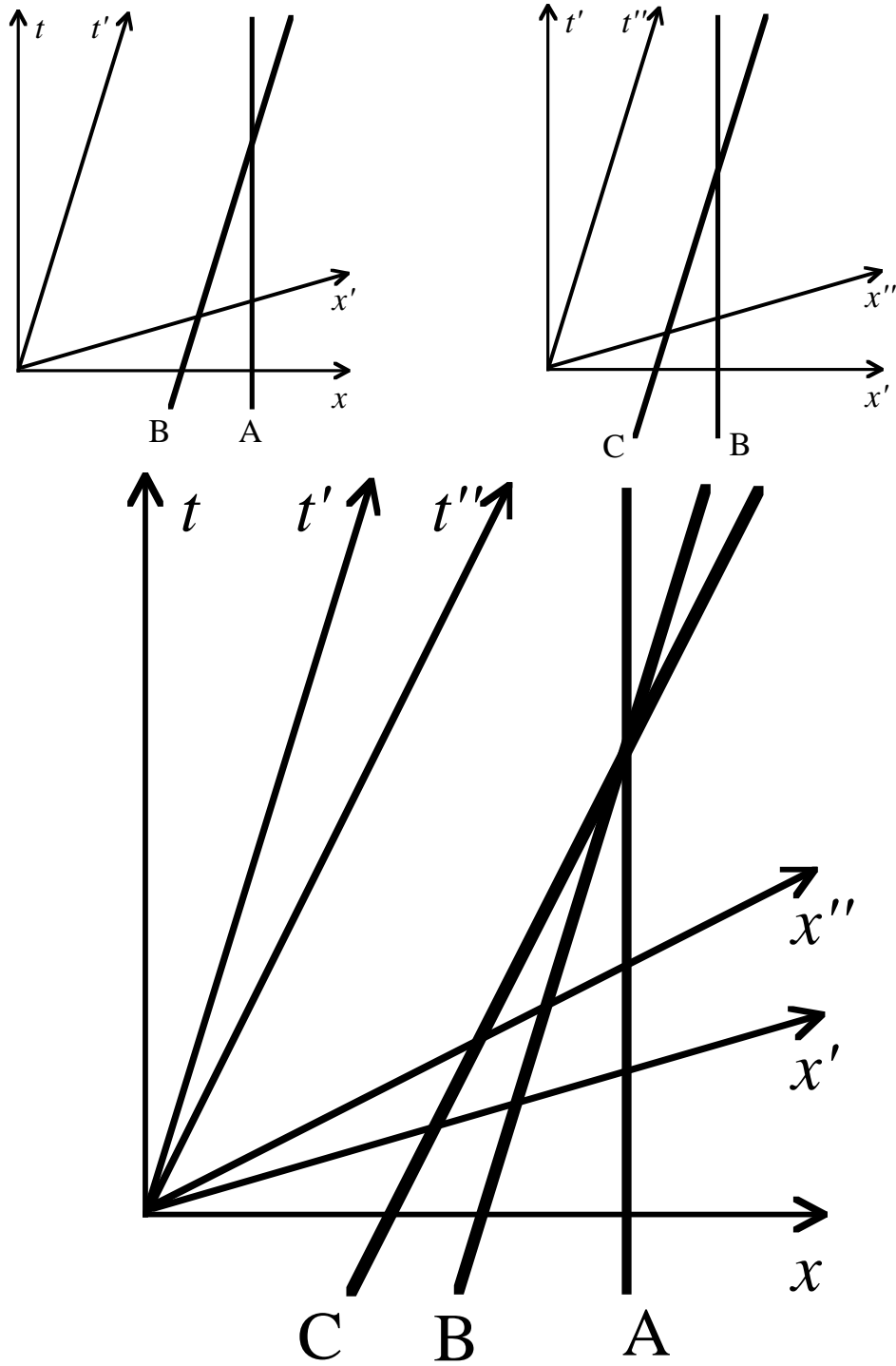
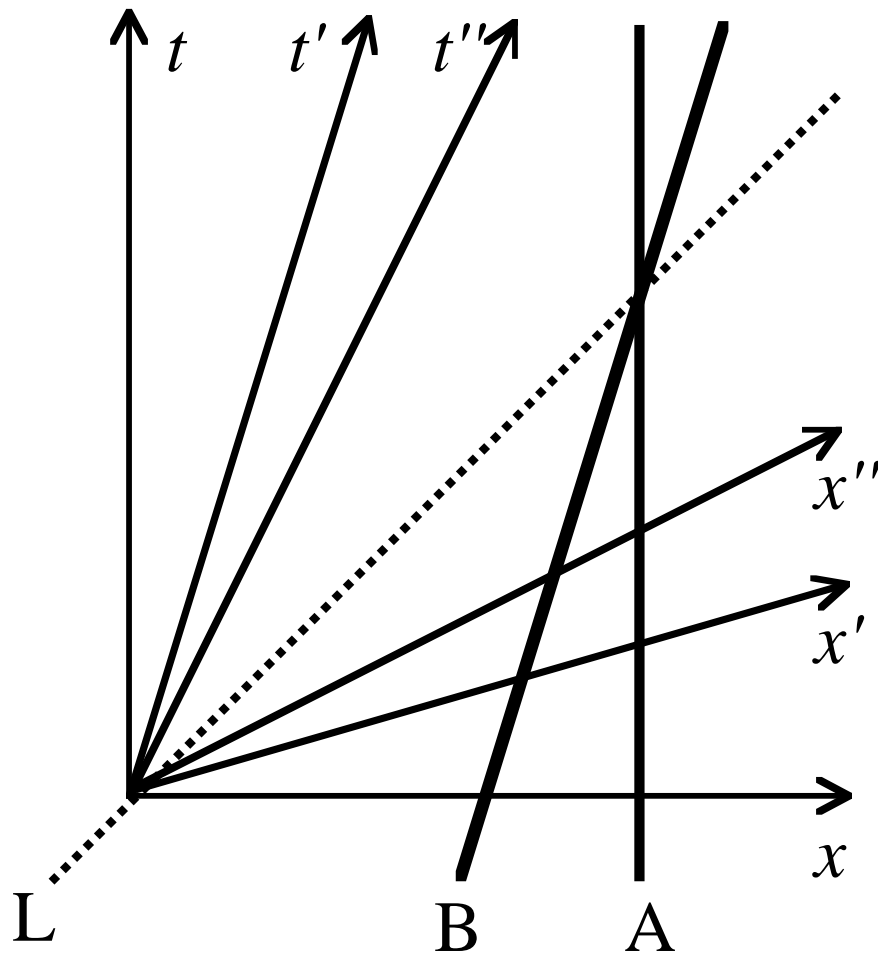
