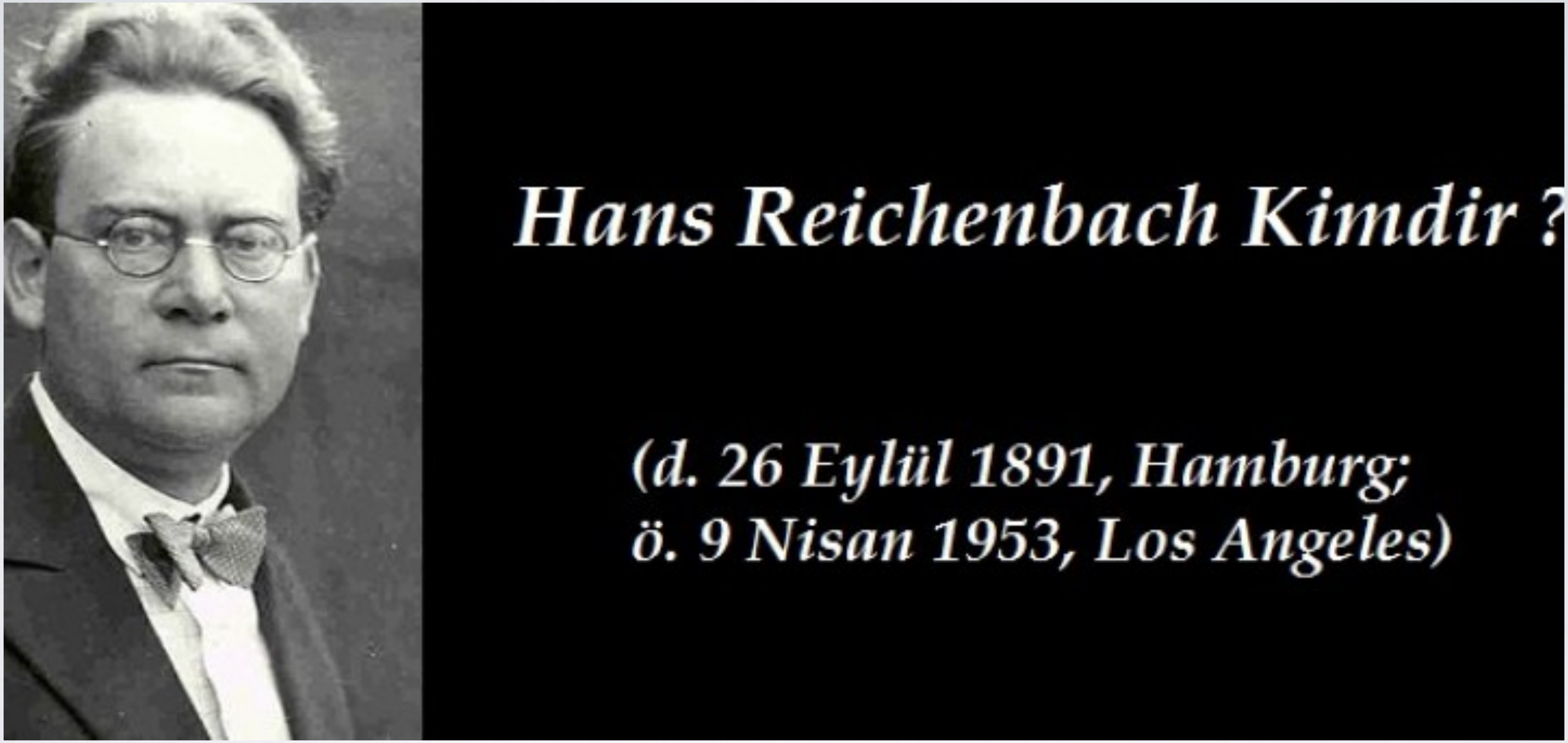
REICHENBACH ON SPACE (CH. 1)

