Spacelike, Timelike, Lightlike
Let's look at three ways to classify events

Let's return to the idea of the interval, which we defined as:

$$(c\Delta t)^2 - (\Delta x)^2 = (c\Delta t')^2 - (\Delta x')^2 = (\text{interval})^2$$

Case 1: $(c\Delta t)^2 - (\Delta x)^2 = (c\Delta t')^2 - (\Delta x')^2 = 0$ A light-like interval.

If the value of the interval corresponding to two events is zero then we say that the interval is light-like, because only something traveling at the speed of light could be present at both events.

Case 2: $(c\Delta t)^2 - (\Delta x)^2 = (c\Delta t')^2 - (\Delta x')^2 =$ *positive* A time-like interval.

If the value is positive then we say that the interval between two events is time-like. Such events can actually occur at the same location for some observers, and simply be separated in time.

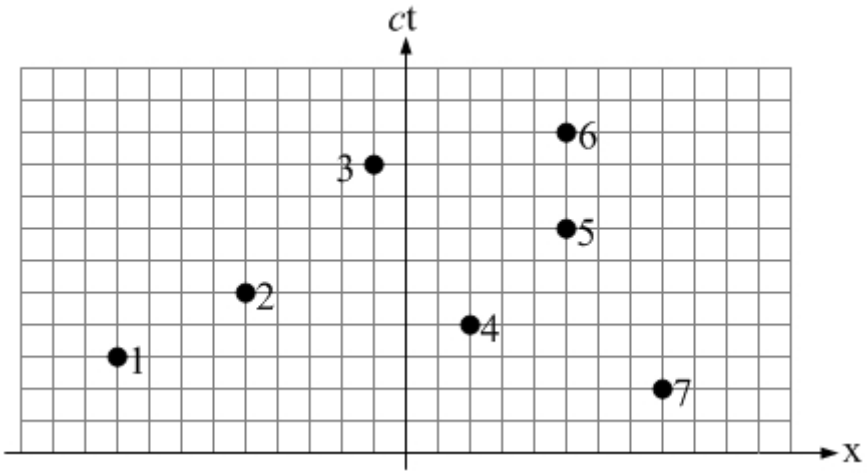
Case 3: $(c\Delta t)^2 - (\Delta x)^2 = (c\Delta t')^2 - (\Delta x')^2 =$ *negative* A space-like interval

If the value is negative then we reverse the expression so we're not dealing with imaginary numbers. In this case $(\Delta x)^2 - (c\Delta t)^2 = (\Delta x')^2 - (c\Delta t')^2$ gives positive values and we say that the interval between two events is space-like. Such events can occur simultaneously for some observers, and simply be separated in space.

If an interval between two events is light-like for a particular observer does this mean it is light-like for all observers? Explain why or why not.

Can an interval between two events be time-like for some observers and space-like for others? Explain why or why not.

Consider the spacetime diagram below, showing various events, in your reference frame.



State two pairs of events for which the interval is light-like.

State two pairs of events for which the interval is time-like.

State two pairs of events for which the interval is space-like.

Consider Events 1 and 2.

Which event, 1 or 2, happens first, according to you?

How fast, and in which direction, does an observer have to be moving relative to you to see events 1 and 2 occurring simultaneously?

What about an observer moving even faster than that, in the same direction as our previous observer? Which event happens first according to that observer?