AST-191 Special Topics:
“Radiative Processes in Astrophysics”

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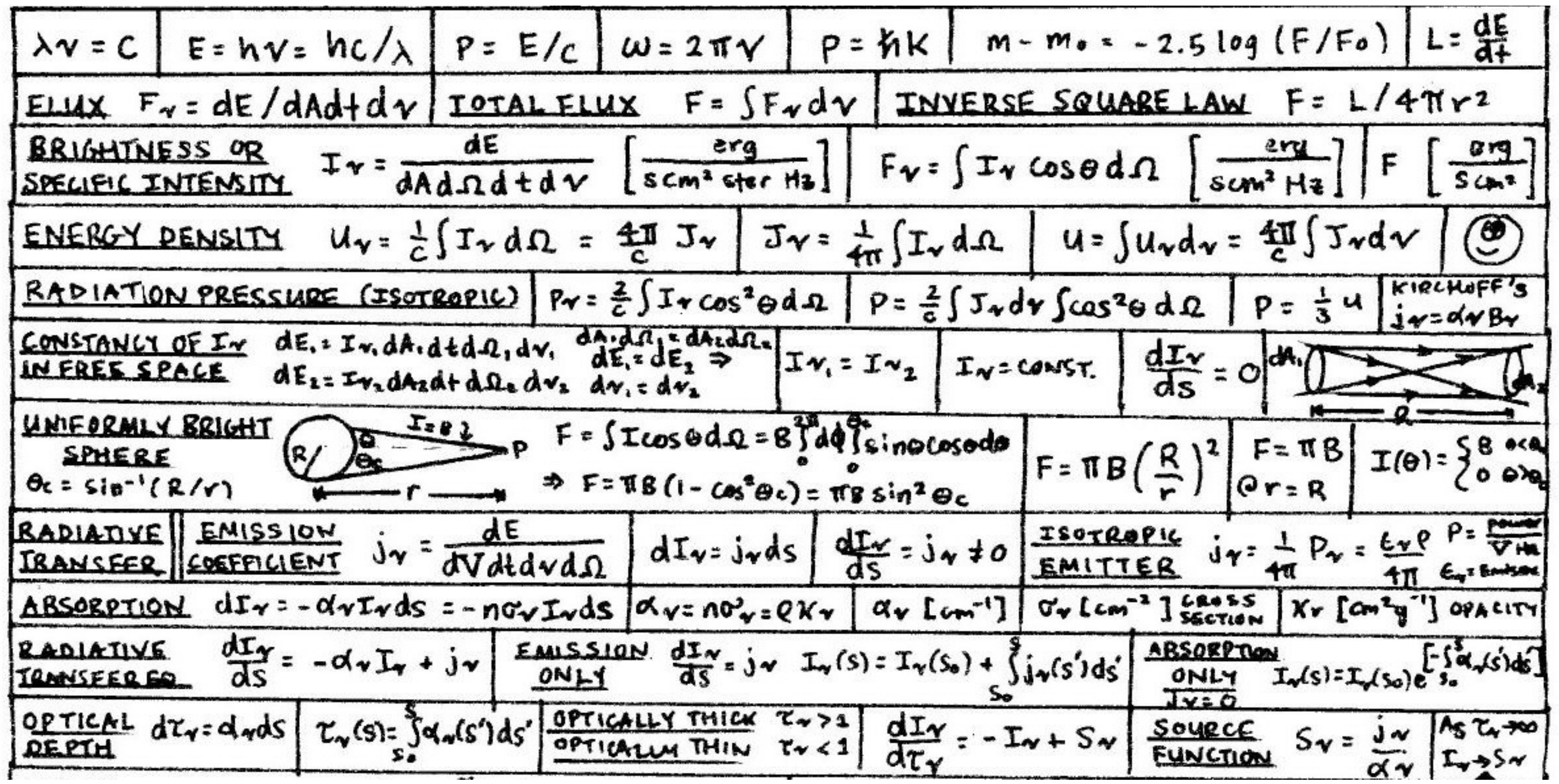
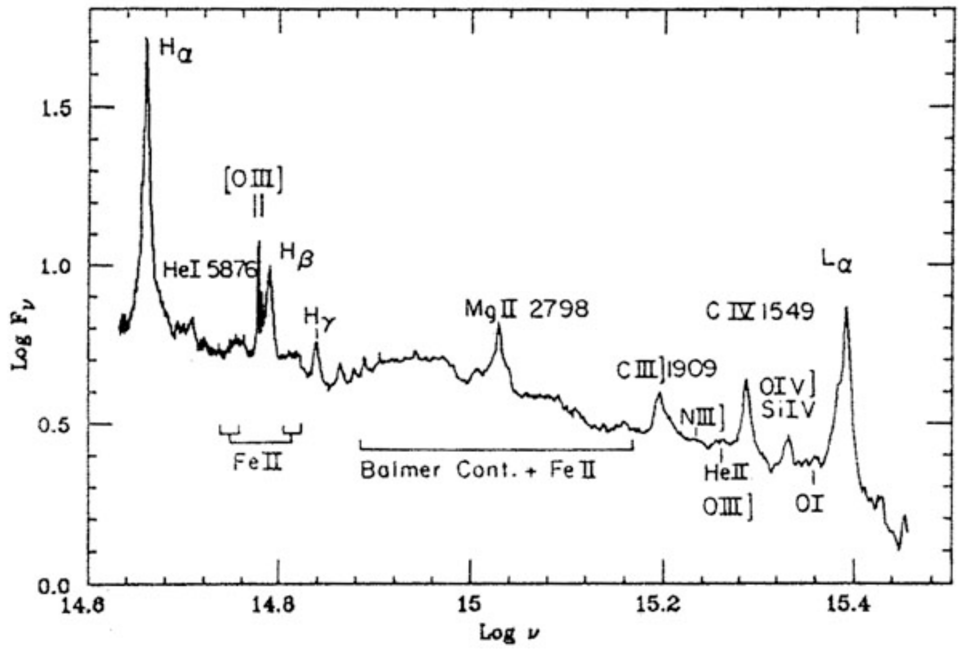
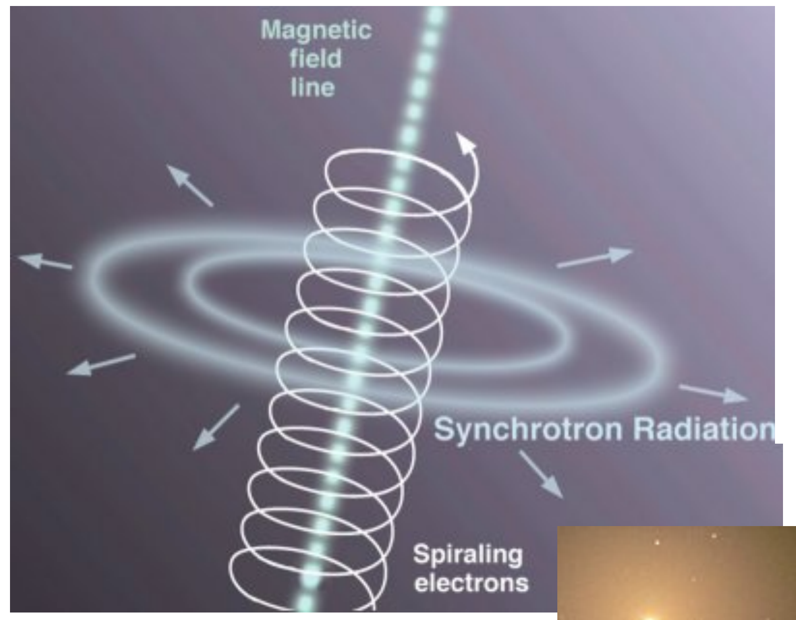


