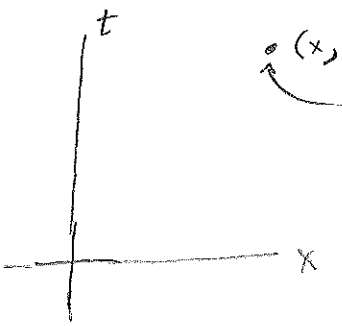
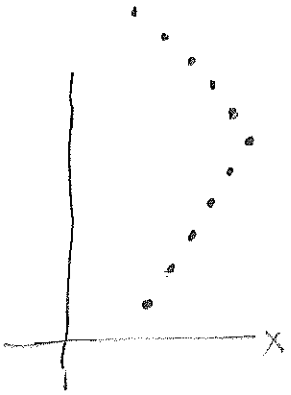
Spacetime diagrams

time on vertical axis

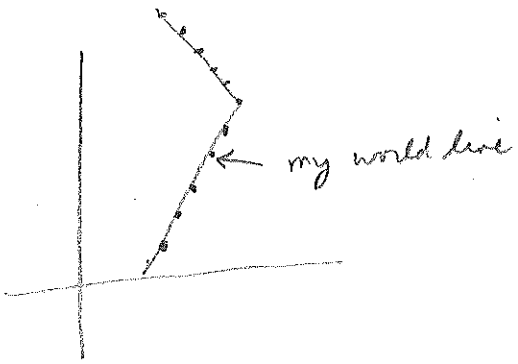
[suppress y & z coords due to tedious constraints]



[eg me snapping my fingers; I admit not a very exciting event]

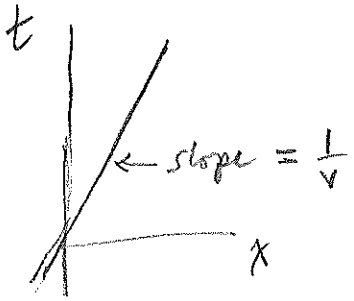


[me walking across the room & back snapping my fingers]



[George Gamow's autobiography "My Worldline"]

worldline = plot of position vs time
w/ x & t axis switched.



$x = vt$

$t = \left(\frac{1}{v}\right)x$

[say don't work, this: world line]

t-axis = worldline of the origin
x-axis = all events occurring at $t = 0$

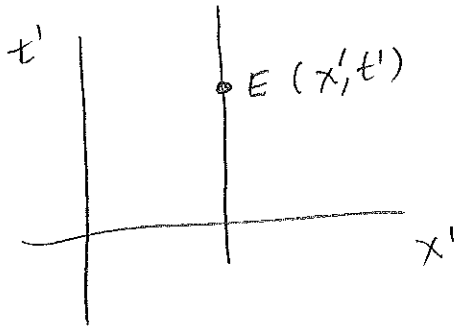
any line parallel to t-axis = events occurring at same place

any line parallel to x-axis = events occurring at same time (simultaneous events)

Let S' denote a frame moving w/ const speed v_0 in the $+x$ direction with respect to S

[eg S' = frame of moving train]

Consider an object at rest in S' [eg passenger on train]

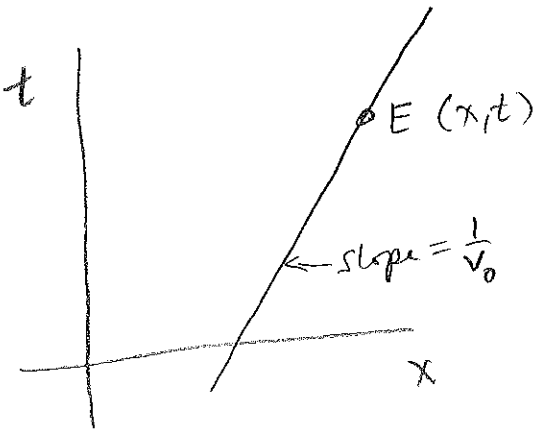


Let E be some event on the worldline w/ coordinates (x', t')

[eg passenger lights up a cigarette]

[next event: conductor kicks the passenger off the train!]

