Q01

April 26, 2025

[1]:
```
import numpy as np
import smplotlib
import matplotlib.pyplot as plt
import scipy.integrate as integrate
```

[2]:
```
gaussian_opacity = lambda x, tau0: tau0 * np.exp(-x**2 / 2)
```

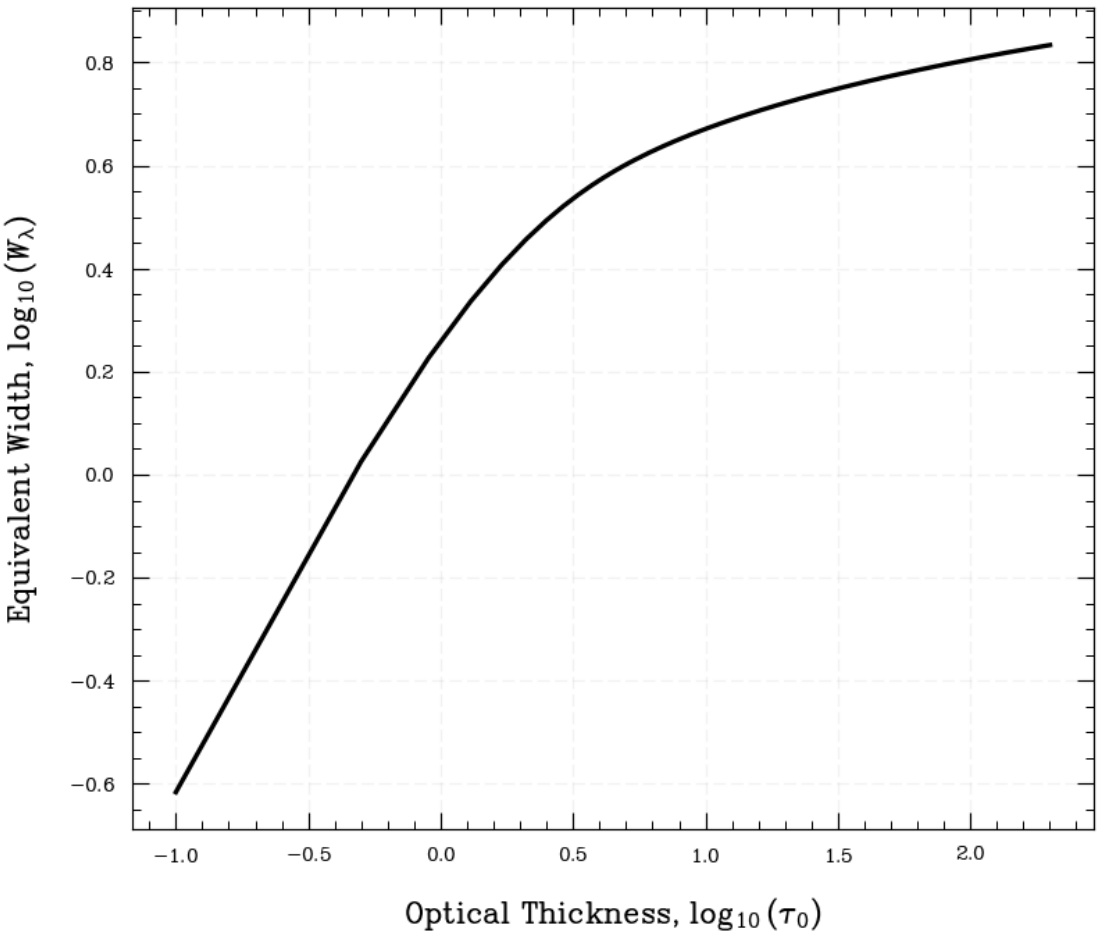
[3]:
```
def equivalent_width(tau0):
    integrand = lambda x: (1 - np.exp(-gaussian_opacity(x, tau0)))
    result, _ = integrate.quad(integrand, -np.inf, np.inf)
    return result
```

[4]:
```
tau0_values = np.linspace(0.1, 200, 500)

W_lambda_values = [equivalent_width(tau0) for tau0 in tau0_values]

fig, ax = plt.subplots(figsize = (7, 6))
ax.grid(alpha = 0.1)
plt.xticks(fontsize = 10); plt.yticks(fontsize = 10)
ax.set_xlabel(r'Optical Thickness, $\log_{10}(\tau_0)$', fontsize = 15,␣
 ↪labelpad = 12)
ax.set_ylabel(r'Equivalent Width, $\log_{10}(W_\lambda)$', fontsize = 15,␣
 ↪labelpad = 12)
ax.plot(np.log10(tau0_values), np.log10(W_lambda_values), lw = 2, color =␣
 ↪'black', ls = 'solid', label = 'Gaussian Profile')

plt.tight_layout()
plt.savefig('Q01_CurveOfGrowth.pdf', dpi = 800)
```



IN THIS CASE WE HAVE TWO REGIMES, (1) LINEAR (OPTICALLY THIN) UP TO ABOUT $\log(\tau_0) \approx 0.5$, AND (2) FLAT REGIME AFTER THAT VALUE, WHICH CORRESPONDS TO $\tau_0 \sim 1$.