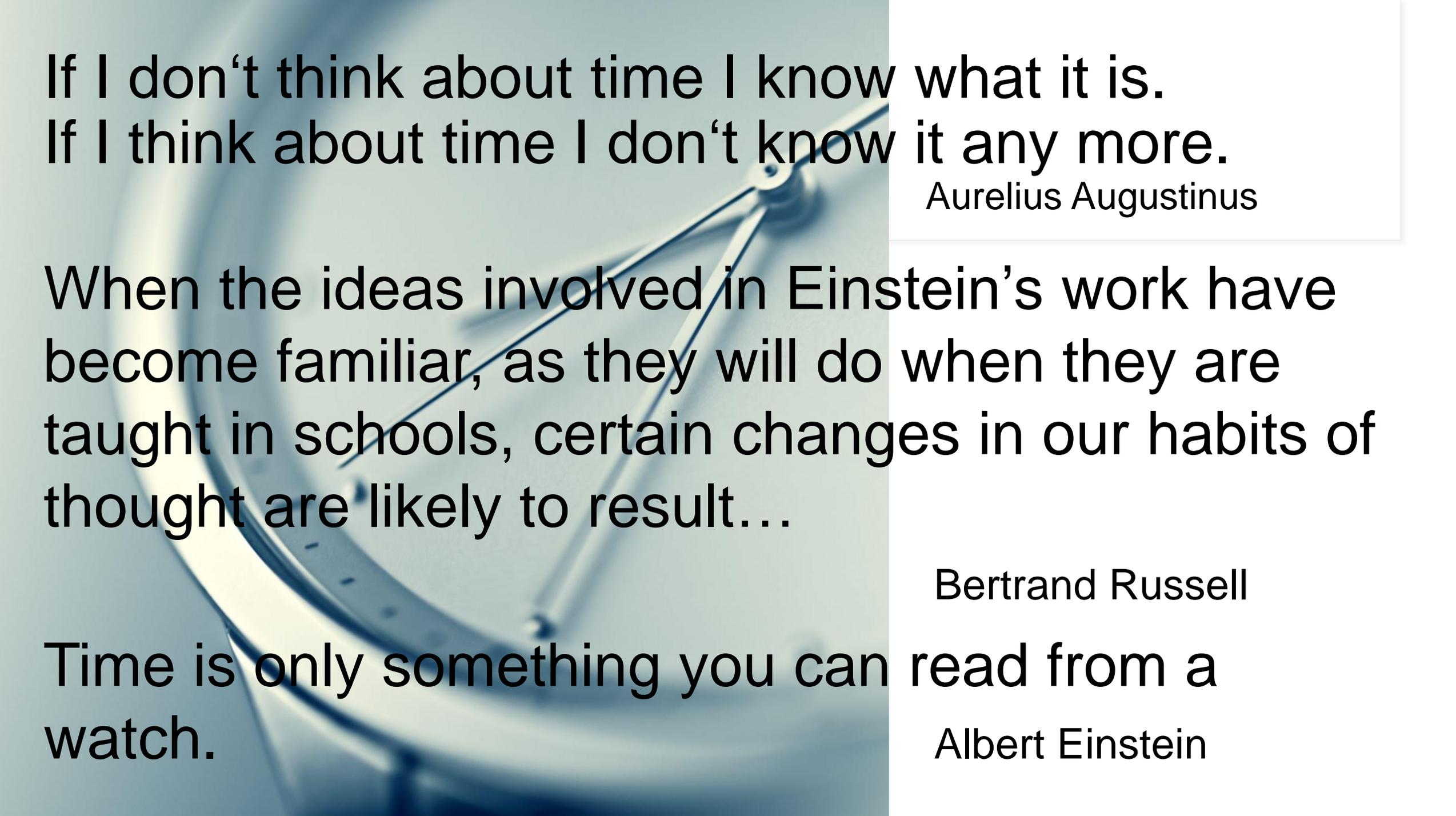




Time in Special and General Relativity

Richard Toellner

toellner.r@st.klara-rottenburg.de



If I don't think about time I know what it is.

If I think about time I don't know it any more.

Aurelius Augustinus

When the ideas involved in Einstein's work have become familiar, as they will do when they are taught in schools, certain changes in our habits of thought are likely to result...

Bertrand Russell

Time is only something you can read from a watch.

Albert Einstein

Don't start a calculation before you know the answer!

