Relativity — Lecture 3

- Summary of Lecture 2
- Time Dilation
- Length Contraction
- Galilean Transformations
- Lorentz Transformations

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Lecture 2

Revision

Postulates of Special Relativity

1. The laws of physics are identical in all inertial frames.
2. Light is propagated in empty space with a definite velocity c that is independent of the state of motion of the emitting body.

Postulates of Special Relativity

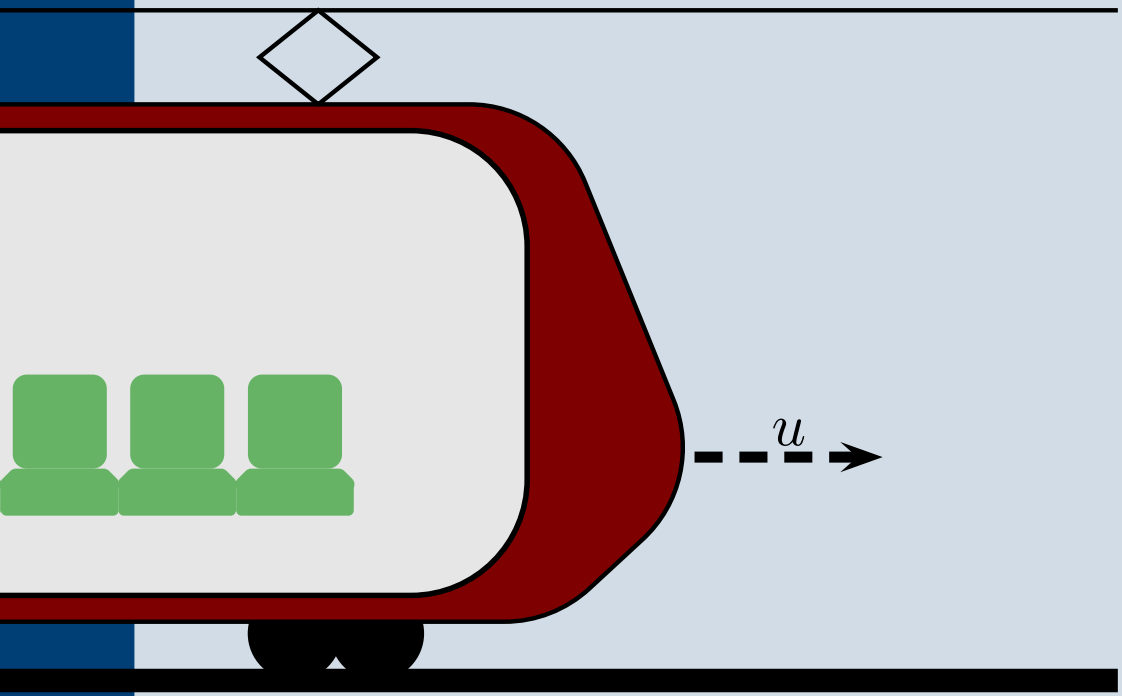
1. **The laws of physics are identical in all inertial frames.**
2. **Light is propagated in empty space with a definite velocity c that is independent of the state of motion of the emitting body.**

➜ **The speed of light in vacuum has the same value c for all inertial observers.**