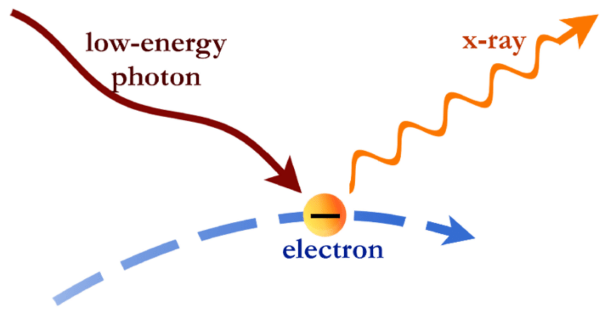
Fall 2024 semester:
Mon-Wed
9:00-10:15am
CLIC 204

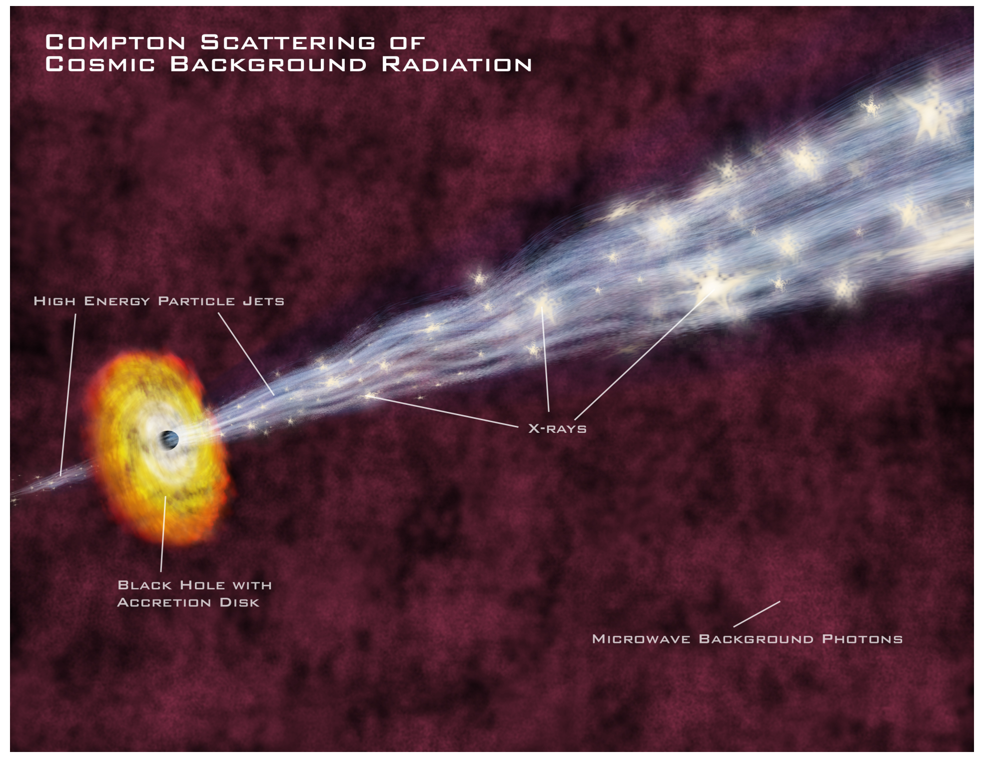
Recommended textbook:
“Radiative Processes in Astrophysics”
by Rybicki & Lightman

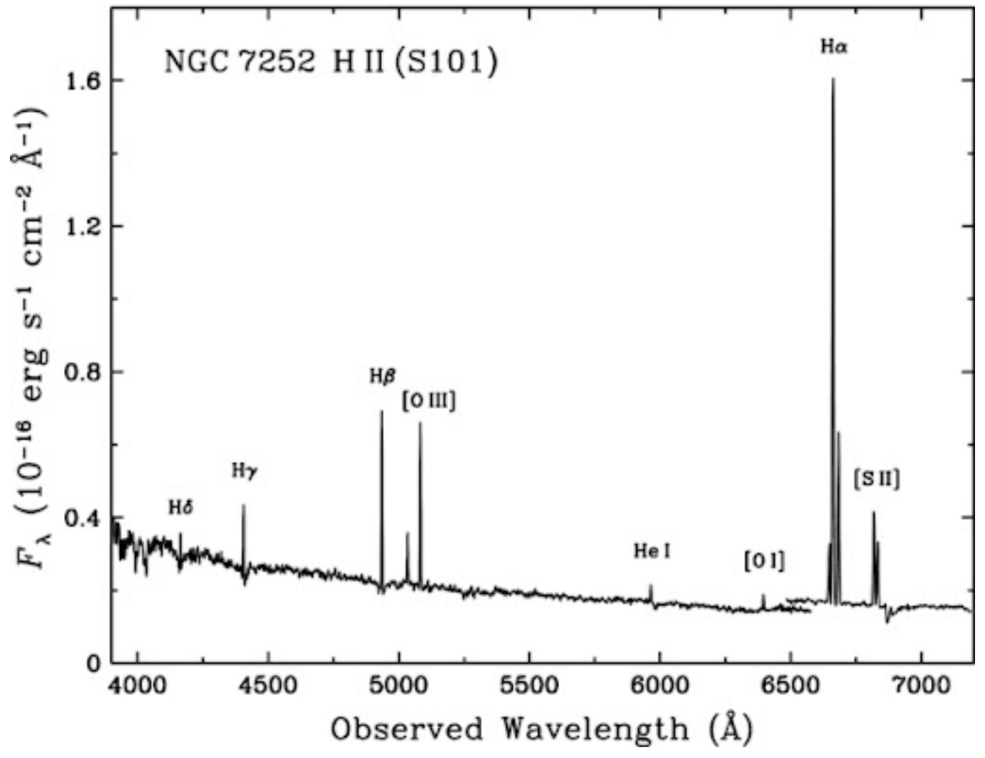
COVERED TOPICS:
- Fundamentals of Radiative Transfer
- Radiation from Moving Charges
- Bremsstrahlung
- Synchrotron Radiation
- Compton scattering
- Plasma Effects
- Atomic Structure
- Radiative Transitions
- Molecular Structure

