hw5_ipynb

September 30, 2024

[ ]:
```python
from astropy.constants import R_sun, M_sun, c
from astropy import units as u
import numpy as np

# Constants
X = 0.7  # Hydrogen mass fraction
kappa = 0.2 * (1 + X) * u.cm**2 / u.g  # Opacity

# Mass and radius of the Sun with astropy units
R = R_sun  # Radius of the Sun in meters with astropy units
M = M_sun  # Mass of the Sun in kilograms with astropy units

# Speed of light with astropy units
c_value = c  # Speed of light in m/s with astropy units

# Volume of the Sun (assuming a spherical shape)
V = (4/3) * np.pi * R**3

# Average density of the Sun
rho = M / V  # Density in kg/m^3

# Optical depth calculation
tau = (rho * kappa * R).decompose()

# Calculating tau^2
tau_squared = tau**2

# Calculating R * tau / c in seconds using astropy units
R_tau_over_c = (R * tau) / c_value

# Convert R_tau_over_c to years
R_tau_over_c_years = R_tau_over_c.to(u.yr)

# Output results
print(f"Optical depth (tau) of the Sun: {tau:.3e}")
print(f"Optical depth squared (tau^2): {tau_squared:.3e}")
print(f"R * tau / c in years: {R_tau_over_c_years:.3e}")
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Optical depth (tau) of the Sun: 3.335e+10
Optical depth squared (tau^2): 1.112e+21
R * tau / c in years: 2.452e+03 yr
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from astropy.constants import c, sigma_sb, L_sun, R_sun, G, M_sun, m_p, R_sun,␣
↪k_B
from astropy import units as u

# Constants: Sun's luminosity and radius from astropy.constants
L_sun_value = L_sun  # Sun's luminosity in W
R_sun_value = R_sun  # Sun's radius in meters

# Calculate the Sun's surface flux using F_sun = L_sun / (4 * pi * R_sun^2)
F_sun_surface = L_sun_value / (4 * np.pi * R_sun_value**2)  # Flux in W/m^2

# speed of light 'c' from astropy.constants
c_value = c  # Speed of light in m/s

# Calculate (3 / ac) * tau * F_sun_surface
result = ((3 / (4 * sigma_sb)) * tau * F_sun_surface)**0.25

# Output the result with units
print(f"Sun's surface flux: {F_sun_surface:.3e}")
print(f"(3 / ac) * tau * F_sun_surface = {result:.3e}")
```

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Sun's surface flux: 6.294e+07 W / m2
(3 / ac) * tau * F_sun_surface = 2.295e+06 K
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[ ]:
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((2/3) * G * M_sun * m_p / (k_B* R_sun)).to('K')
```

[ ]:
15406815 K

[ ]:
```
Tvir = 1.54e7 * u.K
Urad = (16 * np.pi / 9) * (sigma_sb/c) * Tvir**4 * R_sun**3
RM = M_sun * c**2

(Urad/RM).decompose()
```

[ ]:
1.1194893×10^{-7}

[ ]:
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Tc =(0.75 *  (F_sun_surface/sigma_sb) * tau)**0.25
Tc
```

[ ]:
2295381.9 K

[ ]:
```
R_sun
```

[ ]:
6.957×10^{8} m

[ ]: