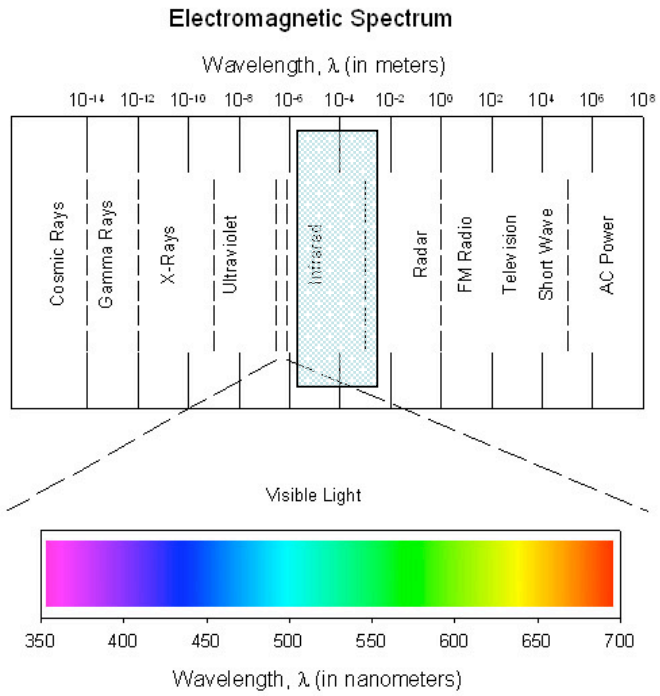
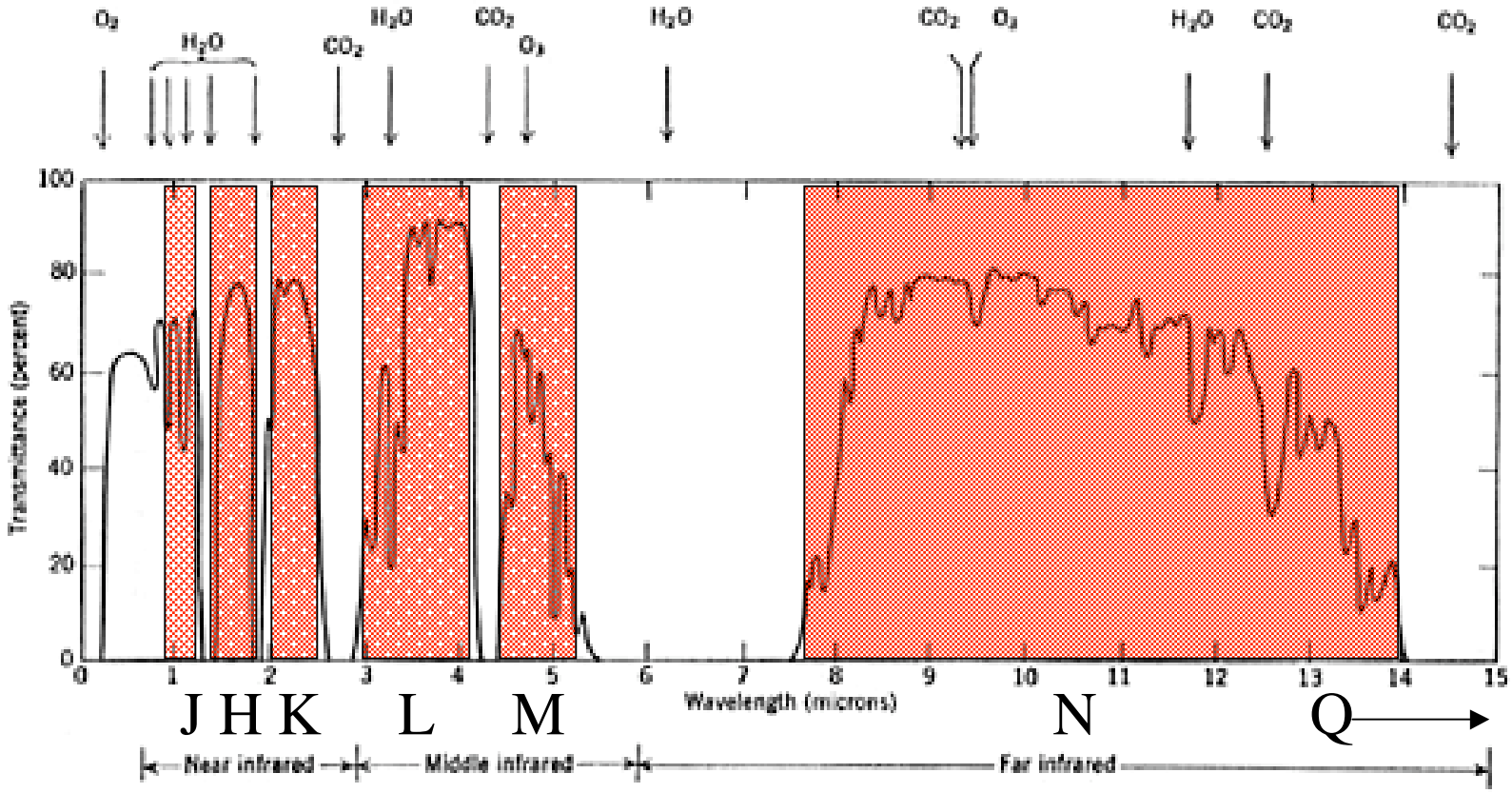
IR Astronomy