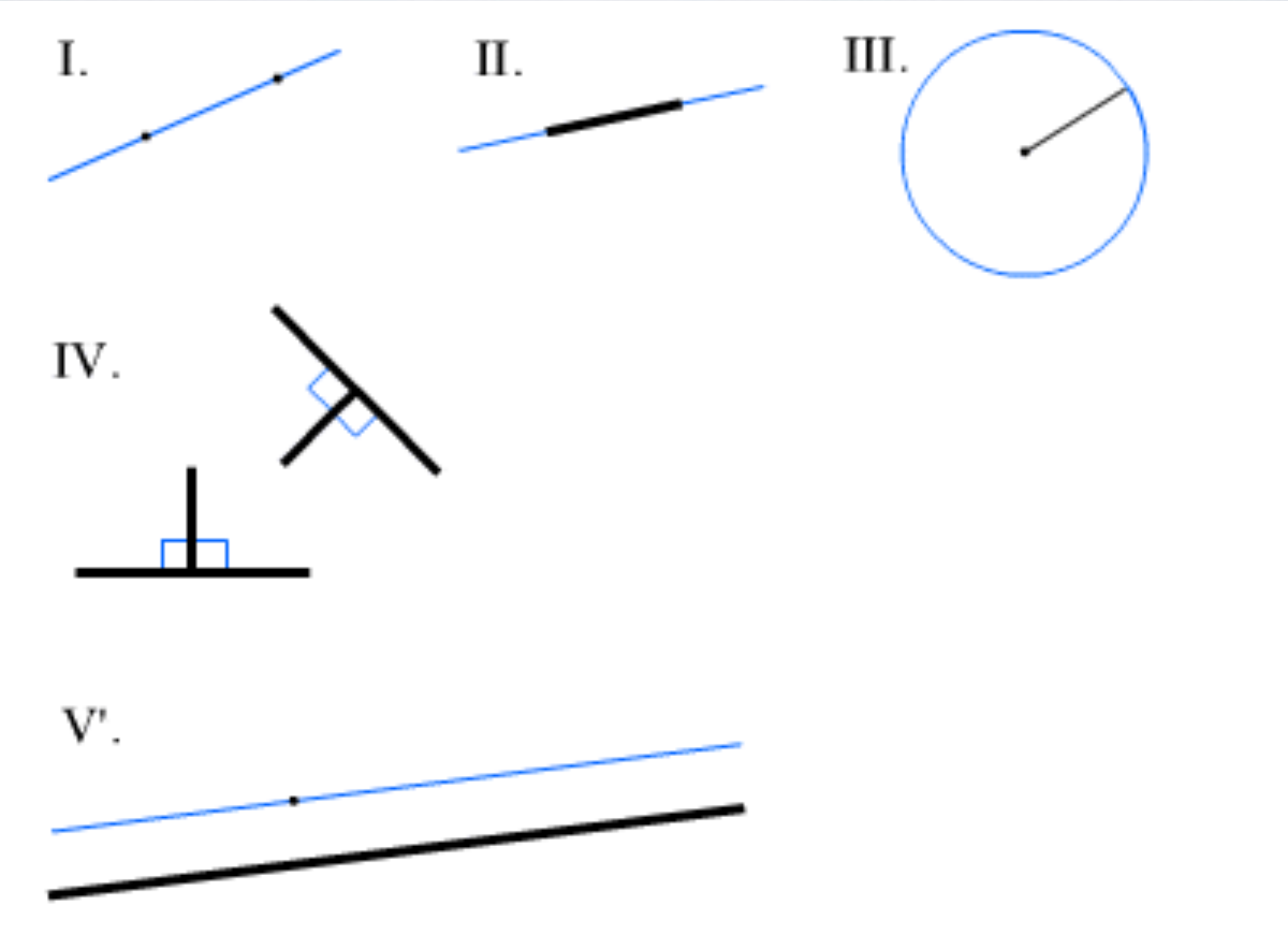
In which space(time) do we live?


