Physics 4

Lecture 11

Time order and Space Separation of Events

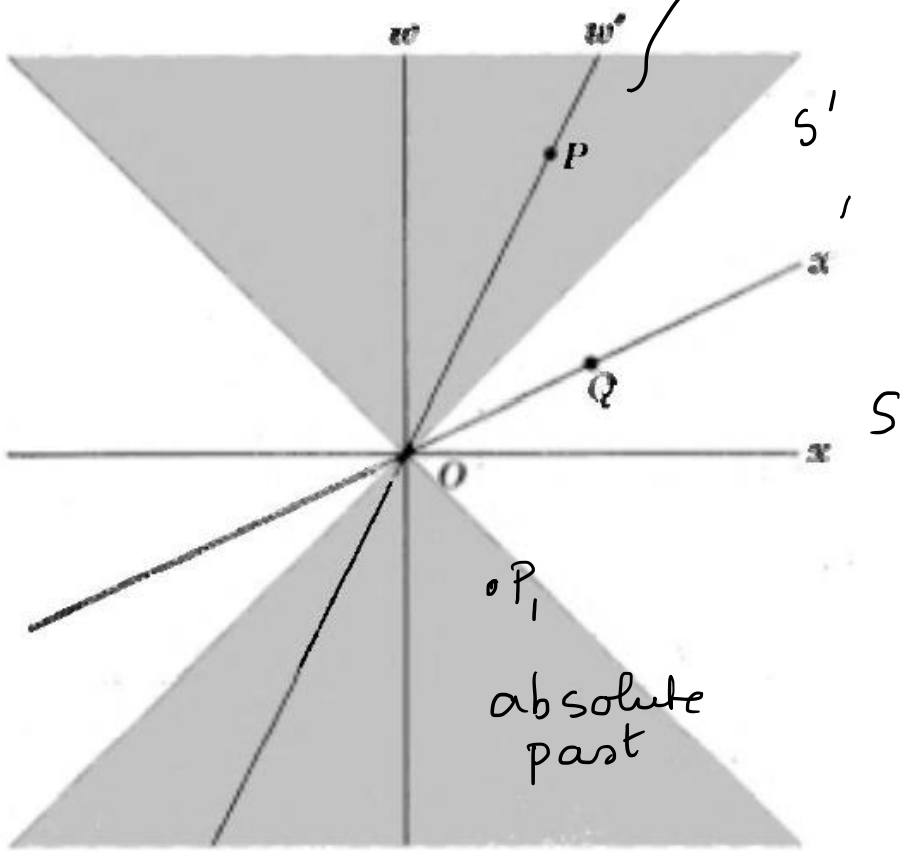


Fig A.9

Consider shaded area in figure, (upper half for the moment).

Notice: Pick any pt P in this region, can always draw a $w' = ct'$ axis through it.

O and P are at the same location ($x' = 0$) line
↳ can always find a frame where events occurs at same location; separated only in time.

Is it always true that P follows O in time irrespective of frame in this region? Yes, absolute time ordering

↓ invariant interval.

ds^2
$= c^2dt^2 - dx^2$

$ds^2 > 0$

↓ timelike interval.

set $dx = 0$

$ds^2 = c^2dt^2$

↙ proper time.