John Wheeler

I want to show elements of a concept which

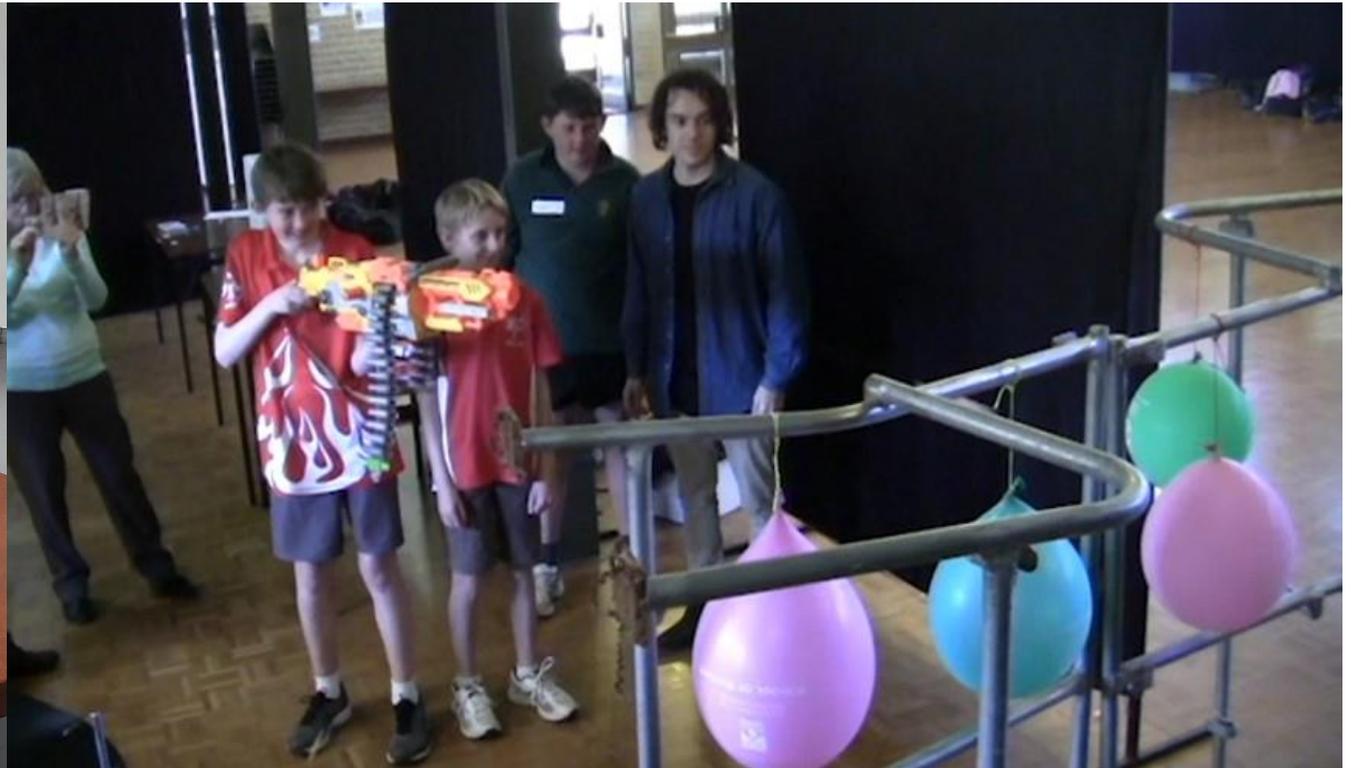
- contains elementary ideas, imaginations and visualisations
- is logically consistent and
- can be exactified until the right formulas are “dropping out”.

For example: the gravitational timeshift $t' = \left(1 + \frac{a \cdot h}{c^2}\right) \cdot t$

comparing the rate of proper ticks for a given height difference and constant acceleration, without much calculations.

Photons have energy and momentum

Ideas from the Einstein First Project:



Electrons are trapped in electric potential “pots”

Real photons can kick the electrons out.

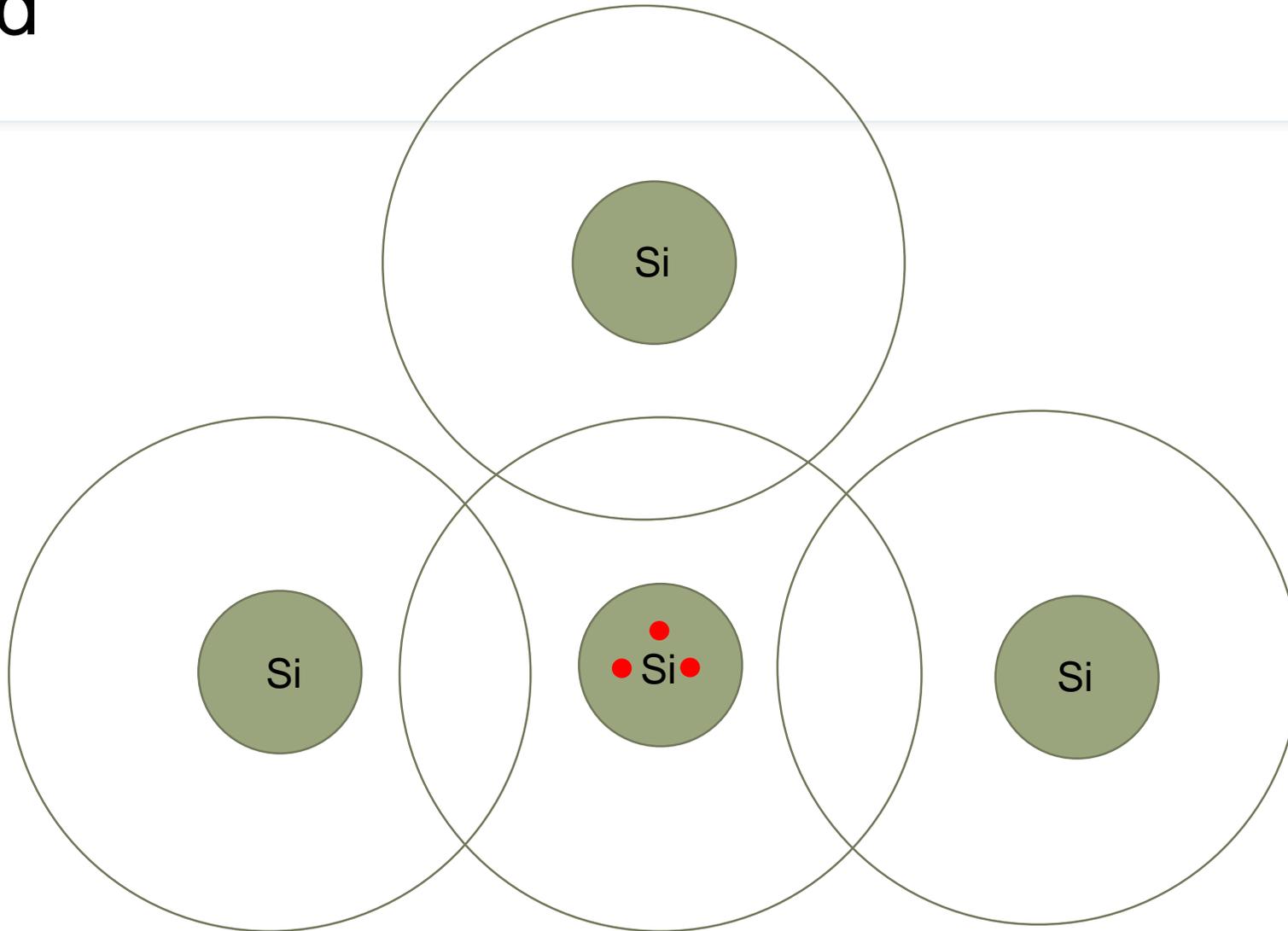
Virtual photons can transport momentum without energy.

