

北京航空航天大学

BEIJING UNIVERSITY OF AERONAUTICS AND ASTRONAUTICS

大学物理作业19

71066001 - 陈伟杰

13-1 太阳辐射峰值波长 $\lambda_m = 0.35 \mu\text{m}$ 和 $0.29 \mu\text{m}$

维恩位移定律 $T\lambda_m = b$

太阳表面温度

$$T_1 = \frac{b}{\lambda_{m1}} = \frac{2.897 \times 10^{-3}}{0.35 \times 10^{-6}} \text{ K} = 8.28 \times 10^3 \text{ K}$$

天*

$$T_2 = \frac{b}{\lambda_{m2}} = \frac{2.897 \times 10^{-3}}{0.29 \times 10^{-6}} \text{ K} = 9.99 \times 10^3 \text{ K}$$

13-2 单色辐射度的峰值波长是由 $0.69 \mu\text{m}$ 变化到 $0.50 \mu\text{m}$ ，求总辐射度改变为原来的多少倍

$$\frac{T_2}{T_1} = \frac{\lambda_{m1}}{\lambda_{m2}} = \frac{0.69}{0.50} = 1.38$$

斯特藩-玻耳兹曼定律 $M_0 = \sigma T^4$

$$\text{总辐射之比} \quad \frac{M_{02}}{M_{01}} = \frac{T_2^4}{T_1^4} = (1.38)^4 = 3.63$$

13-3 太阳表面温度 5800K 半径 $6.96 \times 10^8\text{m}$

* 太阳在一年内由于辐射, 它的重量减小了多少?

$$P = M \cdot S = \sigma T^4 4\pi R^2$$

太阳在一年内辐射出的总能量为

$$\Delta E = P \Delta t$$

质量亏损

$$\Delta m = \frac{\Delta E}{c^2} = \frac{4\pi R^2 \sigma T^4 \Delta t}{c^2}$$

$$\Rightarrow \frac{4\pi \times (6.96 \times 10^8)^2 \times 5.67 \times 10^{-8} \times (5.8 \times 10^3)^4 \times 3600 \times 24 \times 365}{(3 \times 10^8)^2}$$

$$\Rightarrow 1.37 \times 10^{17} \text{ kg}$$

13-6 0.05mm 的小圆孔, $T = 7500\text{K}$

$$M_\lambda(T) d\lambda = 2\pi h c^2 \lambda^{-5} \frac{d\lambda}{e^{hc/\lambda kT} - 1}$$

$$P = M_\lambda(T) d\lambda S = 2\pi h c^2 \lambda^{-5} \frac{d\lambda}{e^{hc/\lambda kT} - 1} \left(\frac{1}{4} \pi d^2 \right) = \frac{(c\pi d)^2 h d\lambda}{2\lambda^5 e^{hc/\lambda kT} - 1}$$

$$\text{式中 } \frac{(c\pi d)^2 h d\lambda}{2\lambda^5} = \frac{(3 \times 10^8 \times 3.14 \times 5 \times 10^{-5})^2 \times 6.63 \times 10^{-34} \times 1 \times 10^{-7}}{2 \times (500 \times 10^{-9})^5}$$

$$= 2.36 \times 10^{-2} \text{ J/s}$$

$$e^{hc/\lambda kT} - 1 = \exp\left(\frac{6.63 \times 10^{-34} \times 3 \times 10^8}{500 \times 10^{-9} \times 1.38 \times 10^{-23} \times 7.5 \times 10^3} \right) - 1 = 45.7$$

$$\text{1/4 } P = M_\lambda(T) d\lambda S = \frac{(c\pi d)^2 h d\lambda}{2\lambda^5 e^{hc/\lambda kT} - 1} = \frac{2.36 \times 10^{-2}}{45.7}$$

$$= 5.16 \times 10^{-4} \text{ J/s}$$