Introducing Spacetime Geometry:

Relativity on Rotated Graph Paper

Rob Salgado
Physics Department
U.Wisconsin-La Crosse
rsalgado@uwlax.edu

“Relativity on rotated graph paper”
Am J Phys 84, 344 (May 2016)

gogebras.org/robphy
Some triangles in Special Relativity

“twin paradox / clock effect”

“time dilation”

“Doppler effect”

\[ S^2 = t^2 - x^2 \]

hyperbola as the “circle in this geometry”
Why the hyperbola?

Experimental evidence

Stop when your wristwatch reads 1 sec.

Galilean PHY 101

Special Relativity

HYPERTOBOLAS are hard... Can we find another way?
Einstein’s Principles of Relativity

• All inertial observers [traveling in a straight line with constant velocity-vector] are equivalent. *No experiment can detect the inertial observer’s state of motion.*

• *All observers measure the same speed of light* (regardless of the state of motion of the source or the observer).
Light Clocks on a Spacetime Diagram

Alice’s **light-clock** and light signals reflecting off her distant mirrors a length $d$ away (in her frame)

\[
x = d \\
t = 1 \left( \frac{2d}{c} \right)
\]

\[
x = 0 \\
t = 0
\]
How do we draw Bob’s Light Clock?

Calibrating Bob’s Light-Clock….

Where is Bob’s first tick event \( F? \)

(What is the separation of Bob’s mirrors?)
How do we draw Bob’s Light Clock?

Calibrating Bob’s Light-Clock....

No experiment can detect the inertial observer’s state of motion.
Identical experiments should result in identical results

Clock diamonds have equal areas!!
Clock diamonds have equal areas!!

\((-1.56, 1.71)\)
\(v = -0.8\)

\((0, 1.25)\)
\(v = 0\)

\((0.94, 1.56)\)
\(v = 0.6\)

**DIAMOND AREA**
=0.5
Some triangles in Special Relativity

\[ s^2 = t^2 - x^2 \]

hyperbola as the “circle in this geometry”
Ordinary Graph Paper rotated can be used in a simple way to allow visual calculations in Special Relativity by counting “ticks”.

Rob Salgado
Physics Department
U.Wisconsin-La Crosse
rsalgado@uwlax.edu

“Relativity on rotated graph paper”
Am J Phys 84, 344 (May 2016)

gogeabra.org/robphy