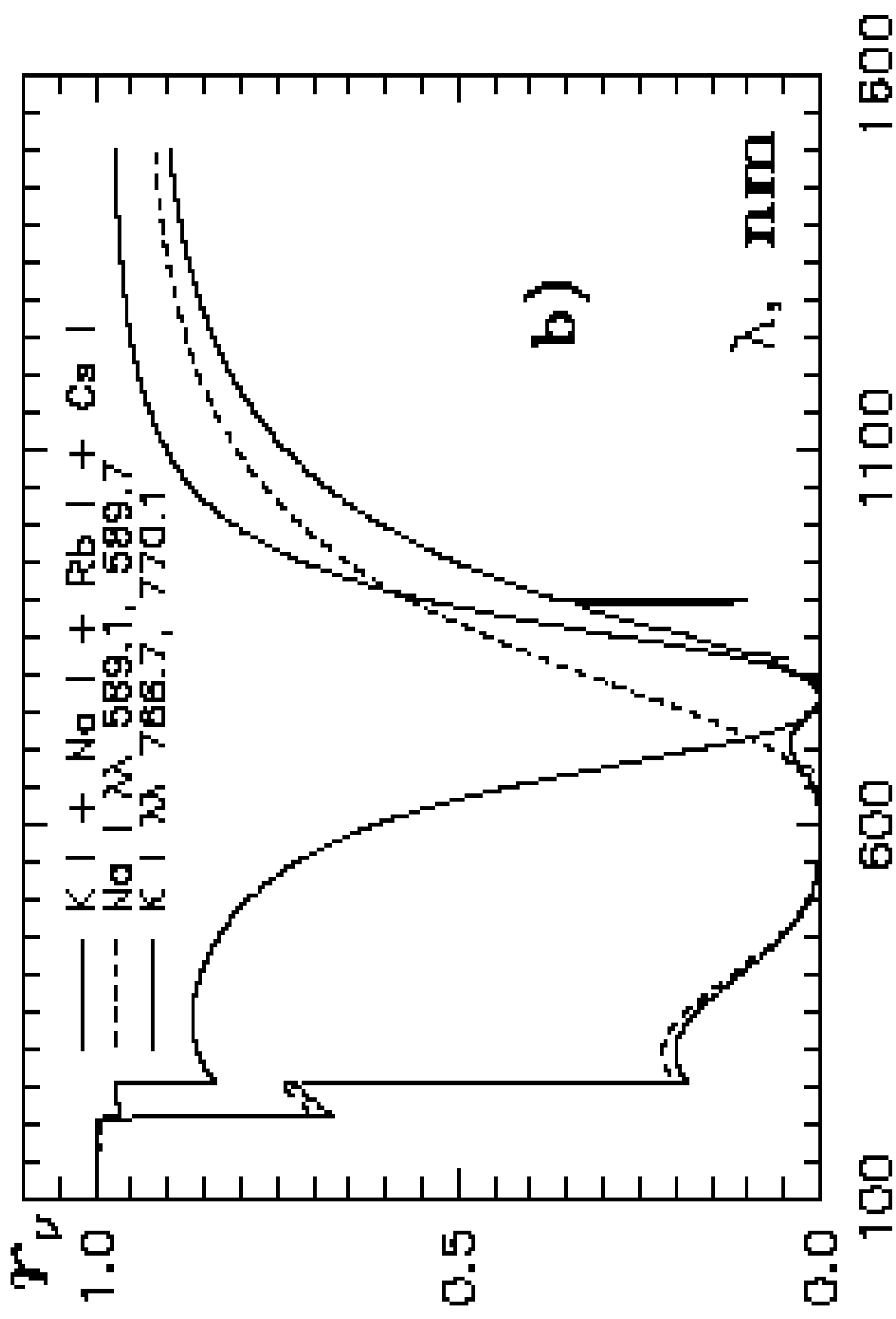
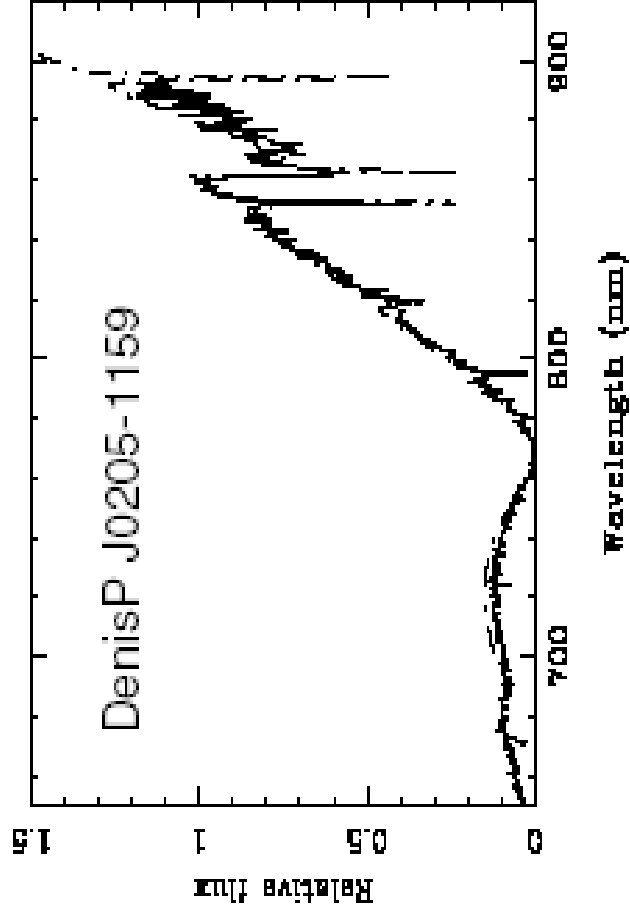
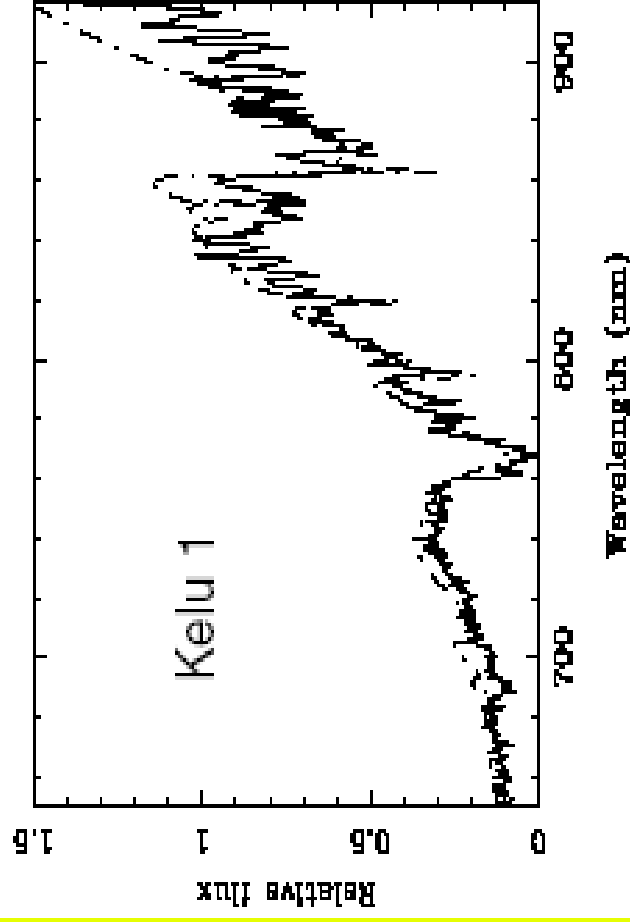
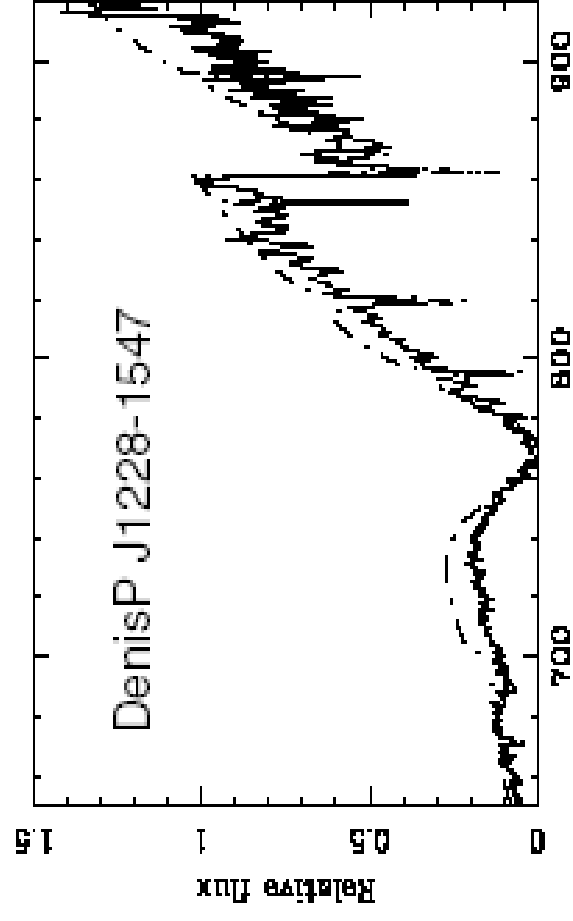
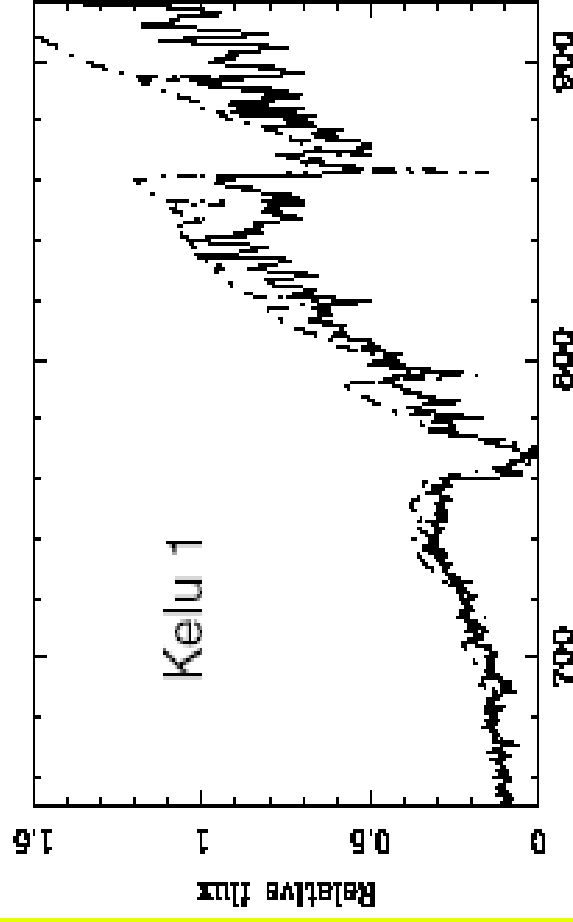