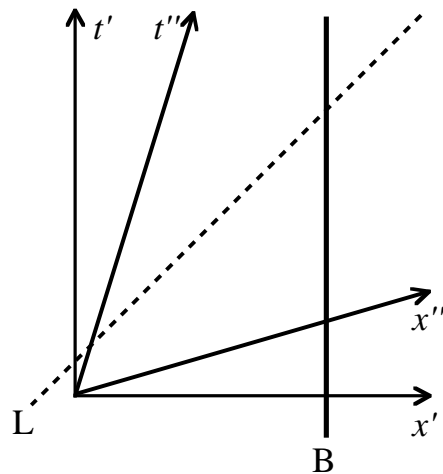
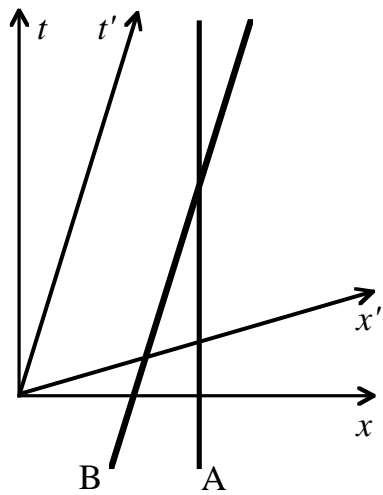
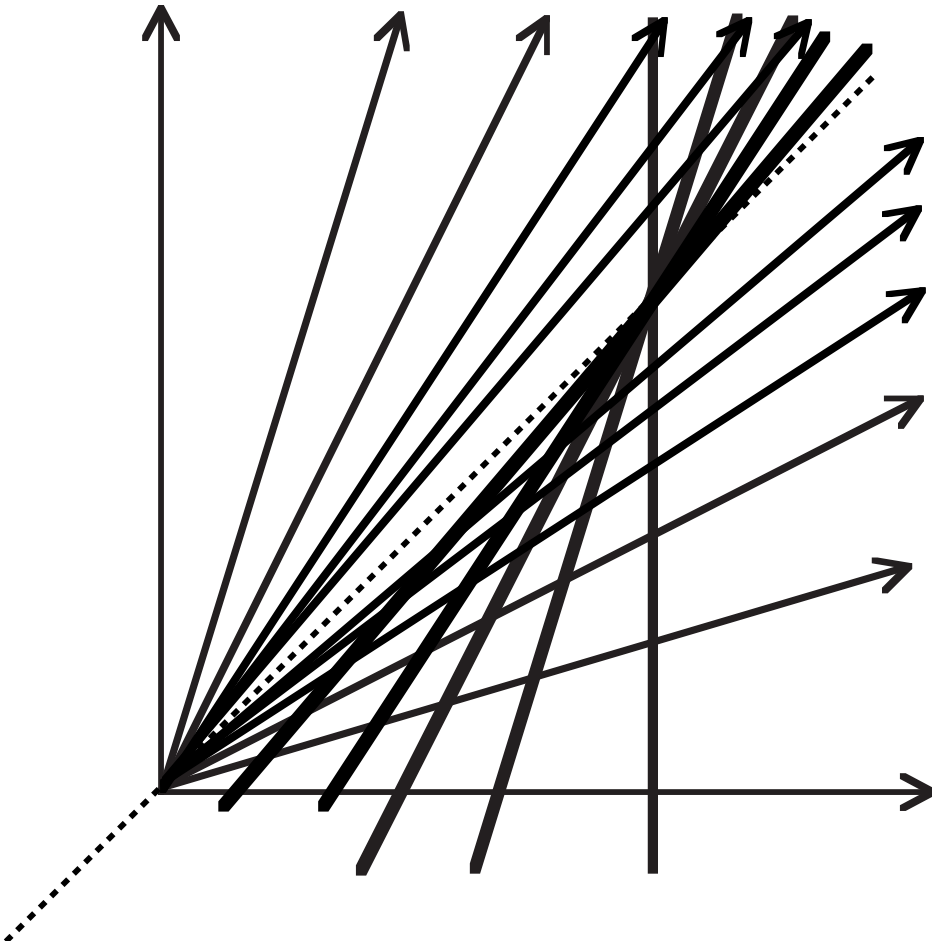