$$c = 299,792,458 \text{ (exact)} \simeq 3 \cdot 10^8 \,\mathrm{m/s}.$$

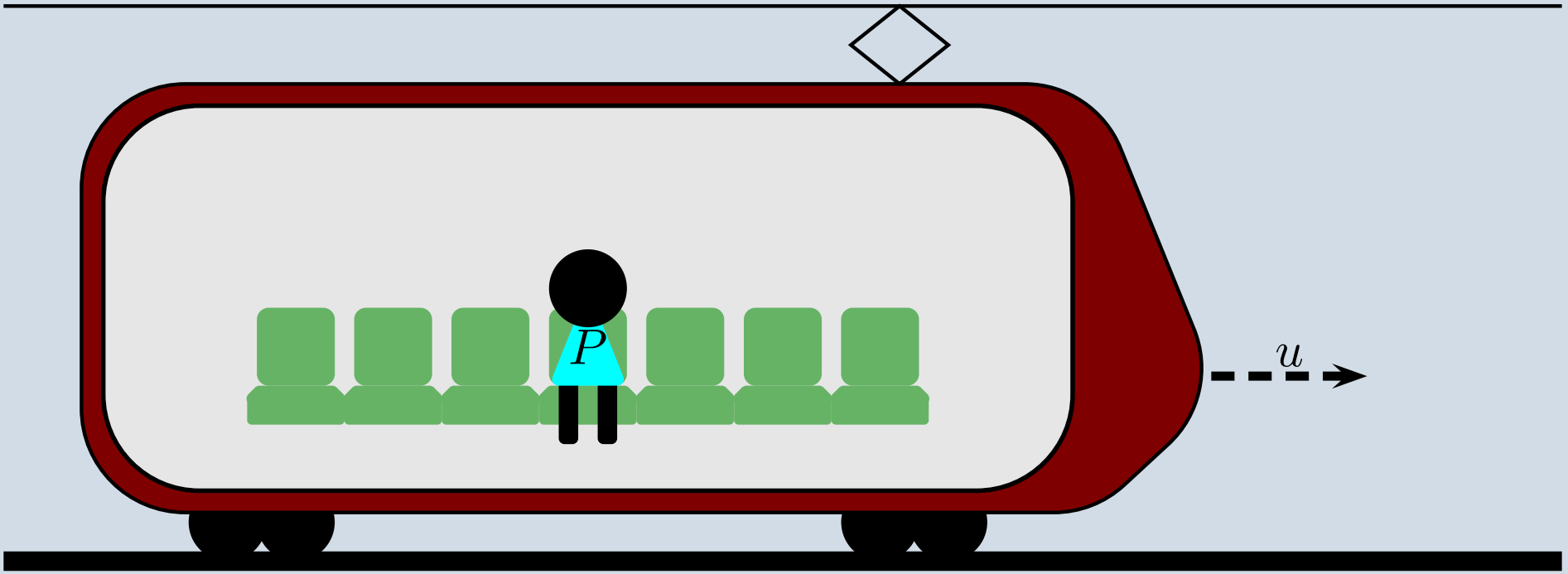
Simultaneity

Warning! Train approaching at speed close to c!