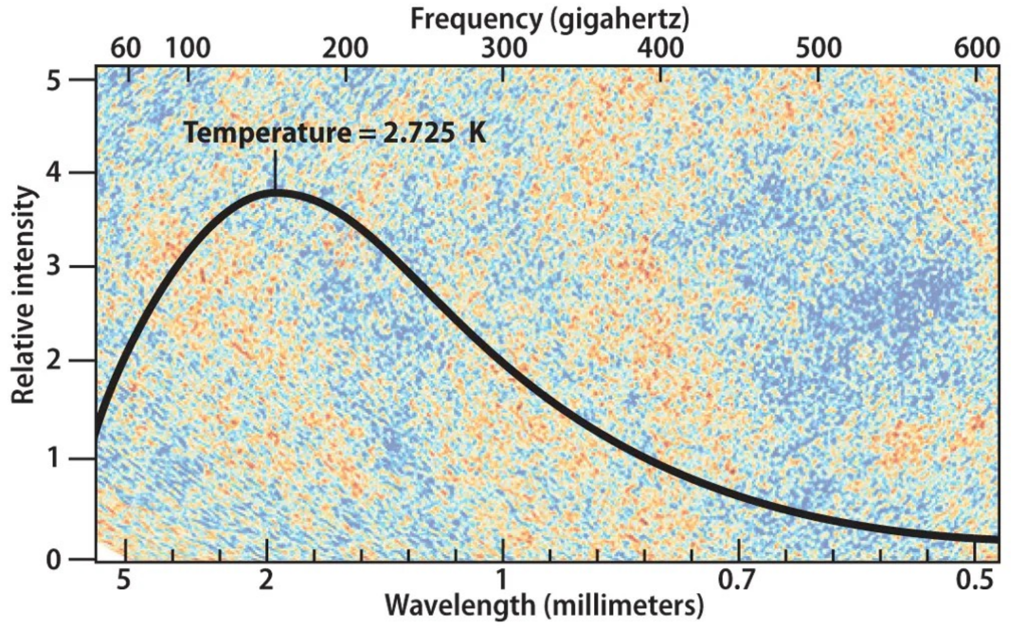


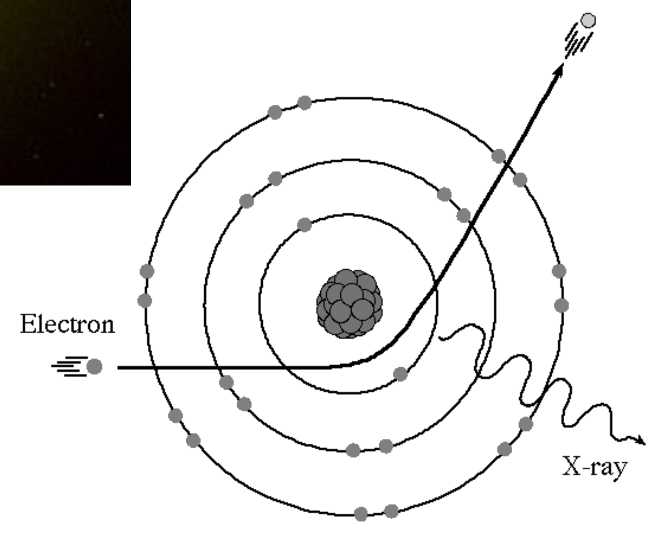


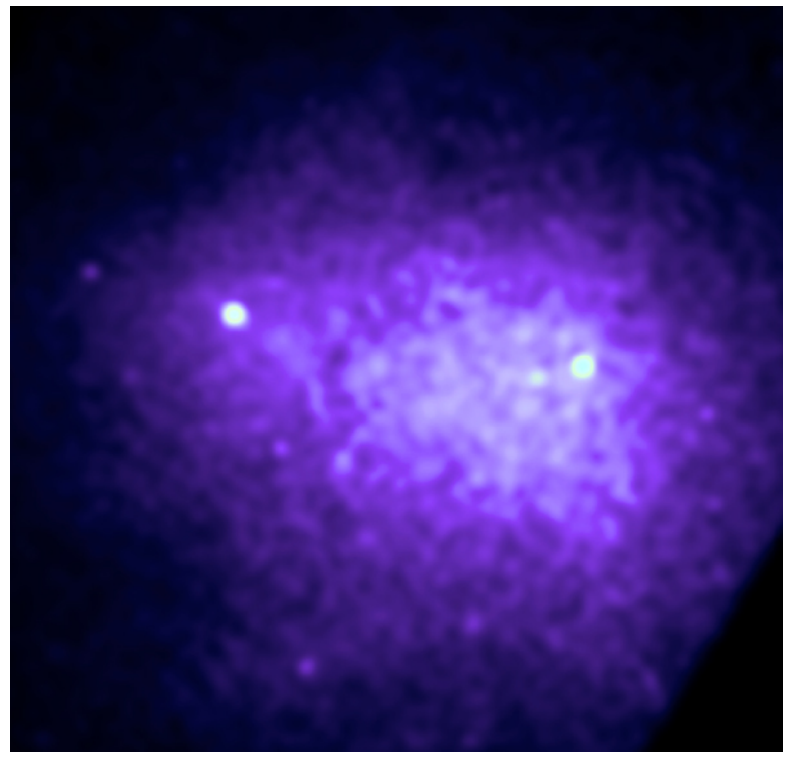




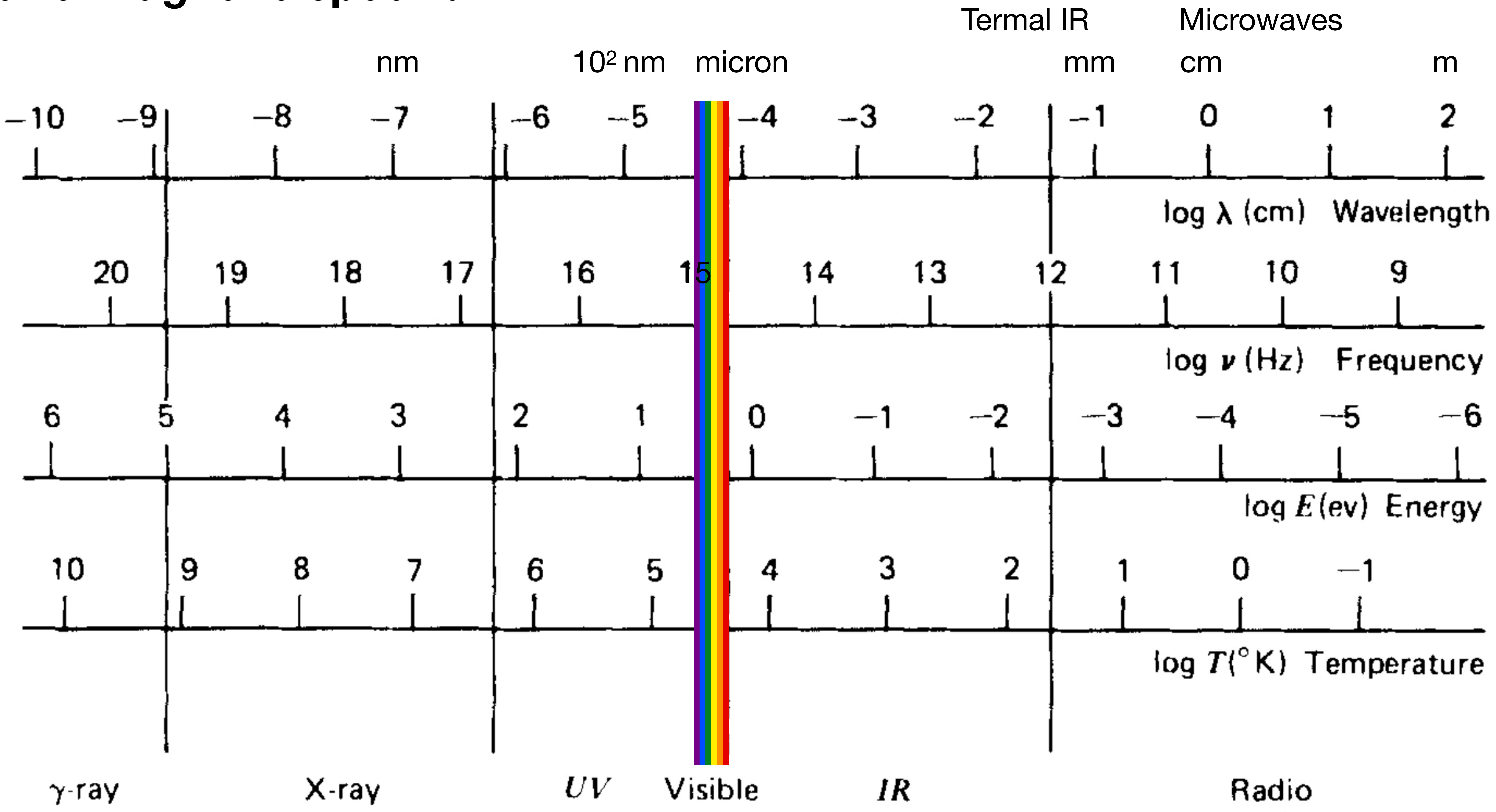


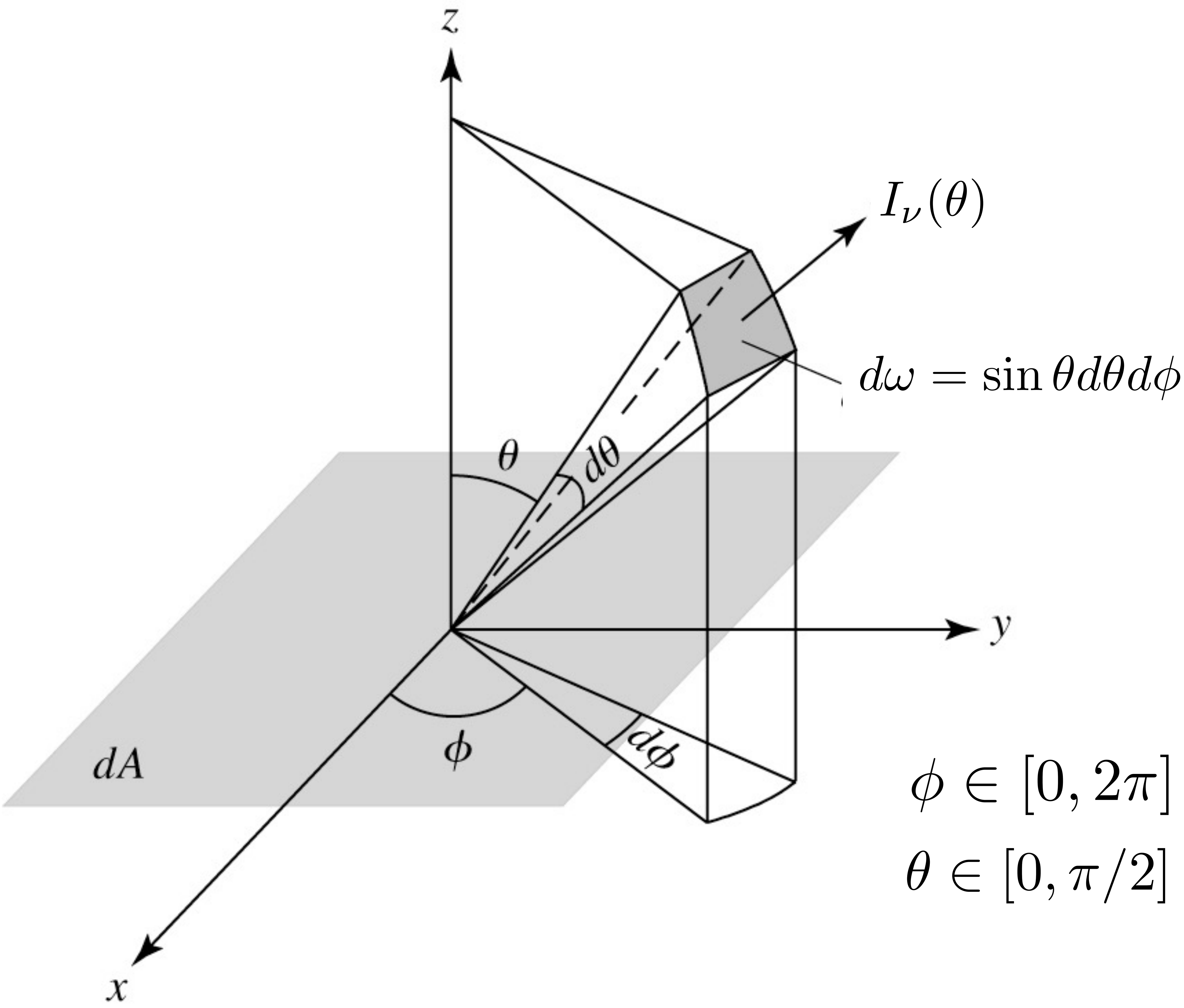




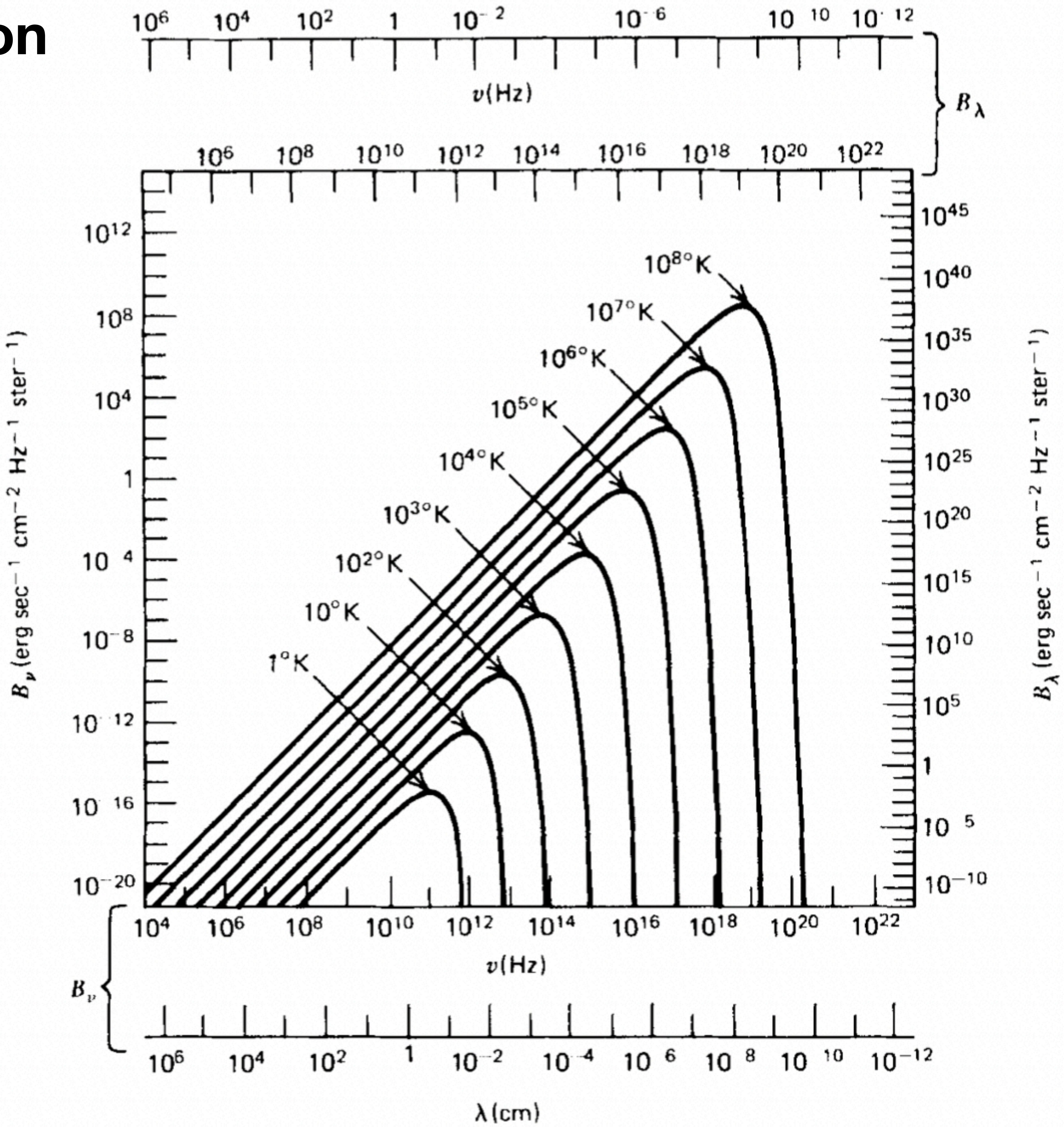