$ds^2 < 0$

spacelike

$ds^2 = 0$

lightlike

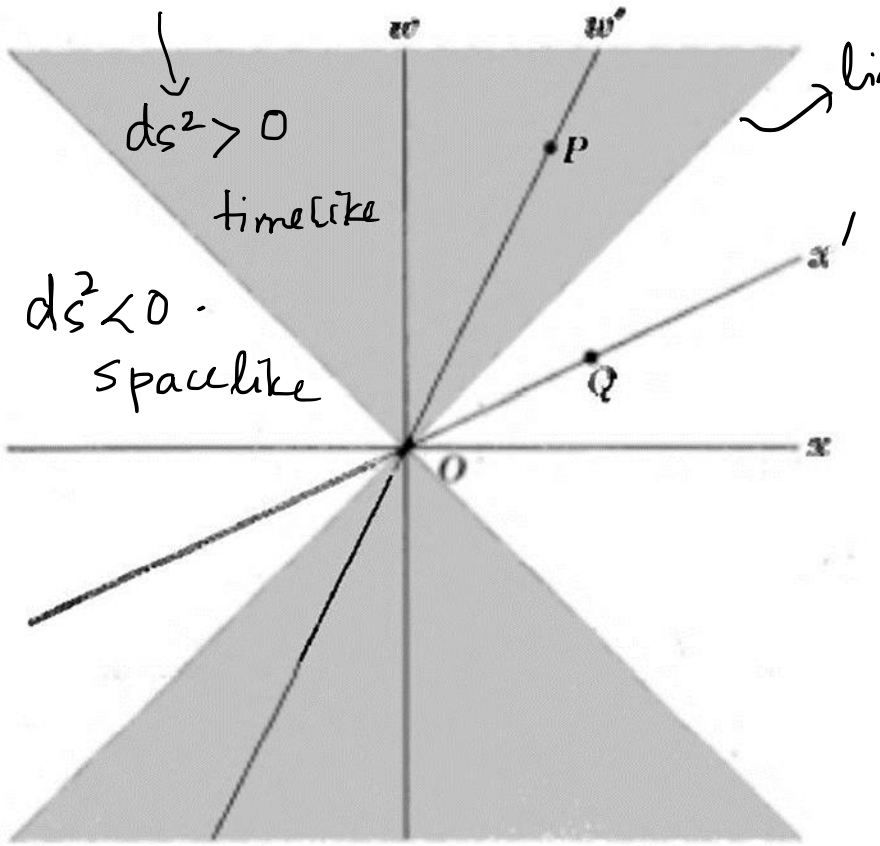


Fig A.9

Unshaded region.

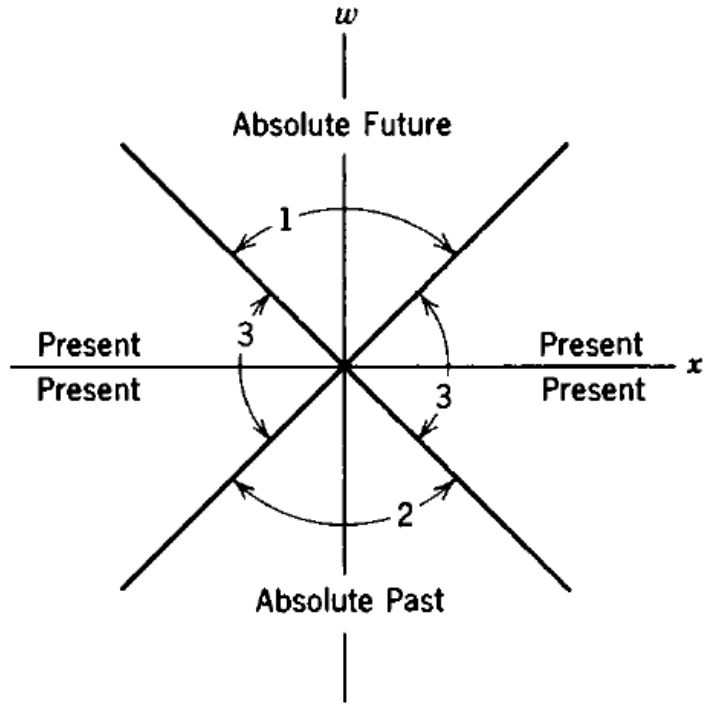
Take any pt Q in unshaded region you can always draw a x' axis through it. O & Q are simultaneous at $t' = 0$