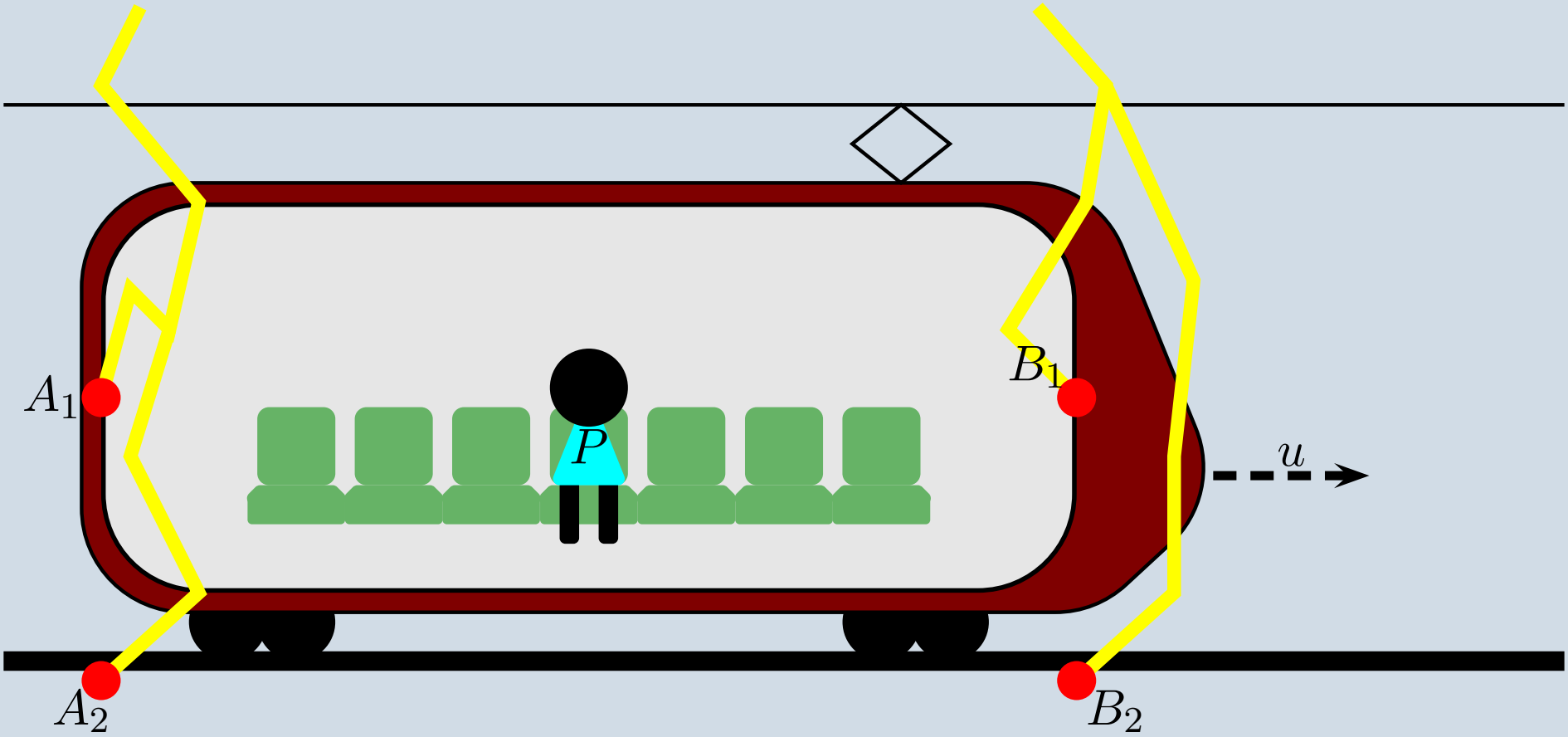
Simultaneity

A train moves at speed u close to c.



