Physics 311
Relativity and Gravitation

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course web page

http://courses.washington.edu/bbbteach/311/index.html

Syllabus, etc.

(regular) Homework

- Assignments given each Wednesday

  ... but not today!
- Due the following Wednesday
- Late homework accepted through the respective Friday, for a 25% penalty

Tutorials

- Most Friday classes are tutorials (some exceptions, see the schedule)
- **Room TBA, but most likely this one**
- 10-minute pre-tests given at the end of Wednesday lectures (not graded)
- Tutorial homework, due the following Friday, no late homework accepted. Only one (random) problem is graded.

The Grade

• Homework	13% tutorial
	27% regular
• Midterm	25% (best of the two)
• Final	35%
• TOTAL	~100%

Special Relativity

Parable of the Surveyors

Once upon a time, there lived in a kingdom far-far away two tribes – the Daytimers and the Nighttimers. They lived happily together except for one little problem. They did not agree on the borders of their lands....

Two excellent Surveyors there were, a daytimer and a nighttimer, who both measured the land well but whose measurements did not agree with one another. Here's what the problem was (but they didn't know it!)....

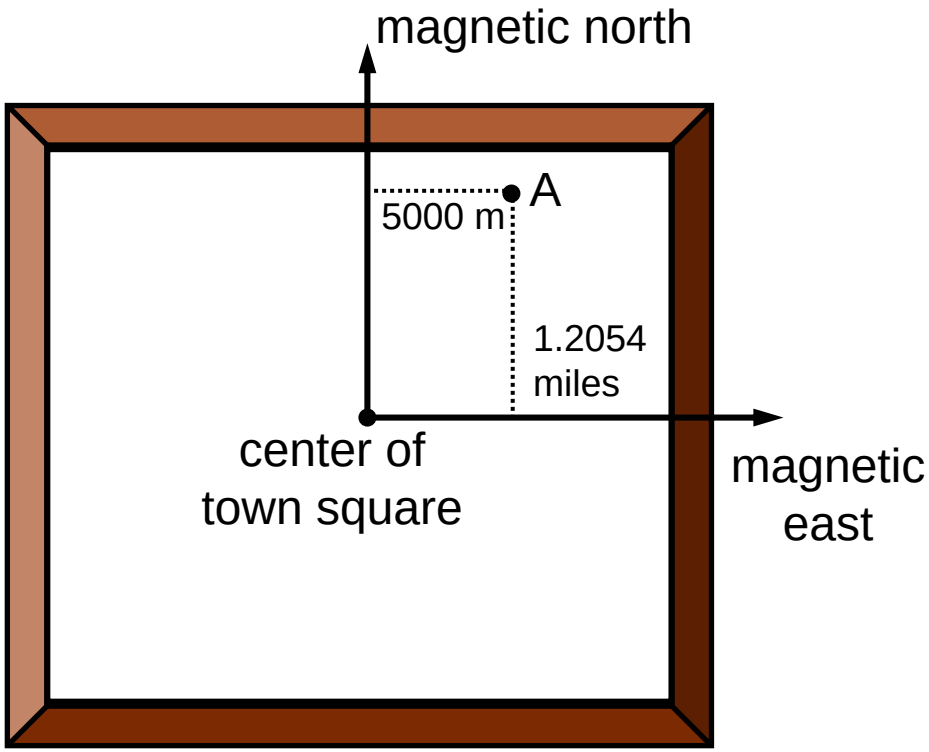
Same land, what's different???