Hans Reichenbach Kimdir ?
(d. 26 Eylül 1891, Hamburg;
ö. 9 Nisan 1953, Los Angeles)

PLAN

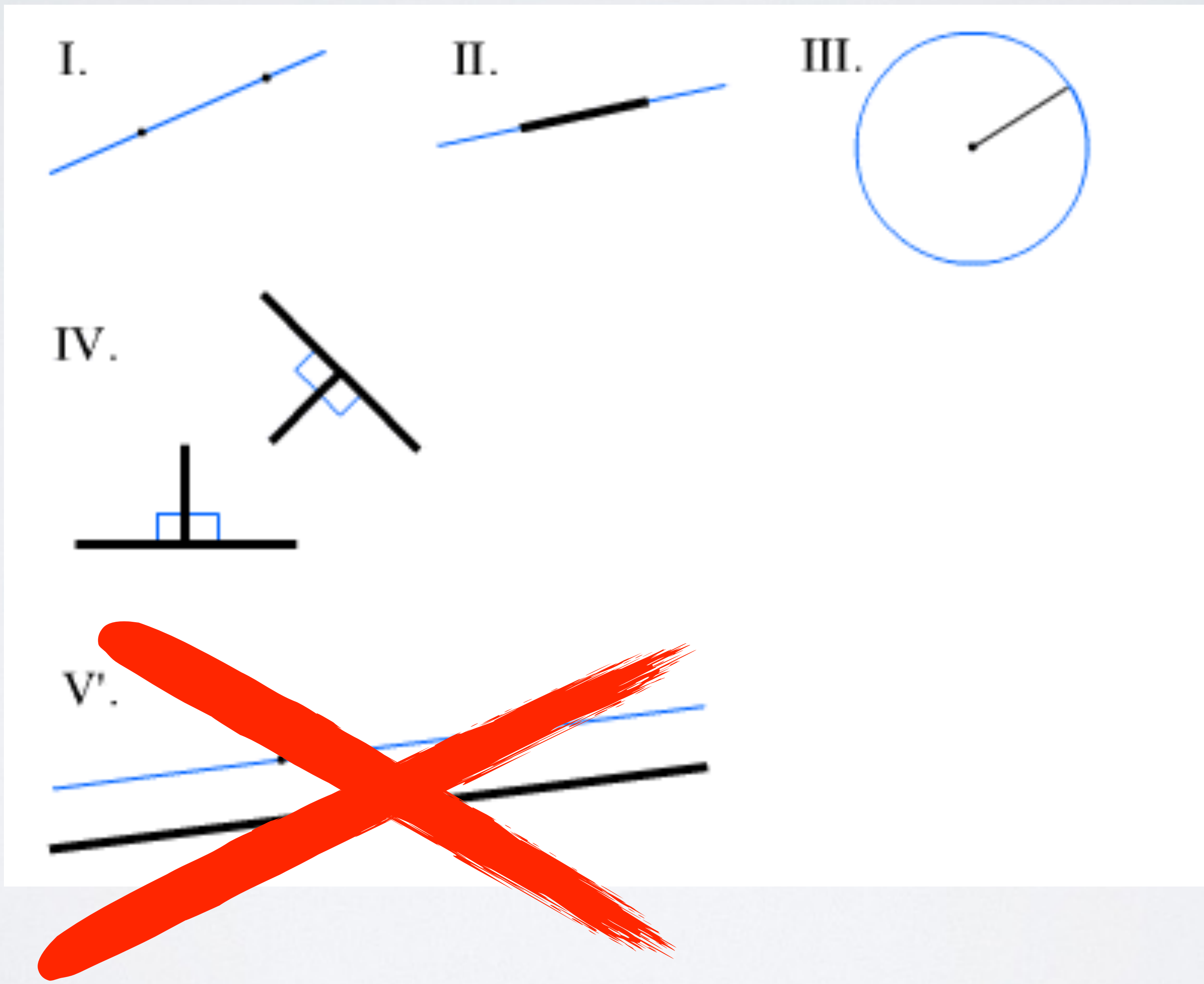
- On non-Euclidean geometry
- The epistemological problem of space

EUCLID'S 5 AXIOMS



LEAVE OUT 5TH AXIOM?