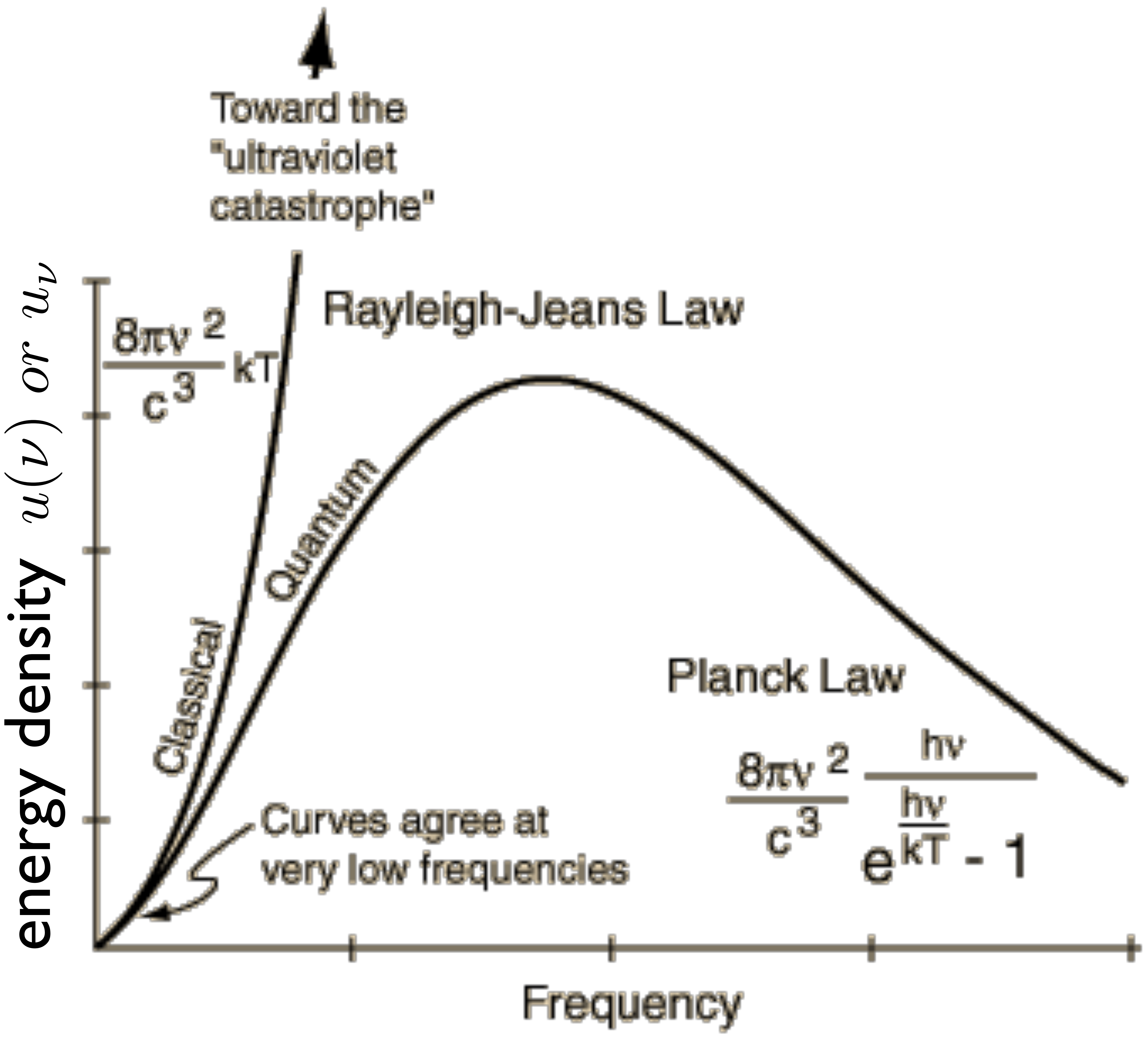
Electro-magnetic spectrum




z
$I_\nu(\theta)$
$d\omega = \sin\theta d\theta d\phi$
θ
$d\theta$
y
ϕ
$d\phi$
dA
x
$\phi \in [0, 2\pi]$
$\theta \in [0, \pi/2]$

Blackbody radiation (Plank's law)





Toward the "ultraviolet catastrophe"
Rayleigh-Jeans Law
$\frac{8\pi\nu^2}{c^3}kT$
Classical
Quantum
Planck Law
$\frac{8\pi\nu^2}{c^3}\frac{h\nu}{e^{\frac{h\nu}{kT}}-1}$
Curves agree at very low frequencies
Frequency
energy density $u(\nu)$ or u_ν