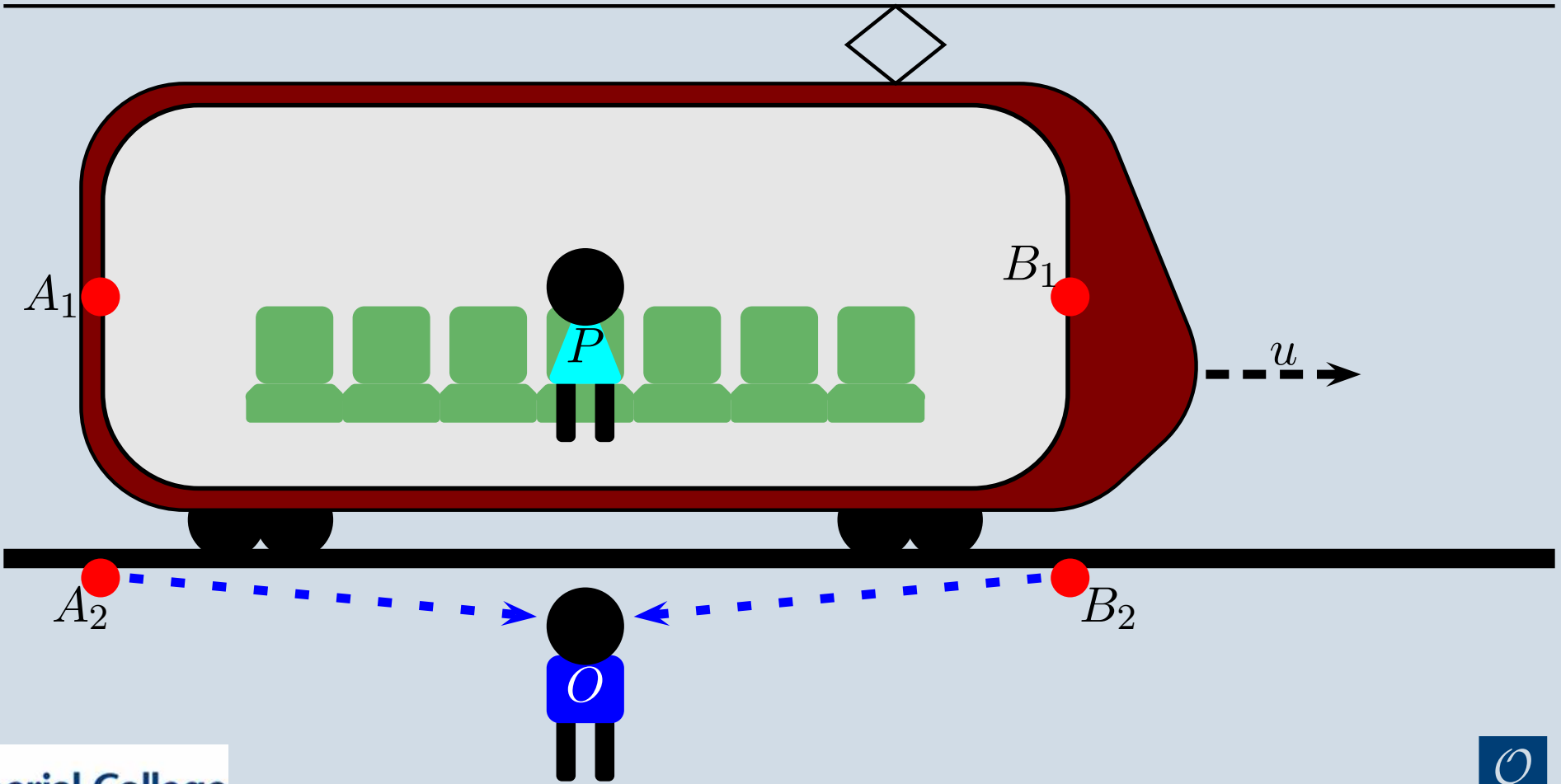
Simultaneity

It is struck by a lightning that hits simultaneously in A_1, A_2, B_1 and B_2.