# Velocity Addition

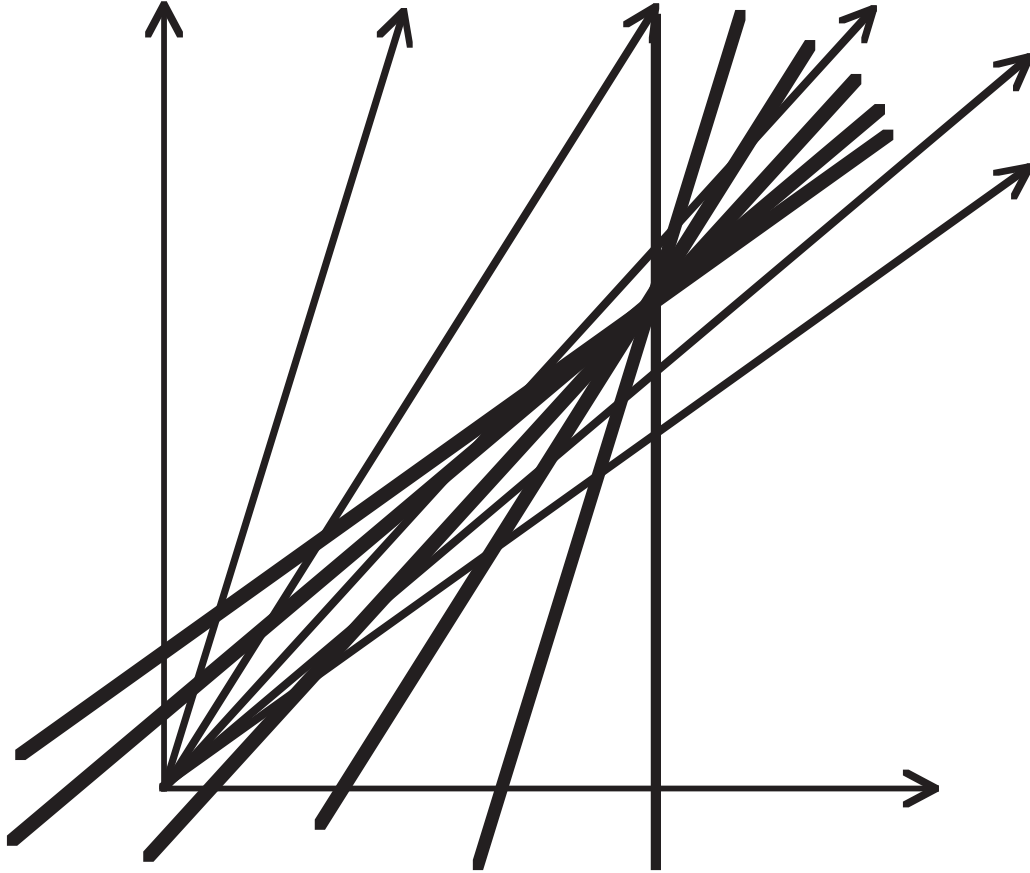




# Velocity Addition in Relativistic ST



# Velocity Addition in the Galilean ST



# Guidelines for Surviving in Relativistic ST

- Determine *what*, exactly, you want to measure.
- Determine *how*, exactly, you will measure it (i.e., what tools you will use and how).
- Represent the situation in ST; include both the objects and/or events on which the measurement is to be performed *and* the tools, in your representation.
- You can work in any reference frame; but your representation may be more perspicuous (for your purposes) in one such frame than in others.
- Make sure to represent precisely all the relevant qualitative details, in particular, the order (both temporal and spatial) of the relevant events, in a particular frame.
- Be sure not to smuggle any Galilean notions (such as absolute simultaneity, etc.) in your analysis.

# Intrinsic Structure of Relativistic vs. Galilean Space-Times

## Galilean:

- Intrinsic:
  - Common time 3-planes (hence times elapsed between events)
  - Straight world-lines (representing motion with constant velocity)
- Extrinsic (restricted to particular observers/frames):
  - Position lines
  - Velocities

## Relativistic

- Intrinsic:
  - Light cones
  - Relativistic intervals between events
  - Straight world-lines (representing motion with constant velocity)
- Extrinsic (restricted to particular observers/frames):
  - Time 3-planes
  - Position lines
  - Velocities

Aristotelian Galilean  
Relativization of position, spatial distance between  
non-simultaneous events, and velocities

Galilean Relativistic  
Additional relativization of time, hence, simultaneity  
and time elapsed between events

- Galilean ST is “flexible” up to beveling-the-deck transformations.
- Relativistic ST is “flexible” up to transformations involving simultaneous folding/unfolding of both the  $x$  and  $t$  axes “toward,” or “away from,” the diagonal (representing the world line of light).
- Consequence of the Galilean ST:
  - Relativity of rest and motion
- Additional consequences of the Relativistic ST:
  - Relativity of simultaneity
  - Time dilation
  - Length contraction

These effects are **REAL**.