Daytime Surveyor

North: magnetic

East-West in meters

North-South in miles

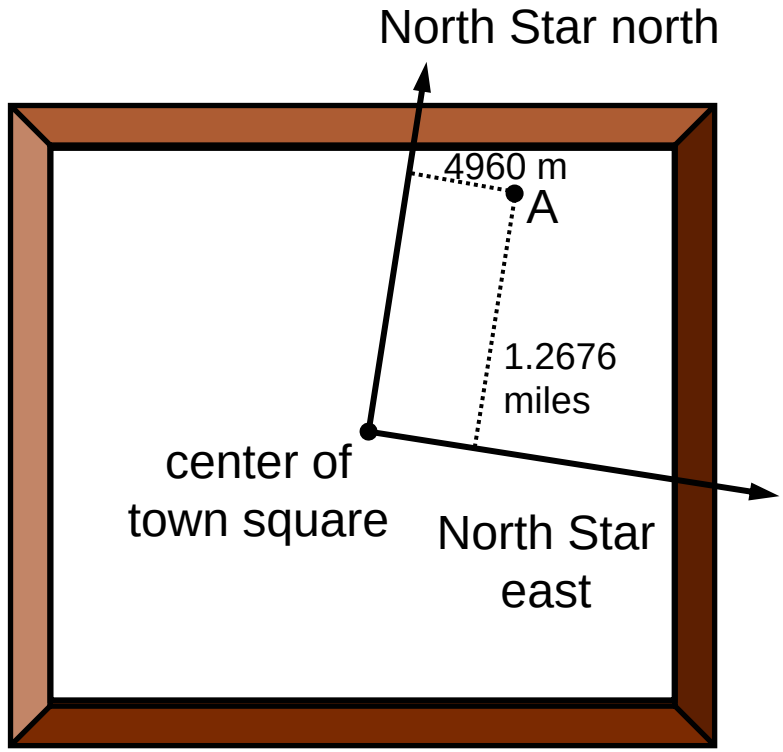


Nighttime Surveyor

North: North Star

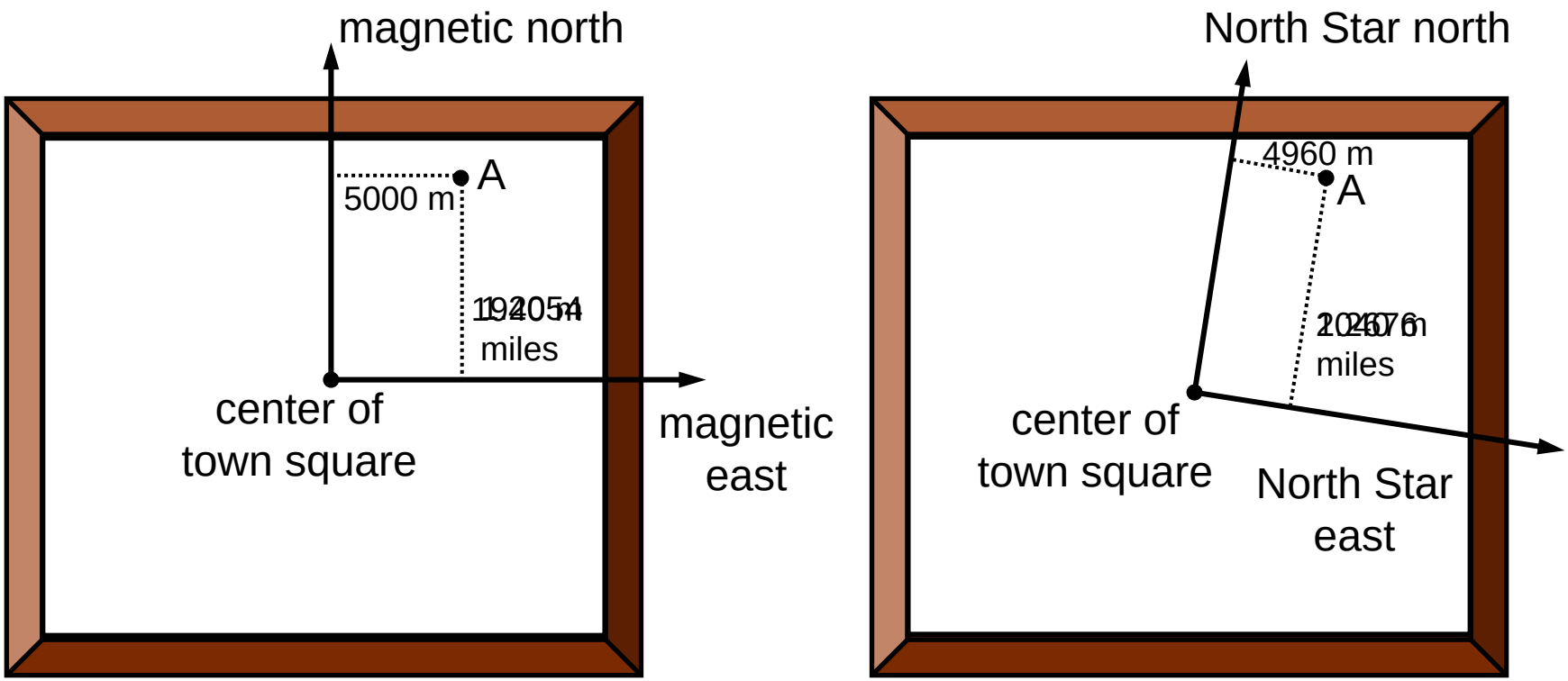
East-West in meters

North-South in miles



Two problems, actually...

