Spectroscopic Classification Schemes for T dwarfs

Talk (Outline) Submittal for Adam Burgasser
Ultracool Dwarf Stars
Surveys, Properties and Spectral Classification
IAU General Assembly (IAU Commissions 29 and 45)
Manchester, UK
12 August 2000

I. What are T dwarfs

- brown dwarfs with spectral signatures of CH_4
- blue NIR colors, red Optical-NIR colors
- searches by 2MASS, SDSS, NTT have uncovered 20 to date

II. NIR Spectroscopic Classification

- $CO + 3H_2 \rightarrow CH_4 + H_2O$ => look for strengthening in CH_4 and H_2O => seen in early "transition" T dwarfs
- problem: latter T dwarfs are very similar
  - EX: Gl 229B and Gl 570D have similar NIR spectra, very different Teff
- differences still exist: relative strength of H and K bands, depth of H_2O and CH_4 bands, strength of K I lines

III. Red Optical Classification

- optical-NIR colors continuously reddening from L -> T
- many Teff-sensitive features: alkalis, FeH, H_2O -> possible to form spectral indices
- difficulty: exceedingly faint, must be done with Keck

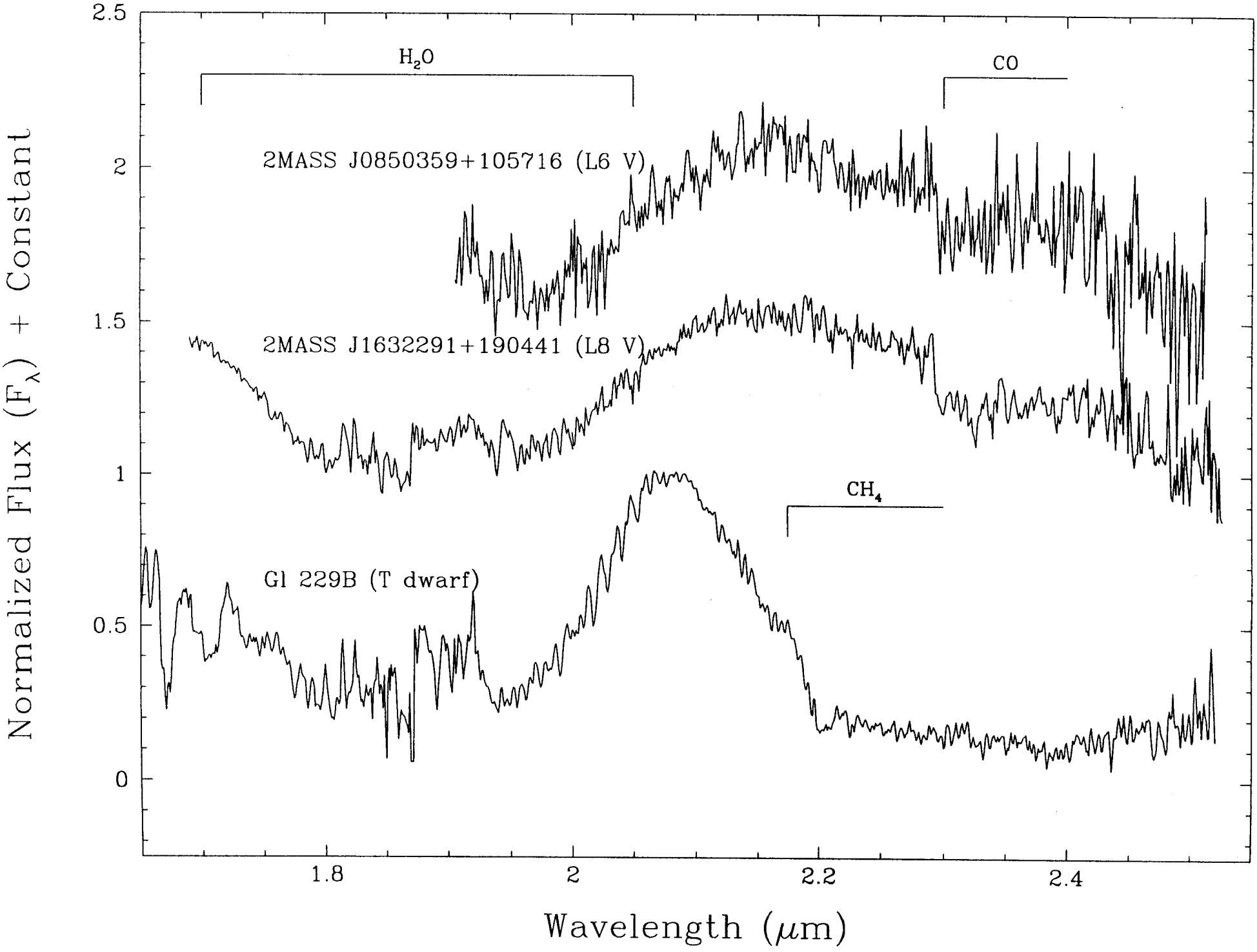
IV. Conclusions

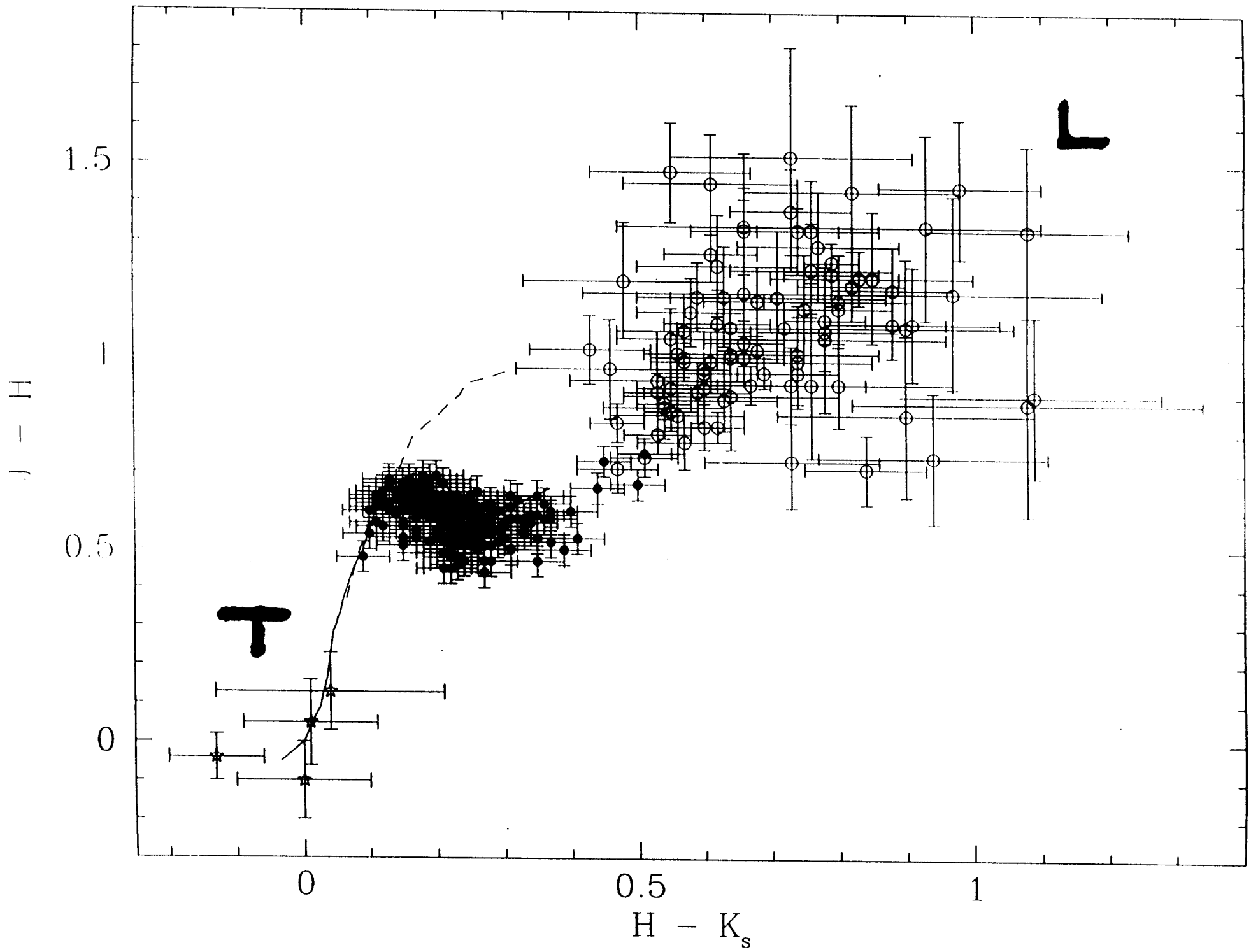
- variety of spectral features exist from 0.6-2.5 um that are readily accessible
- variety of T dwarfs now known to exist from 1300 - 750 K
- must disentangle the effects of gravity, temperature, metallicity in order to gain physical insight

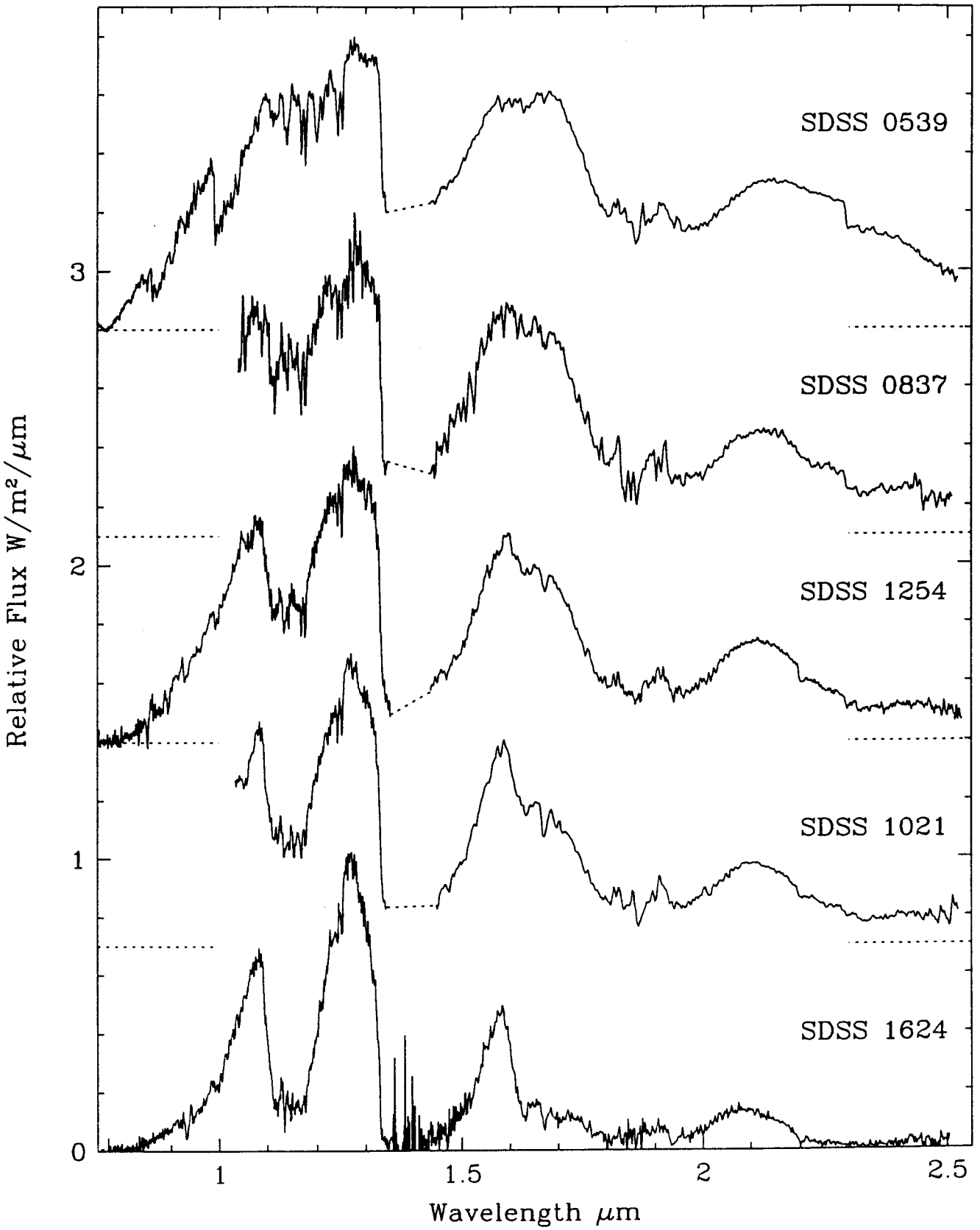
Spectroscopic Classification Schemes for T dwarfs