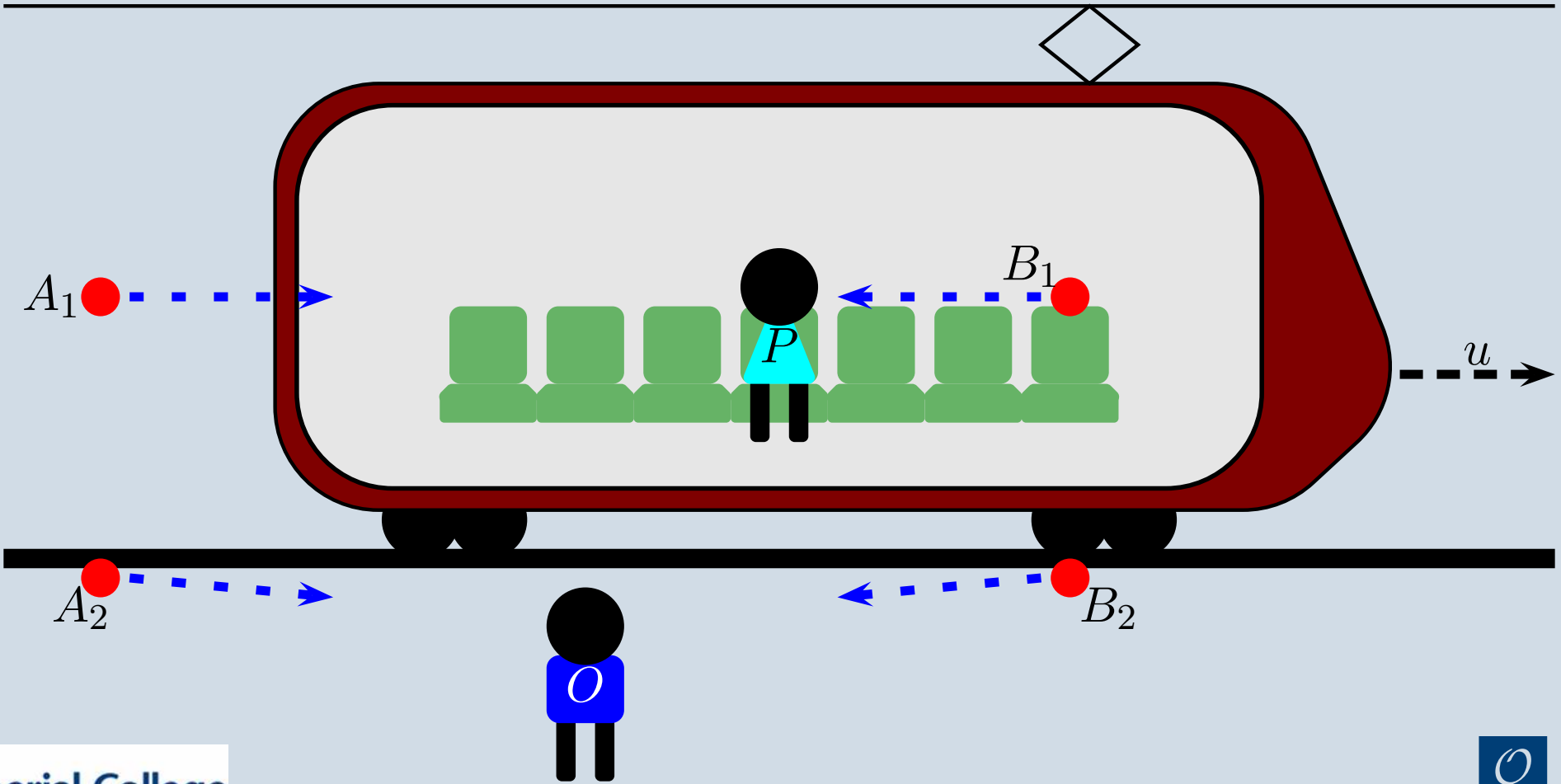
Simultaneity

Branches A **and** B **hit at the same time** because we see the flash from A_2 and B_2 arrive at the same time in O, in the middle.