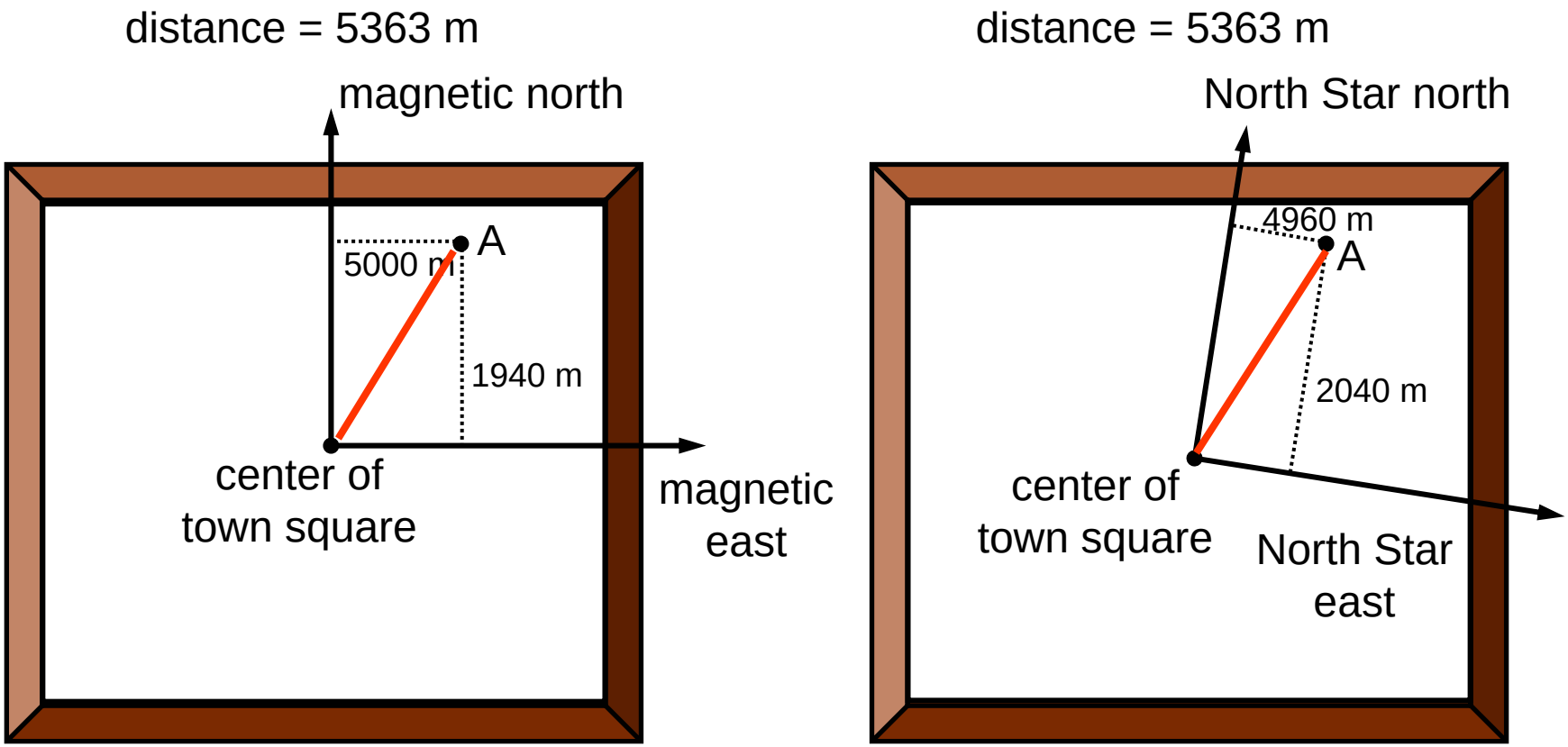
The obvious problem is the different definitions of “North”. Less obvious but no less important is the use of different units for north-south and east-west directions. Let’s fix that by applying a conversion factor k = 1609.344 m/mile:



Solution!

