Scattering on array of resonant emitters in 1D

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We study scattering of an electromagnetic wave, propagating in a one-dimensional waveguide, on an array of identical resonant point light emitters located at the points z_n, see Fig. 1. We describe light-emitter interaction by a wave equation

$$\frac{\mathrm{d}^2}{\mathrm{d}z^2}E(z) + q^2 E(z) = -4\pi q^2 \sum_{n=1}^{N} p_n \delta(z - z_n), \tag{1}$$

where the dipole moment

$$p_n = \frac{1}{2\pi q}\frac{\gamma_{1\mathrm{D}}}{\omega_0 - \omega - \mathrm{i}\gamma} E(0)\,, \tag{2}$$

characterizes the resonant polarization of the emitter. Here, $E(z)$ is the amplitude of the electric field at the frequency ω, $q = \omega/c$ is the light wave vector, ω_0 is the resonant frequency of the emitter, γ is the phenomenological decay rate, characterizing the nonradiative processes withing the emitter and $\gamma_{1\mathrm{D}}$ is the radiative decay rate. An electromagnetic wave $E(z) = E_0 \mathrm{e}^{\mathrm{i}qz}$ is incident upon the emitter from the left.

Goal: Using the Green function for the Helmholtz equation, find the system of equations to calculate the amplitudes p_n. Express the total electric field in the structure via p_n .

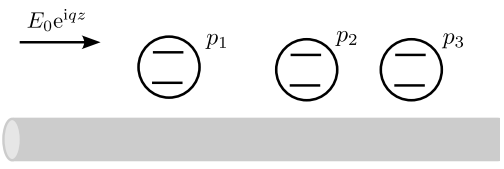

FIG. 1 Schematics of resonant light scattering on $N = 3$ emitters.