Therefore, the nerf guns don't run out of ammunition.

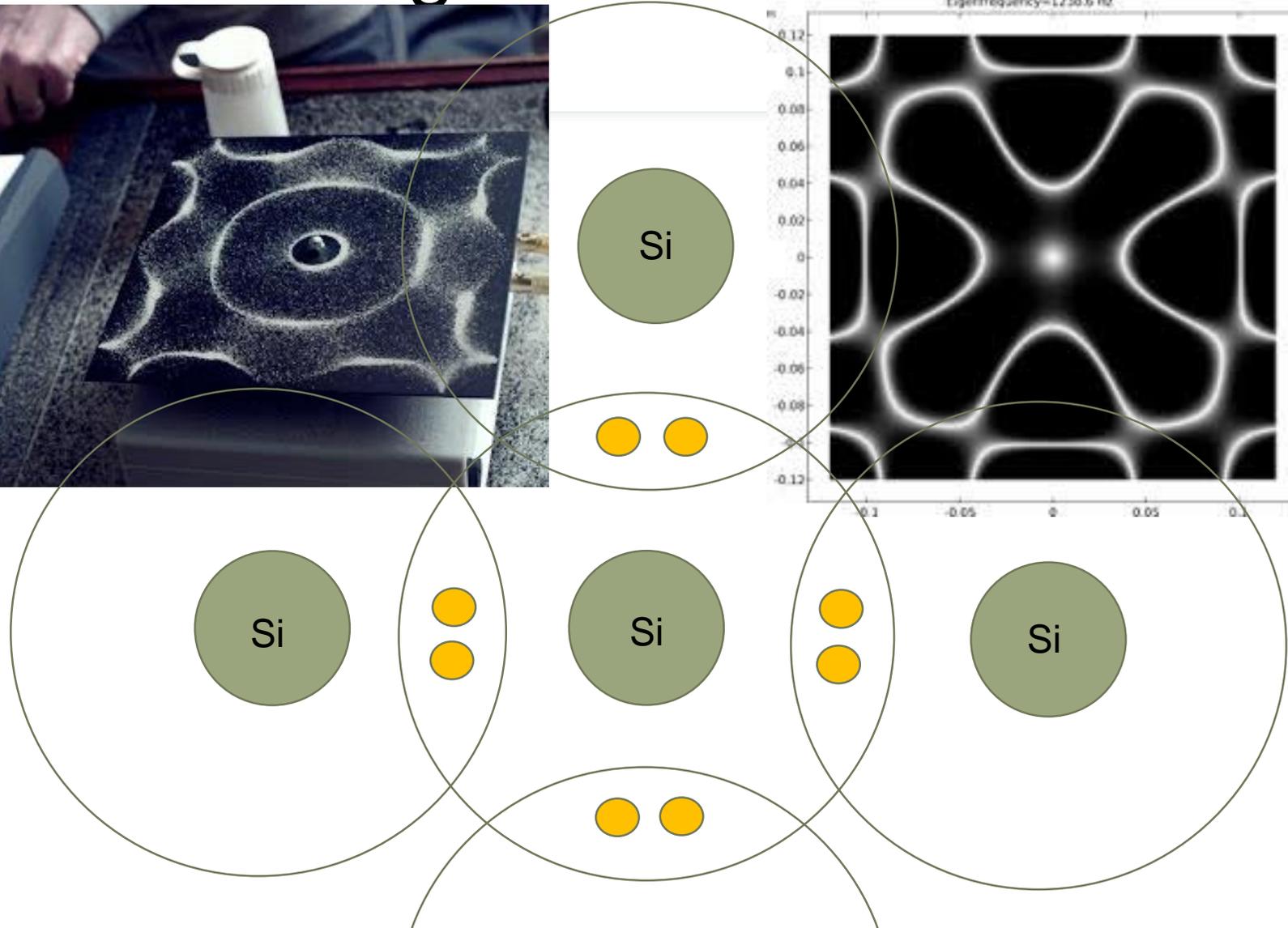
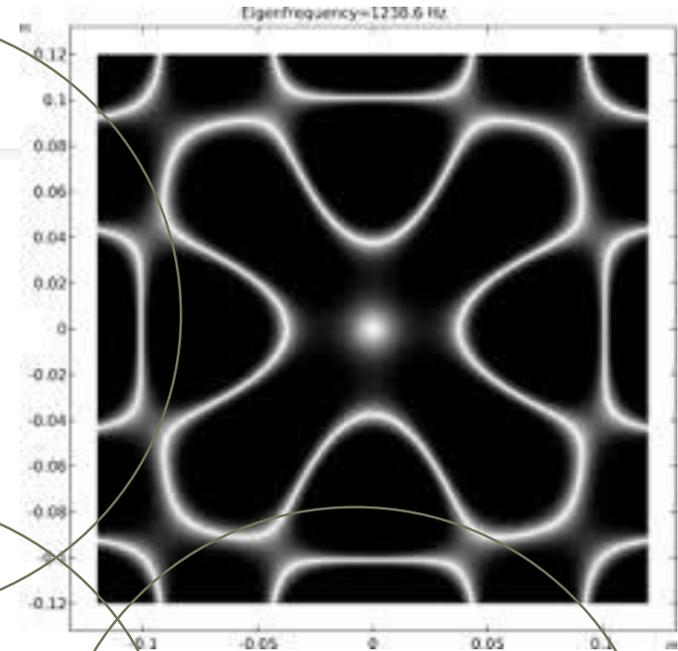
This could explain the electro- magnetic interaction: the rate of hits decreases by increasing distance!