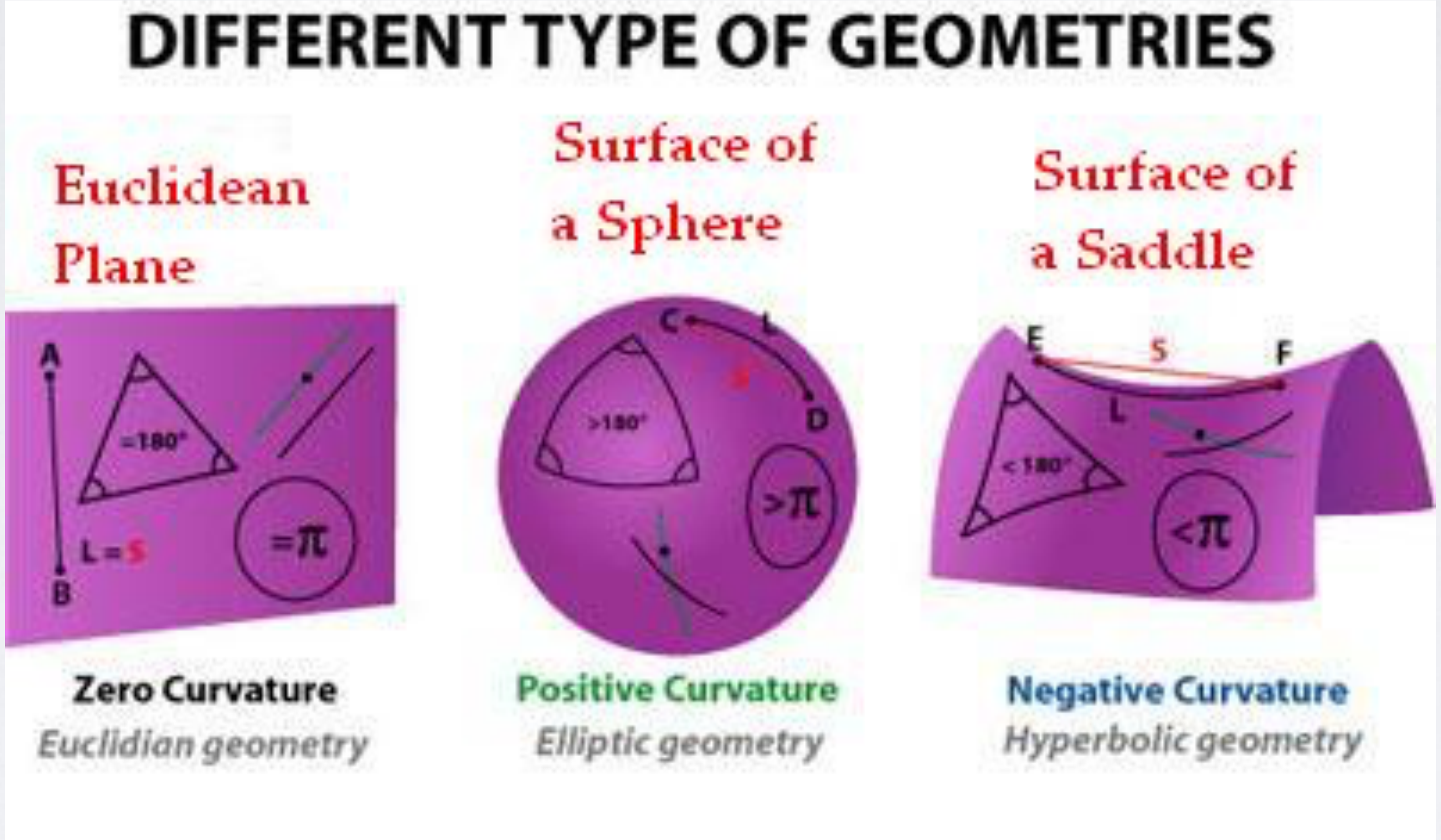
why the 5th?



consequences for geometry and physics?

consistency?