FIG. 7.—Zoom of Keck LRIS spectra in the region 670–810 nm. The spectra have been normalized to the counts at 750 nm. Top: Ketu 1 (solid line), EROS-MP J032–4405 (dotted line), LHS 2065 (dashed line). Bottom: DENIS-P J0255–4700 (solid line), DENIS-P J1228–1547 (dotted line), and DENIS-P J1058–1548 (dashed line). The main photometric



Pavlenko, Zapatero Osorio, Rebolo: On the interpretation of the optical spectra of L-dwarfs



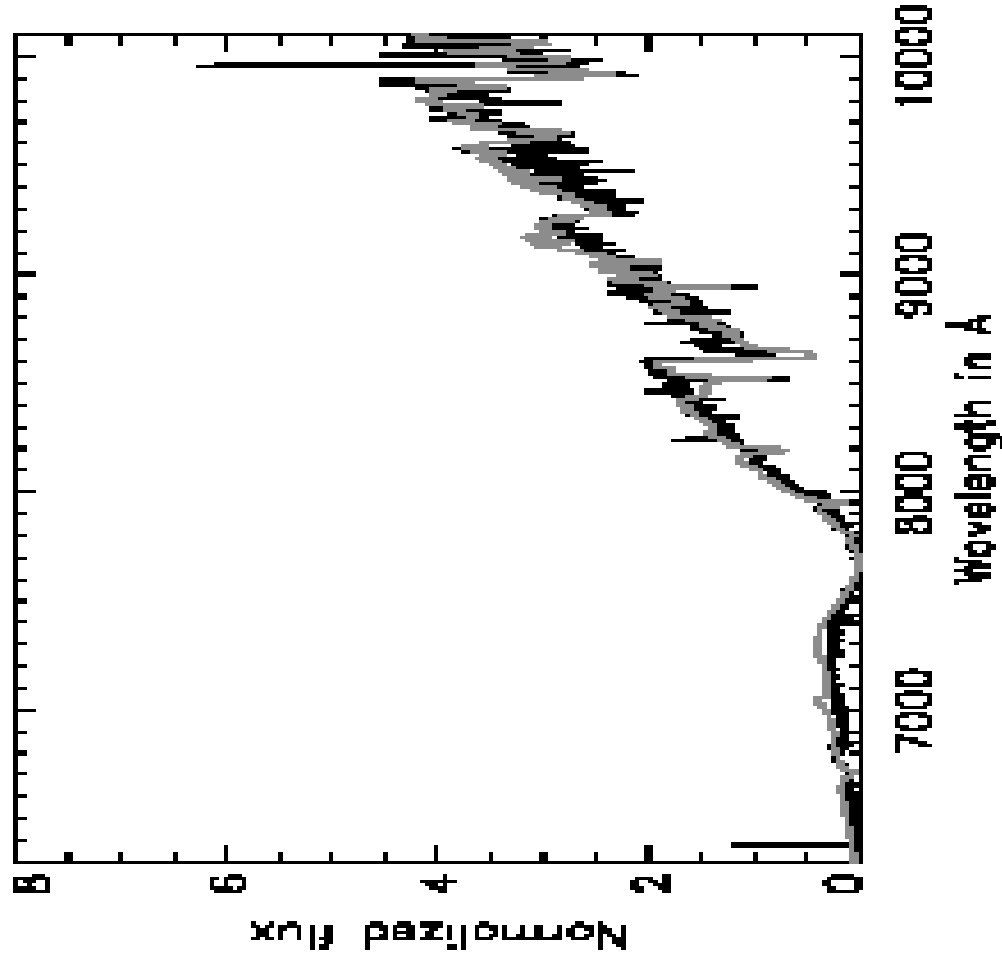


FIG. 1.—Fits (gray line) to optical spectrum of 2MASSs J0850359+105716 (black line). See Table 1 for parameters. Telluric features have not been removed. See Kirkpatrick et al. (1999) for exact locations of telluric bands.

