# Mechanik, Herbstsemester 2024

### Blatt 11 = letztes "offizielles" Übungsblatt
### (Blatt 12 = Bonus-Übungsblatt)

Abgabe: 3.12.2024, 12:00H, **entweder auf adam in den entsprechenden Ordner, oder in das Fach im Treppenhaus 4. Stock!**
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(1) **Dimensions perpendicular to the velocity are not contracted** (2 Punkte)
Two meter sticks, A and B, move past each other as shown in the figure. Stick A has paint brushes on its ends (black squares). Show that a length contraction along the sticks would lead to a contradiction. Conclude that in the frame of one stick, the other stick has still a length of one meter.



A          B
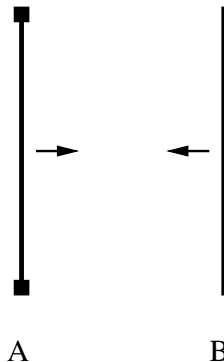
(2) **Police chases criminals** (2 Punkte)
As the outlaws escape in their getaway car, which goes $\frac{3}{4}c$, the police officer fires a bullet from the pursuit car, which only goes $\frac{1}{2}c$. The muzzle velocity of the bullet (relative to the gun) is $\frac{1}{3}c$.

Does the bullet reach its target (a) according to Galileo, (b) according to Einstein?

(3) **Simultaneity** (3 Punkte)
Event $A$ happens at $\mathbf{x}_A = (5, 3, 0)$ and at time $ct_A = 15$; event $B$ occurs at $\mathbf{x}_B = (10, 8, 0)$ and $ct_B = 5$, both in system $K$.

(a) Calculate the invariant interval $I \equiv c^2(t_A - t_B)^2 - (\mathbf{x}_A - \mathbf{x}_B)^2$ between $A$ and $B$. Why is it the same in all inertial systems?

(b) Is there an inertial system $K'$ in which they occur simultaneously? If so, find its velocity (magnitude and direction) relative to $K$.

(c) Is there an inertial system $K''$ in which they occur at the same point? If so, find its velocity relative to $K$.

Repeat (a) – (c) for $\mathbf{x}_A = (2, 0, 0)$, $ct_A = 1$; and $\mathbf{x}_B = (5, 0, 0)$, $ct_B = 3$.

(4) **Communicating with rockets** (3 Punkte)

A rocket ship leaves earth at a speed of $\frac{3}{5}c$. When a clock on the rocket (system $K'$) says 1 hour has elapsed, the rocket ship sends a light signal back to earth (system $K$).

(a) According to *earth* clocks, when was the signal sent?

(b) According to *earth* clocks, how long after the rocket left did the signal arrive back on earth?

(c) According to the *rocket* observer, how long after the rocket left did the signal arrive back on earth?