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Some Definitions (from Elachi, 1987)

Radiant Energy: The energy carried by an electromagnetic wave. It is a measure of the capacity of the wave to do work by heating an object or changing its state.

Radiant Flux: The time rate at which radiant energy passes a certain location.

Radiant Flux Density: The radiant flux intercepted by a unit area of a plane surface. The density for flux incident upon a surface is called *Irradiance*. The density for flux leaving a surface is called *Emittance or Exitance.*

Radiant Intensity: The radiant intensity of a *point source* in a given direction is the radiant flux per unit solid angle leaving the source in that direction

Solid Angle: 4π *steradians* per sphere

Radiance: For an *extended source*, the radiant flux per unit solid angle in a given direction, per unit projected area in that direction. (If radiance does not change as a function of direction of emission, the source is called *Lambertian.*

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Radiometry (aggregate quantities)

Symbol	Quantity	Equation	Units
Q	Radiant Energy		joules
Φ	Radiant Flux	$\Phi = dQ/dt$	watt (j / s)
E	Radiant Flux Density (Irradiance)	$E = d\Phi/dA$	watt / m^2
M	Radiant Flux Density (Emittance or Exitance)	$M = d\Phi/dA$	watt / m^2
I	Radiant Intensity	$I = d\Phi/d\Omega$	watt / sr
L	Radiance	$L = dI/dA \cos\Theta$	watt / m^2 sr

Black-body at any temperature (above -273.15 deg. K) radiates over a continuous range of wavelengths. Strength of contribution to radiance varies with wavelength. Quantify this with a function, *spectral radiance*, $S(\lambda)$, such that,

$$\Delta L = S(\lambda)\Delta\lambda \quad \text{or} \quad S(\lambda) = \left| dL/d\lambda \right|$$

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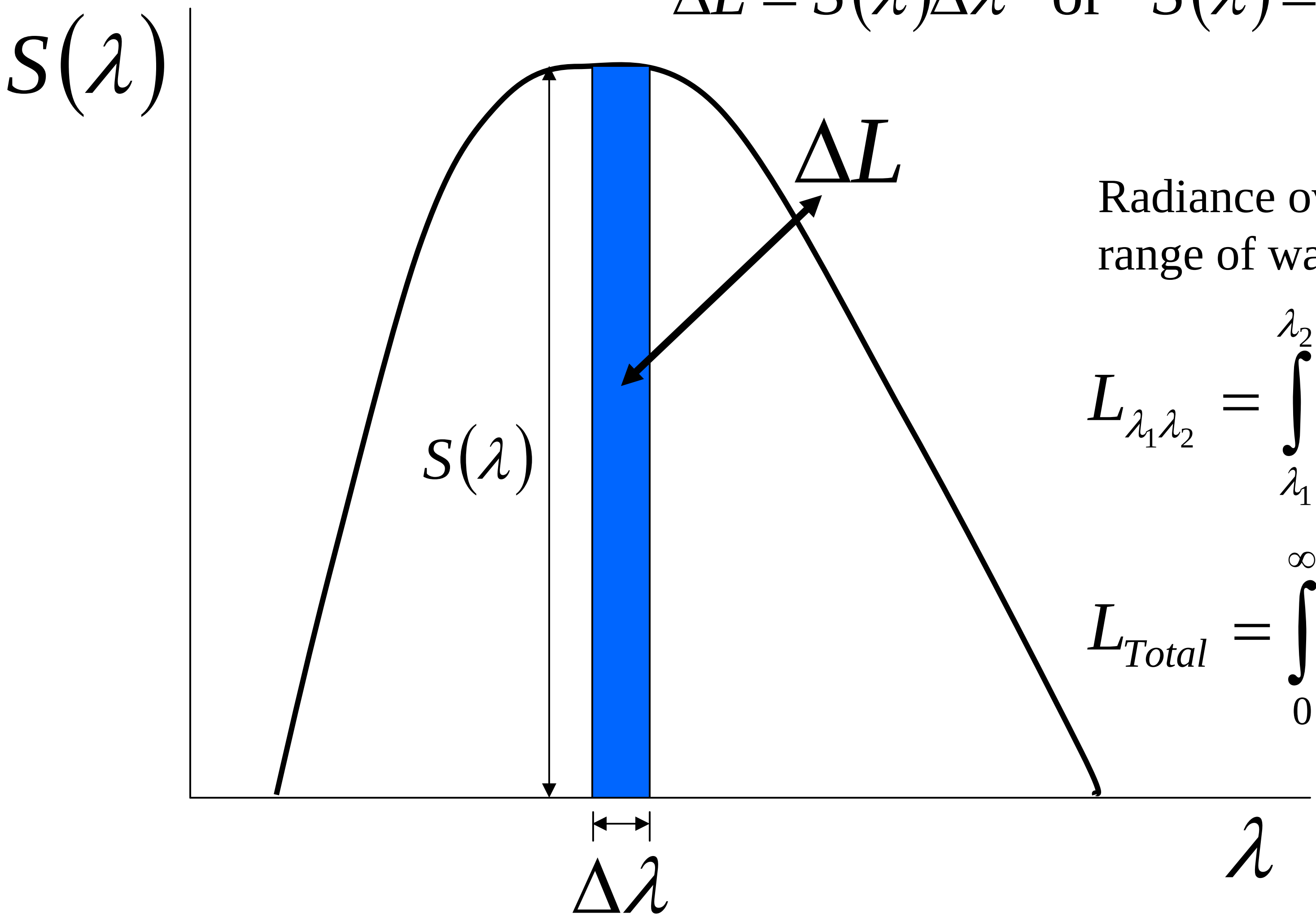