NON-EUCLIDEAN GEOMETRY



shifts

AXIOMATIC GEOMETRY —> ANALYTIC GEOMETRY

RIEMANNIAN —> PSEUDO-RIEMANNIAN

EXAMPLE: SPHERE

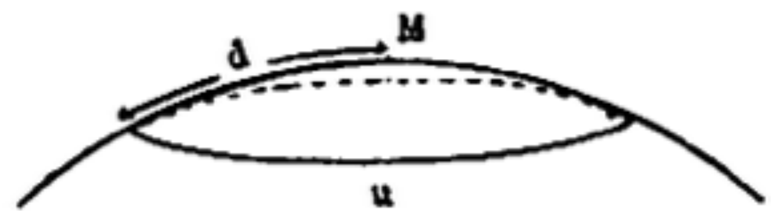


Fig. 1. Circumference and diameter of a circle on the surface of a sphere.

intrinsic geometry vs. extrinsic geometry

THE EPISTEMOLOGICAL PROBLEM OF SPACE

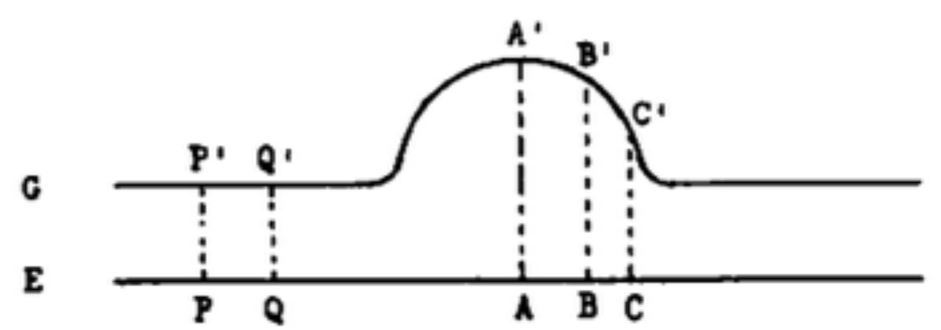


Fig. 2. Projection of a non-Euclidean geometry on a plane.

UNIVERSAL FORCE F on plane E such that

a) F affects all materials in the same way
b) there are no insulating walls

*what about light?

Problem: Can we tell in which geometry we live despite the UNIVERSAL FORCE AMBIGUITY?

THE EPISTEMOLOGICAL PROBLEM OF SPACE

Geometry=Geometry’+UNIVERSAL FORCE

Problem: Can we tell in which geometry we live despite the UNIVERSAL FORCE AMBIGUITY?

UNIVERSAL FORCES?

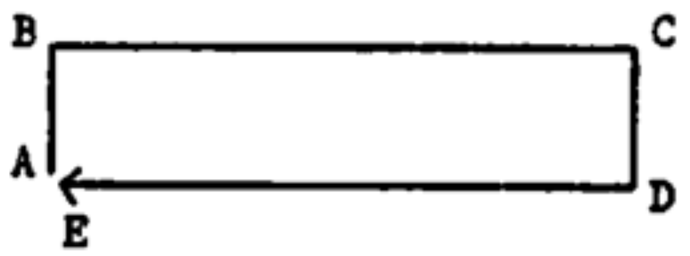
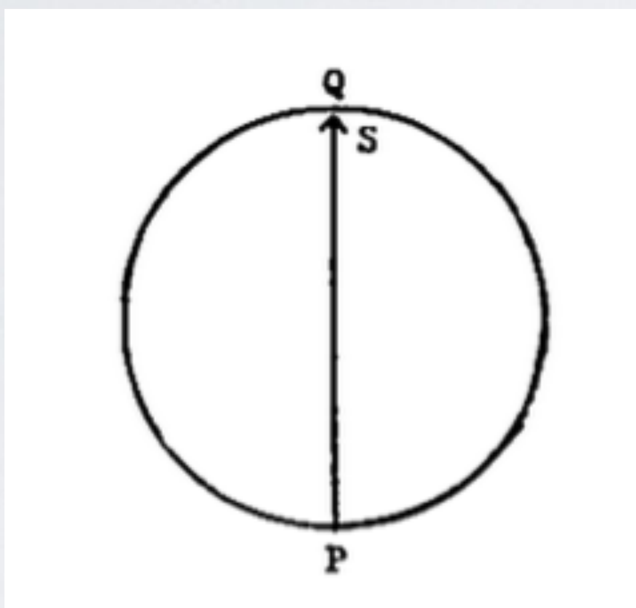