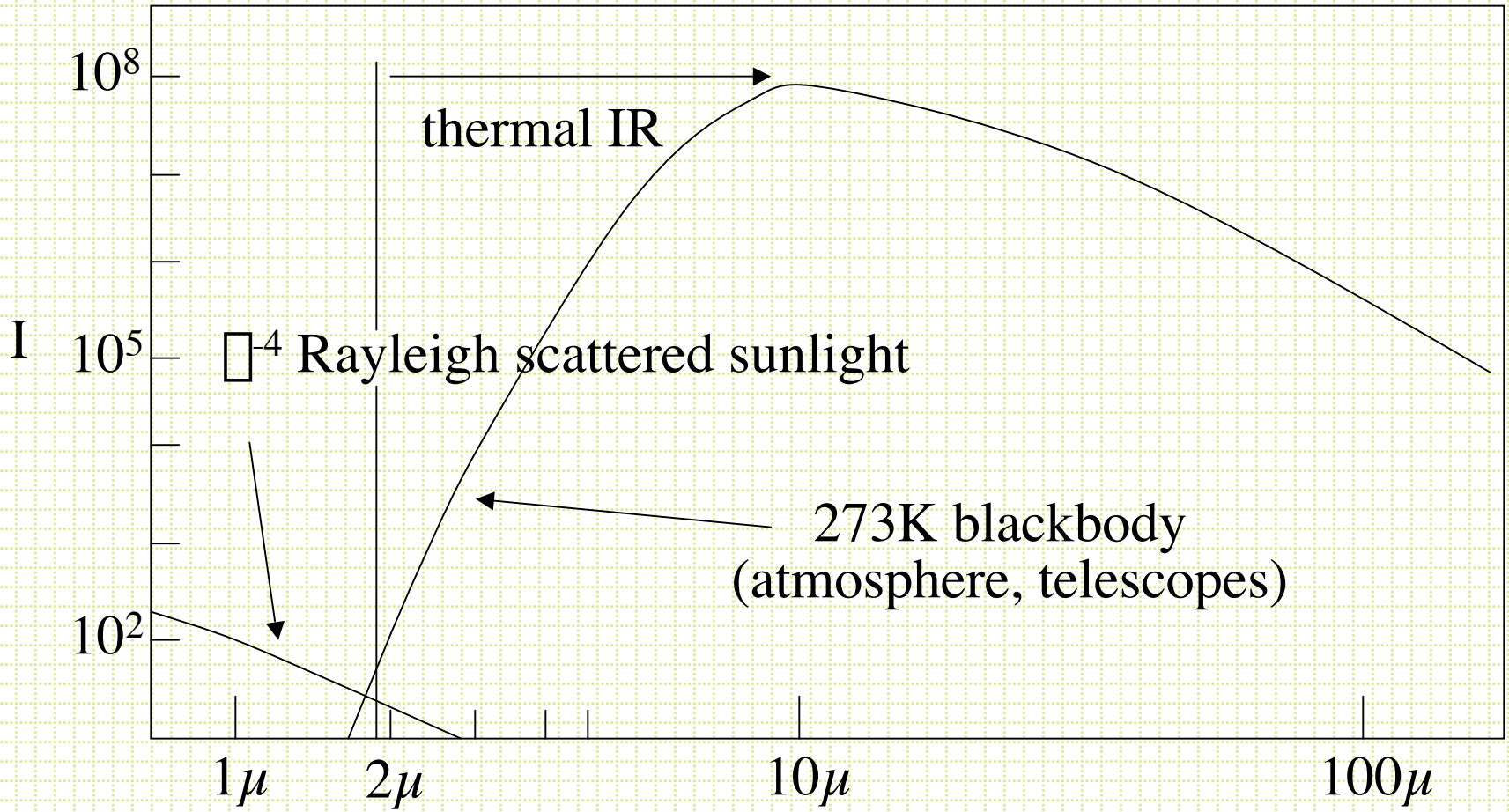
- Eye response goes to 0 at 7500Å
- Silicon bandgap energy of 1.1eV means a hard cutoff in CCD response at 1.1μ
- `near-IR': 1μ - 2.5μ
- `mid-IR': 2.5μ - 25μ
- `far-IR': 25μ - 350μ