Same object in S

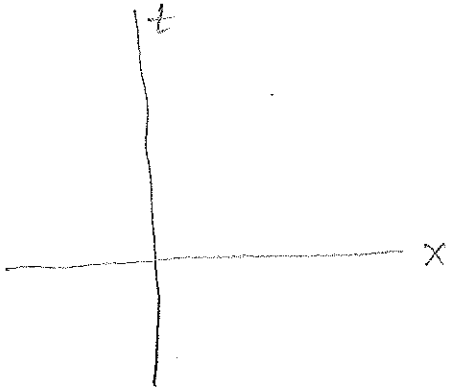


Coordinates of E in S & S' are related by a Galilean transformation

$$x' = x - v_0 t$$
$$t' = t$$

Events are primary, coordinates are secondary

Include both ref. frames in same spacetime diagram

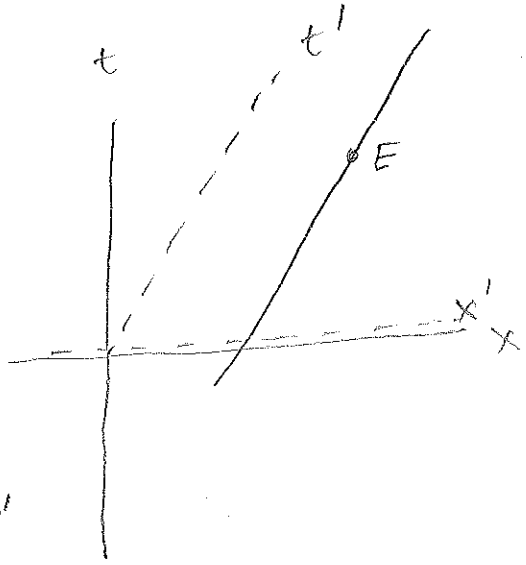


t-axis = worldline of origin of S

x-axis = all events occurring at $t = 0$ in S (simultaneously)

lines parallel to t-axis = worldlines of objects stationary in S

lines parallel to x-axis = events all occurring at same time in S (surface of simultaneity)



t'-axis = worldline of origin of S'

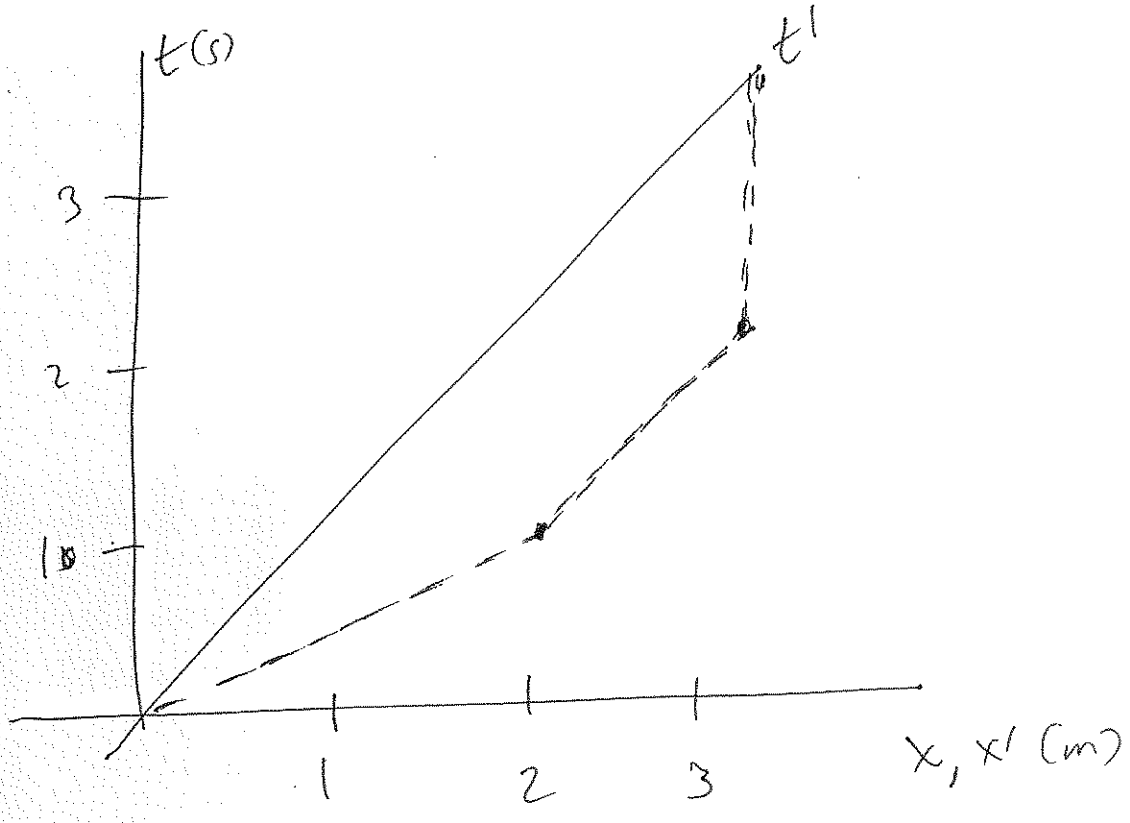
lines parallel to t'-axis = worldlines of objects stationary in S' [eg passengers]

x'-axis = events occurring at $t' = 0$ in S'

Galilean trans: $\Rightarrow t' = t$
so x & x'-axes coincide

lines parallel to x'-axis = events simultaneous in S'

Under galilean trans'ns events simultaneous in S are also simultaneous in S'



EXERCISE 2:
Suppose the frame S' is moving with speed 1 m/s in the $+x$ direction with respect to S. Draw a space-time diagram, with a horizontal x-axis and vertical t-axis. Include the axes of S', assuming that the origins of S and S' coincide. Now carefully draw the worldline of an object that starts at the origin, moves at 1 m/s with respect to S' in the $+x$ direction for 1 s, then stops (with respect to S') for 1 s, and finally moves at 1 m/s with respect to S' in the $-x$ direction for 1 s.