

1. READING:

Ellis and Williams, *Flat and Curved Space-times*

Sections 3.5 and 3.6.

N. David Mermin, *It's About Time*

Chapter 11 (on eReserves)

2. QUESTIONS:

- (1) Ellis and Williams 3.1
- (2) Ellis and Williams 3.16
- (3) Ellis and Williams 3.19
- (4) Ellis and Williams 3.20
- (5) Ellis and Williams 3.19
- (6) In the ladder in barn problem discussed in class, let the speed of the runner be $0.866c$ in the barn frame. The proper length of both the pole and barn is 5 m.
 - (a) What is the length of the ladder in the barn's frame?
 - (b) What is the length of the barn in the ladder's frame?
 - (c) The ladder stops when the front of the ladder reaches the back of the barn in the ladder's frame. Does the ladder fit in the barn?
 - (d) Describe the sequence of events in the barn's frame.
- (7) A steel cable connects two trains at rest on the same track. The cable will snap if it is stretched by as much as 1%. The trains accelerate in such a way as their velocities, as measured in the ground frame, are always equal. Eventually the cable snaps. Explain why this happens. How fast are the trains moving when the cable snaps?
- (8) Two space craft of equal proper length 300 m pass very close to each other, traveling in opposite directions. Their relative speed is $3/5 c$. The captain of one ship, Joyce, intends to "fire a shot across the bow" of the other ship. So, knowing that the other ship, captained by James, is length contracted, she fires the cannon on the tail of her ship just as the bow of her ship passes the tail of James' ship.
 - (a) Construct a careful, scaled space-time diagram in Joyce's frame. Include James and the associated surface of simultaneity for the event of Joyce's cannon firing.
 - (b) Describe the history of events in James' frame.
 - (c) Does the cannon hit James' ship or not? Explain. If you identify a "hidden" assumption above highlight its role.
- (9) **Symmetry in length contraction** Suppose two ("Ovid" and "Brian") equal-length whales pass each other at a relativistic speed. Draw a space-time diagram of this history. Using this diagram show that Ovid's length is contracted in Brian's frame AND Brian's length is contracted in Ovid's frame.