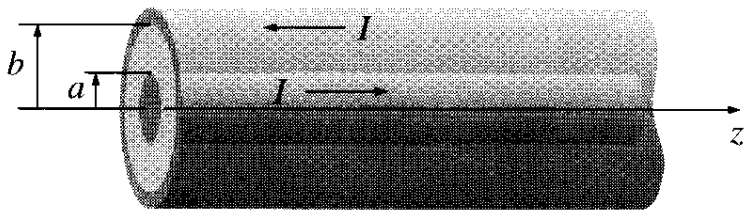
P3323 momentum
November 9, 2016

A long coaxial cable, of length l, consists of an inner conductor (radius a) and an outer conductor (radius b). It is connected to a battery at one end and a resistor at the other. The inner conductor carries a uniform charge per unit length λ, and a steady current I to the right; the outer conductor has the opposite charge and current.



1. What is the electric field in the region $a < s < b$?

2. What is the magnetic field in the region $a < s < b$?

3. Compute the Poynting vector in the region.

4. What is the power transported down the line? How is it related to the power dissipated in the resistor?

5. What is the momentum density in the fields?

6. Now the resistance is increased so the current decreases. What is the total change in the momentum of the fields as the current decreases to zero?

7. As the current changes, the changing magnetic field induces an electric field. What is the electric field if the rate of change of current is $\frac{dI}{dt}$?

8. What is the total momentum imparted to the surface charge due to the induced electric field?