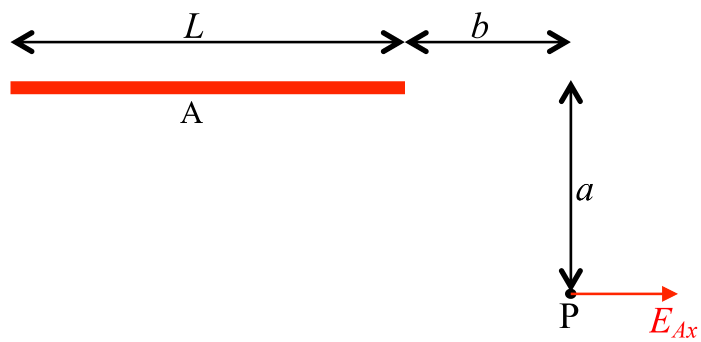
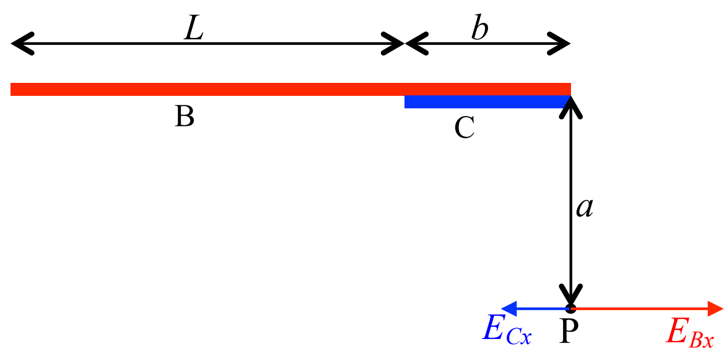
Using Charge Superposition

Given this problem:



With rod A of uniform positive charge density λ, find the component of the electric field at point P that is parallel to the rod.

You could instead do this problem:



With rod B of uniform positive charge density λ, and rod C of uniform change density – λ, find the component of the electric field at point P that is parallel to the rods.

We ***already did*** the integral for B and C in class, so just using that result we have:

$$E_{Bx} = k\lambda\left(\frac{1}{a} - \frac{1}{\sqrt{a^2 + (L+b)^2}}\right)$$

$$E_{Cx} = -k\lambda\left(\frac{1}{a} - \frac{1}{\sqrt{a^2 + b^2}}\right)$$

Therefore, the total electric field horizontal component is

$$\begin{aligned} E_x &= k\lambda\left(\frac{1}{a} - \frac{1}{\sqrt{a^2 + (L+b)^2}}\right) - k\lambda\left(\frac{1}{a} - \frac{1}{\sqrt{a^2 + b^2}}\right) \\ &= k\lambda\left(\frac{1}{\sqrt{a^2 + b^2}} - \frac{1}{\sqrt{a^2 + (L+b)^2}}\right) \end{aligned}$$

This would also be the answer to the original question. The negative C cancels the neighboring part of B (because the charge densities have the same magnitude), so that they are effectively the same as having no charge in that section at all.

You could equally well do the problem with an integration over the length of A, probably with integral limits like b and $b + L$. The two limits would produce the two terms in the formula above. Neither method is "better" than the other, they are just alternatives.