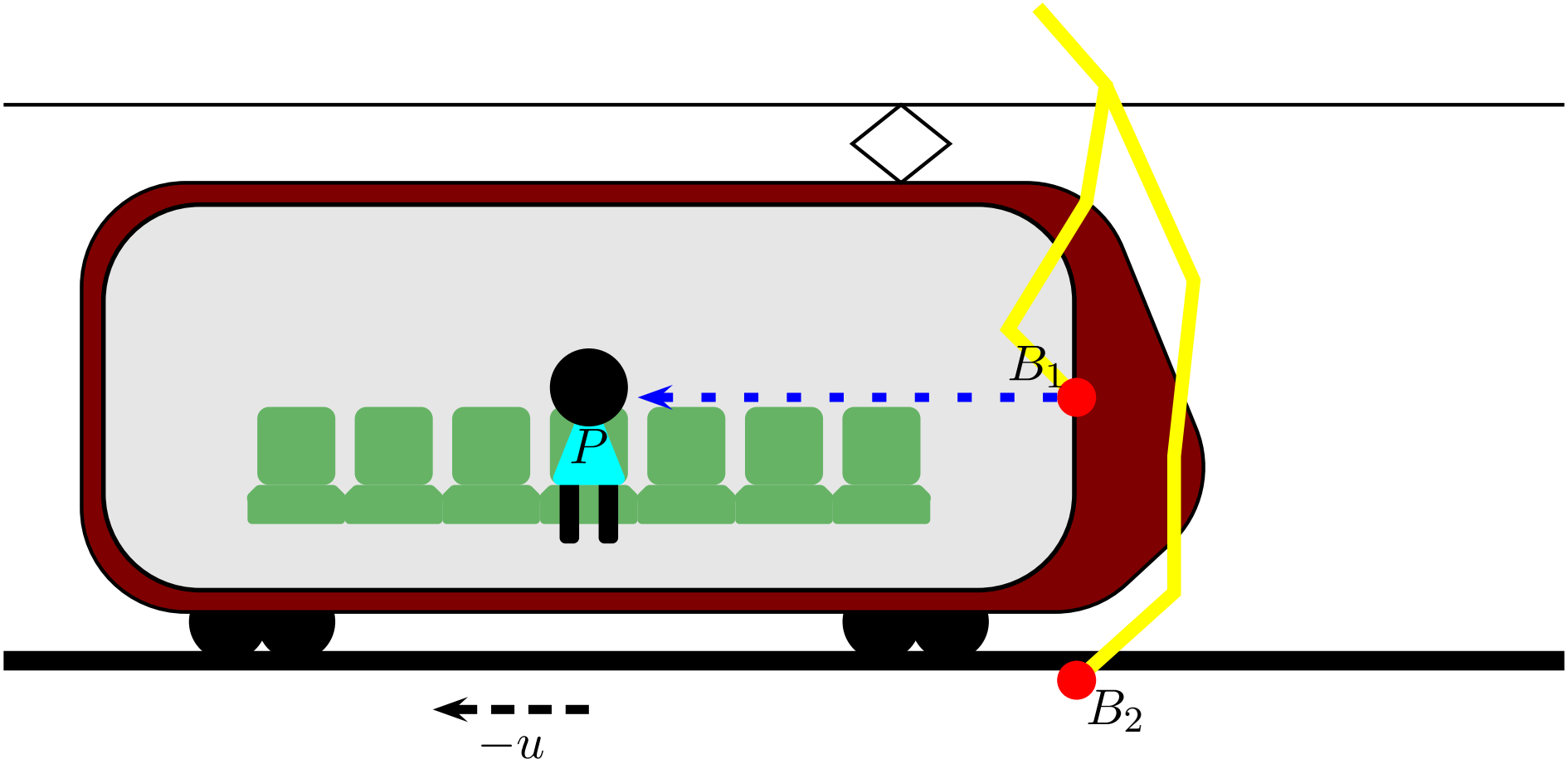
Simultaneity

The passenger sees the flash from B_1 first as she is moving to the right. She's in the middle between A_1 and B_1: $\boldsymbol{B}$ **must have struck first!**



Simultaneity

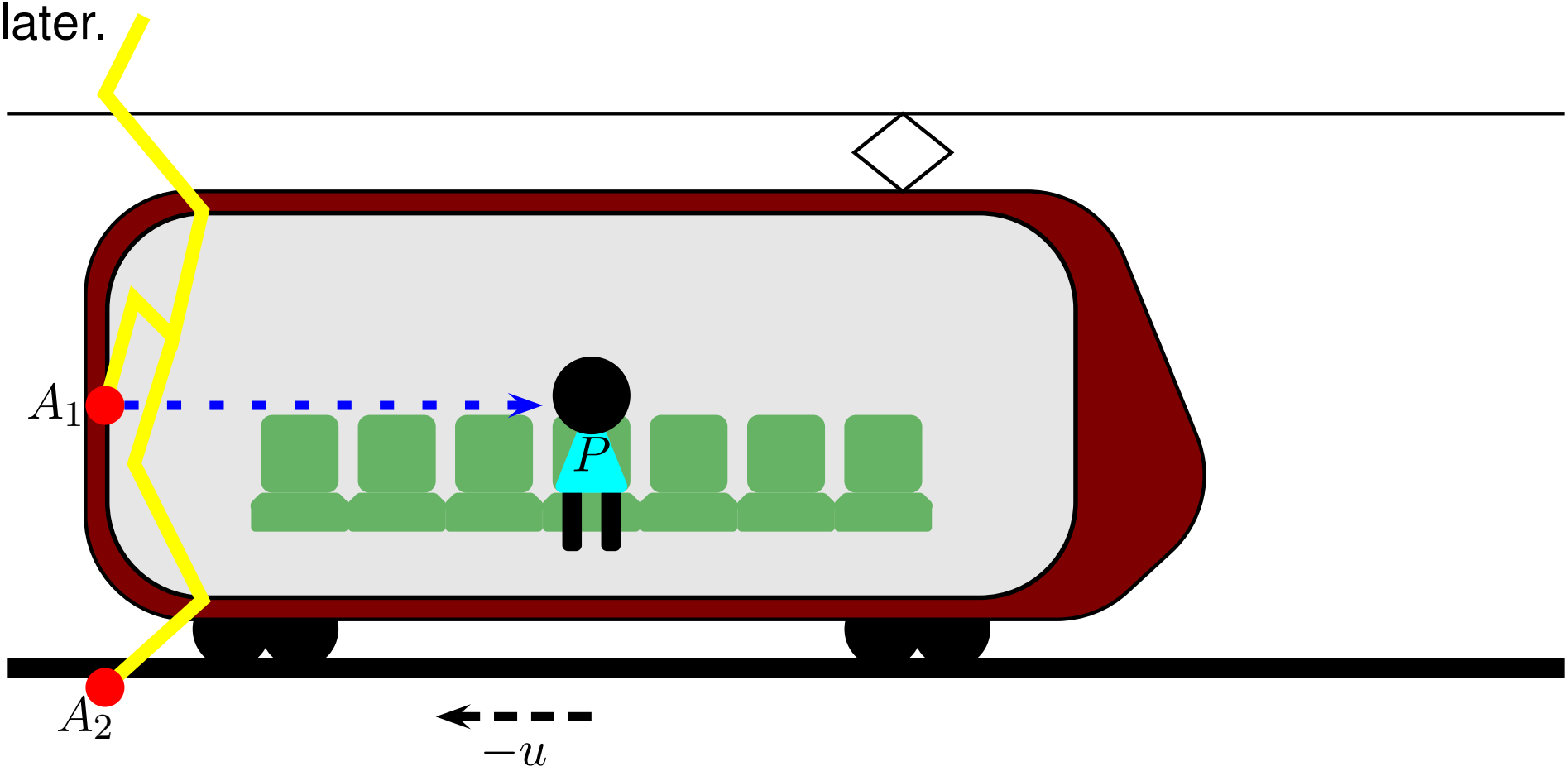
In her reference frame she sees lightning B first,