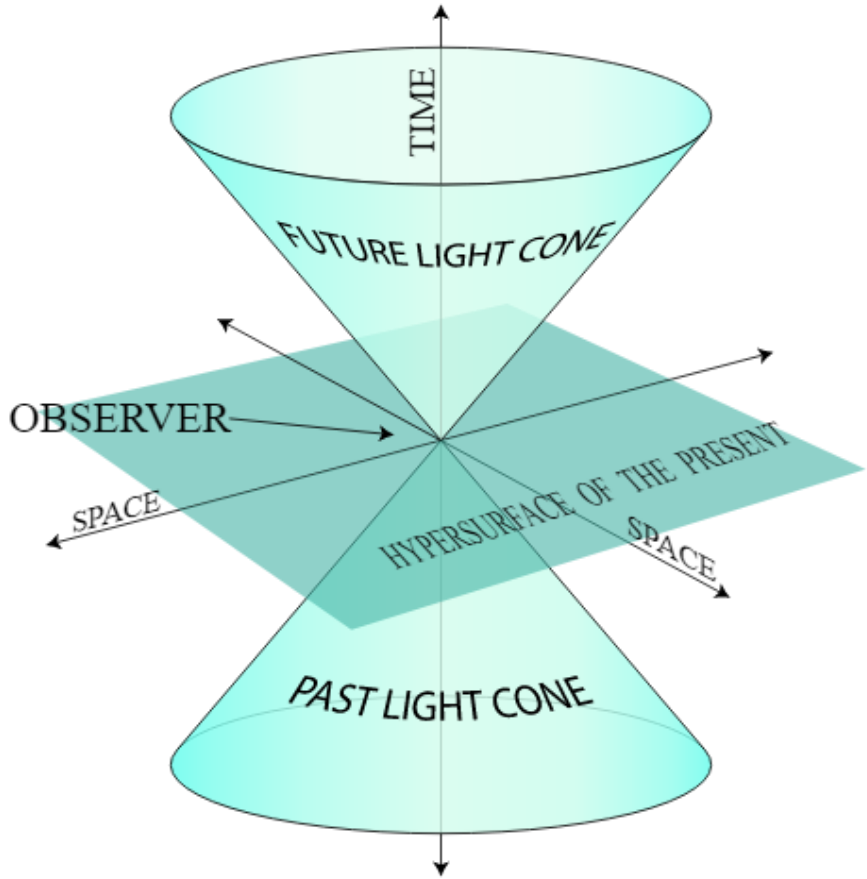
can always go to a frame where O, Q are simultaneous.

Is there absolute time ordering?

No.

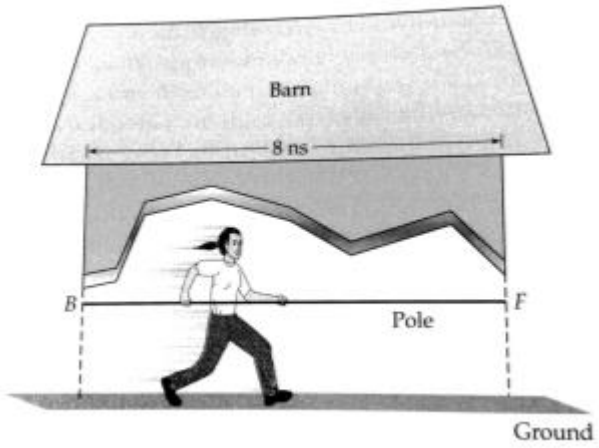
Absolute spatial ordering.


w
Absolute Future
1
3
Present
Present
Present
Present
x
3
2
Absolute Past


TIME
FUTURE LIGHT CONE
OBSERVER
SPACE
HYPERSURFACE OF THE PRESENT
SPACE
PAST LIGHT CONE

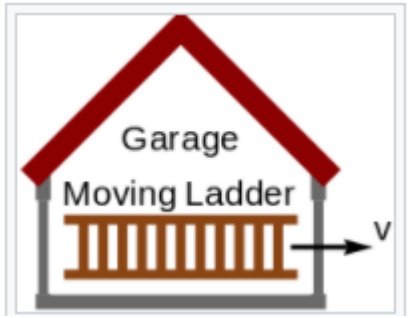
Barn and Pole/ Garage and Ladder Paradox

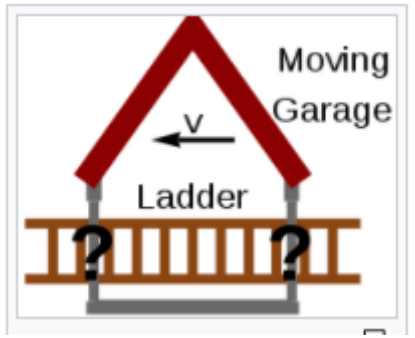
A pole vaulter carrying a pole of rest length 10m runs at a speed v = 3/5 c towards a barn of rest length 9m which has its front and back doors open. An observer on the ground sees the length of the pole contracted to 8m, so the pole just fits in the barn. The pole vaulter on the other hand, sees the barn contracted to 7.2 m, and concludes that his 10m pole definitely does not fit into the barn . Who is right and what is going on ?