The measurements are still *different*, but here's the trick: we find the *distance* between points defined as:

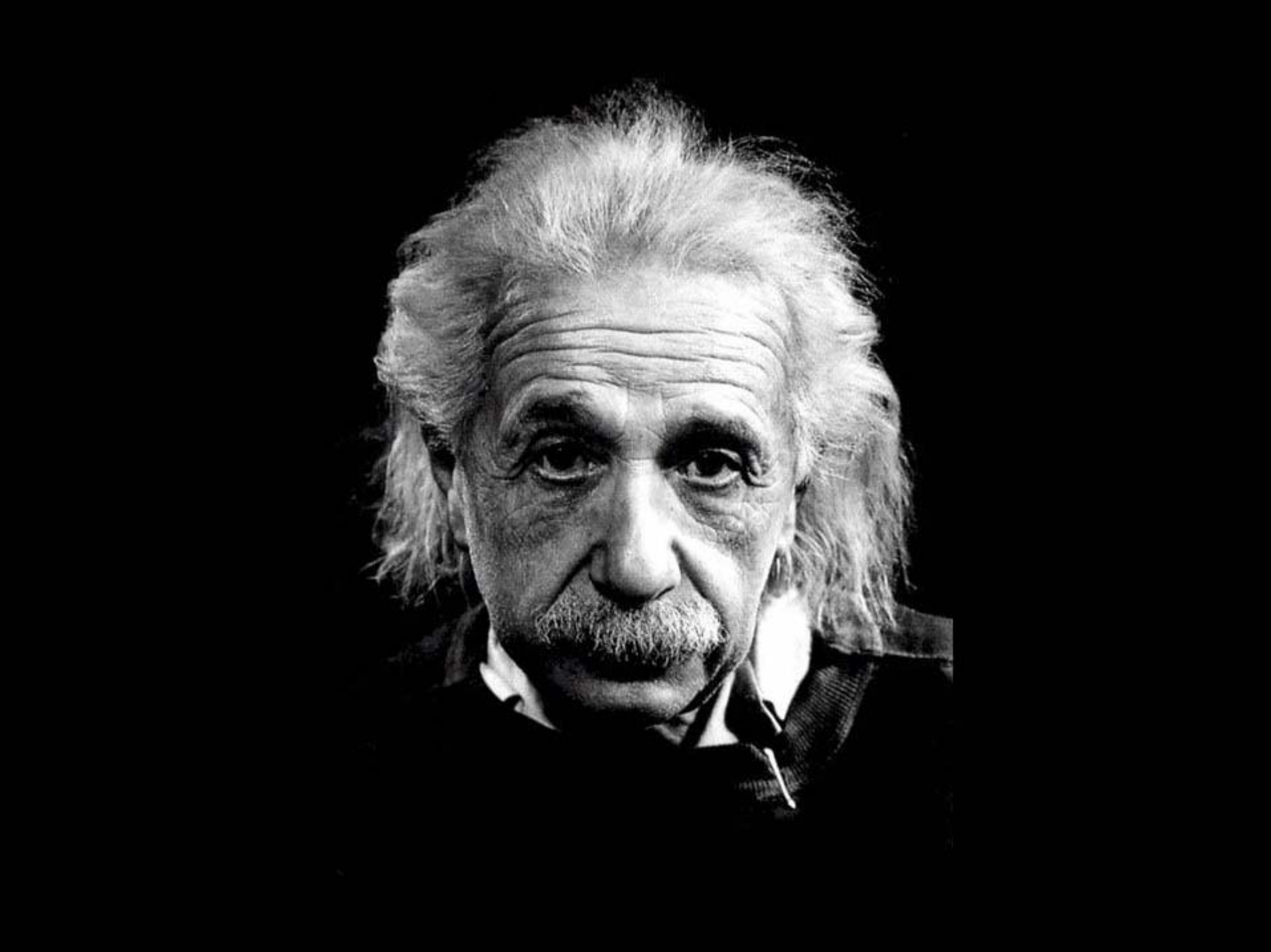
$$distance = \sqrt{north^2 + east^2}$$



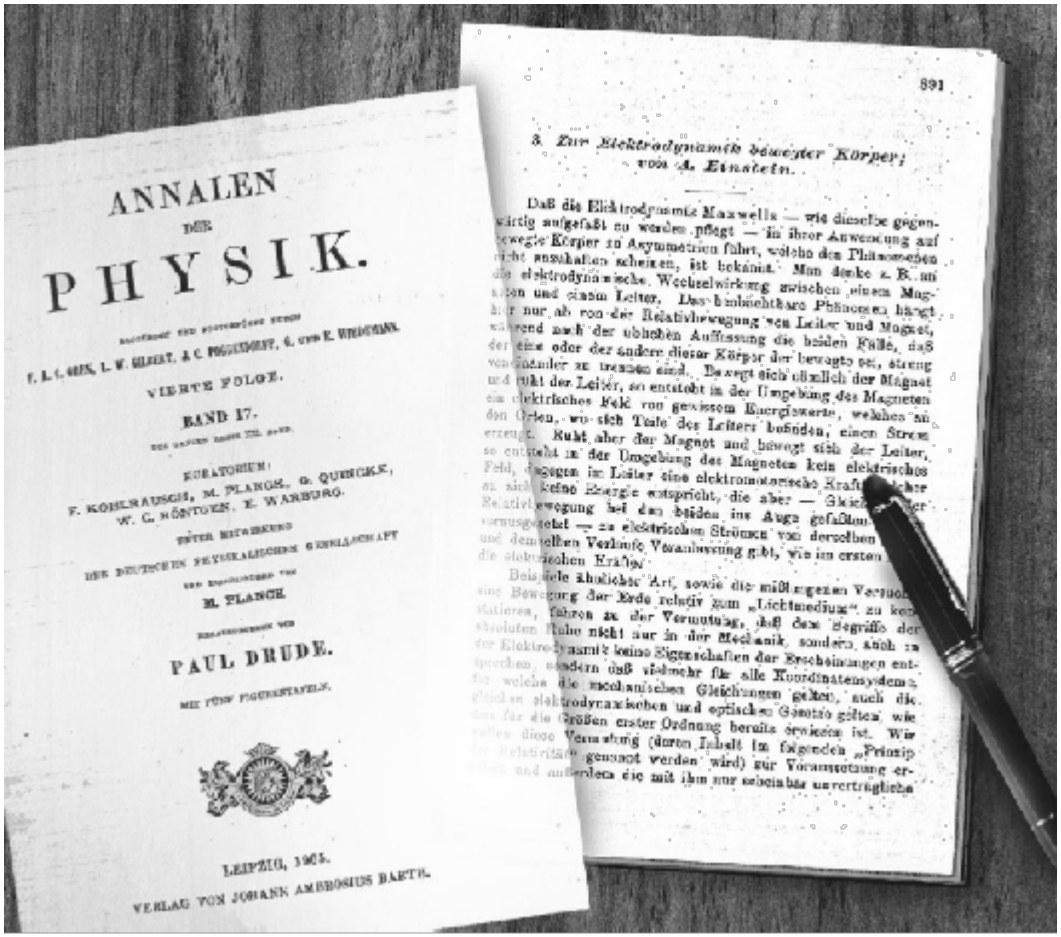
Surveying the Spacetime

The sorry state of surveying in the mythical kingdom was not unlike the state of physics in the late 19th century. As the experiments became ever more sophisticated and precise, evidence grew that something was amiss, that Newtonian mechanics was not describing the Nature correctly.

It took the genius of Einstein to uncover the hidden problems, which were very much the same as in the Parable: the reference frames and the different units.



Einstein’s original article on Special Relativity



A thought experiment
(do not try this at home!)

To John, the two sparks are 33.69 nanoseconds and 2 meters apart.

To the merry folks in the rocket, the two sparks are 33.0228 nanoseconds and 0 meters apart.

What do we do?

First, we realize that we need to measure space *and* time in the *same* units. Strange? – Yes! But most helpful. We use a conversion coefficient of 299,792,458 m/s (which, conveniently, is the speed of light). Then John's measurements are:

time = 10.1 meters

space = 2 meters

For the Rocket folks, we have:

time = 9.9 meters

space = 0 meters.

The measurements are still *different*, but here's the new trick: we define the *interval* between *events* as:

$$interval^2 = time^2 - space^2$$

THE INTERVAL

$$INTERVAL^2 = TIME^2 - SPACE^2$$

Indeed, when we compare the value of the interval as measured by John and as measured by the jolly folk in the Rocket, they are the same 9.9 meters of spacetime

Events and intervals

- In this course we will manipulate the intervals all the time. But... the interval between what and what?
- Another central concept is the *event*. Events (in physics) are defined in spacetime by their space *and* time coordinates. Remember: an event, to be classified as an one, must have a well-defined spatial position and a well-defined time it occur.
- The two sparks in the Rocket story were events. Of course, there's no such thing as a perfect event – everything in the physical world has a finite size and last a non-zero amount of time. We just need to understand the relevant scale of the problem.

Special Relativity

- “Special” : only works for inertial reference frames
- “Relativity” : there is no unique, *absolute* reference frame
- “Special Relativity” : “laws of physics are the same in all (inertial) reference frames”