

Assignment 3

Special and General Relativity

Readings

Kogut ----- Chapter 4: Assorted Applications

Ellis/Williams - Chapter 4.1-4.2: Lorentz Transformation and Invariant Interval

Problem Assignments

Everyone Problem Assignments(hand in at start of seminar)

- Ellis 4.2 Time ordering?
Ellis 4.5 According to different observers ....
Ellis 4.8 Spacetime intervals
Kogut 4.5 Events and Frames
Kogut 4.7 Events and Frames
EP 1 Which way is it going?

Individual Problem Assignments

- Ellis 4.3 Timelike ordering
Ellis 4.10 Null intervals
Ellis 4.13 Light cones
Ellis 4.16 Metrics and K-factors
Ellis 4.18 Null coordinates
Kogut 4.1 Events and Frames
Kogut 4.2 Events and Frames
Kogut 4.3 Events and Frames
Kogut 4.4 Events and Frames
EP 2 Earliest time?
EP 3 Events
EP 4 Simultaneous somewhere?
Ellis 4.6 Boosting (6P only)
Ellis 4.7 Group Theory (6P only)

Subject Presentations (5 minutes)

- Lorentz Transformations
Spacetime Interval and Light Cones

**EP-1** Two radar pulses sent out from the earth at 6:00 AM and 8:00 AM one day bounce off an alien spaceship and are detected on earth at 3:00 PM and 4:00 PM. You are not sure, however, which reflected pulse corresponds to which emitted pulse, Is the spaceship moving toward earth or away? If its speed is constant (but less than  $c$ ), when will it (or did it) pass by the earth? Drawing a spacetime diagram will make this problem easy.

**EP-2** A rocket R moves in the  $+x$  direction relative to an observer A on Mars, at a speed  $1/2$ . Their positions coincide at  $t=0$ . Plot the worldlines of A and R in a spacetime diagram.

The rocket emits light signals in both the forward and backward directions at  $t=2$  sec. Draw the corresponding light rays on your spacetime diagram. The observer A signals to the rocket at time  $t=1$  sec. What is the earliest time she can expect to get a reply?

**EP-3 More events in different frames** In the solar system frame, two events are measured to occur 3.0 hr apart in time and 1.5 hr apart in space. Observers in an alien spaceship measure the two events to be separated by only 0.5 hr in space. What is the time separation between the events in the alien's frame?

**EP-4 They are simultaneous somewhere....**

The space and time coordinates of two events as measured in a frame S are as follows:

$$\text{Event 1: } x_1 = x_0, t_1 = x_0 / c \quad , \quad \text{Event 2: } x_2 = 2x_0, t_2 = x_0 / 2c$$

- (a) There exists a frame in which these two events are simultaneous. Find the velocity of that frame(S') with respect to S.
- (b) What is the value of  $\gamma$  at which both events occur in the new frame S'?