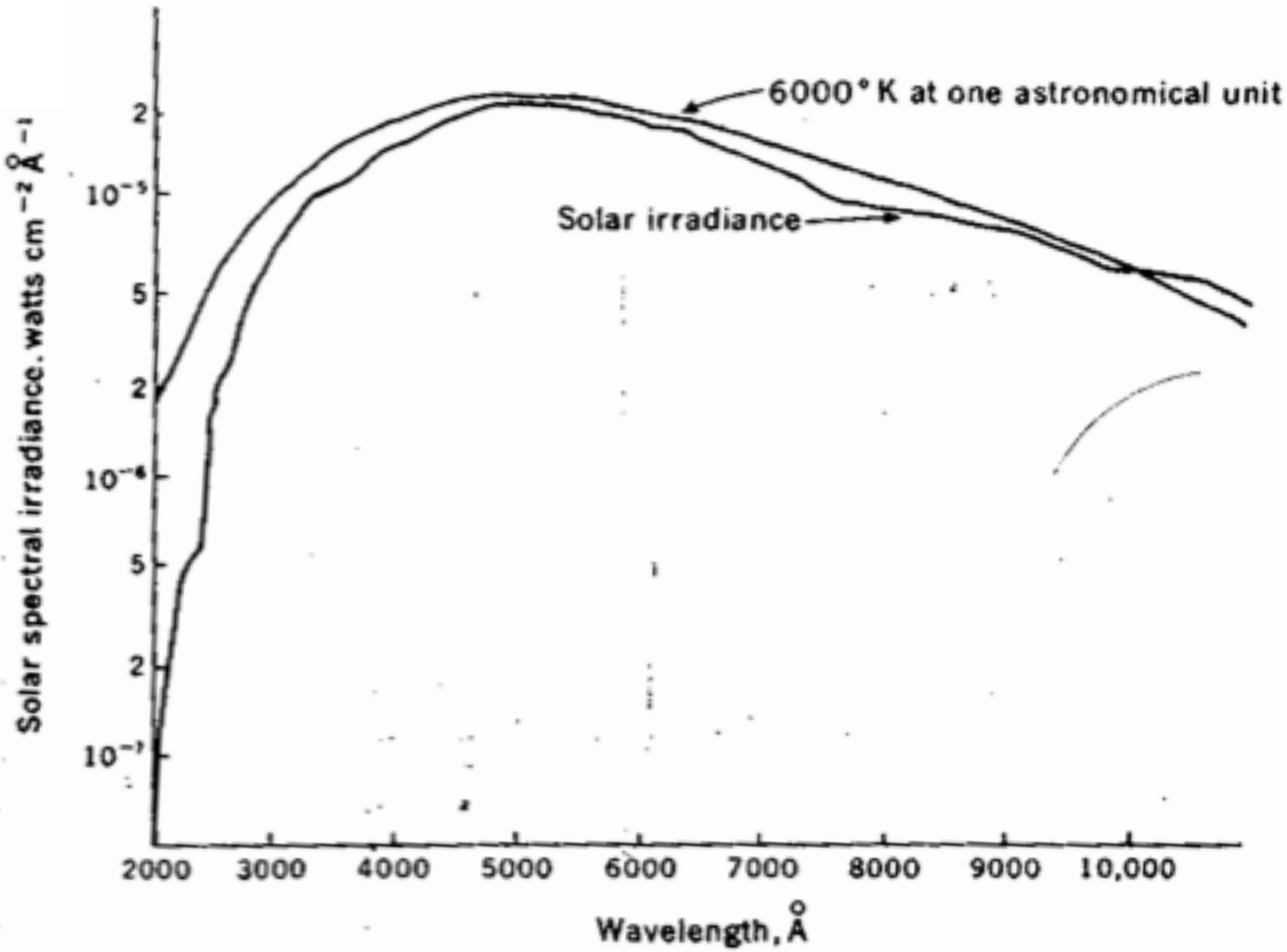
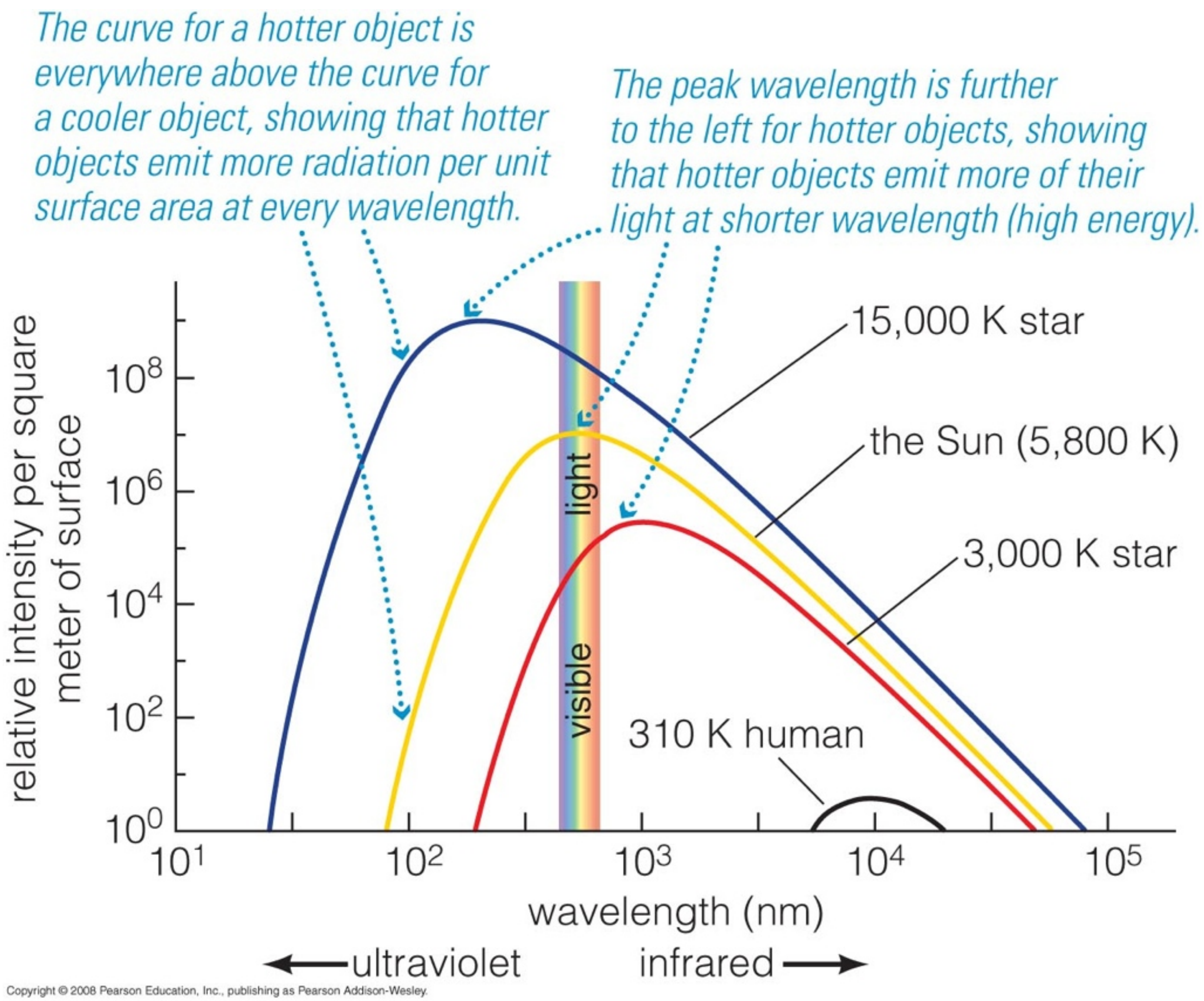
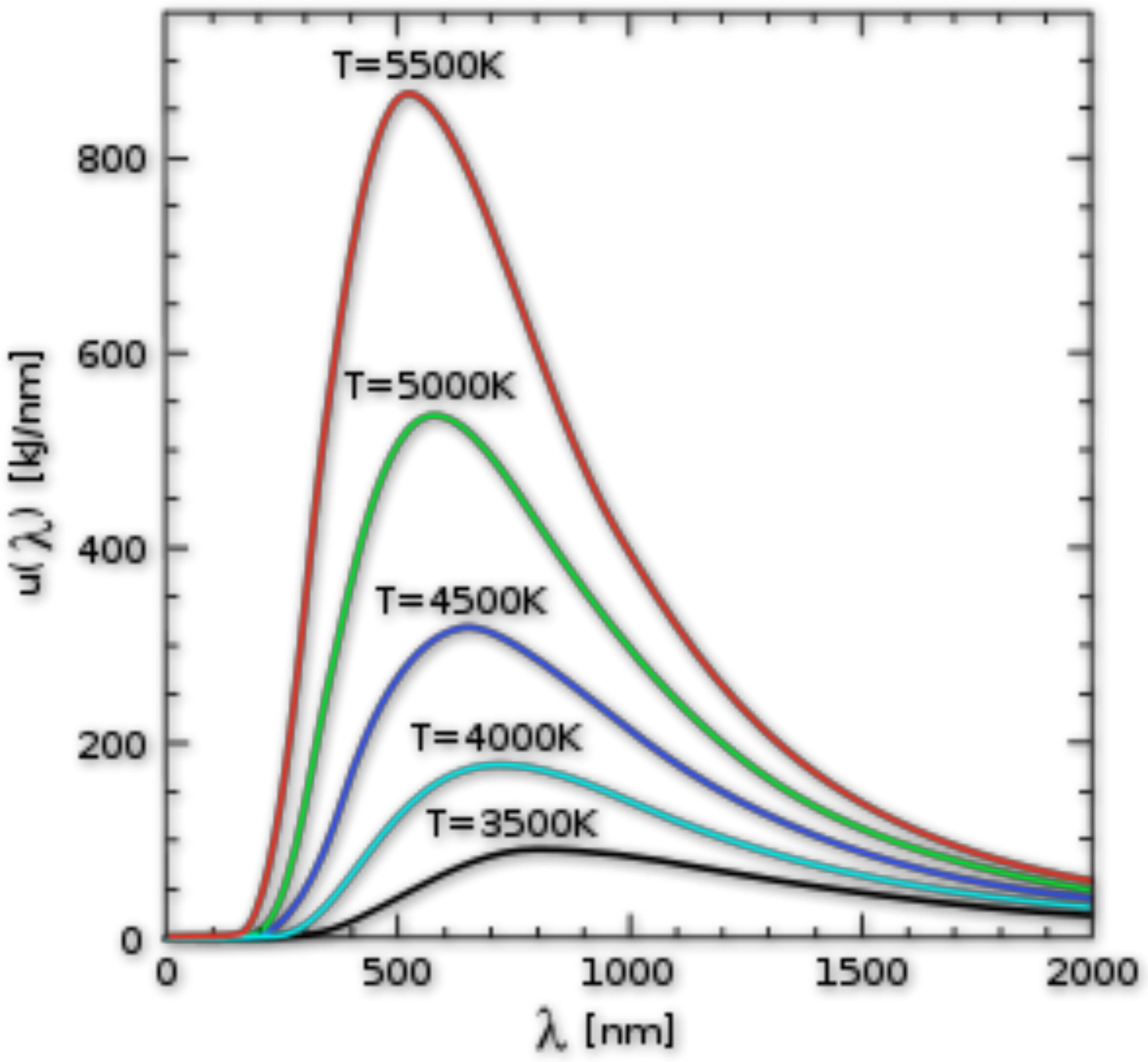


Fig. 1-5 Comparison of the visible solar energy-distribution curve with that from a blackbody at 6000°K. The overall resemblance is good, although the sun is quite deficient in the ultraviolet. [*D. P. Le Galley and A. Rosen (eds.), "Space Physics," p. 111, John Wiley & Sons, Inc., New York,* 1964.]