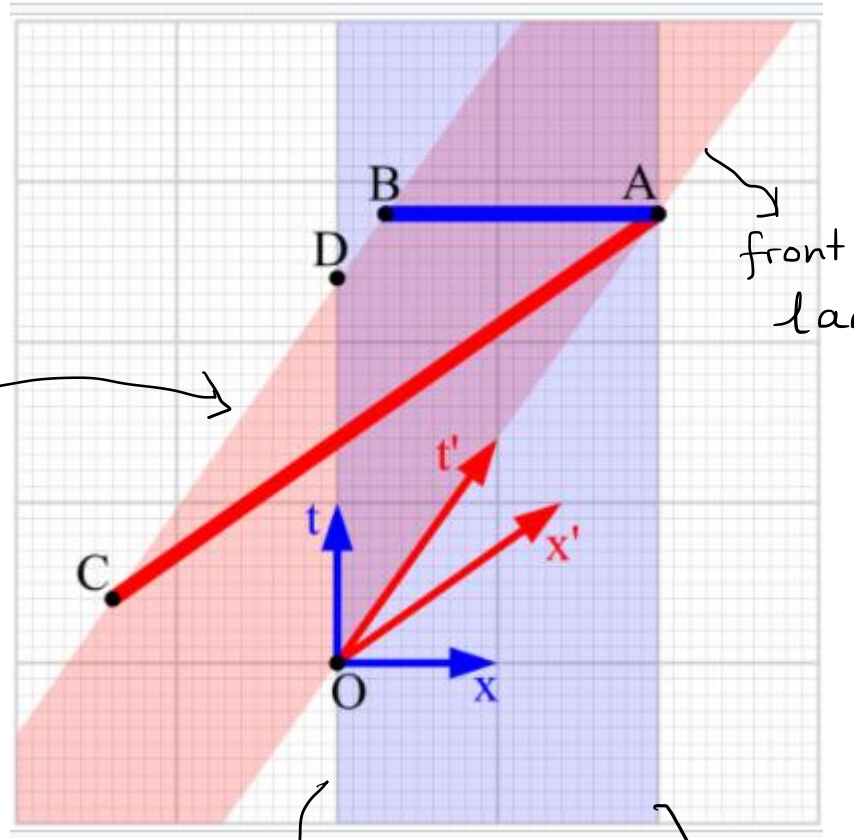



Garage
Ladder
Front door
Back door

rest


Garage
Moving Ladder
v


Moving
Garage
v
Ladder
?
?



world line back of ladder

front of ladder

world line back of garage

world line front of garage

light blue : garage rest frame.

pink : ladder frame.

Event A : front end of pole meeting garage end.

Event D : back end of pole meeting garage front.

From S.

AB depicts the time when A front end meets garage end.

According to S, ladder "fits" in garage.

From S'.

line of simultaneity in AC.

At C, end of ladder has not reached front of garage.