Radiance over a range of wavelengths

$$L_{\lambda_1\lambda_2} = \int_{\lambda_1}^{\lambda_2} S(\lambda)d\lambda$$

$$L_{Total} = \int_{0}^{\infty} S(\lambda)d\lambda$$

Spectral radiance of blackbody at a given temperature

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Planck’s formula for spectral radiance

$$S(\lambda) = \frac{2hc^2}{\lambda^5 \left(e^{hc/\lambda kT} - 1\right)}$$

In which,

$$h = 6.6261 \times 10^{-34}\ Js,\ \text{planck}$$

$$k = 1.3807 \times 10^{-23}\ JK^{-1}, \text{boltzmann}$$

$$c = 2.9979 \times 10^{8}\ ms^{-1}, \text{speed of light}$$

$$\text{T} = \text{temperature in degrees kelvin}$$

$$\lambda = \text{wavelength in meters}$$

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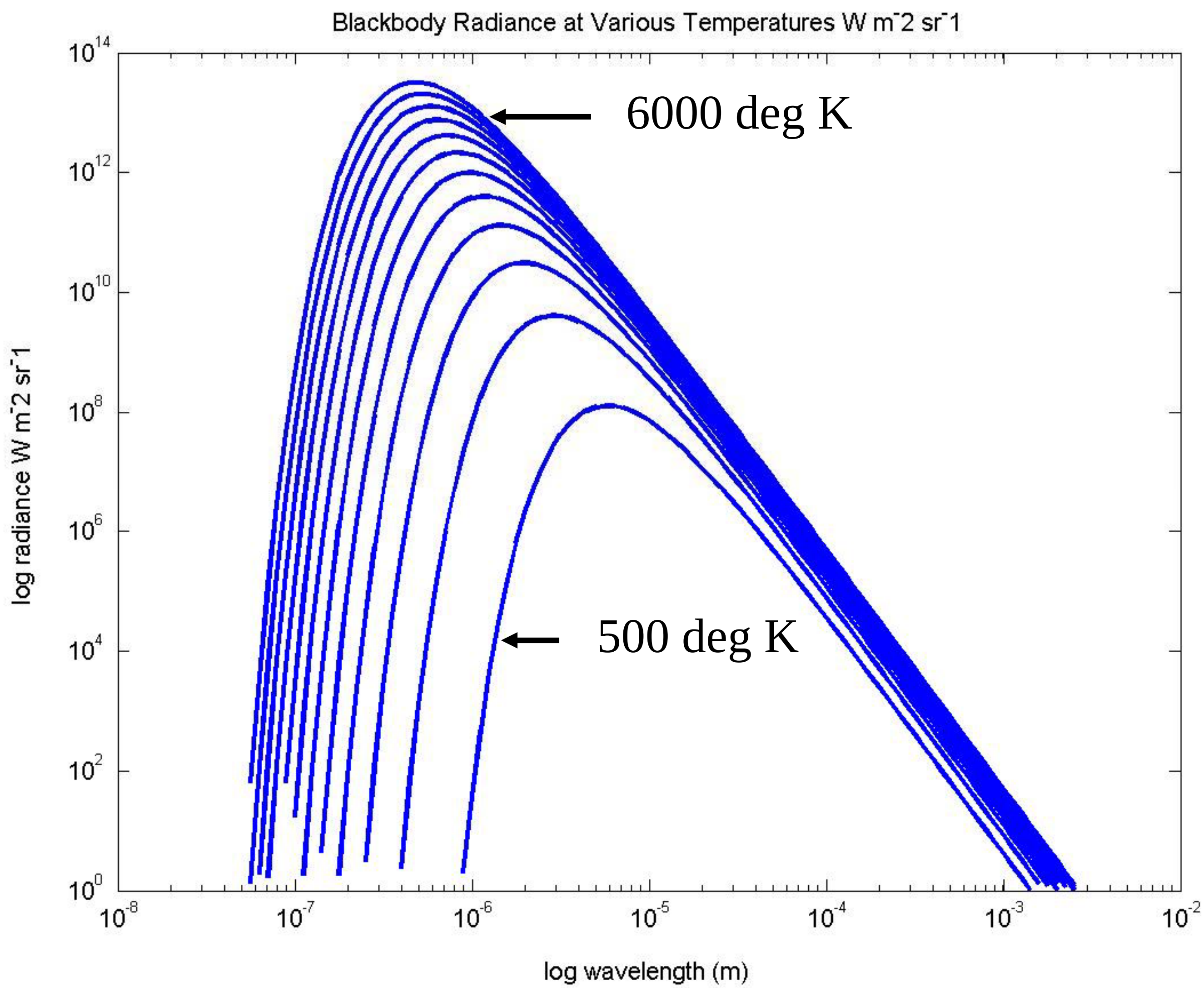
This is actually a log-log plot of S(λ) vs. wavelength for black-bodies at various temps.