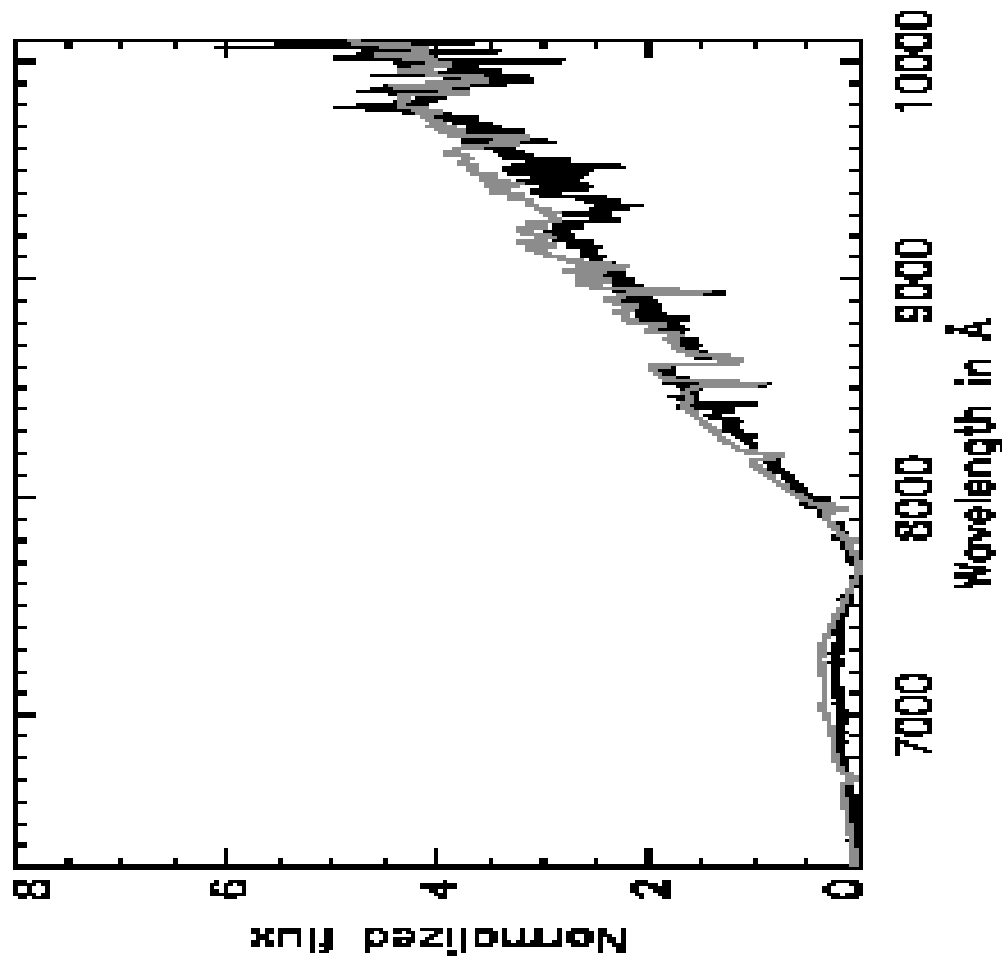


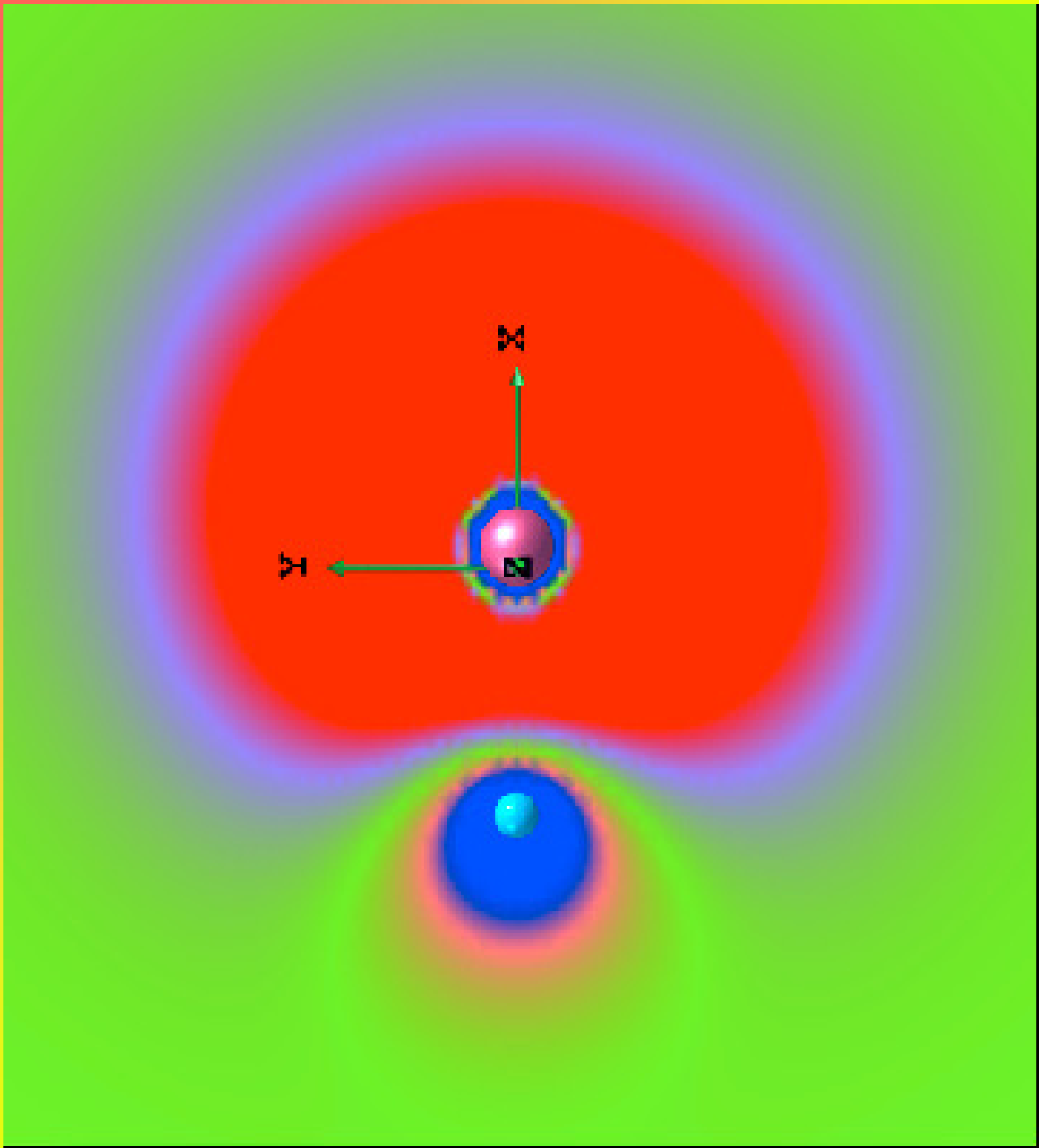
FIG. 3.—Same as Fig. 1, but for 2MASS J0825196+211552