Fig. 3. Sketch of an apparatus for the measurement of heat expansion.

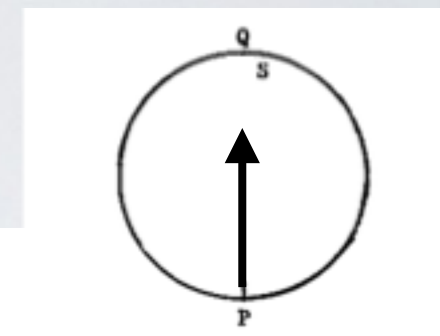
- vs. DIFFERENTIAL FORCES (affects different materials differently)

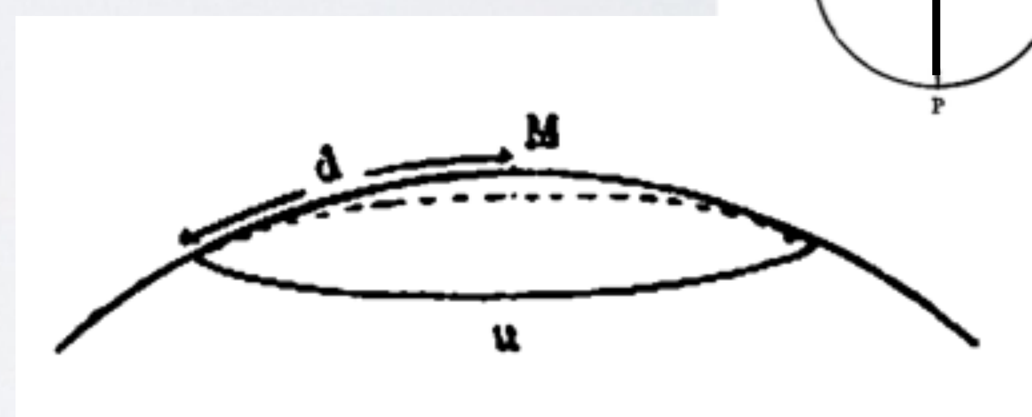
UNIVERSAL FORCES?

THERMOMETER…



…OR SPACETIME INDICATOR?





Curved space

UNIVERSAL FORCES?

- Force in the sense of *geometrical change*
- Force in the *usual* physics' sense? Not really (cf. Weatherall, Manchak 2014)

UNIVERSAL FORCES
F s.t.
geometry'+F=geometry

coincidence preserving forces

THE EPISTEMOLOGICAL PROBLEM OF SPACE

Geometry=Geometry'+UNIVERSAL FORCE

Problem: Can we tell in which geometry we live despite the UNIVERSAL FORCE AMBIGUITY?

