McLeanゼミ

Section 11 Exercise 1&7

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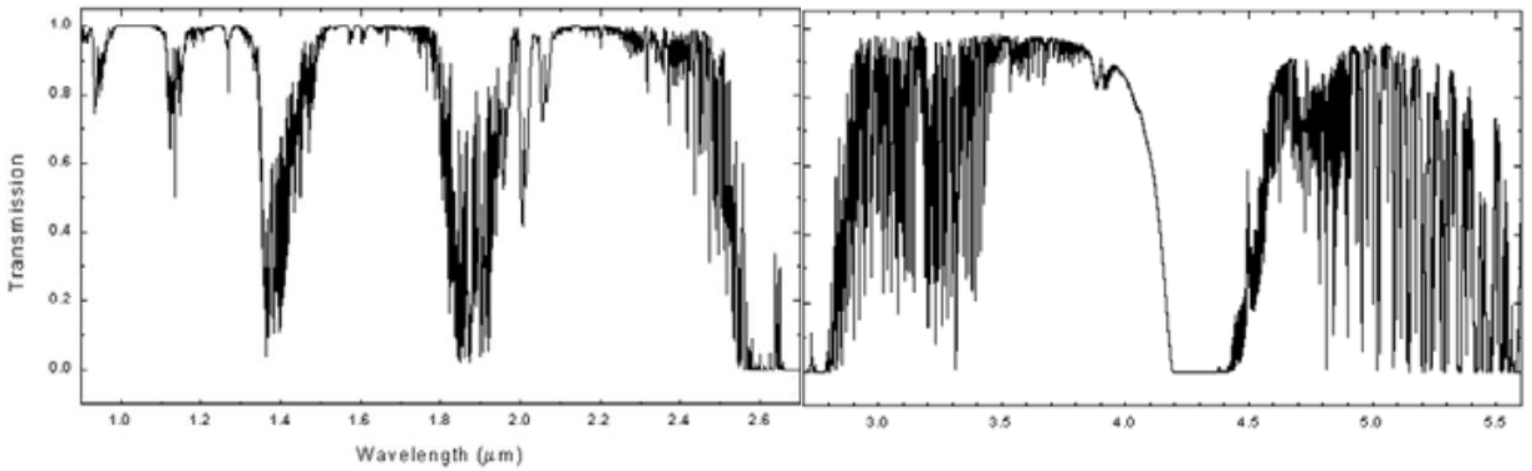
1. Explain the terms “atmospheric window” and “thermal background” as they apply to ground-based infrared astronomy.

Atmospheric window

- H_2O and CO_2 block out a lot of infrared radiation from space.
- Water vapor absorption occurs in certain wavelength intervals.
- Between those intervals, the atmosphere is remarkably transparent and these wavelength ranges are called “atmospheric windows”.
- Definition of infrared photometric bands is based on these windows.