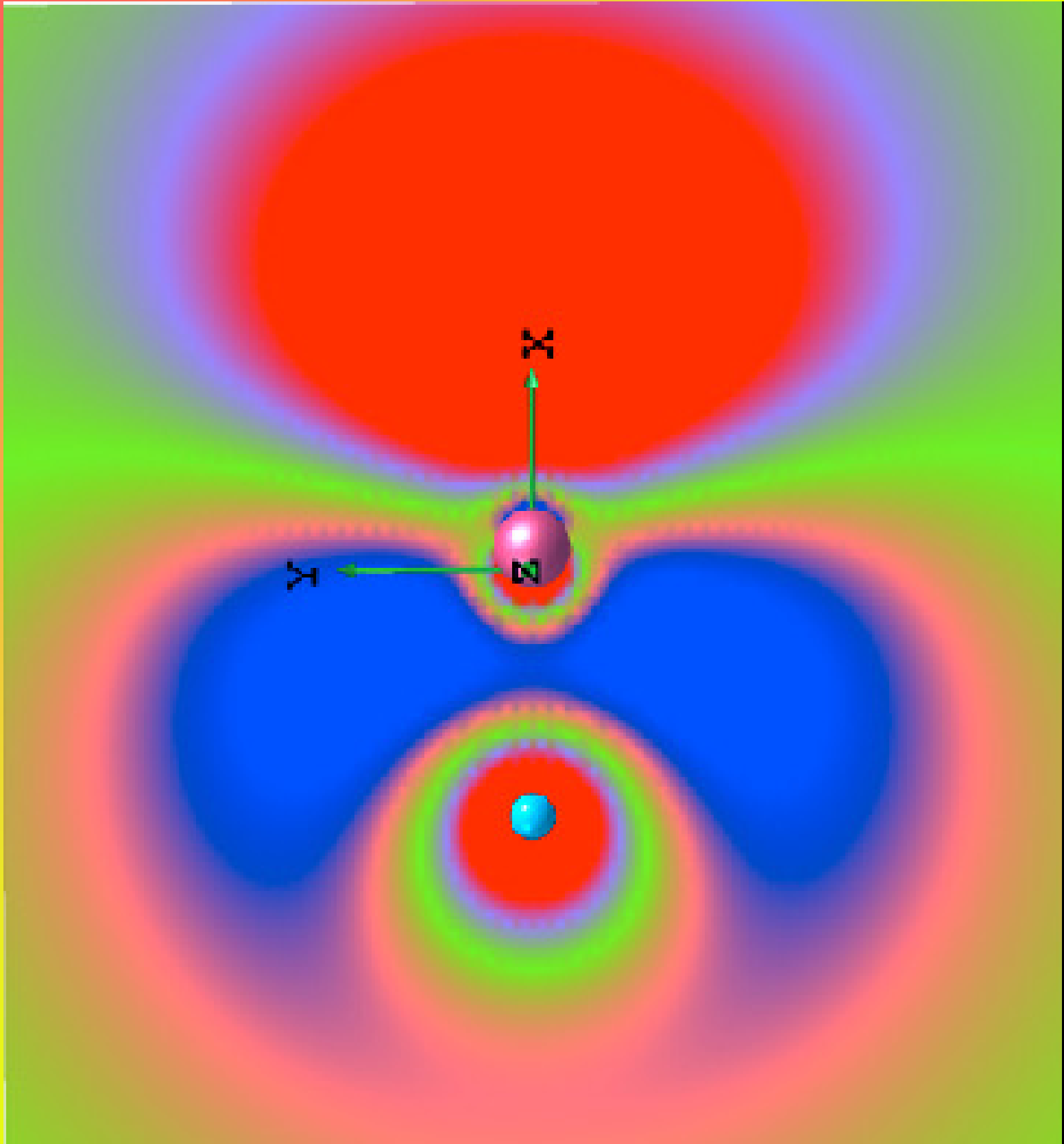
#### 4.2. Infrared Spectra

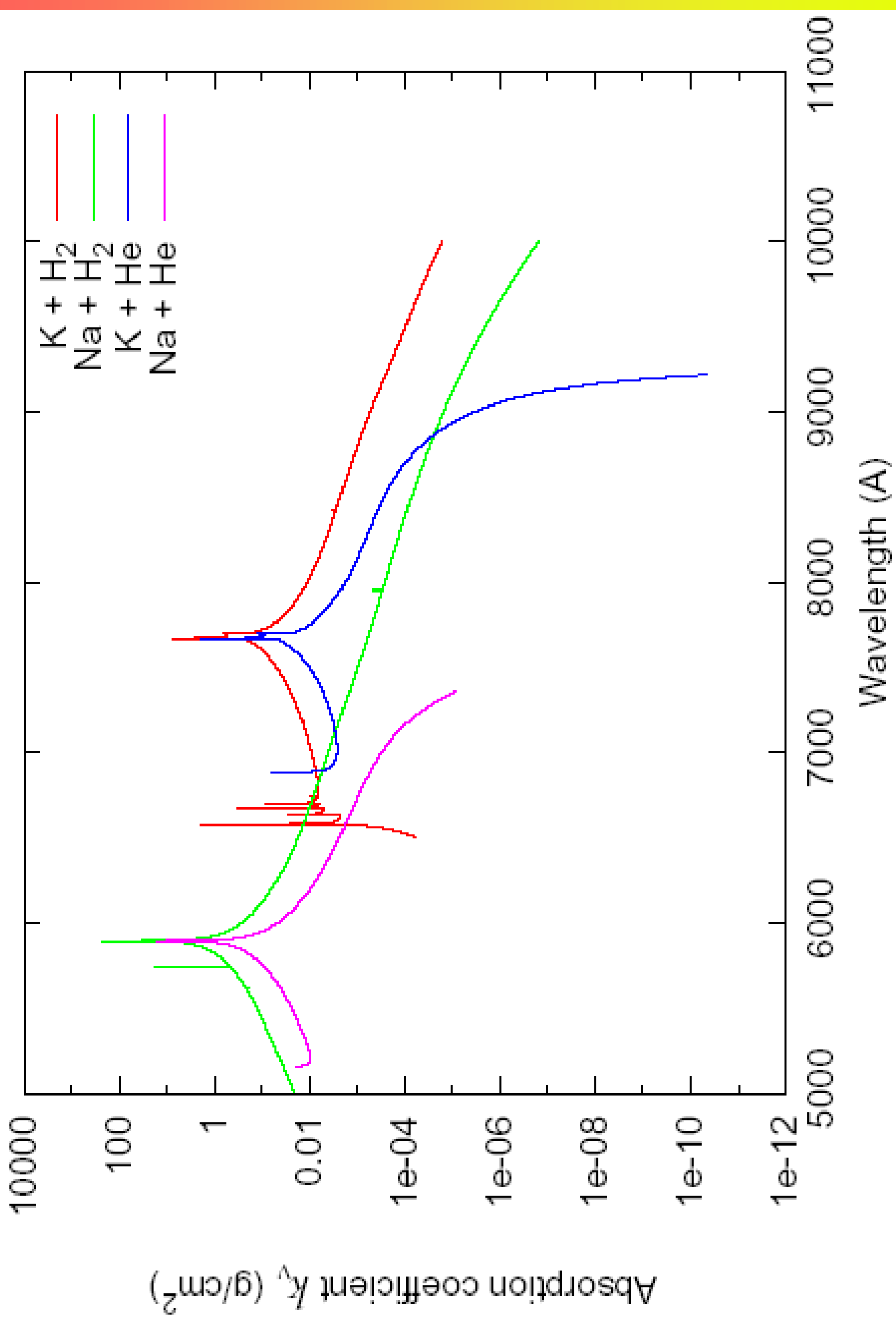
..., but ☹️:

**Collisional approach cannot be used in far wings (close interactions),**

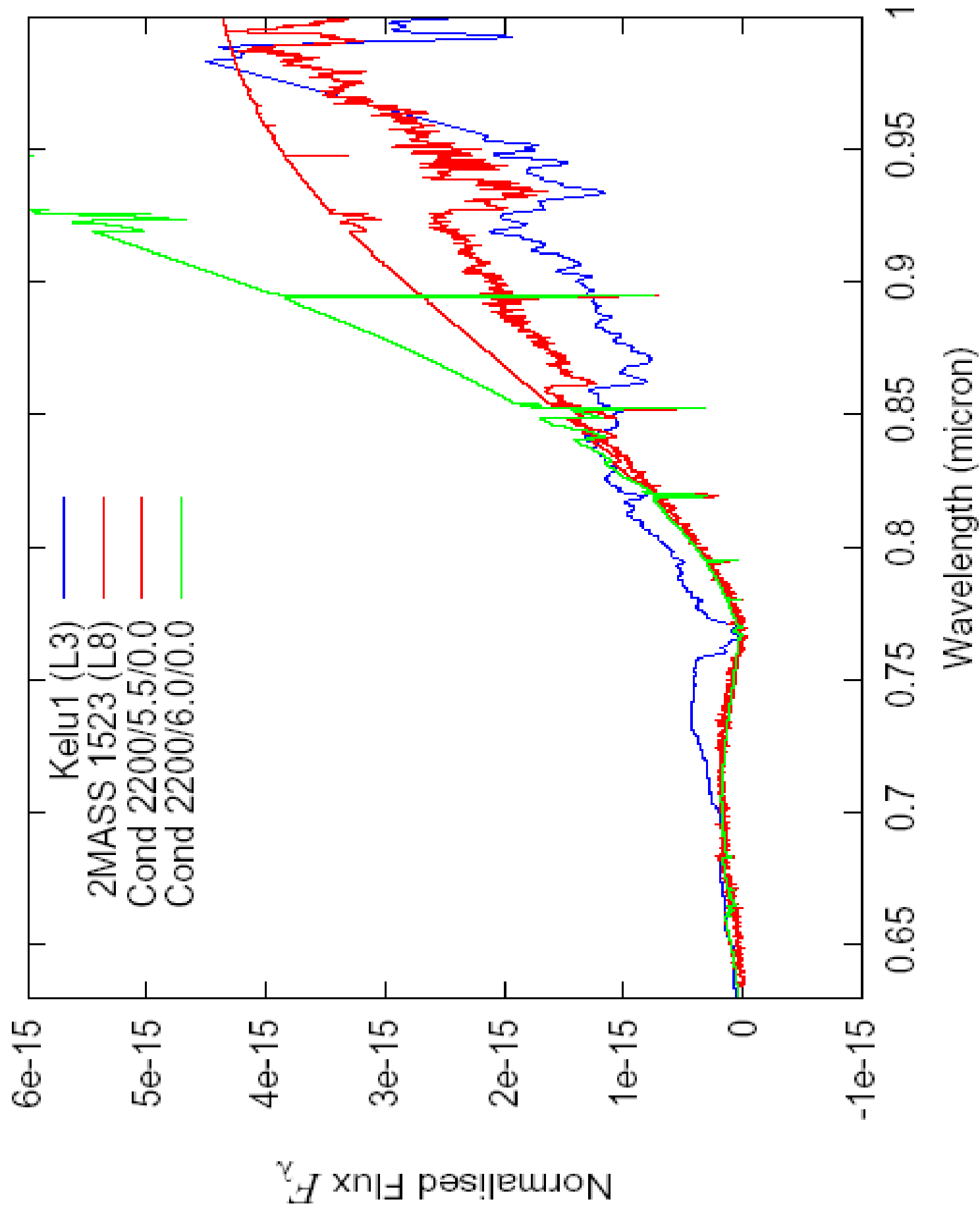
**Quantum chemical approach is the only reliable way...**