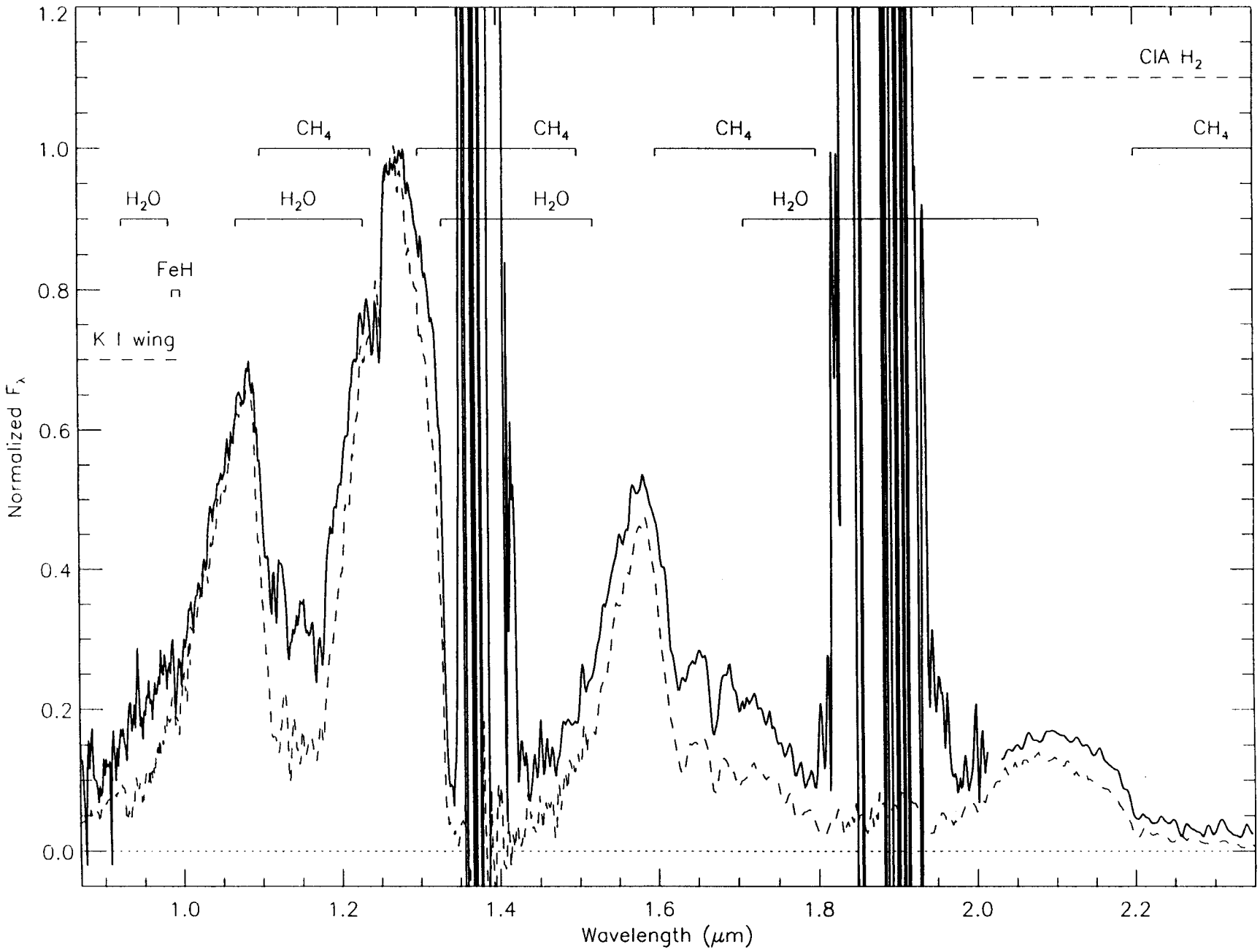
Adam Burgasser

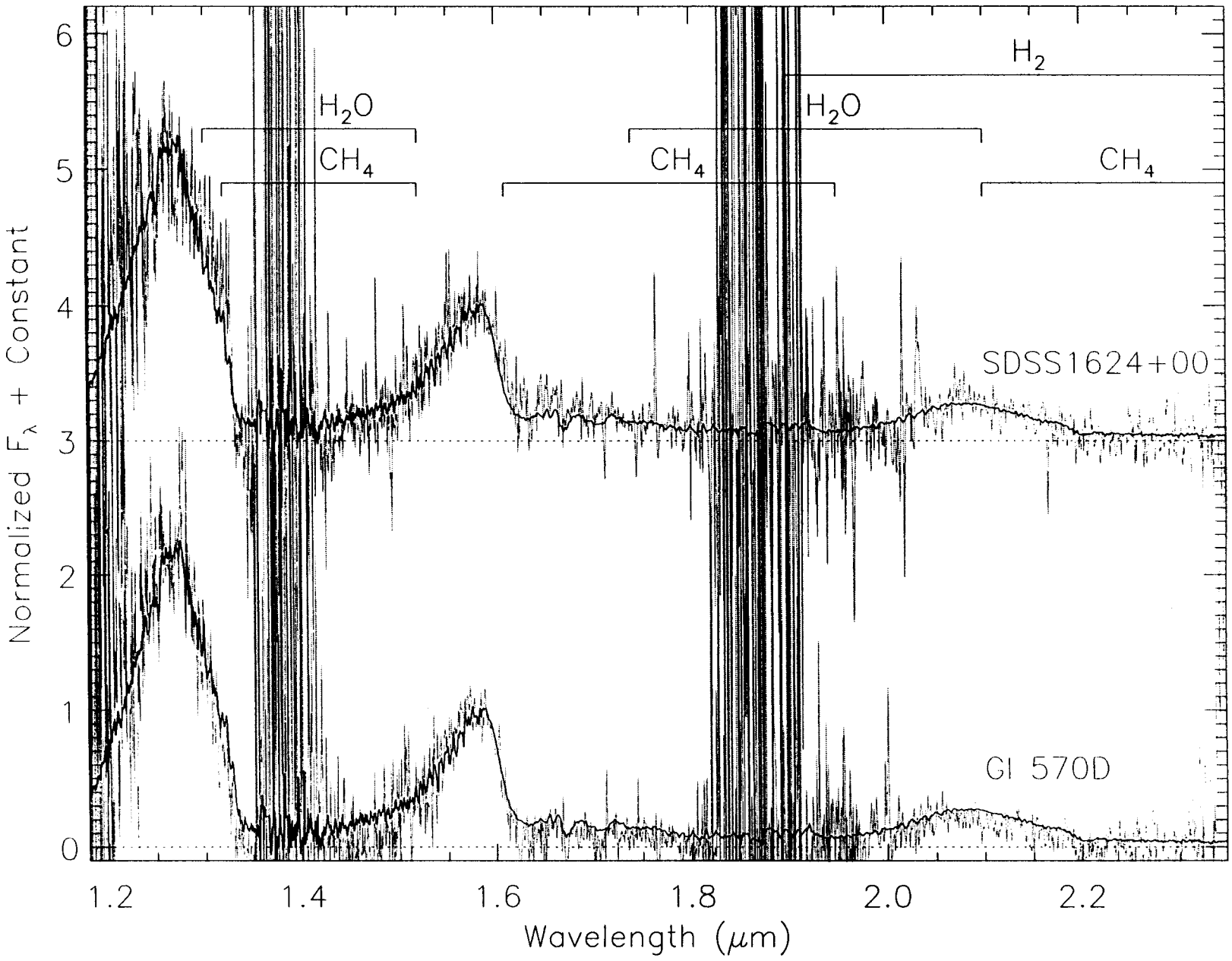
IAU August 2000

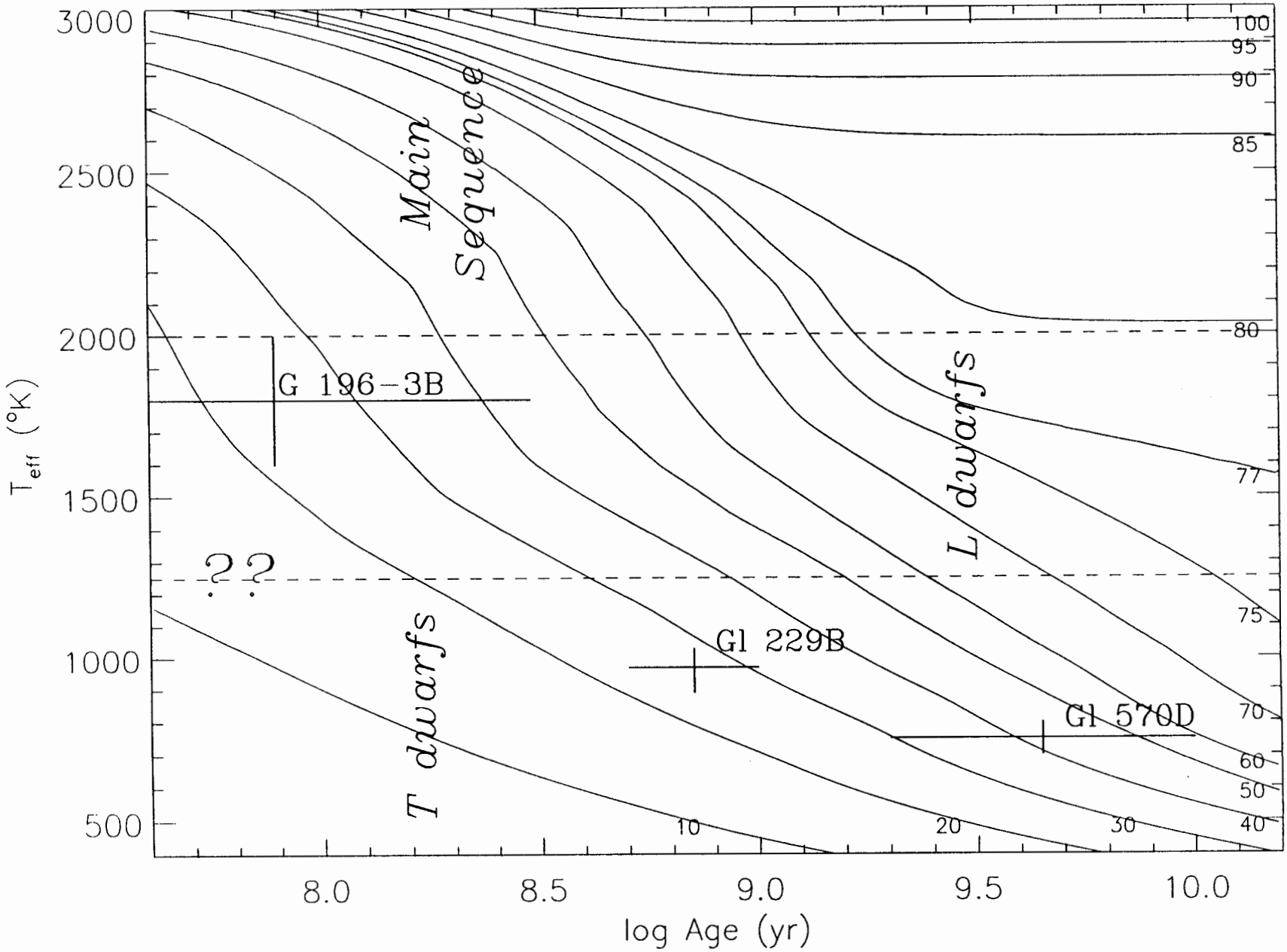

H2O
CO
CH4
2MASS J0850359+105716 (L6 V)
2MASS J1632291+190441 (L8 V)
Gl 229B (T dwarf)
Normalized Flux (Fλ) + Constant
Wavelength (μm)
2.5
2
1.5
1
0.5
0
1.8
2
2.2
2.4