Reichenbach's answer: question presupposes that talk about geometry *and* universal force is well-defined **(it is not)**

EXCURSION

COORDINATIVE DEFINITIONS

- physics builds on
  - *reductive definitions*
  - *AND coordinative* definitions (co-defs)
- co-defs are *partly* arbitrary

EXCURSION

COORDINATIVE DEFINITIONS

- *unit of length*

- *congruence of length:* comparison of two unit lengths at different locations

EXCURSION

COORDINATIVE DEFINITIONS

- DEFINITION OF CONGRUENCE
  - *„The problem does not concern a matter of cognition but of definition. There is no way of knowing whether a measuring rod retains its length when it is transported to another place…"*
  - *one way (in our simple world): transported* ***rigid*** *rods register geometry and only geometry*
  - *another way (in our and other worlds): each space point has own unit*

EXCURSION

COORDINATIVE DEFINITIONS

- *rigid rod: solid bodies — not affected by diff. forces — universal forces are neglected*
- *realized if internal forces >> external forces*

REICHENBACH'S SOLUTION

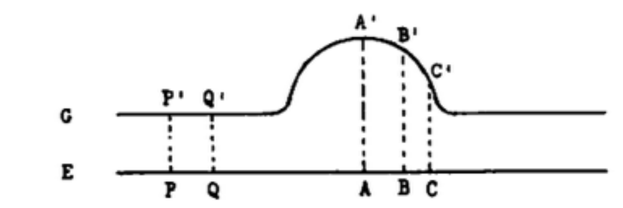


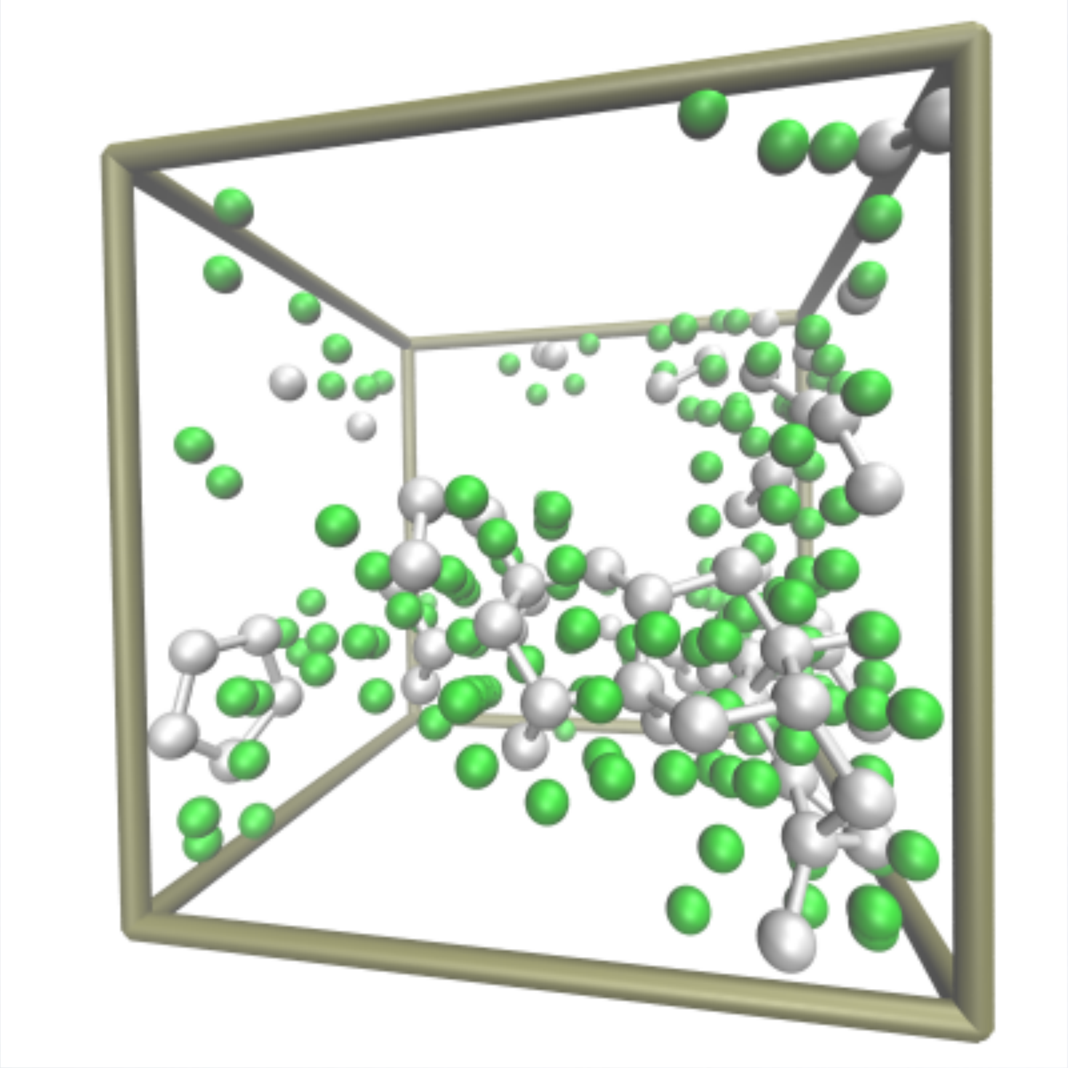
Fig. 2. Projection of a non-Euclidean geometry on a plane.

