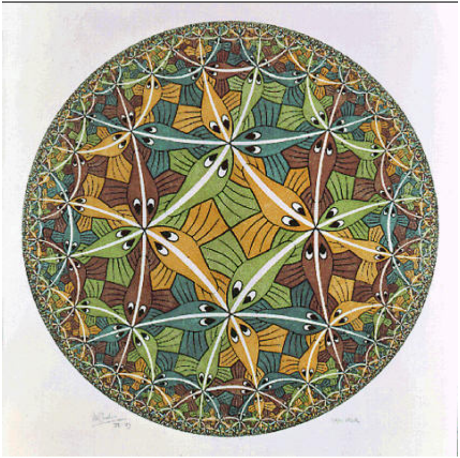
# Gauss' Law (Chapter 28)

- To figure out the force on a particle due to a charge (or to define the field) we used Coloumb's Law.
- Coloumb's Law is very useful in many circumstances, but sometimes another approach would be useful - that is where Gauss' Law comes in.
- If you recall your mechanics experience, sometimes you used Newton's Laws to solve things, sometimes the conservation of momentum or energy.
- Which one should you use? Well, in principle it doesn't matter...they are equivalent:

  $$\vec{F} = m\vec{a} = \frac{d\vec{p}}{dt}$$

  Newton's Laws can be derived from Conservation of Momentum (and vice versa).
- Coloumb's Law and Gauss' Law can be derived from each other too. Use whichever is easiest/best for a certain situation.

# Symmetry (28.1)

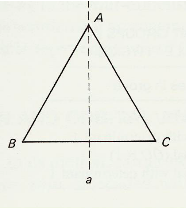


- SYMMETRY — YRTEMMYS
- Symmetries are **very** important in physics.
- Exploiting symmetries makes solving problems much easier.
- What is a symmetry??

## Symmetry

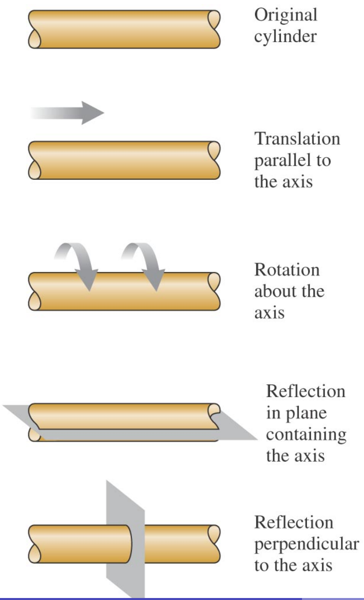
A symmetry is an operation you can perform on a system which leaves the system invariant. In other words, you cannot tell that you did anything!

Consider an equilateral triangle as an example




You can rotate this by 120 degrees and not know that you did it. You can flip it about axis Aa (or similar axes) and not know that you did it. These are symmetry operations.

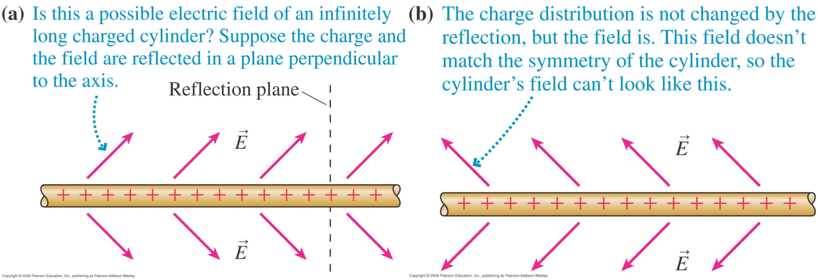
# Symmetry




- Imagine an infinitely long cylinder full of charges. What geometric operations could you perform on that cylinder and not know that you did it??
- Well, we could
  - Translate the charge along the cylinder
  - Rotate the charge about an axis
  - Reflect the charge in a mirror

(See the figures to the left)

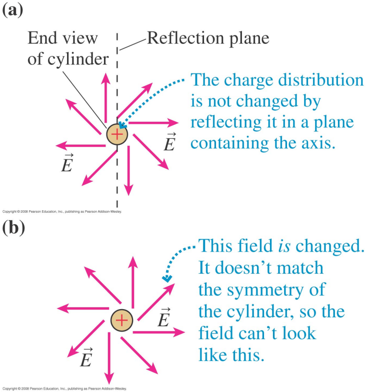
# Symmetry




- The field on the left does not remain the same under a reflection!
- That is not going to work because the charge distribution which generates the field is symmetric with respect to reflection.

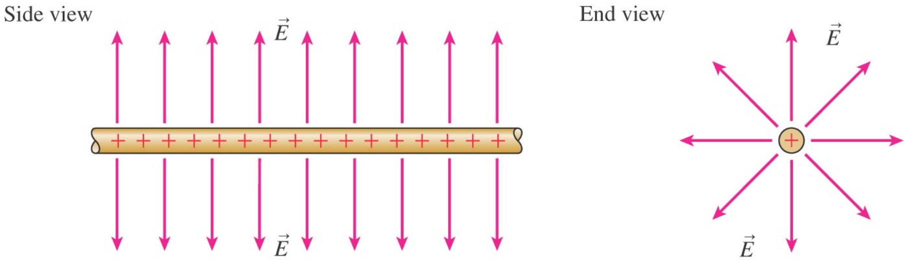
The symmetry of the electric field must match the symmetry of the charge distribution.

# Symmetry




- The previous page showed us that an electric field component parallel to the cylindrical axis will not work.
- However, what about the electric field pictured on the left?
- Nope. Also bad. If we reflect it through a plane containing the axis I can tell it changed!

# Symmetry






- Well, there is only one shape left!
- The electric field must be radial, pointing straight out from the center of the cylinder.
- You can see already how we exploit symmetries. We have used them to rule out possible field shapes.

# Some Fundamental Symmetries