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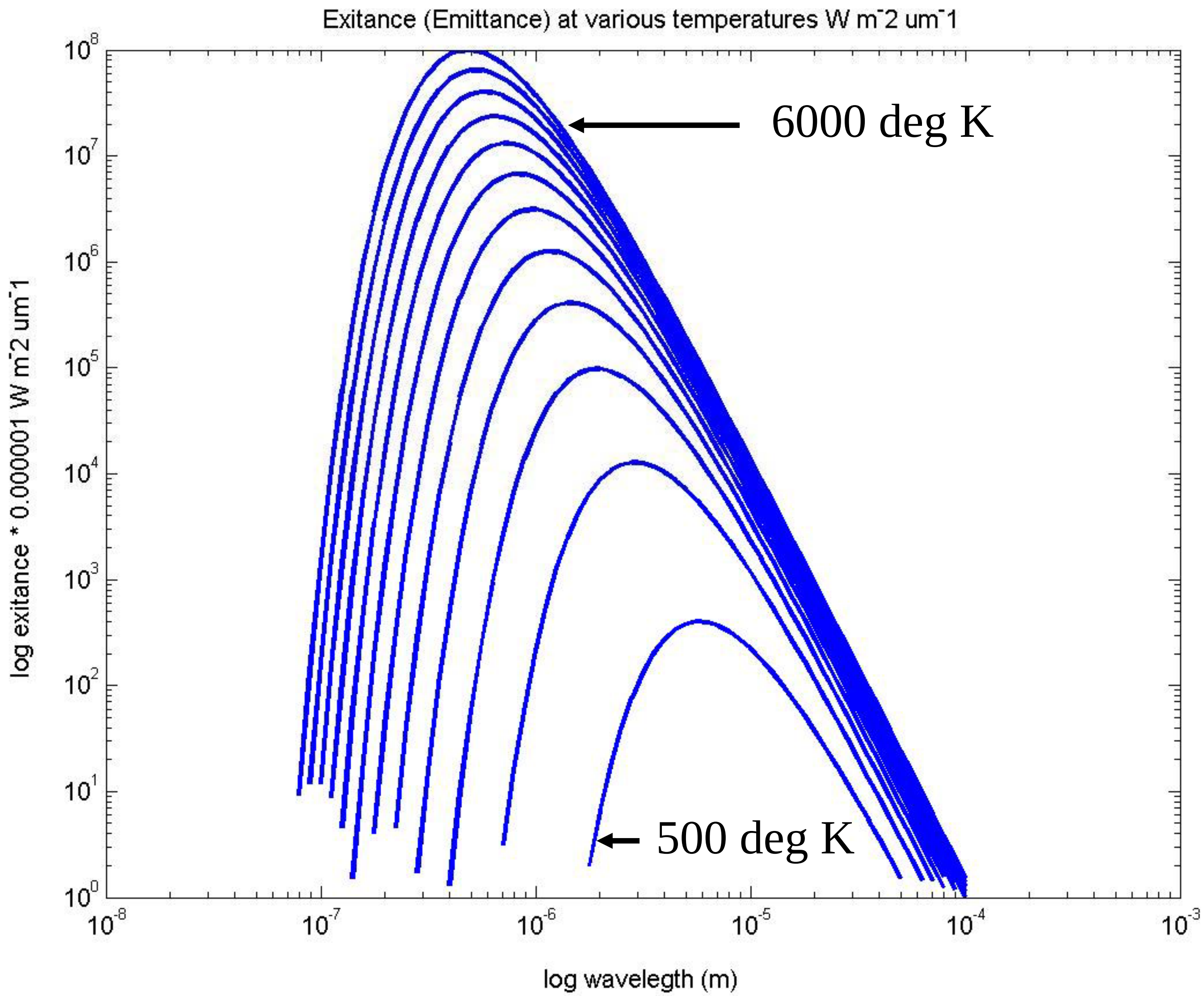
Convert units of S(λ) by multiplying by 1E-06, convert to spectral exitance, M(λ) by multiplying by pi.



