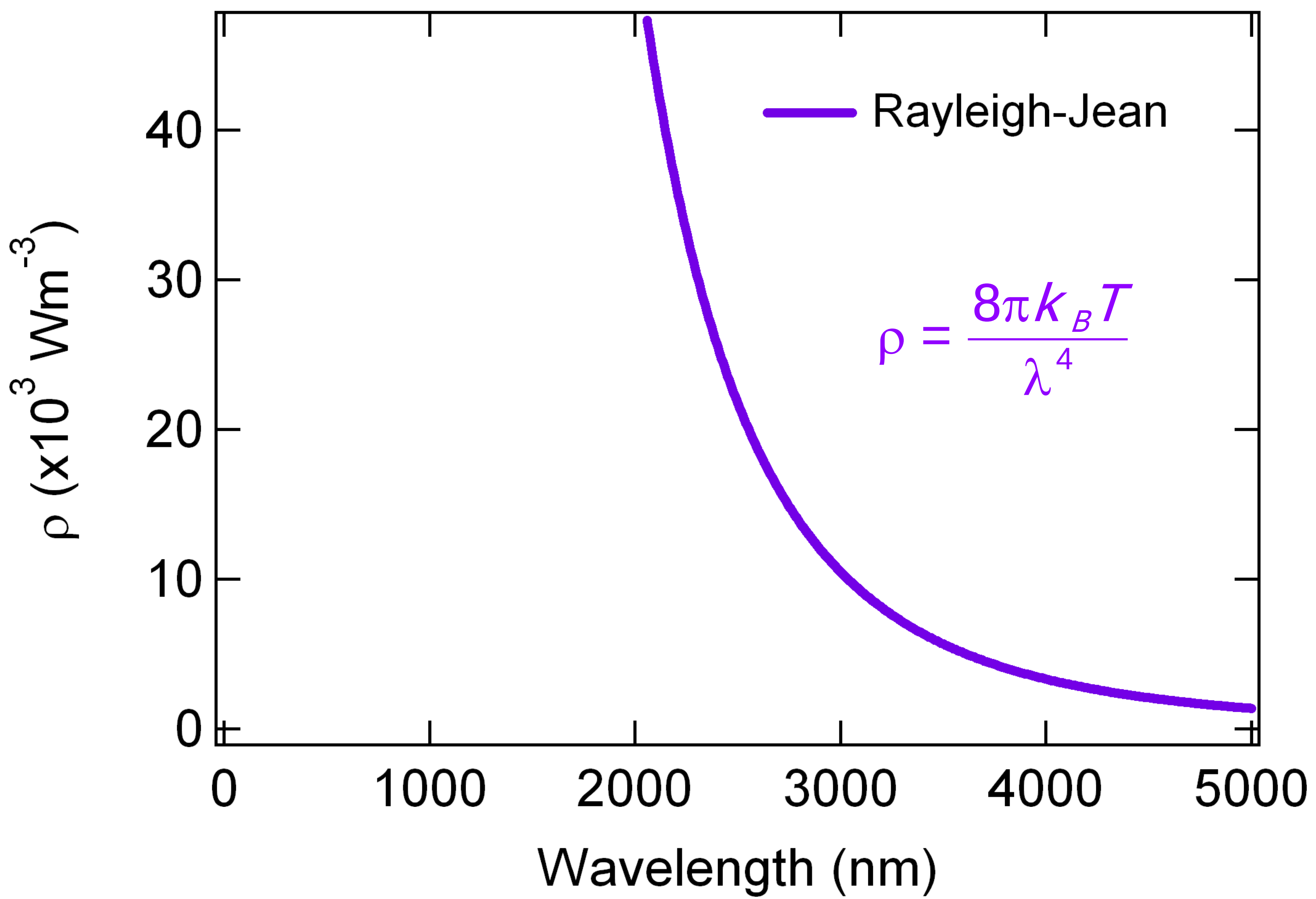

Rayleigh-Jean
ρ = 8πk_B T / λ^4
ρ (x10^3 Wm^-3)
0
10
20
30
40
0
1000
2000
3000
4000
5000
Wavelength (nm)

This diagram shows the energy density as a function of wavelength, as predicted by classical physics. The Raleigh-Jeans law uses an idealized cavity with a small opening as a model for blackbody emission. Blackbody emission is perhaps better thought of as thermal emission since ideal blackbodies do not exist and, of course, most objects we consider (like our sun for instance) appear to be anything but black. The model using classical physics is based on the idea of modes of radiation trapped inside the cavity. Some of the radiation escapes and this is what we know of as thermal radiation. The problem is that classical physics predicts that the energy density, rho, increases without bound as the wavelength is lowered. This theoretical prediction is clearly wrong.

For example, the Wien displacement law predicts that the maximum of the thermal emission will be inversely related to temperature. The Rayleigh-Jeans law does not predict a maximum. The Wien displacement observation is not explained at all. When the discrepancy was first realized physicists called it the ultraviolet catastrophe. You can imagine their puzzlement that Maxwell’s theory fails to explain something so basic. Remember that thermal physics is needed to explain why our earth can have a temperature different from the sun. The resolution of the physical problem is a simple assumption regarding the spacing of modes in the cavity. As we will see shortly, the Raleigh-Jeans law can be replaced with an accurate model simply by assuming that the energy of the radiation must be quantized.