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Laser Technology – Exercise Sheet 2

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Summer semester 2020

1 Solid angle and radiance

a) Which solid angle does the moon cover on the sky? Its diameter is 3476 km, its average distance from earth is 384 392 km.

b) Compute the radiance of an LED with a surface area of 1 mm^2 emitting an optical power of 1 mW uniformly into the half-space (i.e., $0° \leq \theta \leq 90°$). How big is the intensity and energy density measured in 1 m distance at $\theta = 0°$?

2 Thermal equilibrium

a) The energy levels of the hydrogen atom are given by $E_n = -13.6\,\mathrm{eV}/n^2$, $n = 1, 2, \ldots$, and degeneracy $g_n = n^2$. For $T = 300\,\mathrm{K}$, how big is the occupation probability for the levels $n = 1$, 2 and 3?

3 Mode density

a) Derive the 1-dimensional mode density in a resonator of length L analogously to our derivation of the three-dimensional mode density (i.e., assume periodic boundary conditions, make plane wave ansatz, and count modes, assuming $L \to \infty$). Does the mode density change when assuming boundary conditions $\mathbf{E}(0) = \mathbf{E}(L) = 0$?