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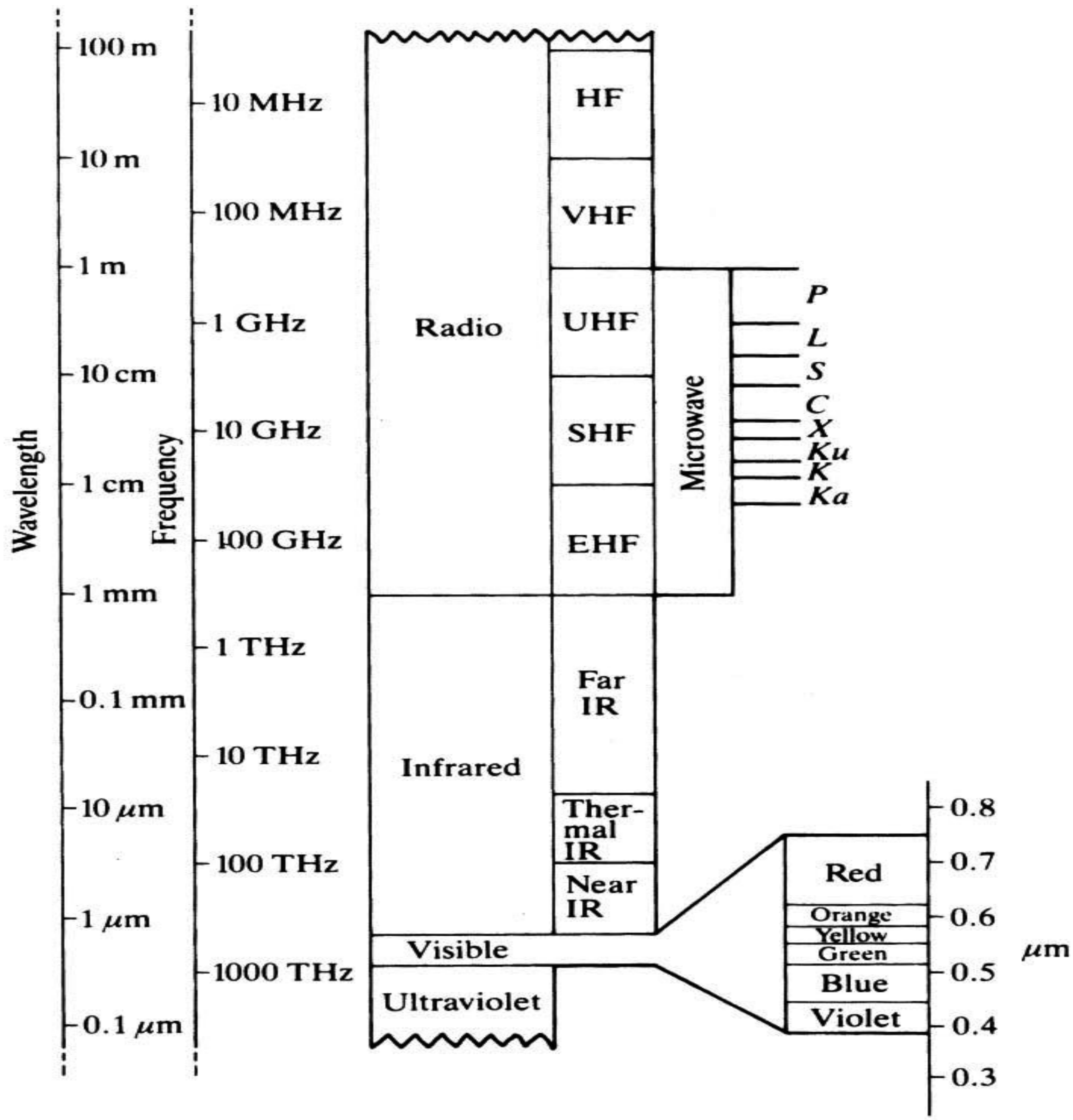

