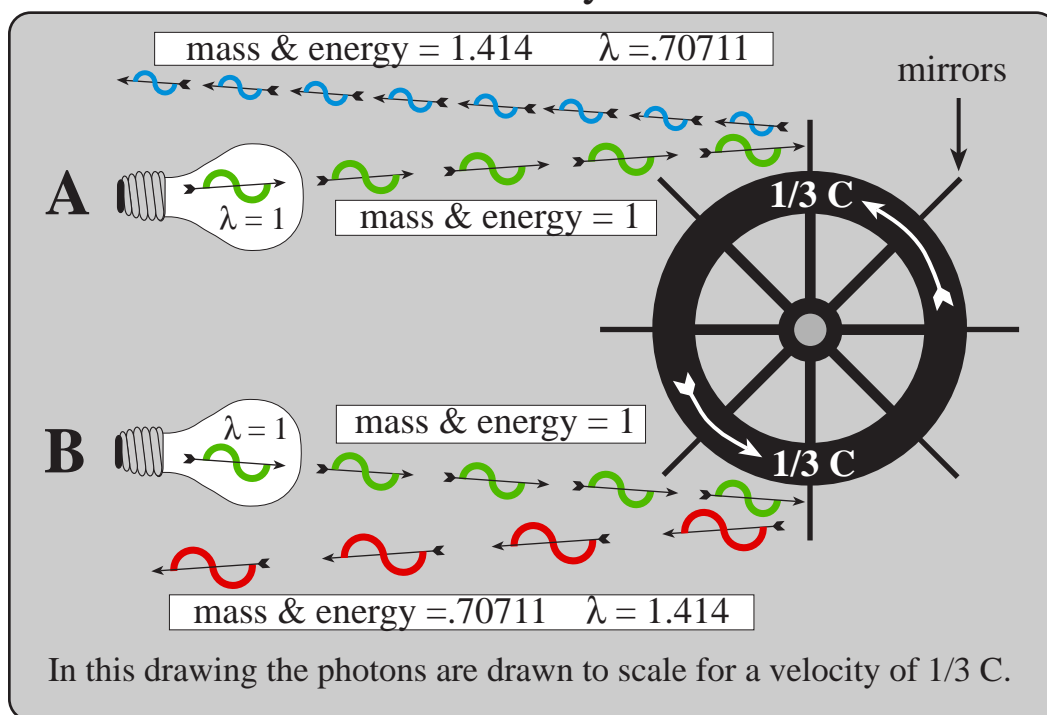


Photon Flywheel



As an example of how the change in a body's kinetic energy must also change its mass, consider a thought experiment in which a flywheel made of an exceedingly strong imaginary material with mirrors attached to its outer surface like the fins of a paddlewheel. The wheel is then spun so that the mirrors are moving at the velocity of $1/3 C$.

Two lasers, **A** and **B**, shoot photons at the mirrors on opposite sides of the wheel. These photons, which all have a wavelength, energy and mass of exactly one, reflect from the mirrors at a velocity of exactly C relative to their velocity before striking the mirror. The velocity of the mirrors has no effect on the photons' velocity but it does change their wavelength, energy and mass.

The photons from laser **A** are blue-shifted to a wavelength of $.70711$ as they reflect from the approaching mirror, and their energy and mass are increased to 1.414 . In this process, the velocity of the spinning wheel is slowed as mass and energy are transferred to the reflecting photons.

The photons from laser **B** are red-shifted as they reflect from the receding mirror to a wavelength of 1.414 and an energy and mass of $.70711$. In this case, the velocity of the wheel increases as mass and energy are transferred from the photons to the wheel. In both of these examples, momentum is conserved and both mass and energy remain separate and constant.

If we attempt to explain this experiment in terms of massless photons then the conservation of mass is lost. The photons from laser **A** take energy away from the wheel and decrease its mass. Laser **B** photons transfer energy to the wheel and increase its mass. In both cases, energy remains constant but mass either vanishes into or appears from nowhere. How can mass and energy be equivalent if energy remains constant but mass does not? If energy has mass how can photons not have mass?