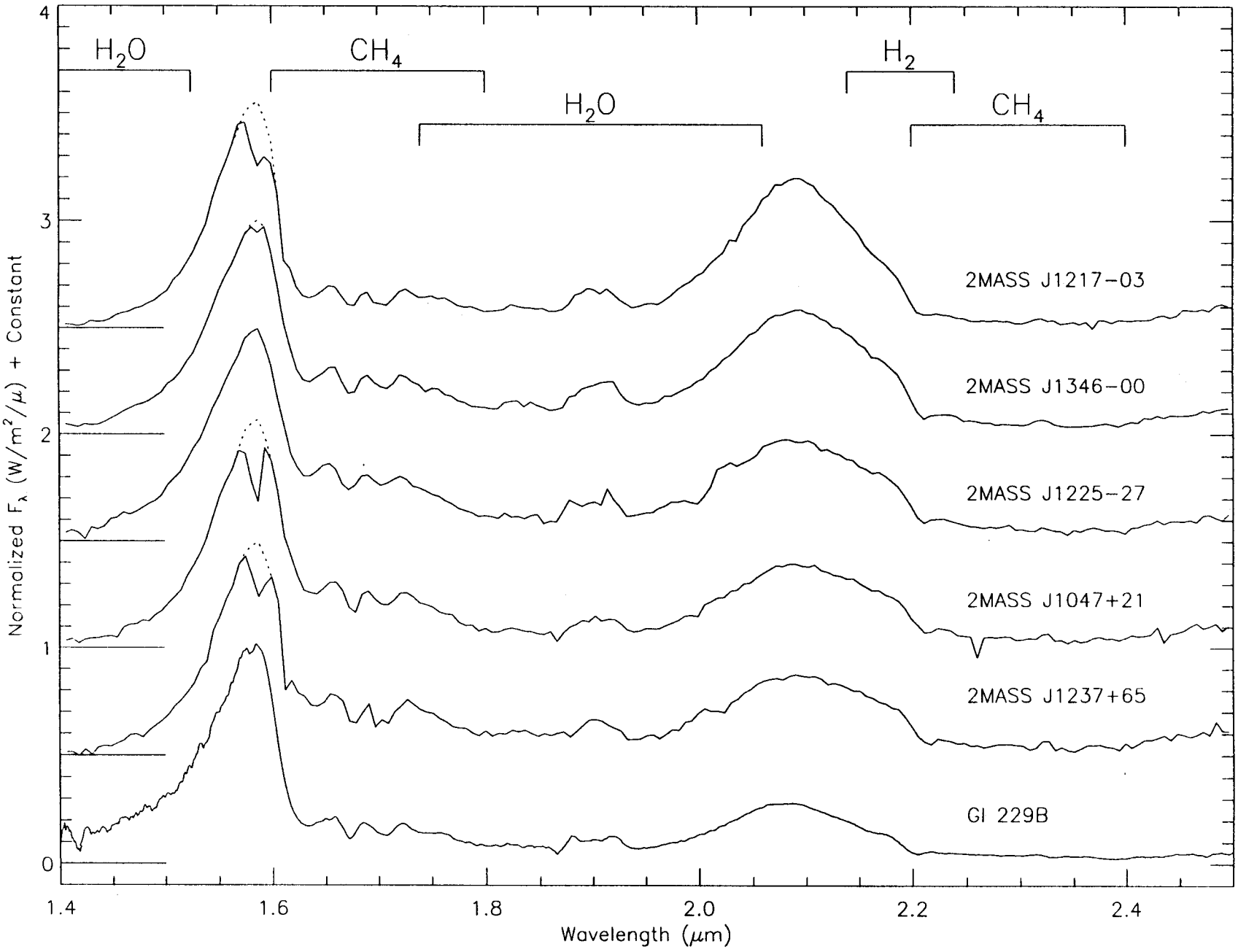

L
T
1.5
1
0.5
0
J − H
0
0.5
1
H − K_s

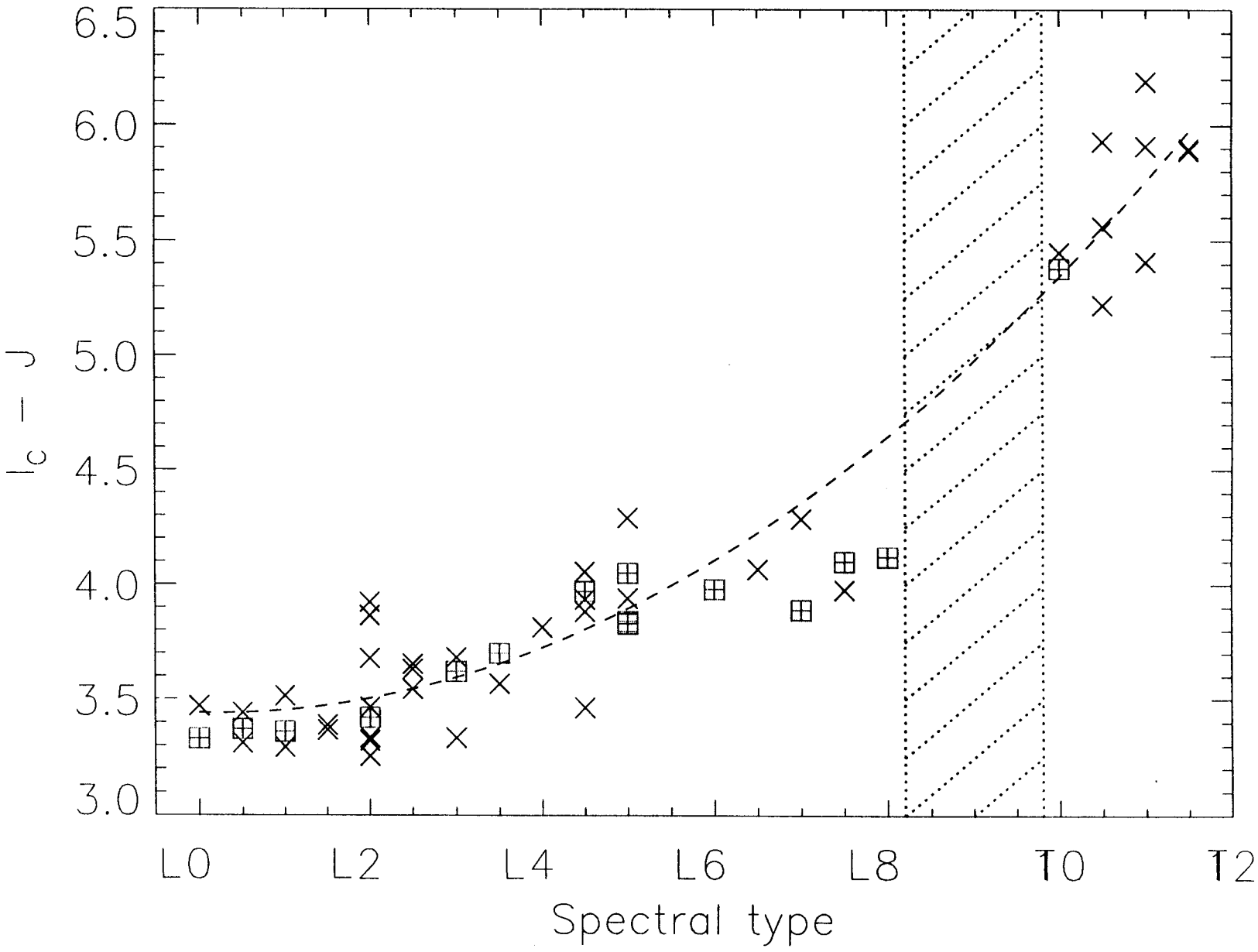

SDSS 0539
SDSS 0837
SDSS 1254
SDSS 1021
SDSS 1624
Relative Flux W/m²/μm
Wavelength μm
0
1
2
3
1
1.5
2
2.5