Virtual photons as exchange particles in a silicon grid

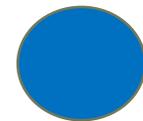
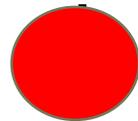
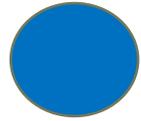


Electrons as standing waves

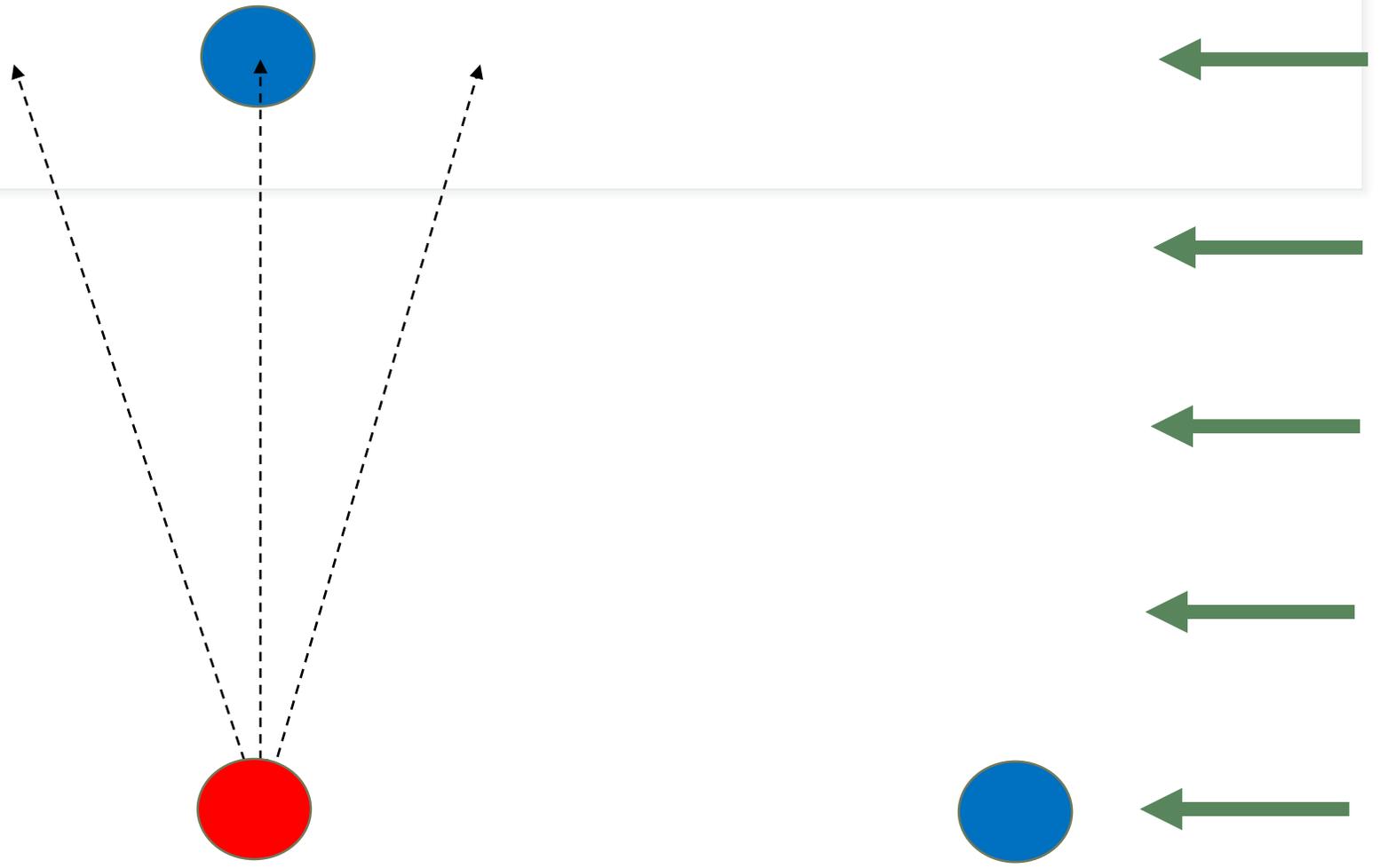