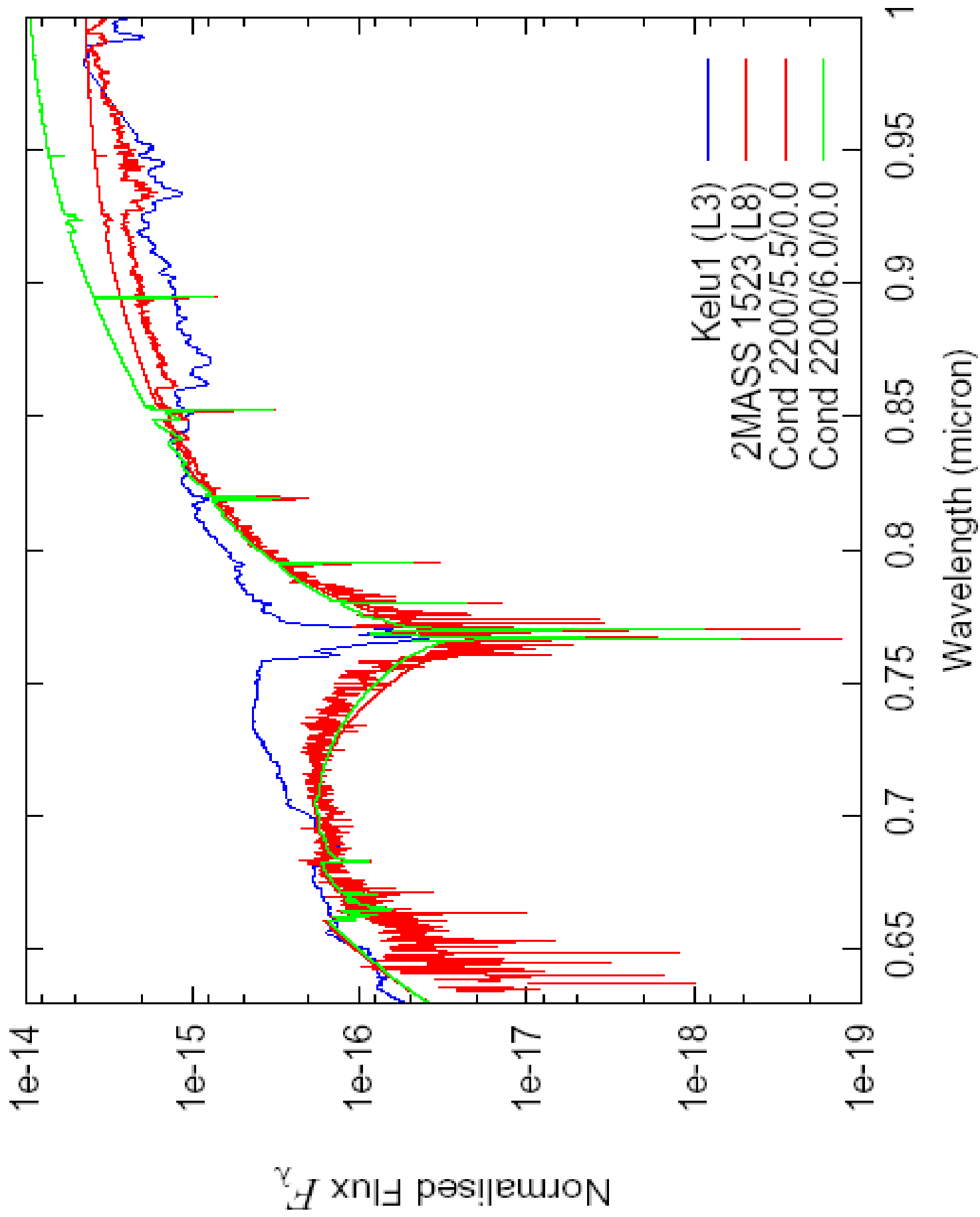










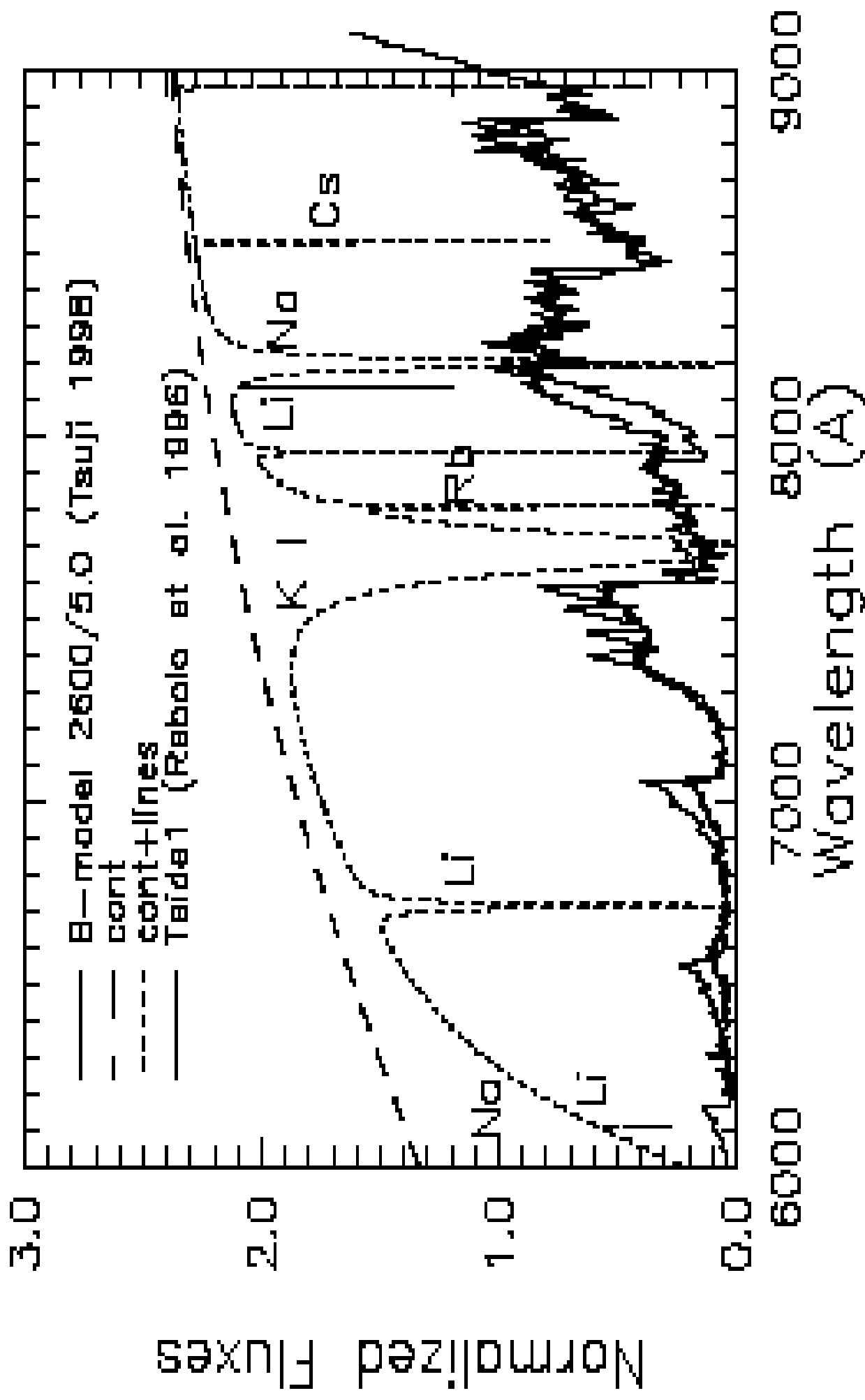


Lithium

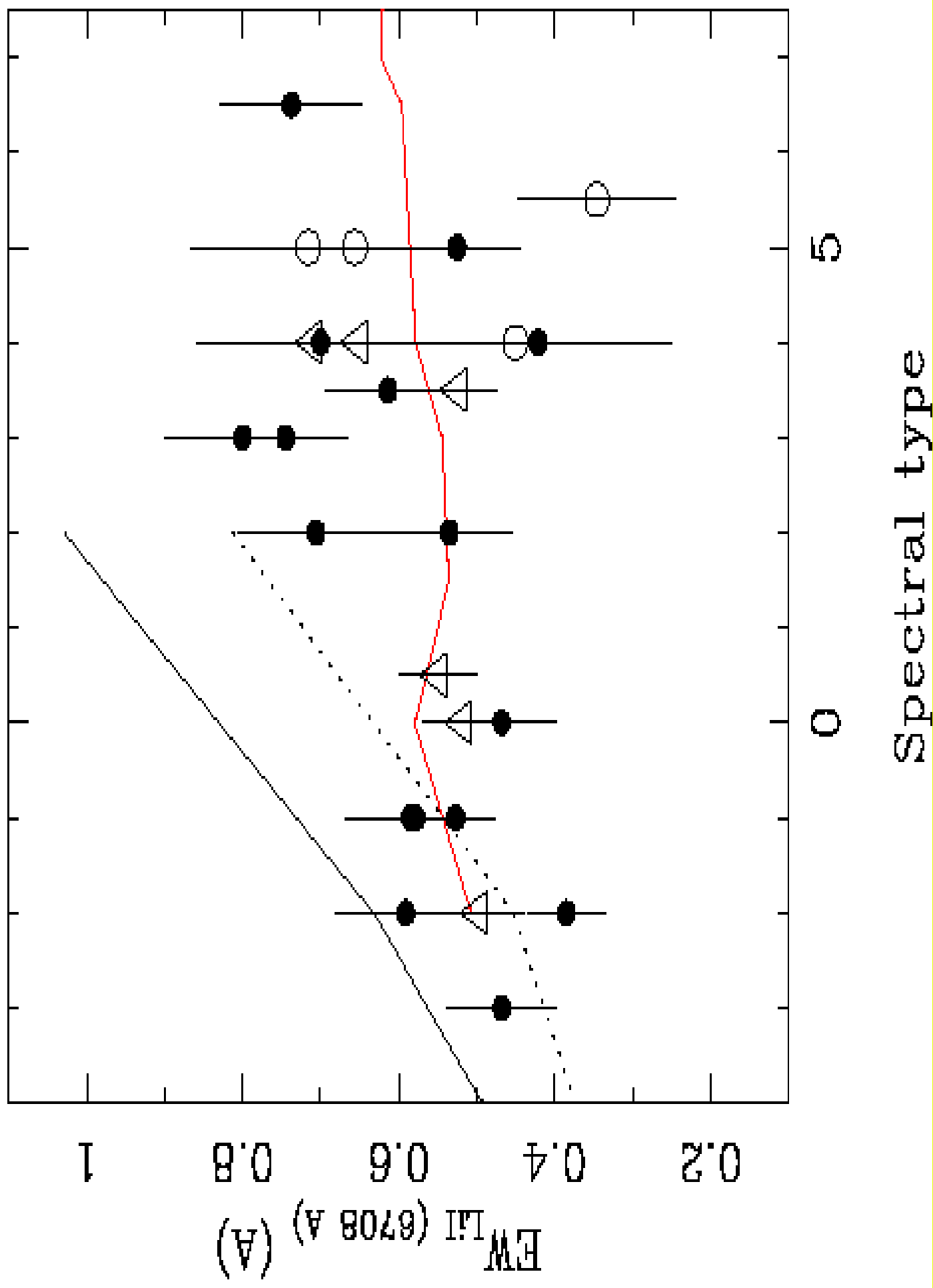
is so

romantic...

Virginia Trimble



- a) We can measure  
only  $p_{EW}$
- b)  $p_{EW}$  is NOT  $EW$
- c)  $p_{EW} = f(\text{Resolut, rotat})$



