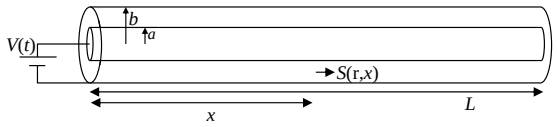
2. **Coaxial cable**

A long co-axial cable is connected to a power supply with a variable voltage $V(t)$. The cable has a cylindrical inner perfect conductor of outer radius a and a cylindrical outer perfect conductor with inner radius b. The length of the cable L is much greater than b. The space between the conductors is empty.



(a) The voltage $V(t)$ is very slowly ramped up from zero to a finite value V_0 (on a time scale much longer than L/c). There is nothing connected to the other end of the cable. Find the Poynting vector $\vec{S}(r, x)$ a distance x into the cable (far from the ends) and show that the time integral of the total energy flux at x is equal to the final electromagnetic energy stored from x to the end of the cable.

(b) Now the voltage is kept constant at V_0 and a resistor of resistance R is connected across the other end of the cable, so equal and opposite steady-state currents are flowing in the two conductors. Find the linear momentum stored in the cable and explain how a system with no net current can have a nonzero linear momentum.