- *„… whether AB=BC is not a matter of cognition but of definition. If in E the congruence distances is defined in such a way that AB=BC, E will be a surface with a hump in the middle; if the definition reads differently, E will be a plane.“*

- geometry hinges on preceding coordinative definition (not a question of true or false)

CONCERNS

not being able to measure the *right geometry does not mean that it does not exist, or?*



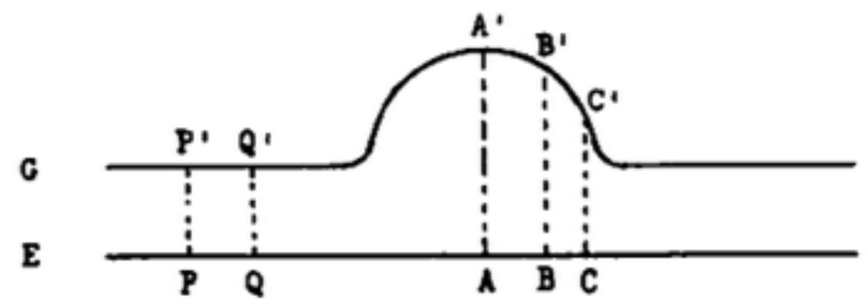


Fig. 2. Projection of a non-Euclidean geometry on a plane.

technical impossibility

logical impossibility

CONCERNS

But can’t we single out the geometry which is *simplest*?

AGAIN: You cannot get started without coordinative definitions. Question should be rephrased as: which coordinative definition is the simplest one?

As a matter fact: coordinative definition such that a) the logical simplest and b) in continuity with our previous notions

Favour the rigid rod definition for congruence?

OTHER SOLUTIONS SKLAR

- REDUCTIONIST (REICHENBACH)
- ANTI-REDUCTIONIST
  - SKEPTIC
  - CONVENTIONALIST (?)
  - APRIORIST (KANTIAN, NEO-KANTIANS)

WHY „REDUCTIONIST“?

- „same meaning for theories with exactly the same observational content“ — equally true theories
- no reductionism in the strong sense: no reduction of the actual meaning to observational content

APRIORIST'S REPLIES

Reply 1

measurement devices are built and used under the presupposition of Euclidean geometry

how can they then be used to infer non-Euclidean geometry?

APRIORIST’S REPLIES

Reply 2

Visual self-evidence forces us to believe in the „truth“ of Euclidean geometry

THE UPSHOT

- no one runs around shouting: how long is a meter? how long is it really?
- similarly, we should not run around asking: which pair of (geometry, universal force) is the right one
- BEFORE talking about units/geometry/…, we have to make our coordinative definitions

MORE?

- continue reading chapter 1 to the end
- for extensive material on the other positions, see *Sklar*
- interesting cross relations of debate to
  - hole argument, AB-effect, gauge symmetries, …?