# Lithium in LP944-20

# LP944-20 as a “roaring mouse”

**Sp ~ M9 V**

**T<sub>eff</sub> ~ 2400 K,**

**log g ~ 4.5,**

**log N(Li) ~ 0.5 (Tinney 1978),**

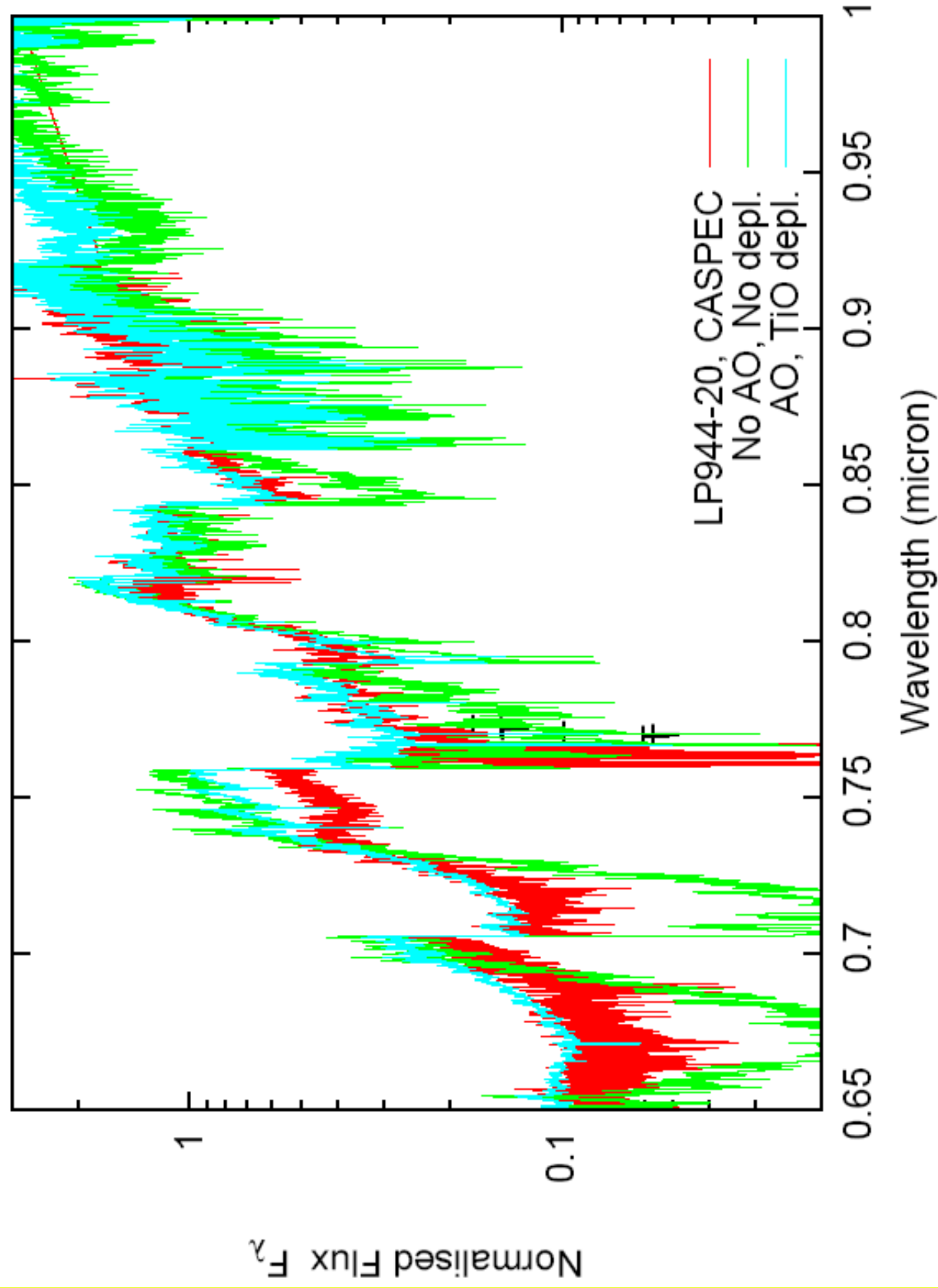
**X-ray flare (Rutledge et al. 2000)**

**synchrotron radio emission, flares (Berger et al. 2002)**

**fast rotation:  $V^* \sin i = 32 \pm 1$  km/s (Jones et al, 2005)**

**“weather phenomena”**





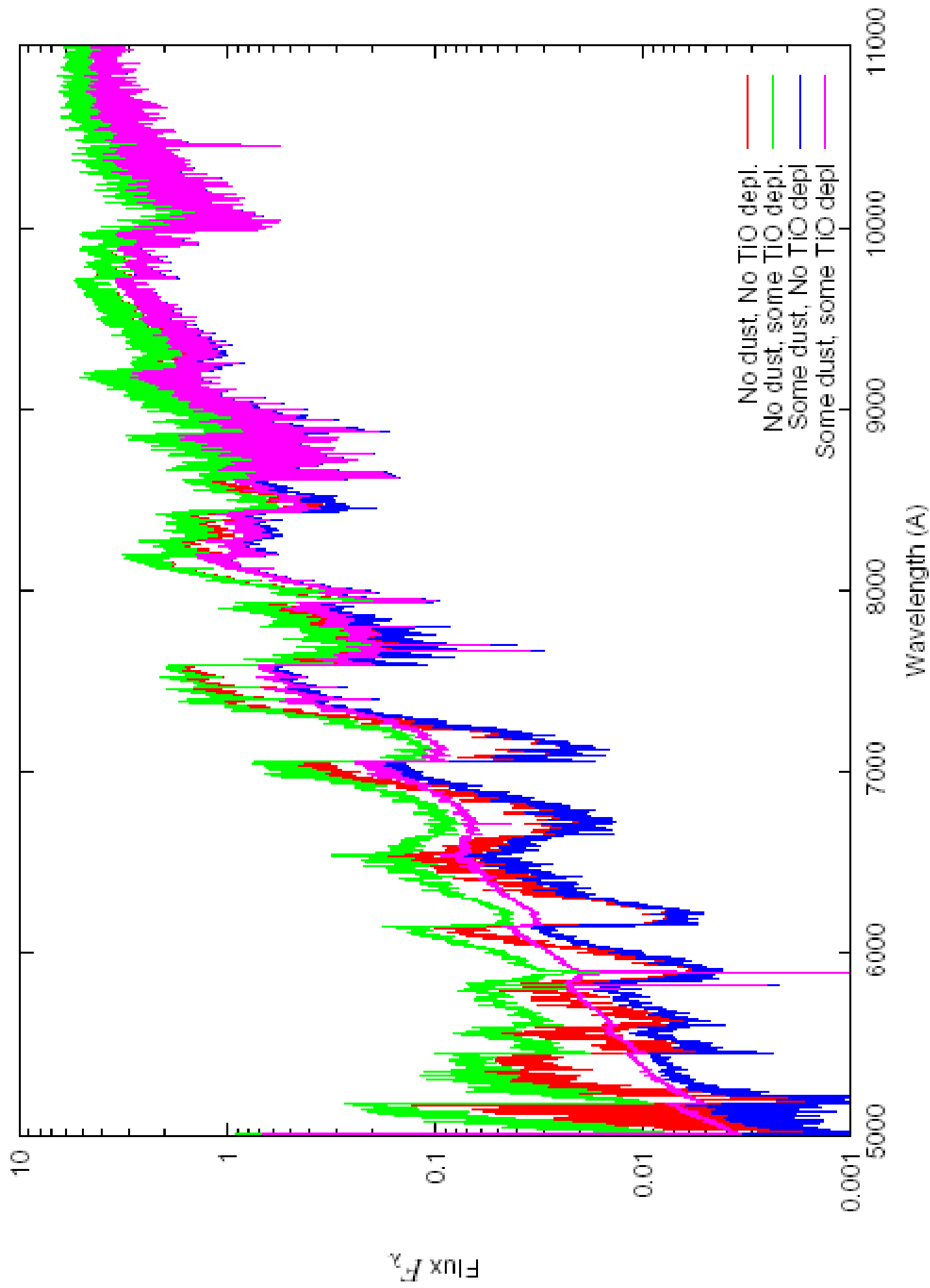
