4. symmetry and simultaneity

Consider a moving ring (black) interacting with a light source (blue).

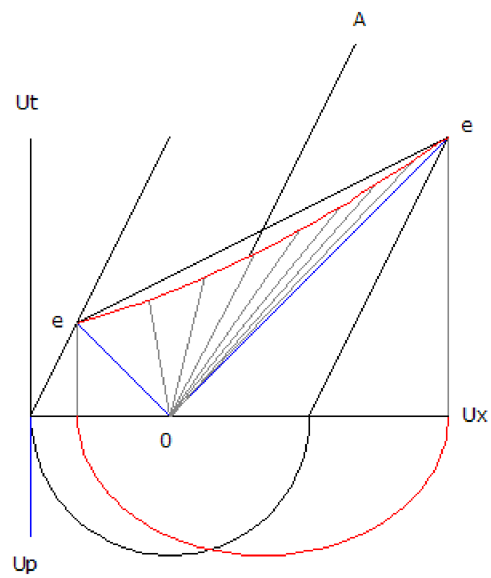

fig.4

In the U frame, the propagation pattern of light is spherical from its origin. Photons emitted simultaneously from the center of a circular ring will reflect simultaneously from all locations on the ring, and return to the center simultaneously. Fig.4 is a reflective circle (black) with a radius of r centered on observer A. Light is emitted at the origin moving outward 360 degrees in the x-p plane of the circle, forming a light cone in time. Light meets the circle to the rear first, then sequentially along the perimeter to the front forming an intercept curve (red) over time (edge and plan view). The intersections of A's circle with the light cone are plotted above the major axis for a range of points. The photons arrive at varying times (early) relative to the (e-e) plane of simultaneity and therefore will not arrive simultaneously after reflection.

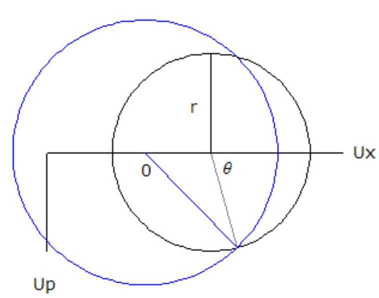

fig.4a

Calculating for the red ellipse in the x-p plane using fig.4a, the time out is

$$c^2 t^2 = (r\cos\theta + v\,t)^2 + r^2 \sin^2\theta \tag{4.1}$$

$$t^2\left(c^2 - v^2\right) - 2\,v\,t\,r\cos\theta - r^2 = 0 \tag{4.2}$$

dividing by c, with a = v/c, and $t_0 = r/c$

$$t^2\left(1 - a^2\right) - 2\,a\,t\,t_0\cos\theta - t_o^2 = 0 \tag{4.3}$$

solving for t

$$t = \gamma^2 t_0\left(a\cos\theta \pm \sqrt{1 - a^2\sin^2\theta}\right). \tag{4.4}$$

To calculate return time

$$c^2 t^2 = (r\cos\theta - v\,t)^2 + r^2 \sin^2\theta \tag{4.5}$$

which results in

$$t = \gamma^2 t_0\left(-a\cos\theta \pm \sqrt{1 - a^2\sin^2\theta}\right) \tag{4.6}$$

Adding (4.4) and (4.6), round trip time is

$$t_r = 2\,\gamma^2 t_0\left(\pm\sqrt{1 - a^2\sin^2\theta}\right) \tag{4.7}$$

Round trip time t_r for a given speed, varies with the angle θ.
This is equivalent to the MM experiment but without rotation.

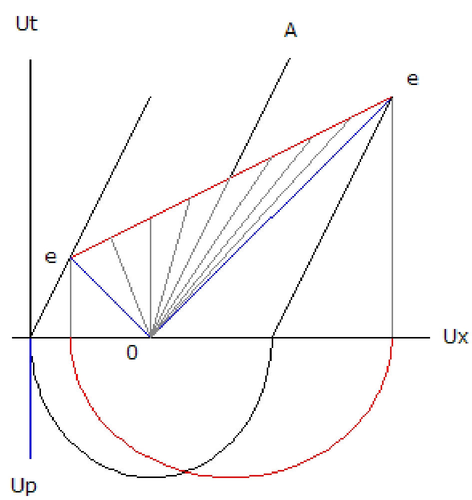

fig.4b

Fig.4b is fig.4 modified with an ellipse with p-radius of r and x-radius of r/γ, (edge & plan view) centered on observer A. The intersections of A's ellipse with the light cone are plotted above the major axis for a range of points. All the photons intercept A's ellipse in the (e-e) plane.
Substituting r/γ for r in (4.1) and (4.5) yields

$$t_r = \gamma\, t_0\,(1 + a \cdot \cos\,\theta) + \gamma\, t_0\,(1 - a \cdot \cos\,\theta) = 2\,\gamma\, t_0 \qquad (4.8)$$

By symmetry, the return cone will be the outbound cone rotated 180 º on the p axis. The round trip times will be equal for all positions on the ellipse. Even though the reflection events occur over an interval of space and time in the U frame, A's perception is that of simultaneous reflections. Length contraction resolves the MM experiment.