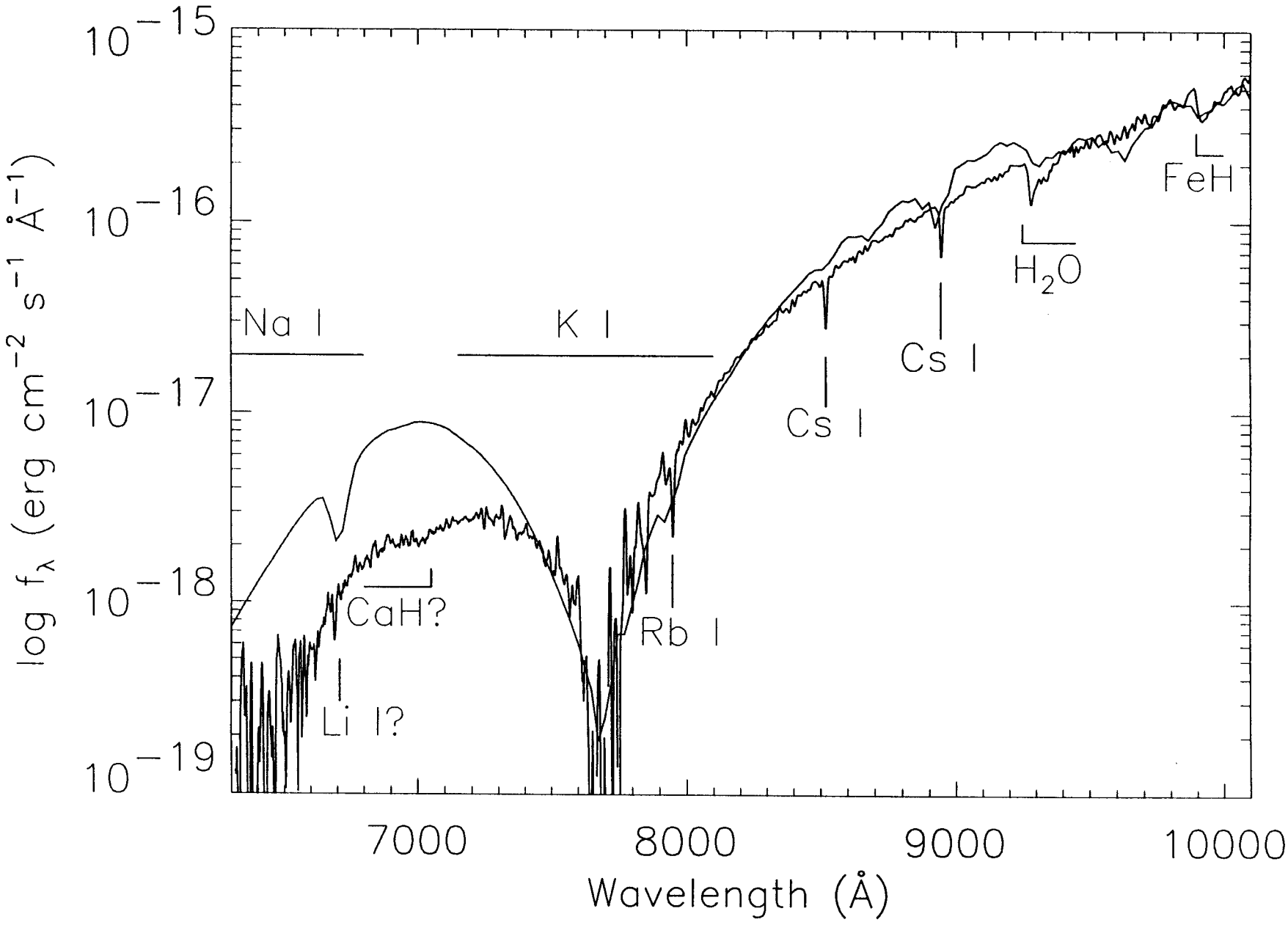

CIA H_2
CH_4
CH_4
CH_4
CH_4
H_2O
H_2O
H_2O
H_2O
FeH
K I wing
Normalized F_λ
Wavelength (μm)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1.0