Wien’s displacement law

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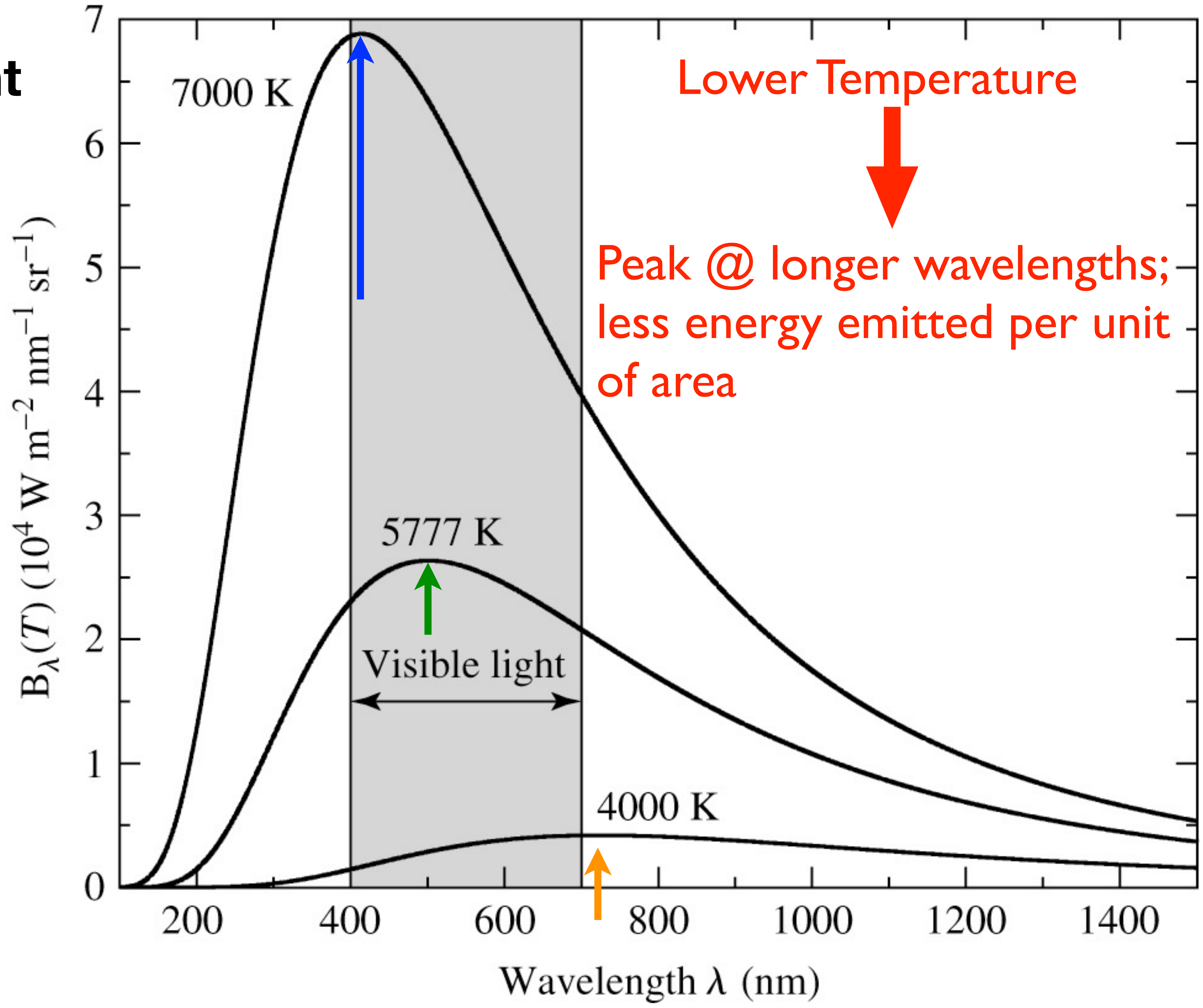


