581.

Problem 42.15 (RHK)

We have to calculate the Doppler wavelength shift expected for light of wavelength 553 nm *emitted from the edge of the Sun's disk at the equator due to the Sun's rotation.*

Solution:

Period of rotation of the Sun about its axis,

$T = 26 \text{ day} = 26 \times 8.64 \times 10^4 \text{ s.}$

The mean radius of the Sun, $R = 6.96 \times 10^8 \text{ m}.$

Therefore, the speed of rotation of the Sun's disk at its equator, $u = \frac{2\pi R}{T} = \frac{2\pi \times 6.96 \times 10^8}{26 \times 8.64 \times 10^4} \text{ m s}^{-1}.$

For $u = c$, the approximate form of the Doppler shift is $\frac{\Delta\lambda}{\lambda} \cong \frac{u}{c}.$

As the velocity of the Sun's disk will be toward the Earth from one edge of its disk and away from the Earth from the other edge of its disk, the magnitude of the Doppler

shift of the light of wavelength 553 nm observed from the Earth will be

$$|\Delta\lambda| = \lambda \times \frac{u}{c} = \frac{553 \times 1.946 \times 10^3}{3 \times 10^8} \text{ nm}$$
$$= 3.58 \times 10^{-3} \text{ nm.}$$

Therefore,

$$\Delta\lambda = \pm 0.0036 \text{ nm.}$$