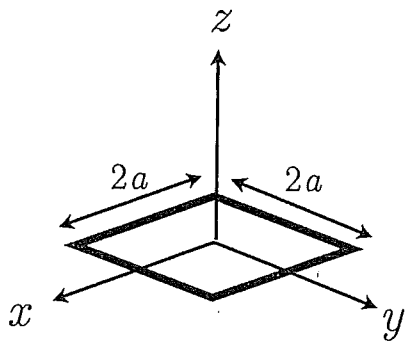
2. Square loop antenna

A square conducting loop with sides of length $2a$ is in the x-y plane, concentric with the origin, with its sides parallel to the coordinate axes. The current in the loop is $I_0 \cos(\omega t)$, where $a \ll \omega/c$. The loop is surrounded by vacuum.



(a) What is the electric field in the radiation zone (*i.e.*, in the limit of distances $r \gg \omega/c$ from the origin)? Characterize the type of radiation this represents.

(b) How does the total power P radiated by the loop depend on ω? What is its precise value?

An infinite, perfectly-conducting plane is now placed at $z = -b$, where $b \ll c/\omega$.

(c) What type of radiation field is now seen for $r \gg \omega/c$, and how does its radiated power depend on frequency in this case?

(Note that you are only asked about the **frequency-dependence** of the power, not for an elaborate calculation which would be needed to find the precise value of the radiated power in (c)).