According to S', ladder does not "fit" into garage

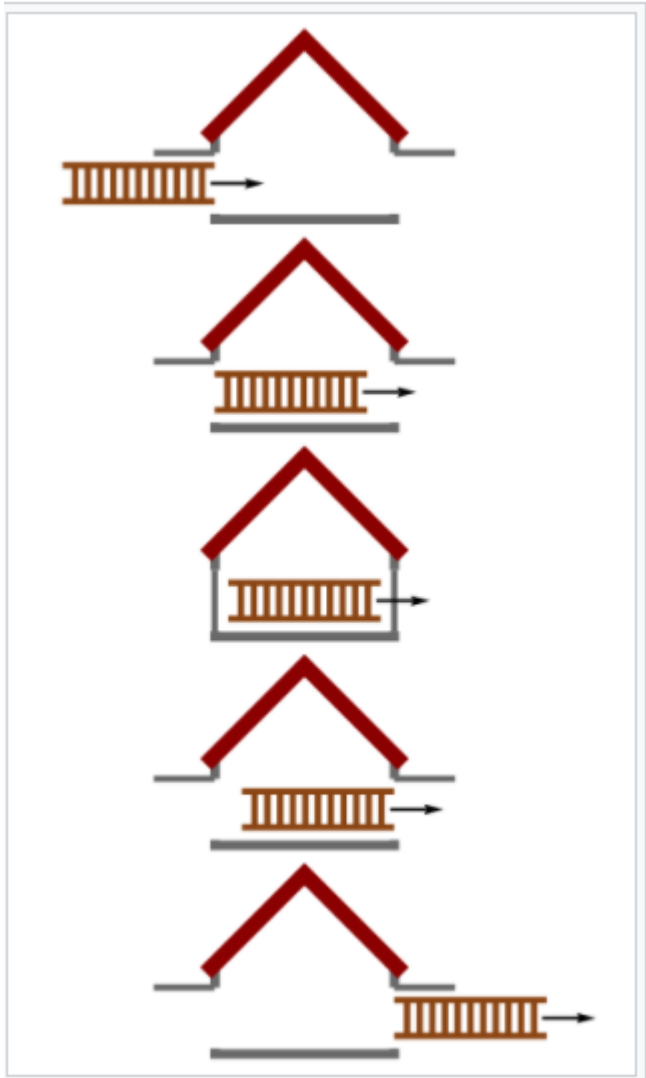


Figure 4: Scenario in the garage frame: a length contracted ladder passing through the garage

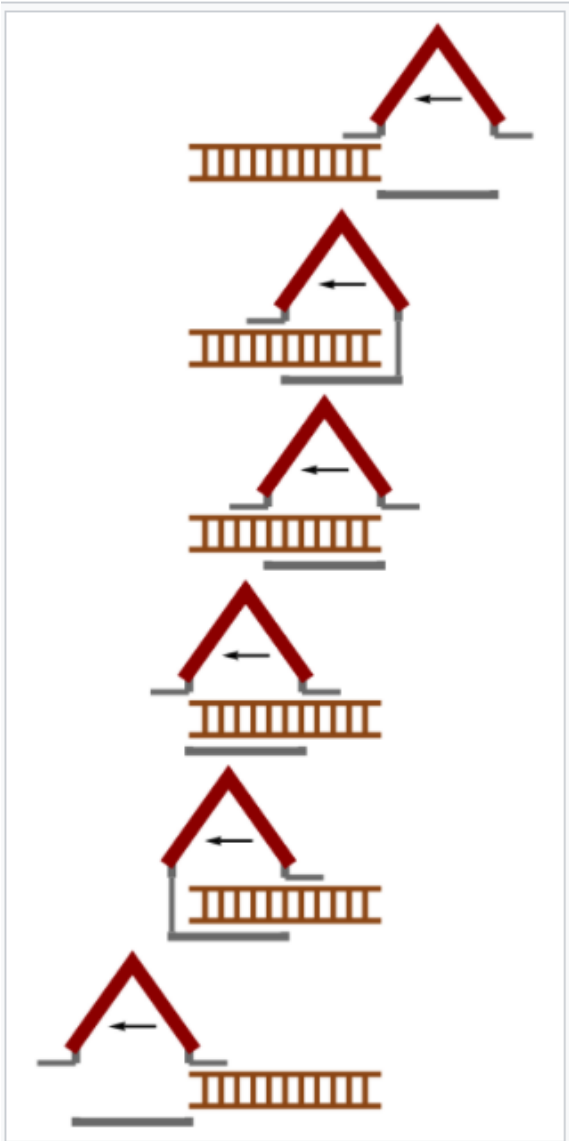


Figure 5: Scenario in the ladder frame: a length contracted garage passing over the ladder. Only one door is closed at any time