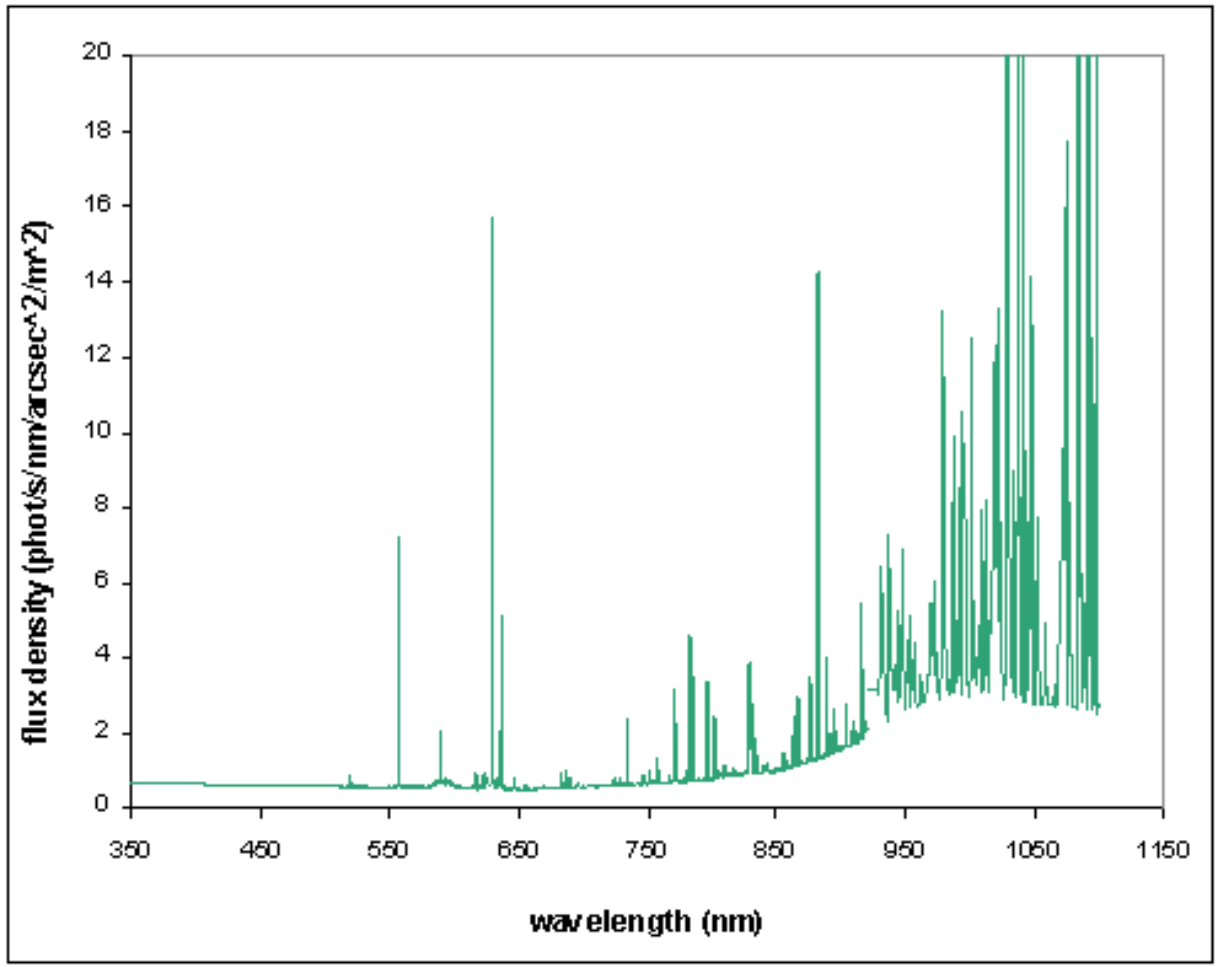
Atmospheric Windows

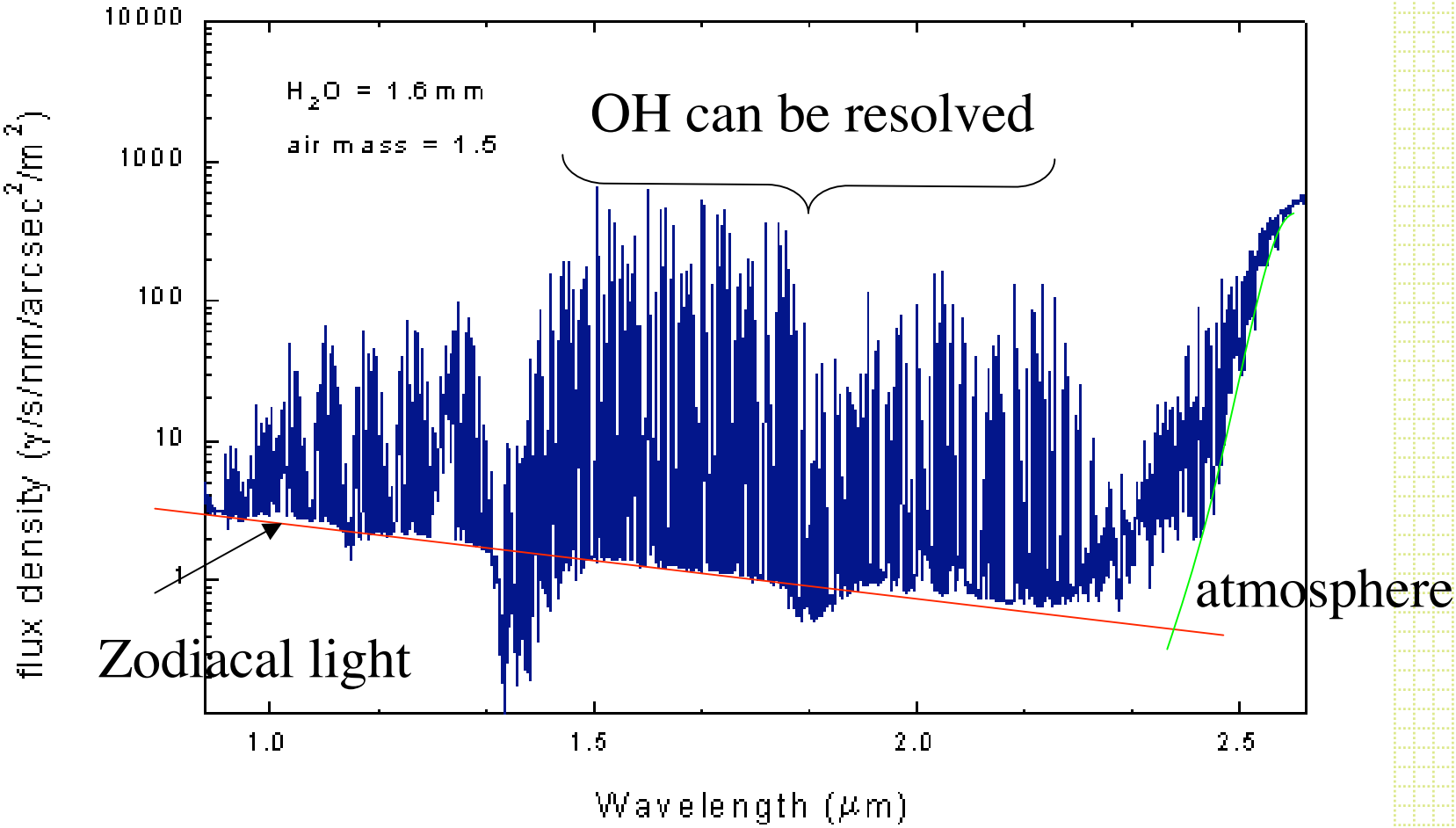