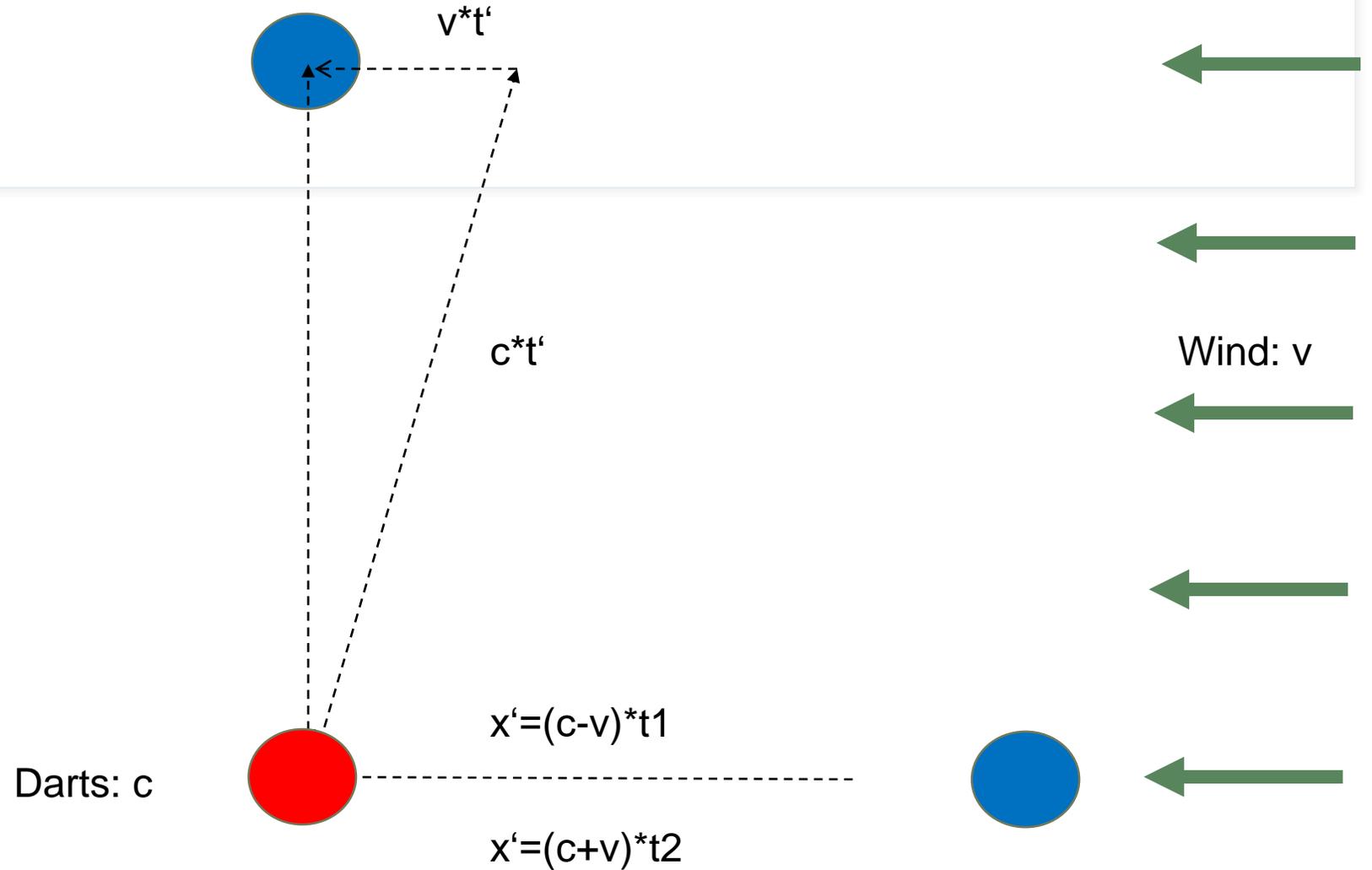
Mexican
standoff with
nerf guns



Mexican
standoff with
head- wind



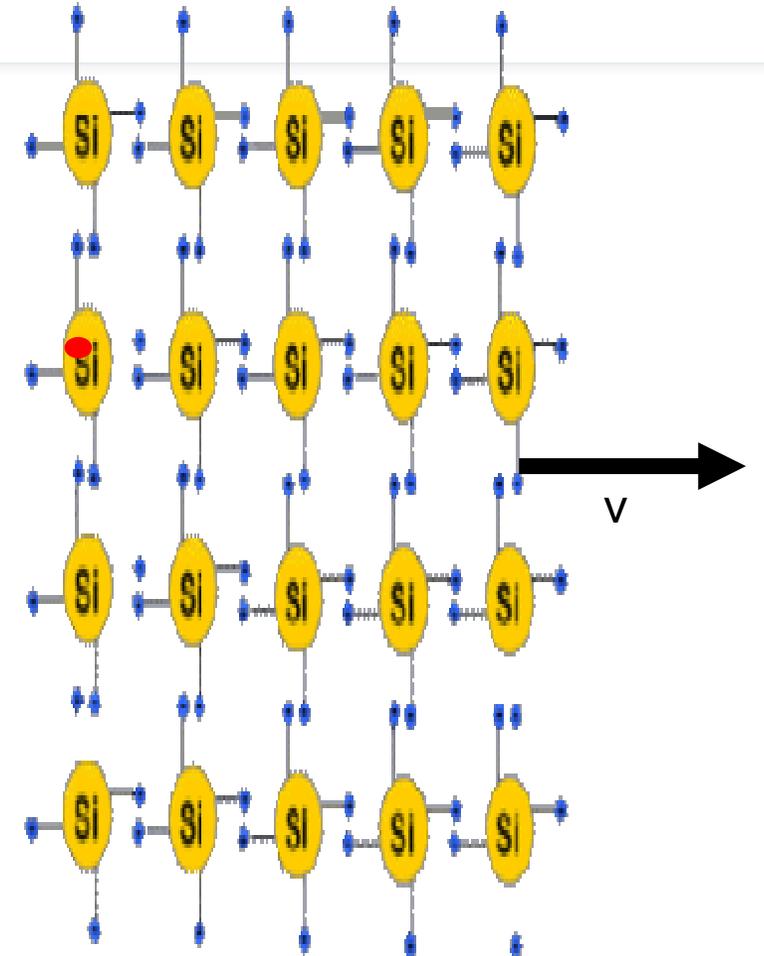
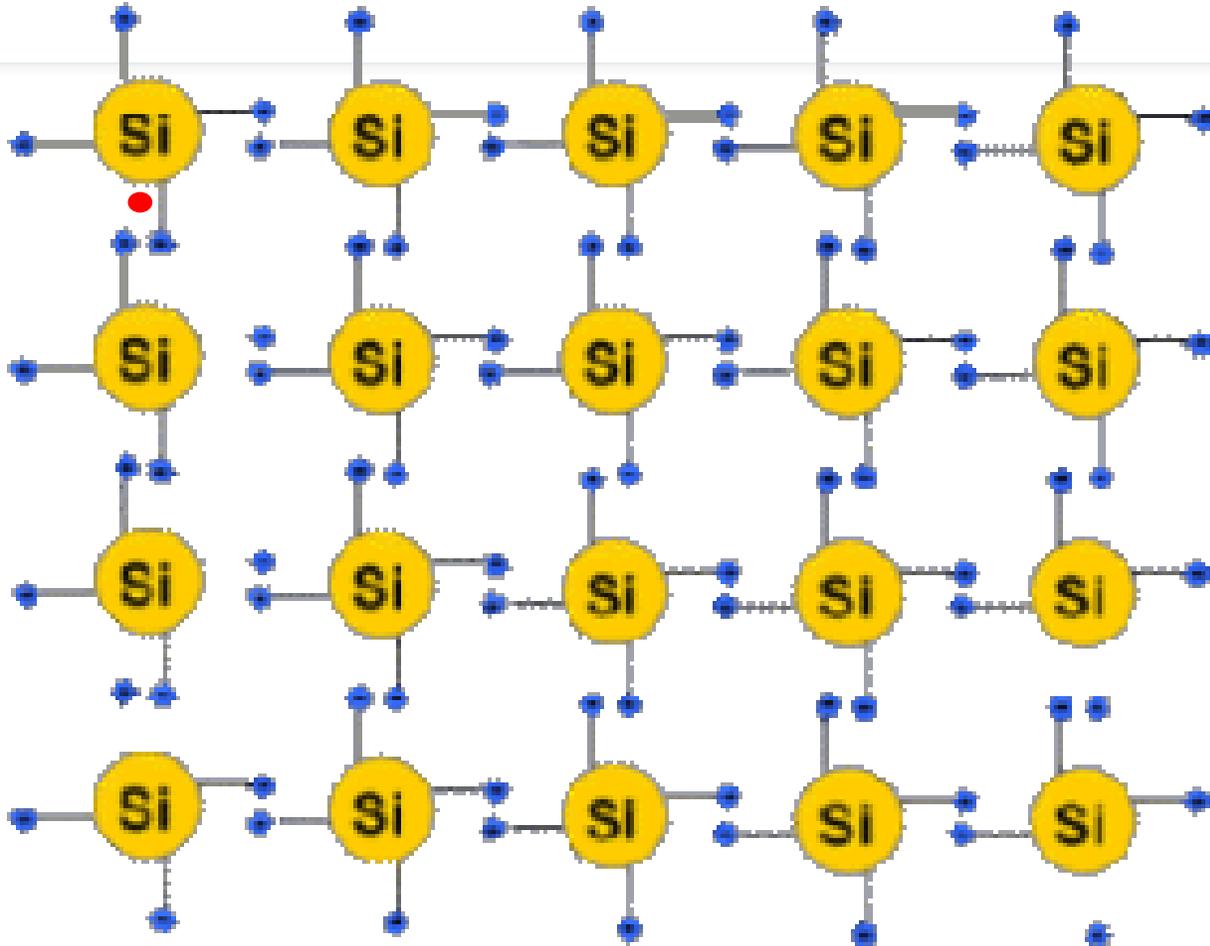
Mexican
standoff with
head- wind:
the darts
come back
in time