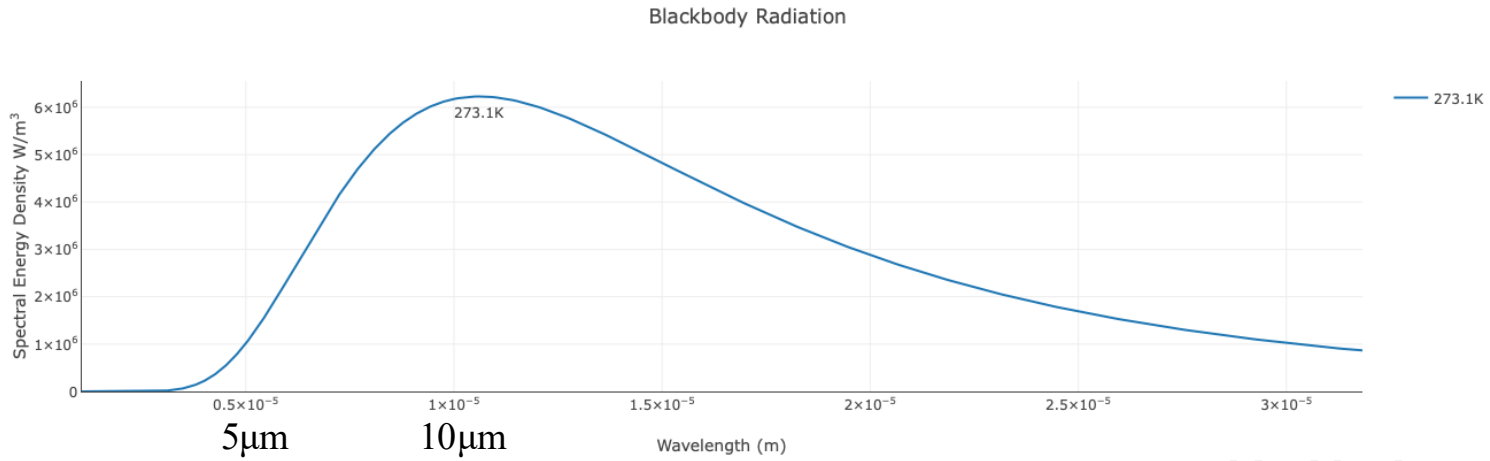


Center wavelength (μm)	*Designation of the bandwidth*	*Width (FWHM)* (μm)
1.25	J	0.3
1.65	H	0.35
2.2	K	0.4
3.5	L	1.0
4.8	M	0.6
10.6	N	5.0
21	Q	11.0

1. Explain the terms “atmospheric window” and “thermal background” as they apply to ground-based infrared astronomy.

Thermal background

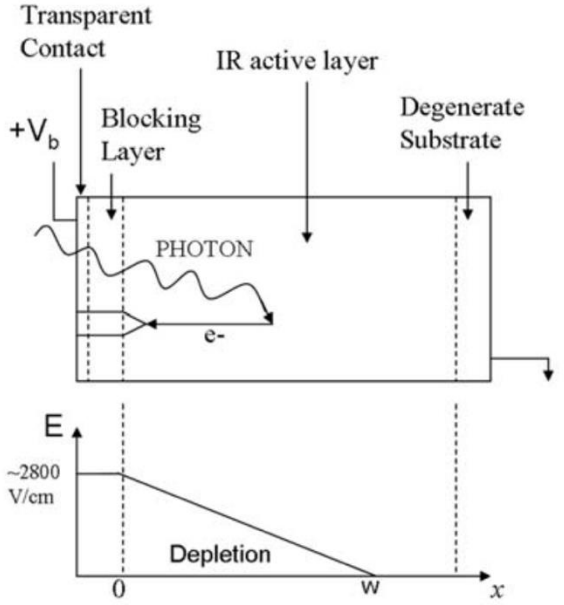
- There are two major sources of unwanted background photons, one is OH emission lines and the other is black-body thermal emission from the telescope.
- The latter, called “thermal background”, is problematic even when the telescope is at an ambient temperature close to 0 C (273 K) , because in such a condition black-body emits strongly in infrared.

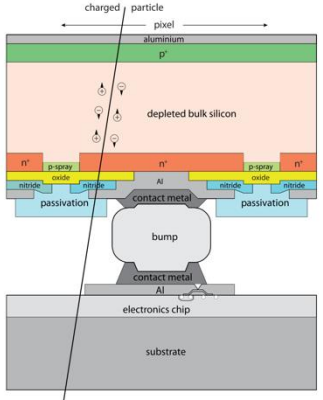


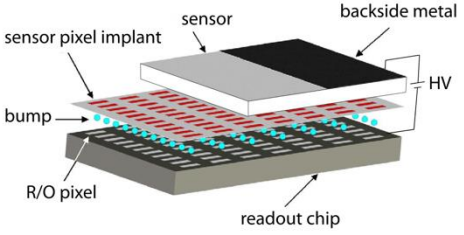
blackbody curve@273K

7. Describe the construction and principle of the blocked-impurity-band (BIB) detector. Why is this device better than a photoconductor?

- Place a contact on a relatively thick (300μm-500μm) intrinsic Si substrate.
- The infrared-active (doped) layer is then grown, followed by the blocking layer which is undoped.
- The final contact is masked to define the individual pixels and establish the connection to the multiplexer via indium bumps.
- It works in the way similar to an extrinsic semiconductor.
- Its properties:
  - can prevent dark current due to “hopping” by the blocking layer.
  - do not exhibit generation-recombination noise since the collected electrons are transported over a region devoid of holes, which is formed by holes migration due to the applied electric field.







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7. Describe the construction and principle of the blocked-impurity-band (BIB) detector. Why is this device better than a photoconductor?

- In a photoconductor, usually the concentration of the impurity must be kept low to prevent tunneling or “hopping”.
- If you do so, the only way to increase QE is to make the infrared active layer very thick (~several 100μm), which leads to many operational problems.
- In a BIB detector, dark current due to hopping is prevented by the blocking layer.

→<u>Much higher doping levels can be used in the active layer than a photoconductor.</u>

- Therefore, although it is ten times thinner than the equivalent photoconductor, this device can achieve high quantum efficiency.