1.2
1.4
1.6
1.8
2.0
2.2

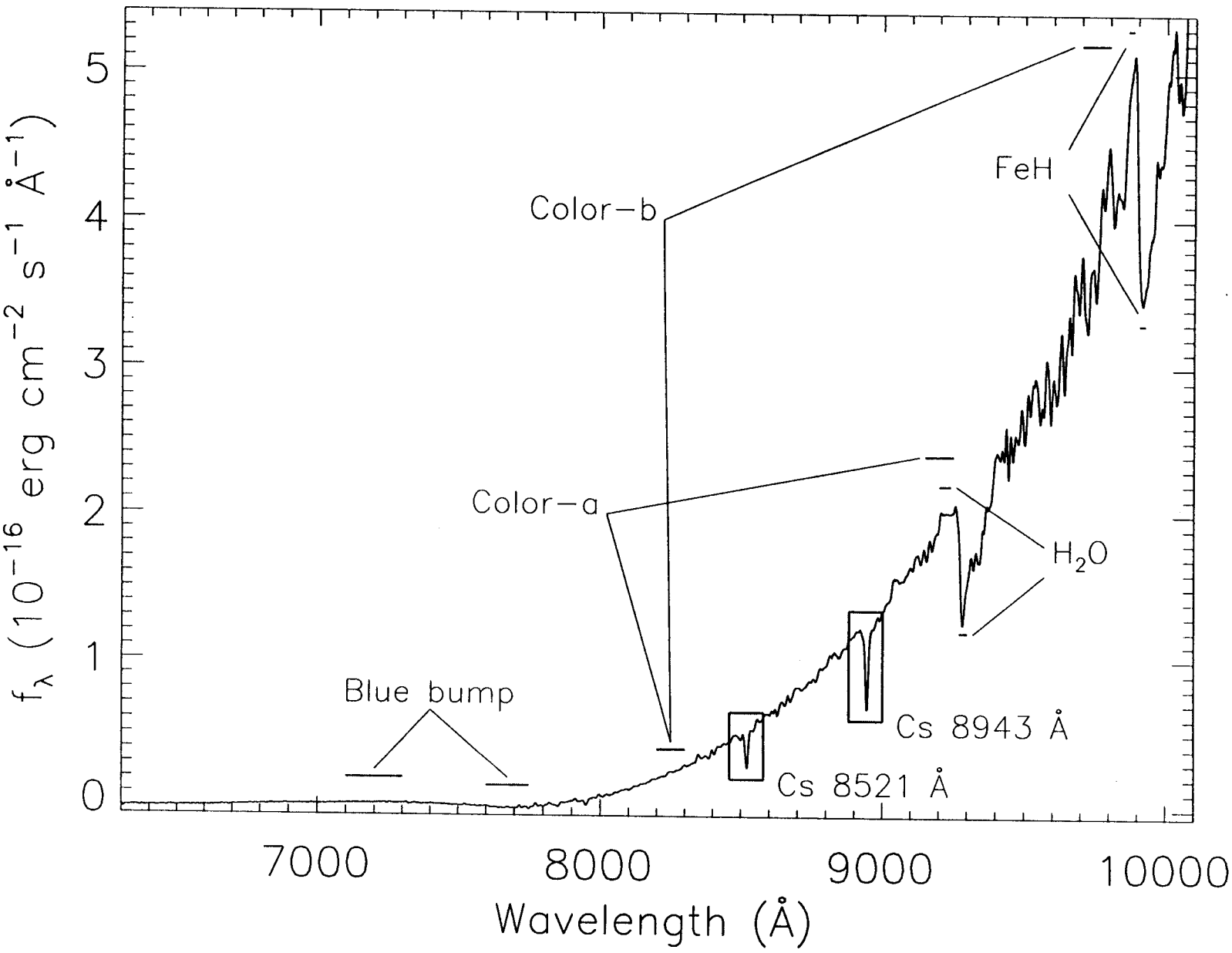

H2O
CH4
CH4
H2O
H2
CH4
SDSS1624+00
Gl 570D
Normalized Fλ + Constant
Wavelength (μm)
0
1
2
3
4
5
6
1.2
1.4
1.6
1.8
2.0
2.2