Backgrounds

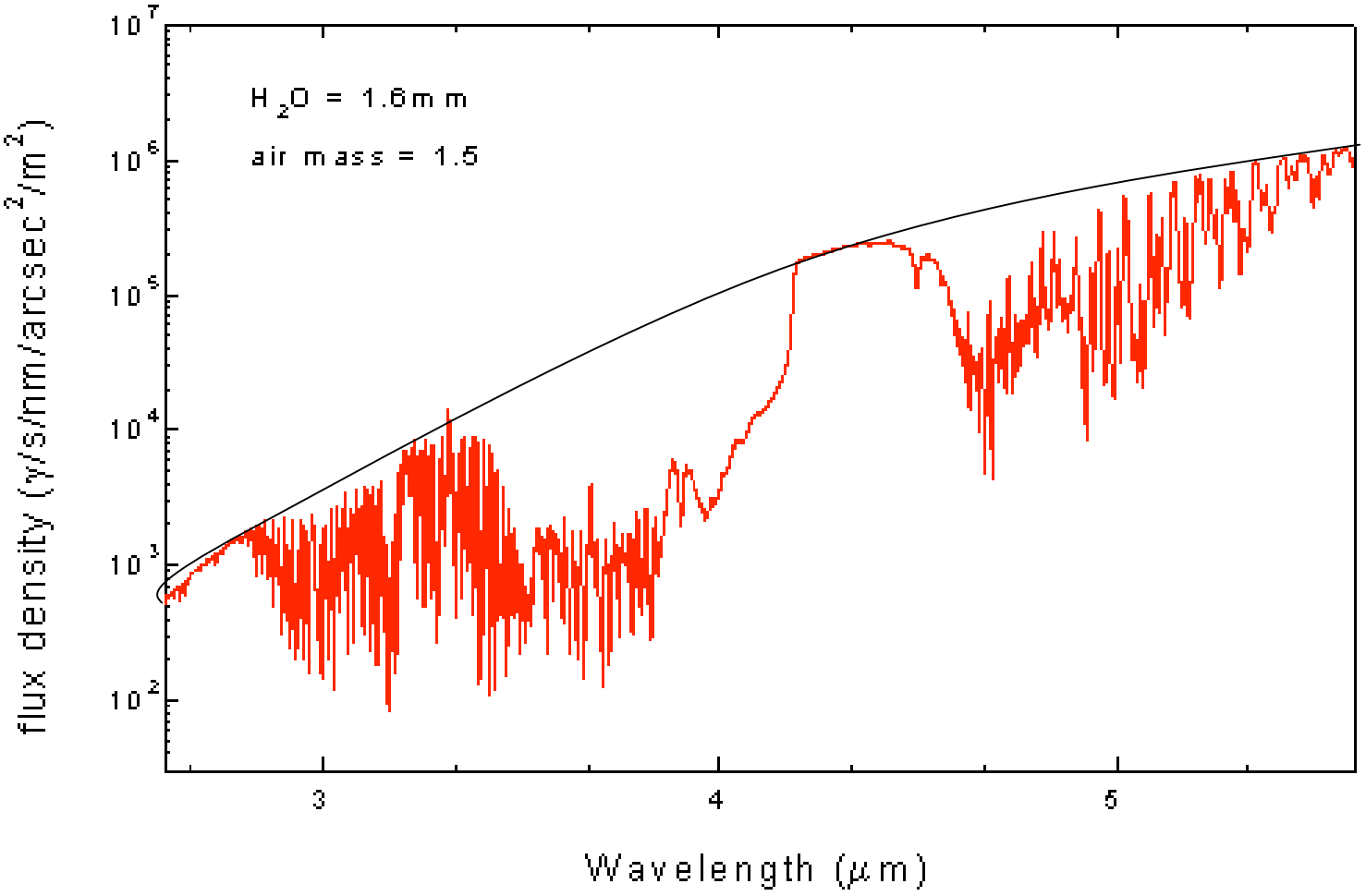


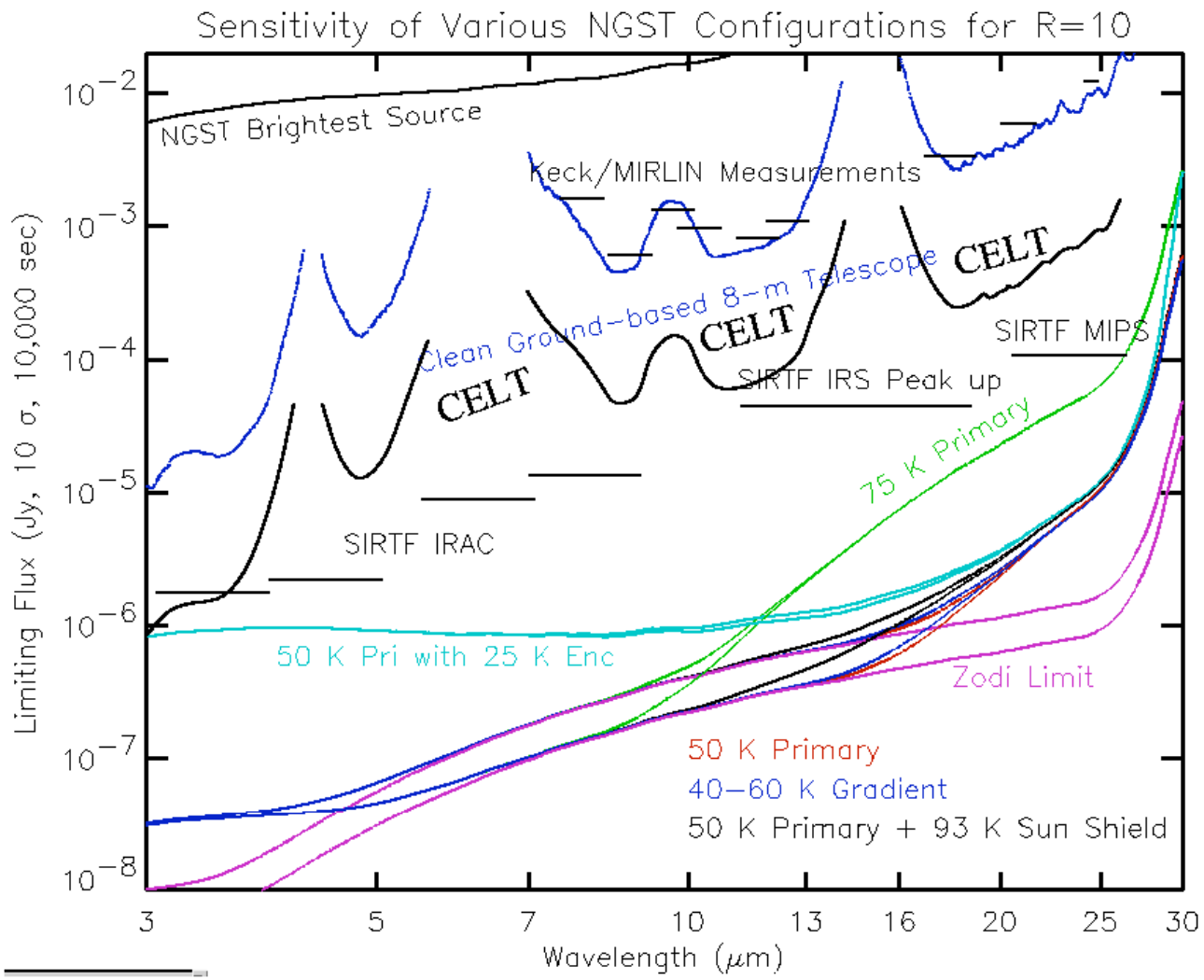
Backgrounds




10000
1000
100
10
1
H_2O = 1.6 mm
air mass = 1.5
OH can be resolved
flux density (γ/s/nm/arcsec^2/m^2)
Zodiacal light
atmosphere
1.0
1.5
2.0
2.5
Wavelength (μm)

Note vertical scales on plots!