From Rees, 2001

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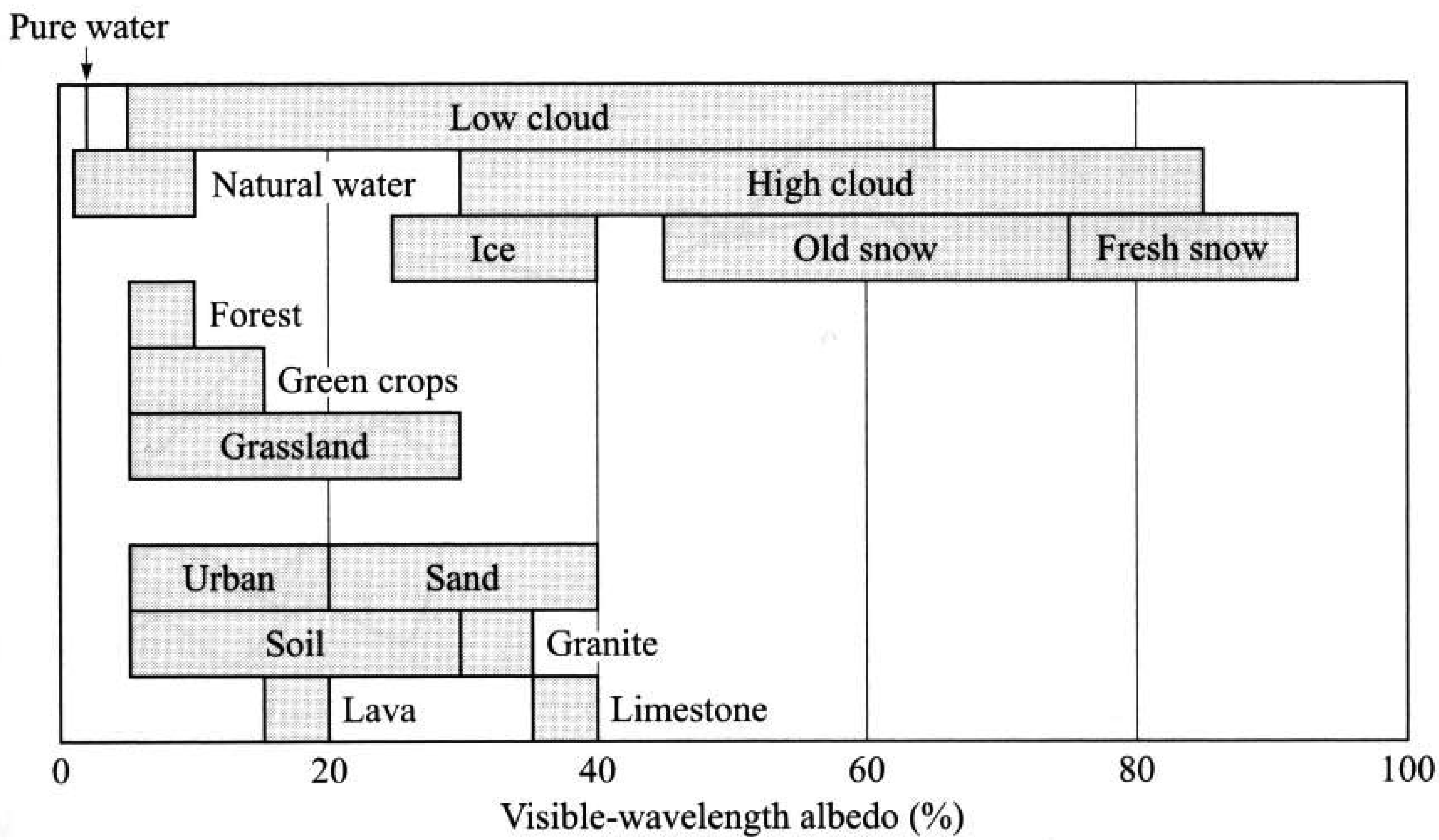

From Rees, 2001