**Weather**  
**in**

**Brown dwarfs**

# Two kinds of phenomena:

a) clouds

b) upper atmosphere  
(active region??)

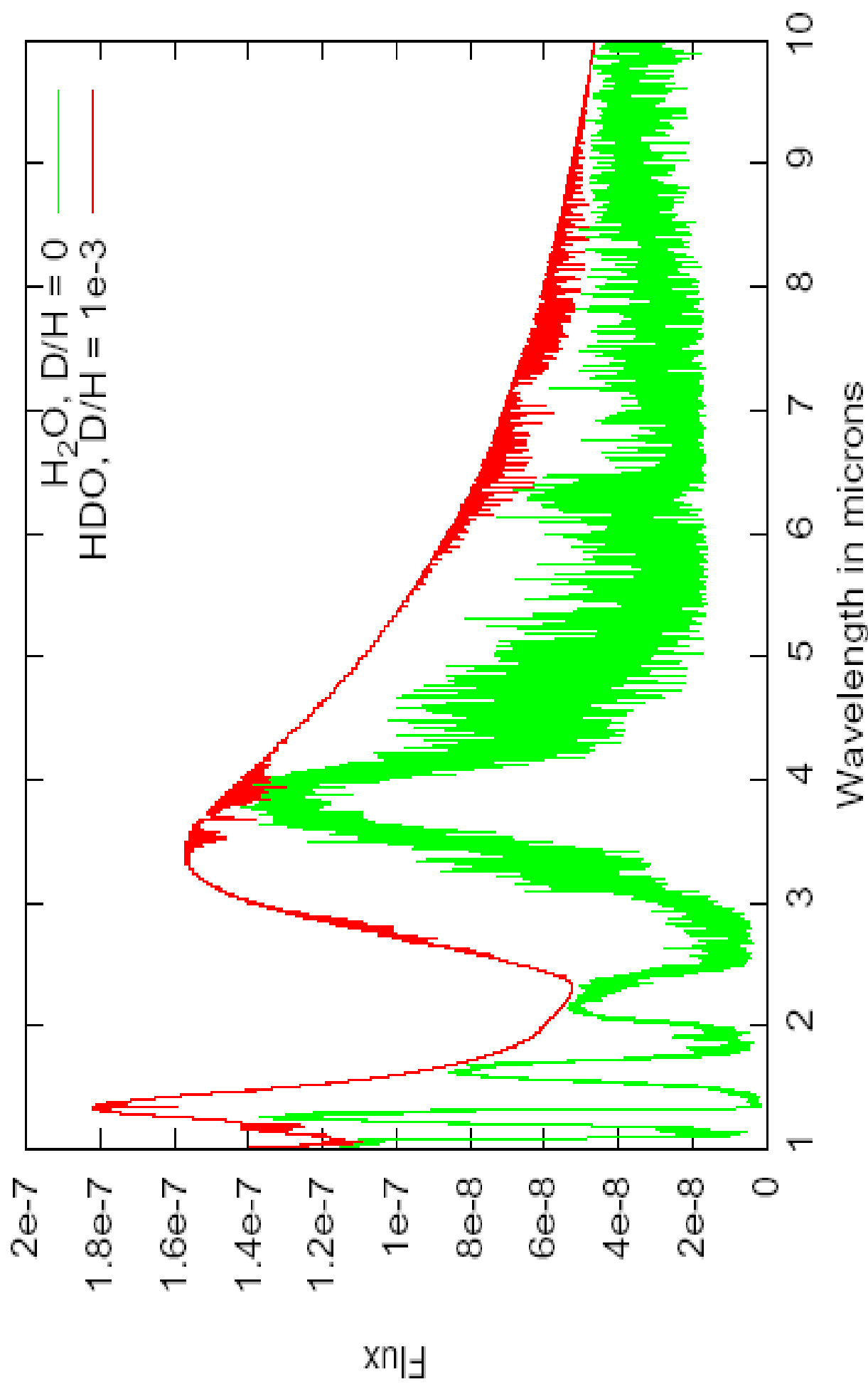


## **One idea:**

to carry out radio and optical observations

**We CAN assess different processes [a) and b)] provided changes in stellar spectra.**

**...Deuterium  
is so heavy...**



## Two options:

- a) other molecules
- b) larger telescopes

AND: THE INPUT DATA OF  
the BETTER QUALITY.

But😊: Better Theory and  
Theoreticians to be here!