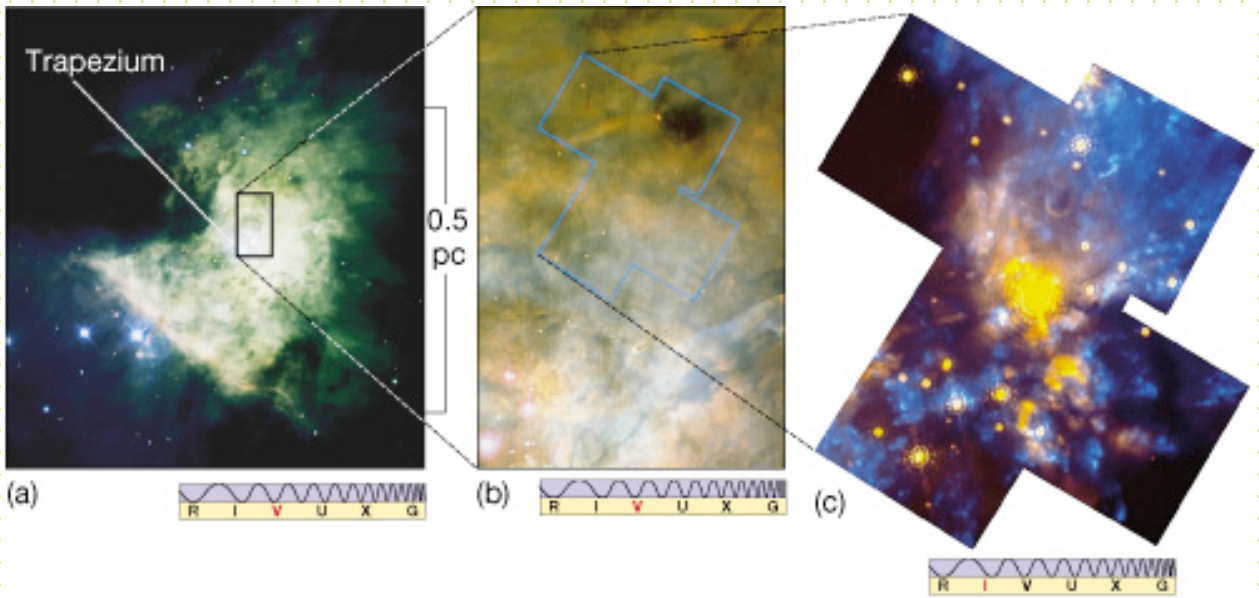

Sensitivity of Various NGST Configurations for R=10
Limiting Flux (Jy, 10 σ, 10,000 sec)
Wavelength (μm)
NGST Brightest Source
Keck/MIRLIN Measurements
Clean Ground-based 8-m Telescope
CELT
CELT
CELT
SIRTF MIPS
SIRTF IRS Peak up
SIRTF IRAC
75 K Primary
50 K Pri with 25 K Enc
Zodi Limit
50 K Primary
40–60 K Gradient
50 K Primary + 93 K Sun Shield

Why IR?

- Galactic dust extinction law:

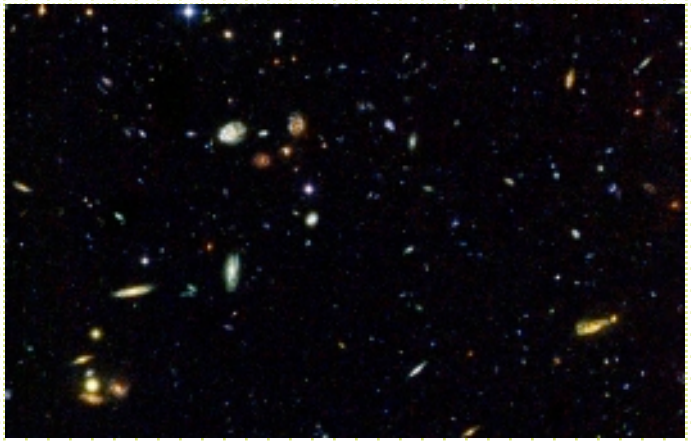
$$k_{2.2\mu} \sim 0.1 k_{0.5\mu}$$

- Cool stuff: $\lambda_{peak}(\text{planck}) = 2898/T\ (\mu)$
  - Cool stars emitted energy peak ~ 1μ
  - Giant planets ~ 6-15μ
  - Dust re-radiation ~ 20-200μ



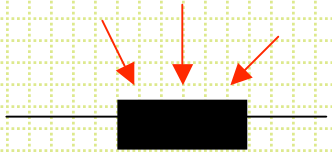
High-z Universe

- $\lambda = \lambda_0(1+z)$
- @z=1.8 Ca H&K `break' redshifted to J band
- @z=8 L



Detectors

- Original IR detectors were lead-sulfide, then germanium *bolometers*.



Photoconductive: resistance a very sensitive function of T. Ran at liquid helium temperatures (4K).

- 1980's the first photo-diode (CCD-like) detectors became available with semicondutors that had smaller bandgaps than silicon

larger dark currents!

Material	wavelength(μ)	$T_{operate}$
Si	<1.1μ	160K
HgCdTe	0.8 - 5μ	65K
InSb	1 - 5.6μ	35K
SiAs	6 - 27μ	10K

Special considerations for IR observing

- Hardly any!
- Chopping (highly variable background)
- Backgrounds are enormous
- Don’t ignore detector dark/readout noise
- Telescope designers be careful
  - Baffling
  - Cold pupils
  - Underfilled secondaries