The Billy and Jane transformations

- $t' = 1/\sqrt{1 - (v/c)^2} \cdot t$
- $x' = \sqrt{1 - (v/c)^2} \cdot x$

Can virtual photons explain the transformations?



Spacetime is an electromagnetic phenomenon

There is no gravitational force.

We are all “following” our geodesic in spacetime... unless we are suddenly inhibited by the floor:

The floor is pressing against our foot soles.

The inertia of the atom kernels compresses the electric field between the atoms and they are accelerated by this way.

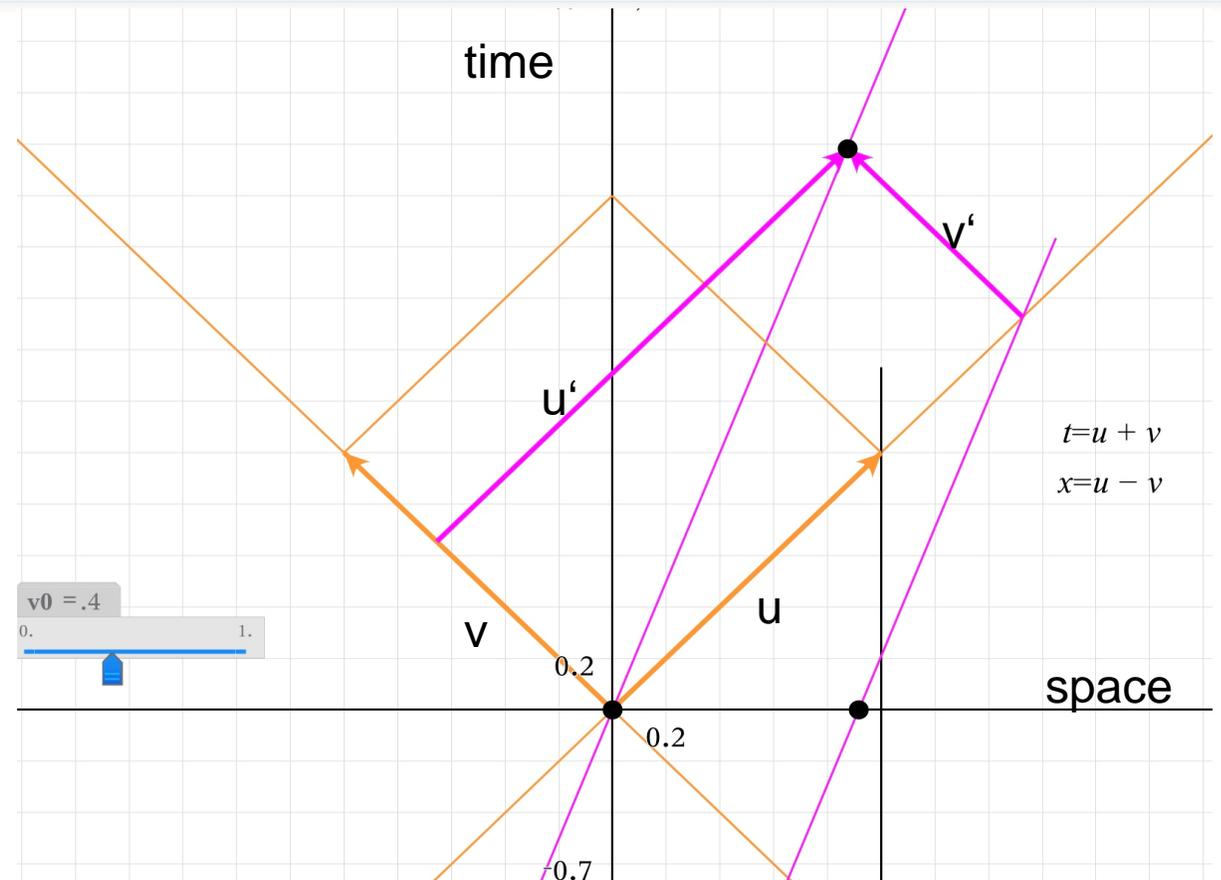
The acceleration we feel from sole to hair tip is an electromagnetic one.