Color temperature T_c

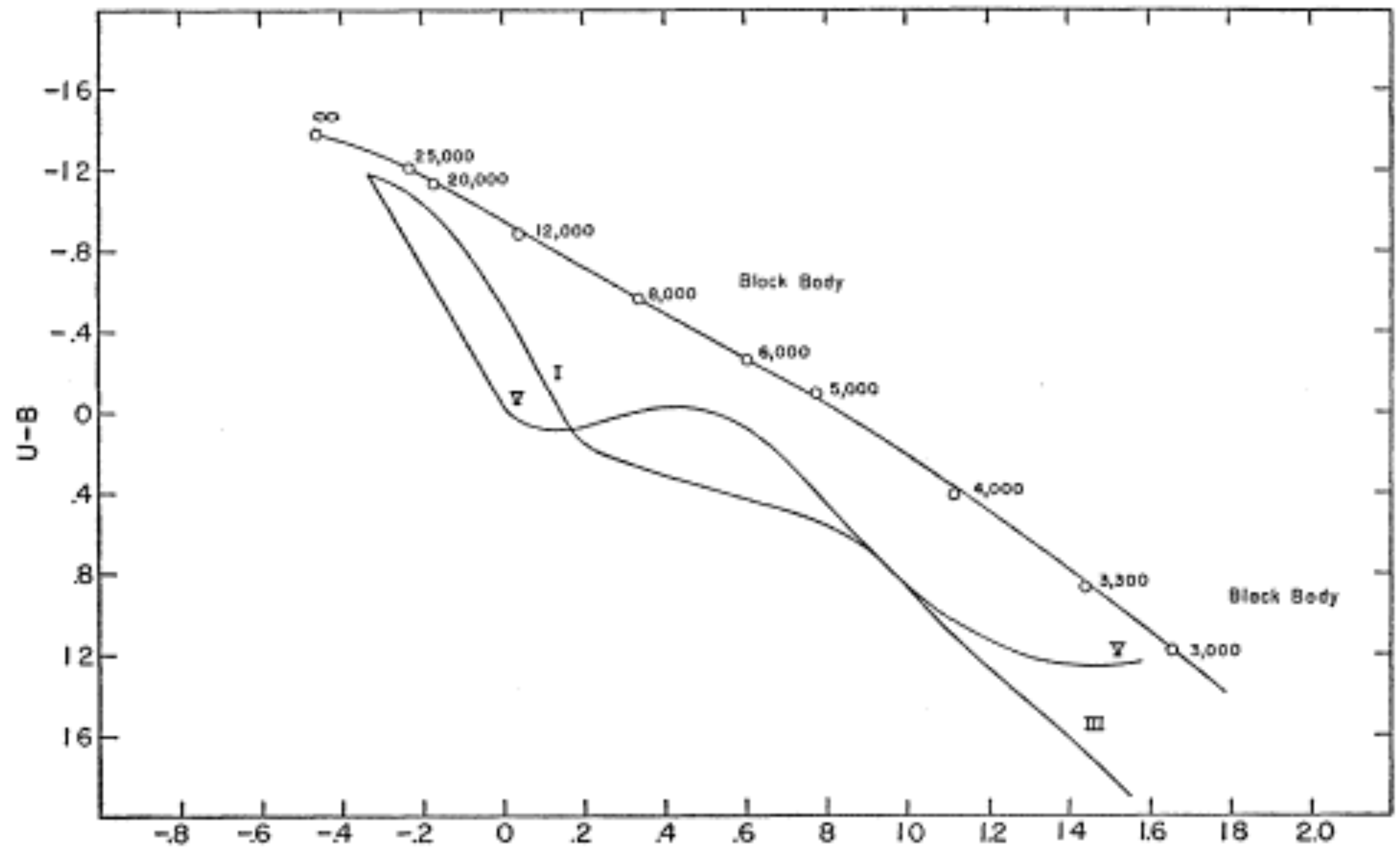
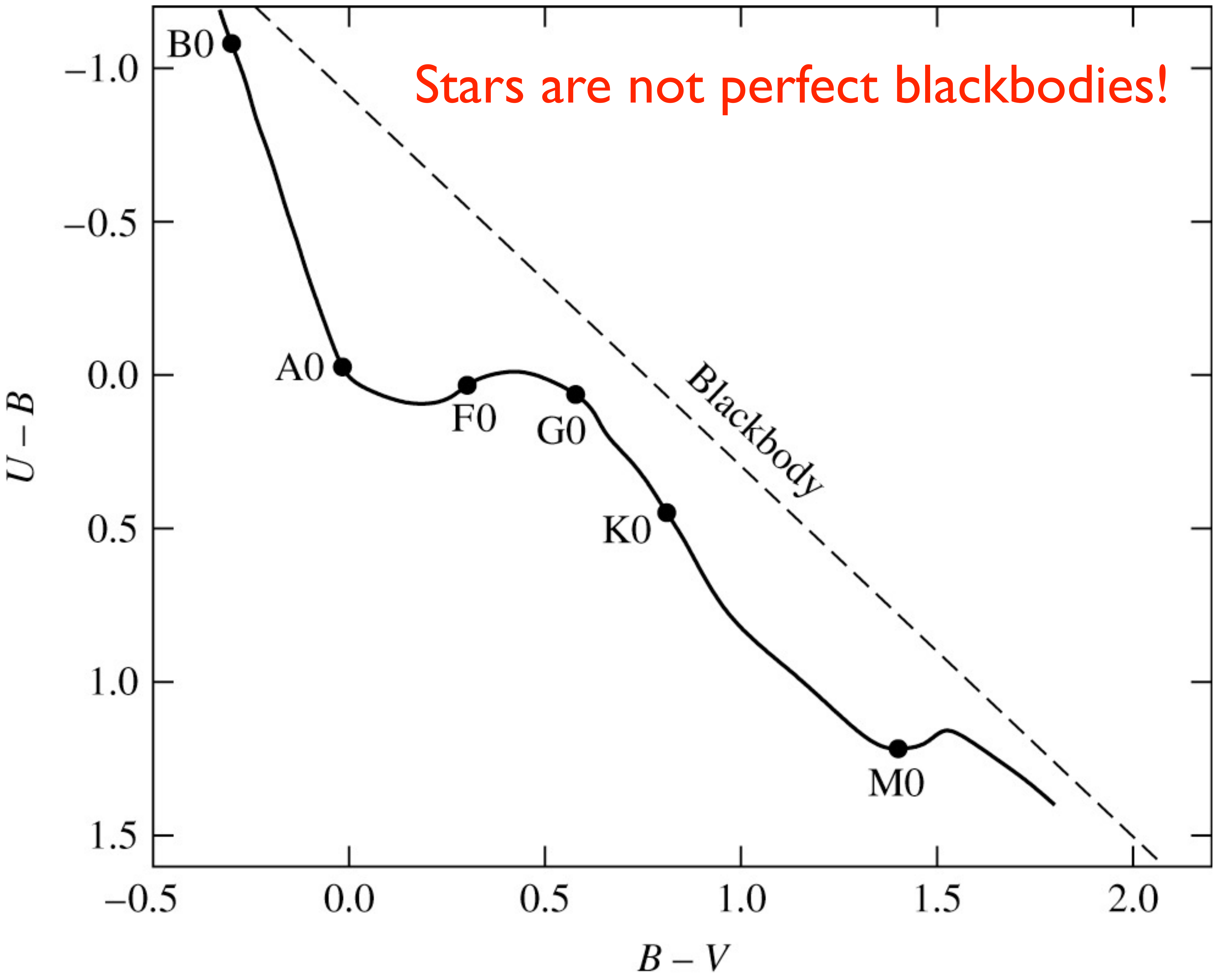
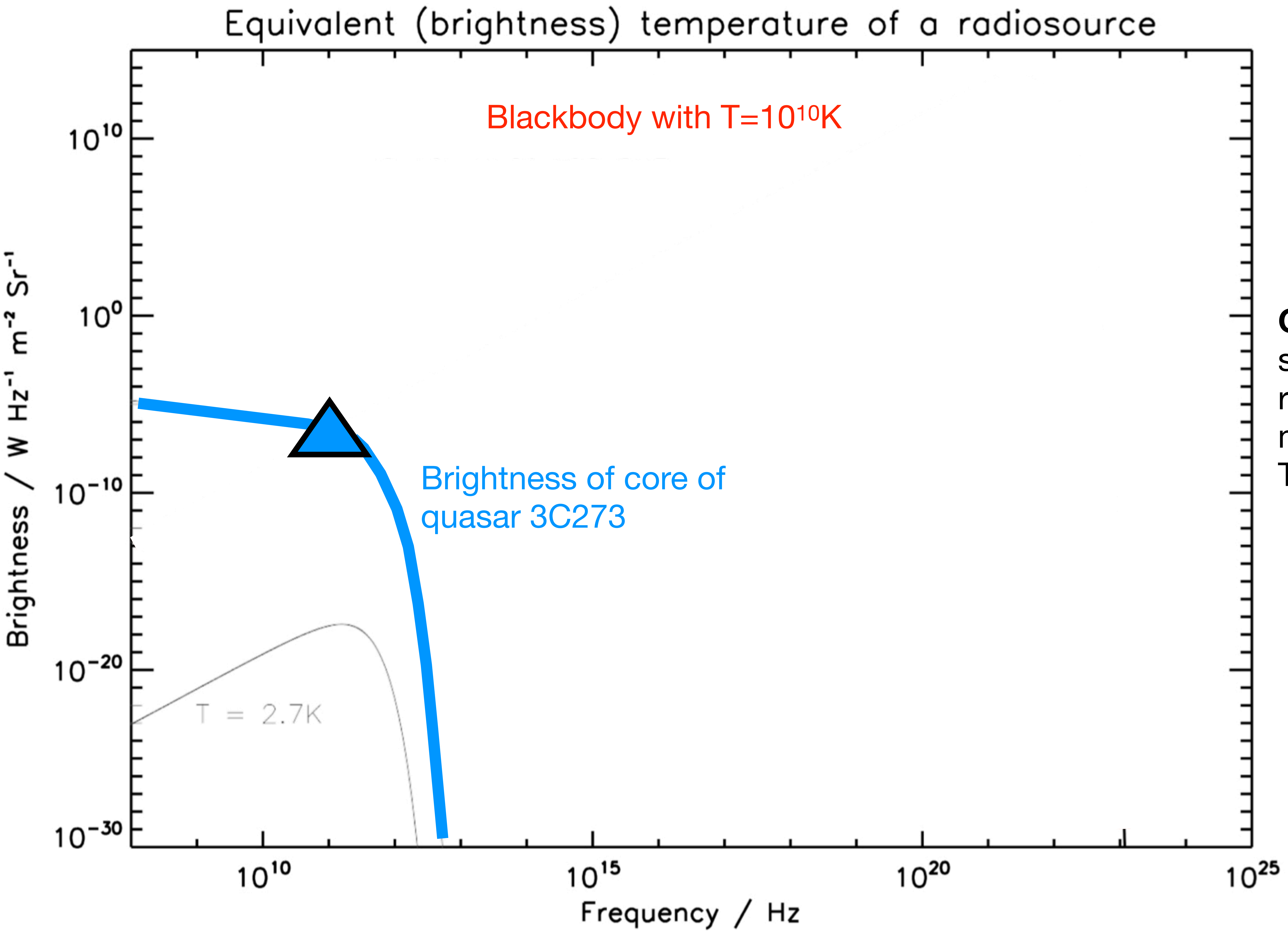


FIG. 1.—The $U - B$, $B - V$ relation for black bodies. The plotted points are taken from the last two columns of Table 2. The standard Johnson relations for stars of luminosity classes I–V are also shown.


Stars are not perfect blackbodies!
B0
A0
F0
G0
K0
M0
Blackbody
U – B
B – V
−1.0
−0.5
0.0
0.5
1.0
1.5
−0.5
0.0
0.5
1.0
1.5
2.0



CAREFUL! If the emitted spectrum is not blackbody radiation, then temperature measurements of T_b, T_c, or T_{eff} are wrong.