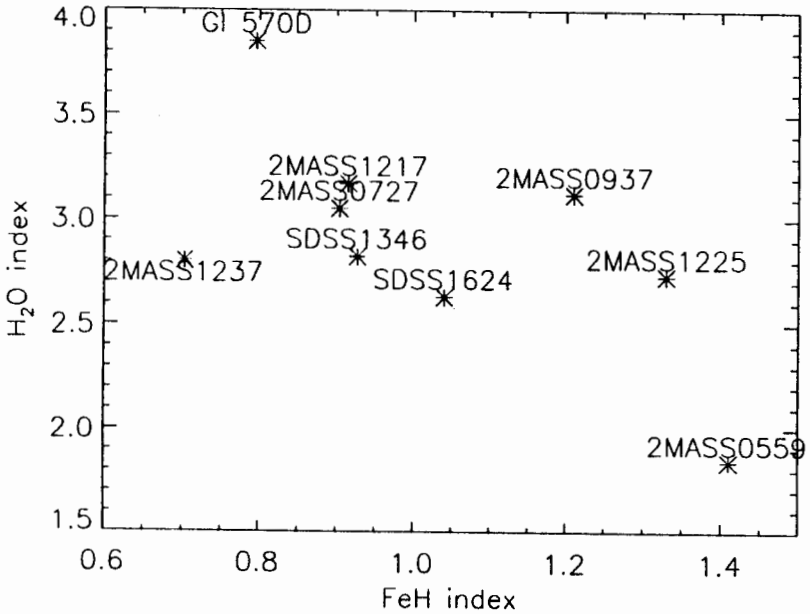

3000
2500
2000
1500
1000
500
T_{eff} (°K)
8.0
8.5
9.0
9.5
10.0
log Age (yr)
100
95
90
85
80
77
75
70
60
50
40
30
20
10
Main Sequence
L dwarfs
T dwarfs
G 196-3B
Gl 229B
Gl 570D
??

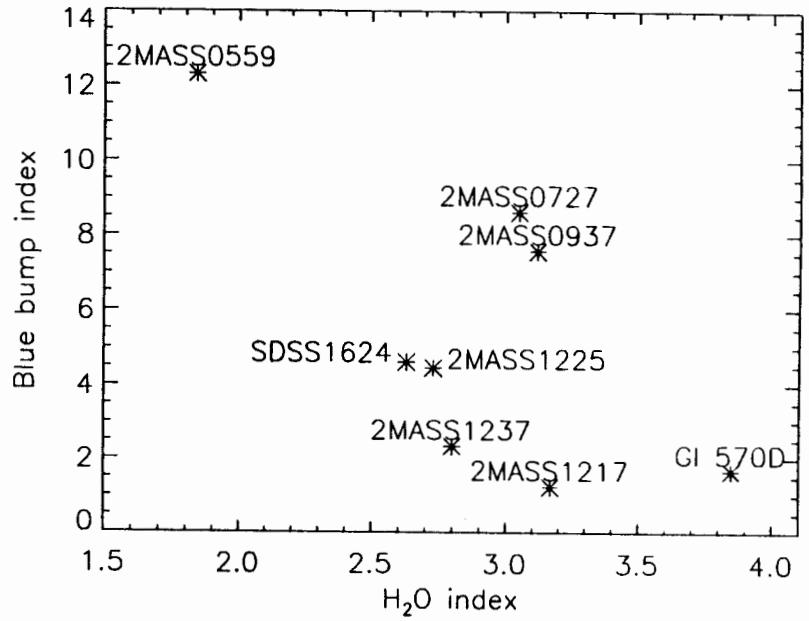

H2O
CH4
H2O
H2
CH4
2MASS J1217−03
2MASS J1346−00
2MASS J1225−27
2MASS J1047+21
2MASS J1237+65
Gl 229B
Normalized Fλ (W/m²/μ) + Constant
Wavelength (μm)
0
1
2
3
4
1.4
1.6
1.8
2.0
2.2
2.4


6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
$I_c - J$
L0
L2
L4
L6
L8
T0
T2
Spectral type


10^{-15}
10^{-16}
10^{-17}
10^{-18}
10^{-19}
log f_λ (erg cm^{-2} s^{-1} Å^{-1})
Na I
K I
Cs I
Cs I
H_2O
FeH
CaH?
Li I?
Rb I
7000
8000
9000
10000
Wavelength (Å)


Color−b
Color−a
FeH
H_2O
Blue bump
Cs 8943 Å
Cs 8521 Å
f_λ (10^{-16} erg cm^{-2} s^{-1} Å^{-1})
0
1
2
3
4
5
7000
8000
9000
10000
Wavelength (Å)


Gl 570D
2MASS1217
2MASS0727
2MASS0937
SDSS1346
2MASS1237
SDSS1624
2MASS1225
2MASS0559
H_2O index
FeH index
4.0
3.5
3.0
2.5
2.0
1.5
0.6
0.8
1.0
1.2
1.4


2MASS0559
2MASS0727
2MASS0937
SDSS1624
2MASS1225
2MASS1237
2MASS1217
Gl 570D
Blue bump index
H_2O index
14
12
10
8
6
4
2
0
1.5
2.0
2.5
3.0
3.5
4.0

Conclusions

- Variety of spectral features from 0.6 - 2.5 μm available for classification.
- Variety of T dwarfs have been discovered ranging in T_{eff} from 1300 to 750 K.
- Must disentangle the effects of gravity, temperature, and metallicity in order to gain physical insight.