Light links

the Bondi calculus

Instead x, t coordinates:
The light paths to the
interferometer mirrors and back
as the basic vectors to describe
events.

Yellow for the resting system,
magenta for the moving system
with velocity $v_0 = 0,4c$.



Rotated graph paper

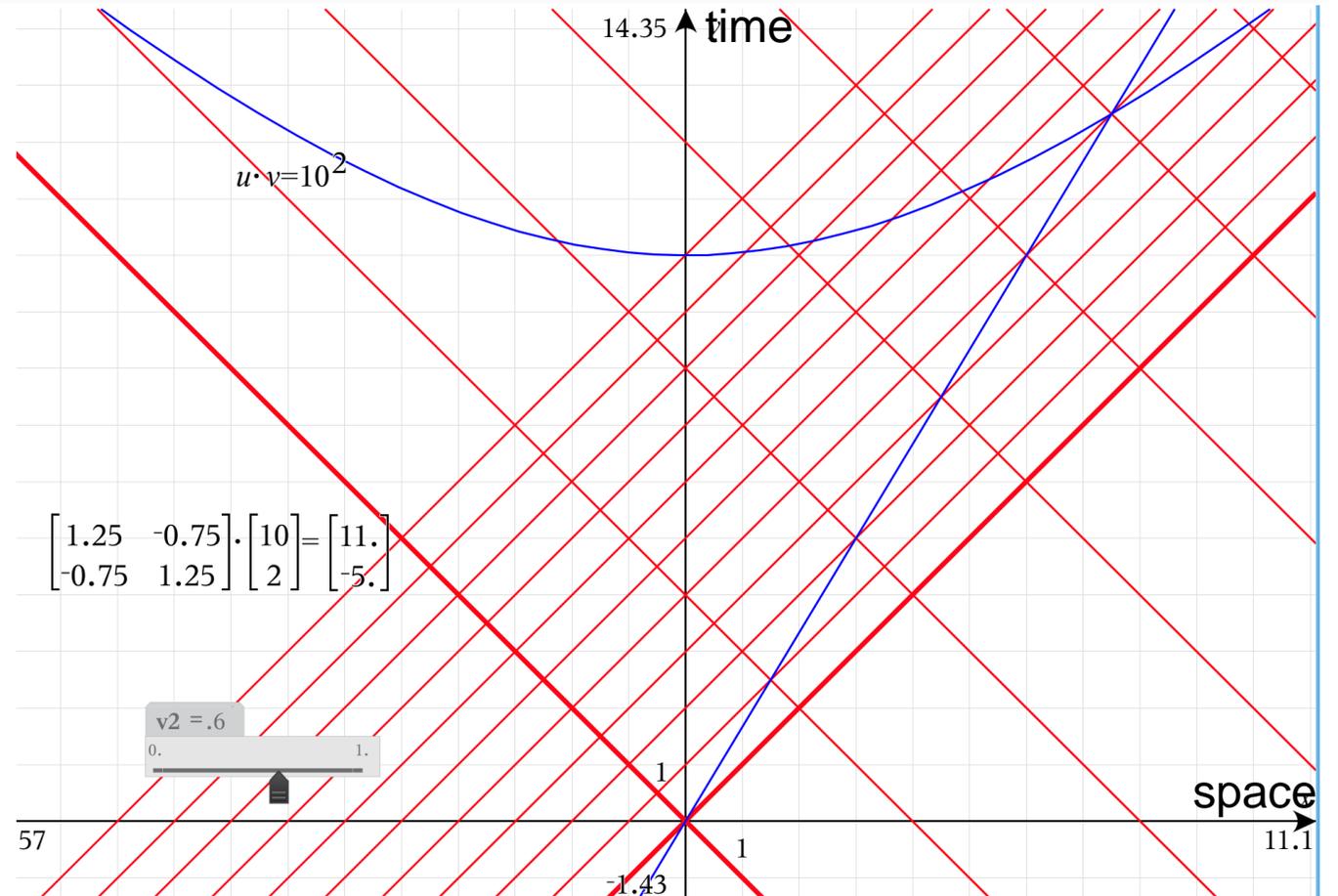
by Roberto Saldago

Multiplying the grid widths with the Doppler factor

$$\sqrt{\frac{1+v/c}{1-v/c}}$$

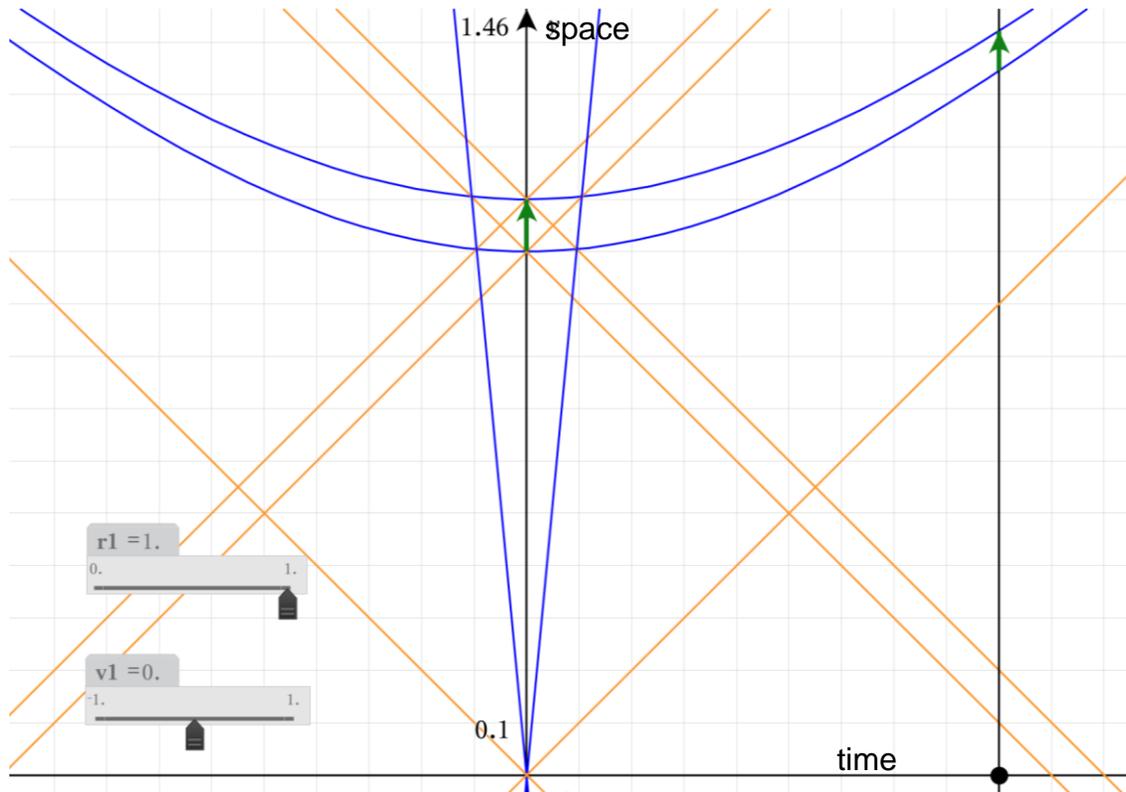
and its reciprocal

gives the transformation. All events with the same proper time (here 10 units) are lying on the same hyperbole.

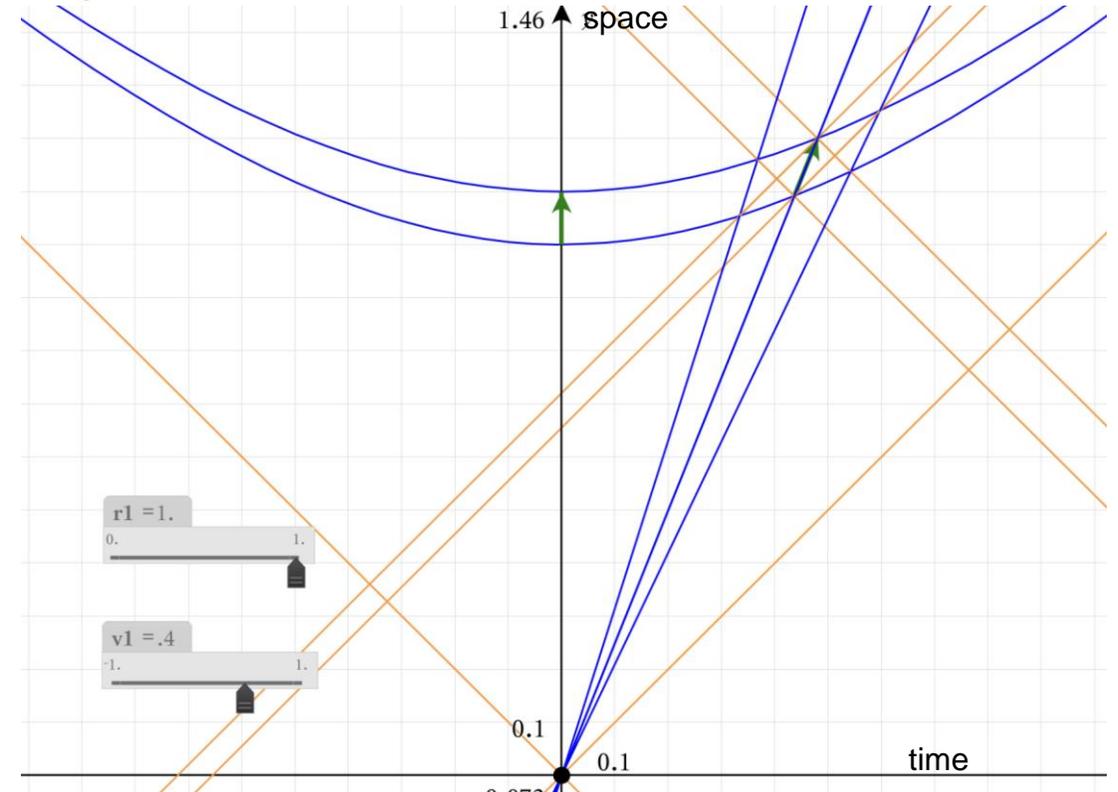


Gingin tower as a launching rocket: the equivalency principle

Euclidean: tidal forces



Light links: simultaneous events



Gravitational contra Doppler time shift: Only a point of view

The light links send up and down from bottom and top are a synchronisation clock which is always running with the same rate of proper ticks (in the accelerated system).

The clocks at bottom and top are running with the same rate of proper ticks (in the inertial system).

The stretch between two ticks up is longer by the factor $\frac{r+h}{r}$ as the lower stretch. The acceleration down is $a = \frac{c^2}{r}$:

Therefore time up is running faster with the factor $1 + \frac{a \cdot h}{c^2}$.

Radius and acceleration

$$\begin{aligned}r(t) &= \sqrt{r^2 + (c \cdot t)^2} \\&= r \cdot \sqrt{1 + \frac{c^2}{r^2} \cdot t^2} \\&\approx r \cdot \left(1 + \frac{1}{2} \cdot \frac{c^2}{r^2} \cdot t^2\right) \\&= r + \frac{1}{2} \cdot \frac{c^2}{r} \cdot t^2\end{aligned}$$

Thanks for your attention!

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