Three light rays are emitted simultaneously in an elevator at rest in the Earth's gravitational field (representing a non-inertial reference frame N^g) from points D, R, and S toward point M. Let I be a reference frame initially at rest with respect to N^g which starts to fall in the gravitational field at the moment the light rays are emitted. The emission of the rays is simultaneous in N^g as well as in I. At the next moment an observer in I sees that the elevator moves upward with an acceleration g. Therefore the three light rays arrive simultaneously not at point M, but at O since for the time $t = r/c$ the elevator moves at a distance $\delta = gt^2/2 = gr^2/2c^2$. As the simultaneous arrival of the three rays at the point O in I is an absolute event (the same in all reference frames) being a *point* event, it follows that the rays arrive simultaneously at O as seen from N^g as well. Since for the *same* coordinate time $t = r/c$ in N^g the three light rays travel different distances $DO \approx r$, $SO = r + \delta$, and $RO = r - \delta$ before arriving simultaneously at point O an observer in the elevator concludes that the *average* downward velocity $\bar{c}^{\downarrow}$ of the light ray propagating from S to O is slightly greater than c

$$\bar{c}^{\downarrow} = \frac{r+\delta}{t} \approx c\left(1 + \frac{gr}{2c^2}\right).$$

The average upward velocity $\bar{c}^{\uparrow}$ of the light ray propagating from R to O is slightly smaller than c

$$\bar{c}^{\uparrow} = \frac{r-\delta}{t} \approx c\left(1 - \frac{gr}{2c^2}\right).$$

The vector form of the average light velocity in N^g can be obtained if R, S, M, and O are taken to lie on a line making an angle with $\mathbf{g}$:

$$\bar{c}^g = c\left(1 + \frac{\mathbf{g}\cdot\mathbf{r}}{2c^2}\right). \tag{1}$$

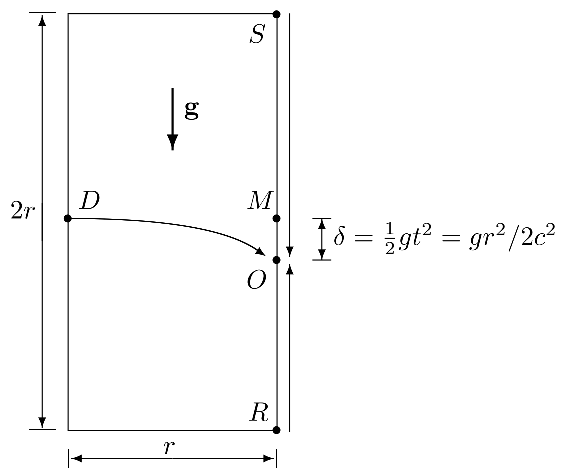

Figure 1. Three light rays propagate in an elevator at rest in the Earth's gravitational field. After having been emitted simultaneously from points D, R, and S the rays meet at O (the ray propagating from D toward M, but arriving at O, represents the original thought experiment considered by Einstein). The light rays emitted from R and S are introduced in order to determine the expression for the average anisotropic velocity of light in a gravitational field. It takes the same coordinate time $t = r/c$ for the rays to travel the distances $DO \approx r$, $SO = r + \delta$, and $RO = r - \delta$. Therefore the average velocity of the downward ray from S to O is $\bar{c}^{\downarrow} = (r + \delta)/t \approx c(1 + gr/2c^2)$; the average velocity of the upward ray from R to O is $\bar{c}^{\uparrow} = (r - \delta)/t \approx c(1 - gr/2c^2)$.