

# 3D Time: From Transportation to Physics

## *Part 2: Objections*



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## Objections to 3D time

- Eight objections
- Show 3D time is possible
- Show 3D time makes sense
- Parallels between space & time
- Time is duration

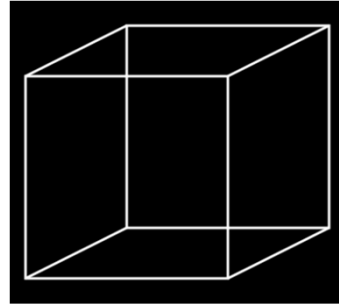


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## Objection #1: Time is measured by clocks, which measure only 1D

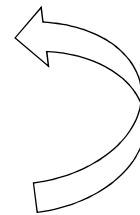
- Length is measured by rulers –
  - and rulers measure only 1D
  - So 3D space takes 3 rulers
    - or 3 measurements by 1 ruler.
- Time is the same way –
  - 3D time takes 3 clocks
    - or 3 measurements by 1 clock
- So time is not limited to 1D.



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## Objection #2: Direction is a property of space, not of time

- Turns in space are measured by angles
  - An angle is part of a circle
- Turns in time are measured by rotations
  - A minute hand turns  $360^\circ$  in an hour
    - So one minute of rotation is  $360/60 = 6^\circ$
- Turning takes place in space and time.



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## Objection #3: We cannot go backwards in time as we can in space

- It depends on what you mean by “backwards”.
- A ruler measures forwards or backwards
  - It’s the same distance
- A clock counts up; a timer counts down:
  - It’s the same duration
- Many measurements are the same
  - backwards and forwards



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## Objection #4: Time flows in one direction

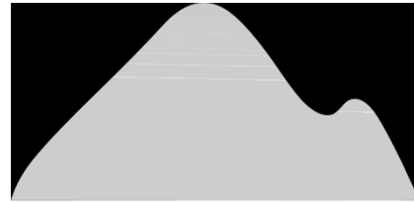
- A clock moves in one direction
  - and the numbers on a ruler are in one direction
- Time “flows” because clocks keep on ticking
  - but stopwatches come to a stop
- Time is often an independent variable
  - so time is seen to be independent
  - distance can be independent, too



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## Objection #5: The arrow of time is one-way; we cannot change the past.

- Yes, the past cannot be changed.
- Past measurements cannot be changed.
  - Past measurements of *distance*
  - Past measurements of *duration*
- Measure altitude going up a hill
  - earlier measures cannot be changed
- The past applies to everything

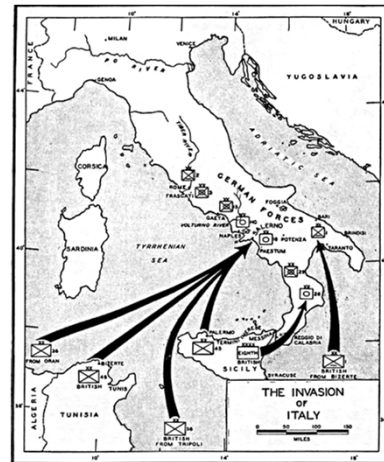


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## Objection #6: Events are ordered by time in a linear sequence

- Events may be ordered in many ways.
- One way is by the date & time
  - counting up or down
- Another way is by the location
  - e.g., a sequence of battles
- Narrators use many orderings
  - e.g., a flashback

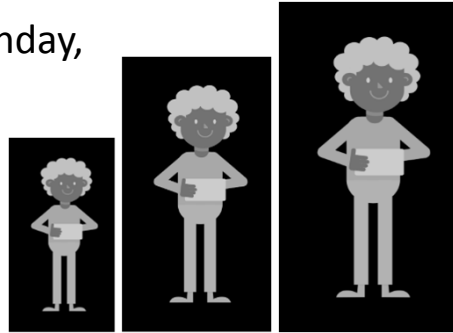


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## The order of events

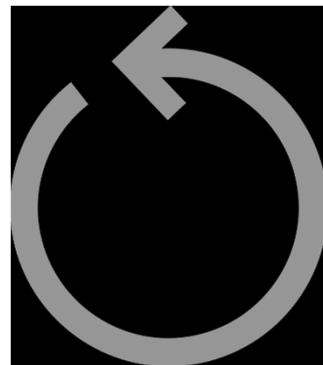
- If we order events by time,
  - that is not the same as time itself
- Record a child's height on their birthday,
  - and order birthdays by height:
  - that is not the same as space
- Timeline orders events by time
- *Placeline* orders events by place



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## Objection #7: We can return to the same place but not to the same time

- We cannot return to exactly the same place
  - places change over time
  - "you can't step in the same river twice"
- We cannot return to the same event
  - an event is in place A at time B
  - which cannot be repeated.
  - a periodic event is never the same
- So the past cannot be repeated



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## Objection #8: Only one dimension of time has been observed

- Well, until now!
  - 3D time is as ordinary as 3D space
- Related to ancient views
  - e.g., the sun on a journey in time
- Physicists have studied 3D time
  - many papers since 1975
  - no one has said what 3D time is,
  - until now.



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## In conclusion

- Remember that time is duration –
  - counting forwards or backwards.
  - 3D requires three measurements.
- The past affects all measurements.
- The order of events is not the same as time.
- *So time can be 3D.*
- Next up is *Part 3: Kinematics I*



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