Picture-Stories of Events in Spacetime

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The Slides

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6. The interval: a distance using both space AND time.

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9. Adding events to the picture-story.

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11. Programming animations with quaternions.

Events in Spacetime

What is spacetime?

A stage for events: Time, X, Y, and Z.

Method: use a genuinely obscure math called quaternions.

- Rebuild physics laws using quaternions exclusively.

- Quaternions.com website for technical math stuff.

- Movies of events to see what it means.

- Open source animation programming to see new physics.

The goal is a collection of animations with precisely the same information content as a graduate level physics textbook.

Physics is Complicated!

Physics is changes of changes of changes of a potential.

Changes Create	*Changes Create*	*Changes Create*	
The Potential	Fields	Field Equations	Conservation Laws
4 numbers	16 numbers	64 numbers	256 numbers
Cannot see :-(	*Where everything is*	*How things work*	*What stays the same*
	Gravity (mass)	Newton for gravity	Mass
	Electricity (charge)	Maxwell for light	Charge

The Minimalist Movie

Only 1 event.
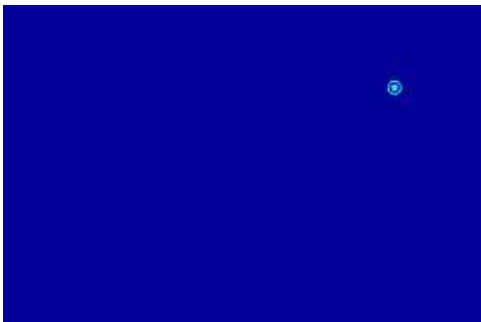
- An event as a dot at a Time, X, Y, and Z.

- An event broadcast as an expanding circle.

- No one hears the event's story.   : - (

Picture-Stories of Events

With more than one event, there is a picture-story.

- The simplest story is between two events.

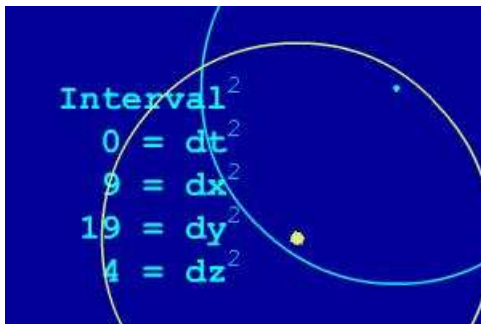- The difference between the two is dt, dx, dy, dz.

Working with events in four dimensions (t, x, y, and z), using simple math (+, -, *, /), quickly leads to very deep issues in physics.

Multiplying Events???

A profound question.

Two parts: An interval and a rope.

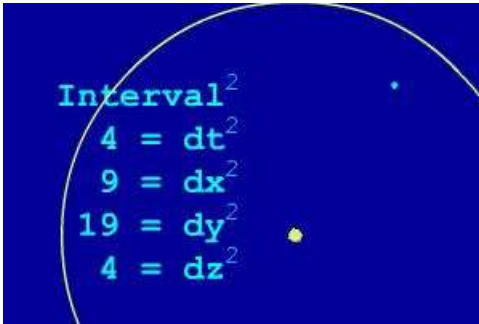An interval is the distance between two events.

- Pythagoras said the distance is: $A^2 + B^2 = C^2$.

- Einstein said the interval is: $\text{Time}^2 - \text{Distance}^2 = \text{Interval}^2$.

- For simultaneous events shown here, $dt^2 = 0$.

The minus sign is why special relativity is tricky!

The Interval: A Distance Using Both Space AND Time

How far apart are events that happen at different times?

- Time^2 is positive.

- Subtract distance^2.

- The difference is the interval squared.

A Rope: The Spacetime Path Between Two Events

A changes in time multiplied by a change in space!

- A rope has 3 numbers.

- A rope has direction temporarily.

Adding Motion to the Observer of the Picture-Story

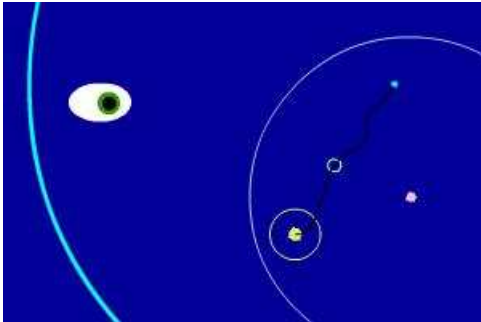If motion is added to the observer (the eye) of a pair of events...

- The interval **is not** changed.

- The rope **is** changed.
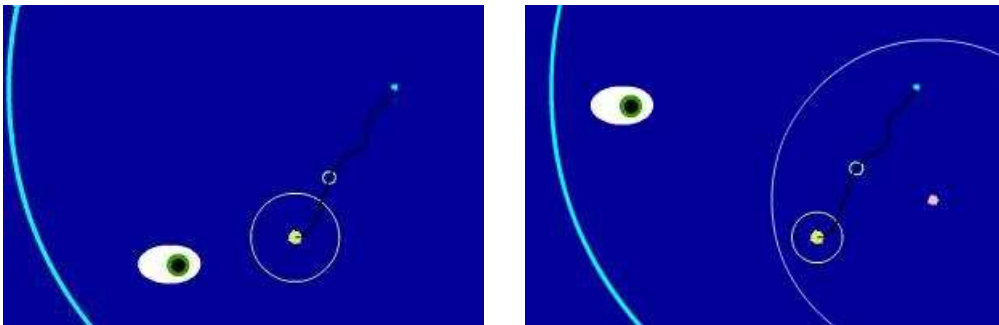
Adding Events to the Picture-Story

This time an event are added to the picture-story of a pair of events, making three total events.

- The interval is changed.

- The rope is not changed.

Same Pair of Events, Different Picture-Stories

Add motion to an observer, or add an event.

- Einstein's special relativity is about the right-hand side.

- Einstein's general relativity is about the left-hand side.

Programming Animations with Quaternions

How does Nature really deal with numbers?

What are appropriate data structures?

- Use math to generate thousands of events.

- Make an animation.

- Use math to study the original set of events.

- Make a new animation.

The goal is a collection of animations with precisely the same information content as a graduate-level physics book. Have written parts of a library in C for speed, and can translate into Javascript for web presentations.