$\mathcal{O}'$

Simultaneity

In her reference frame she sees lightning B first, while lightning A strikes later.



$\mathcal{O}'$

Simultaneity — A Paradox?

Is there a paradox?

- We have used
  1. $L = ct$,
  2. c is contant

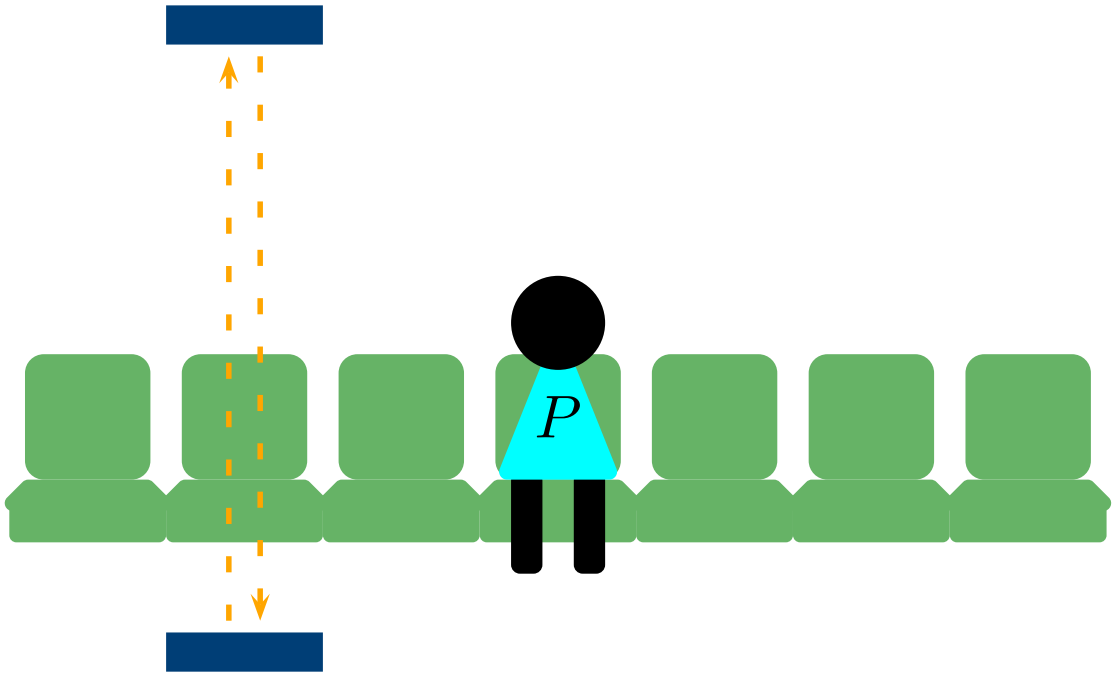
  ➜ knowing L, we conclude about t.
- But we get different results in $\mathcal{O}$ and $\mathcal{O}'$.
- "Common sense" says "*she's wrong: she's the one who's moving!*", the two lightning are *really* simultaneous.
- But that violates the principle of relativity! Both frames are inertial frames. None of them is better than the other.

We have to abandon the concept of simultaneity!

Two events simultaneous in one frame need not be simultaneous in another frame.

Lecture 3

Clock on a Train



Clock on a Train