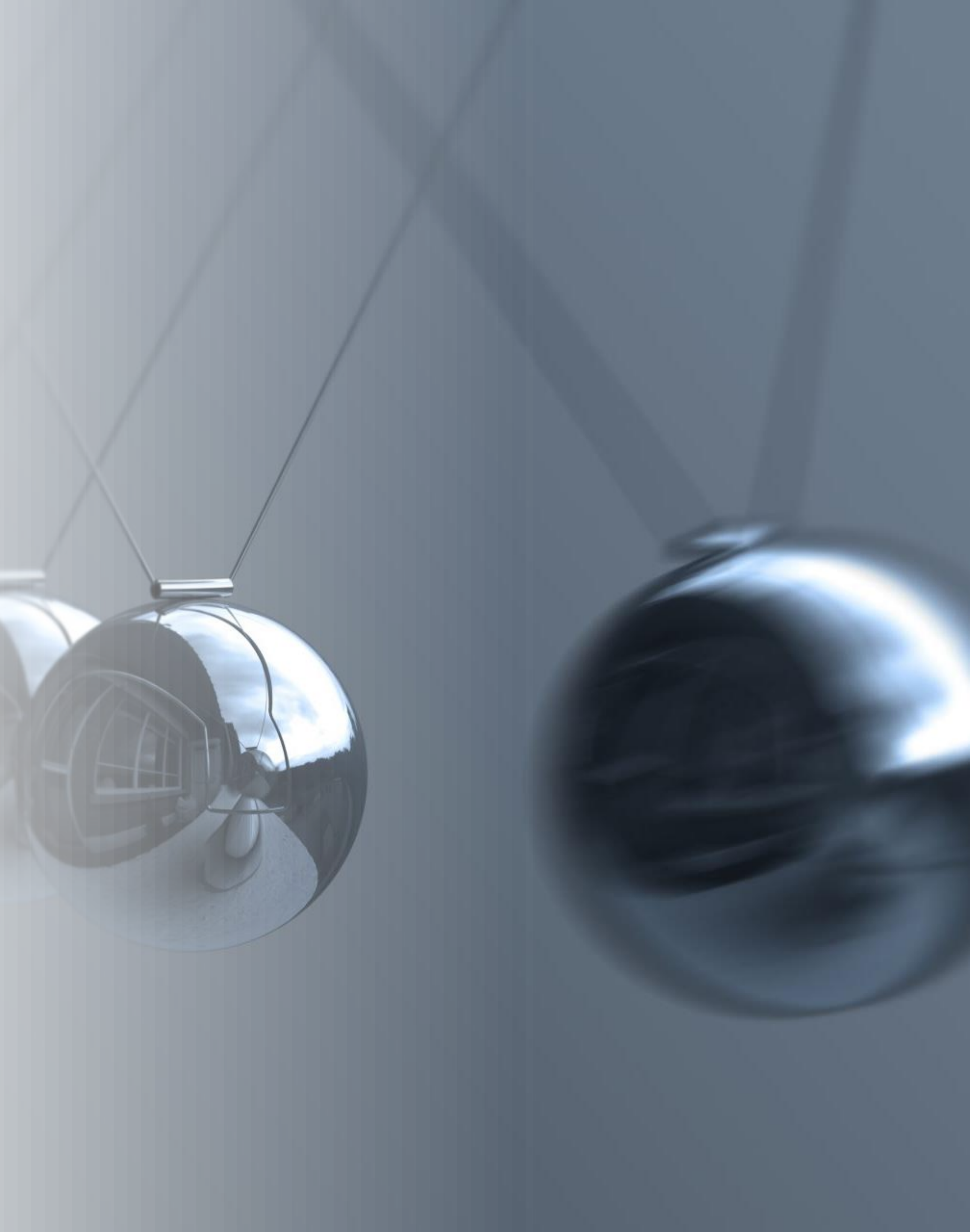
CSU44054/CS7GV4: ~~Augmented~~ eXtended Reality

Gareth W. Young

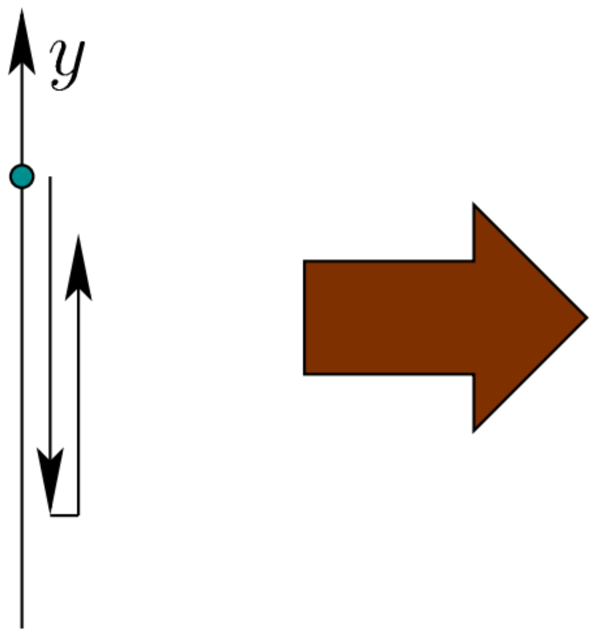
Motion in Real and Virtual Worlds

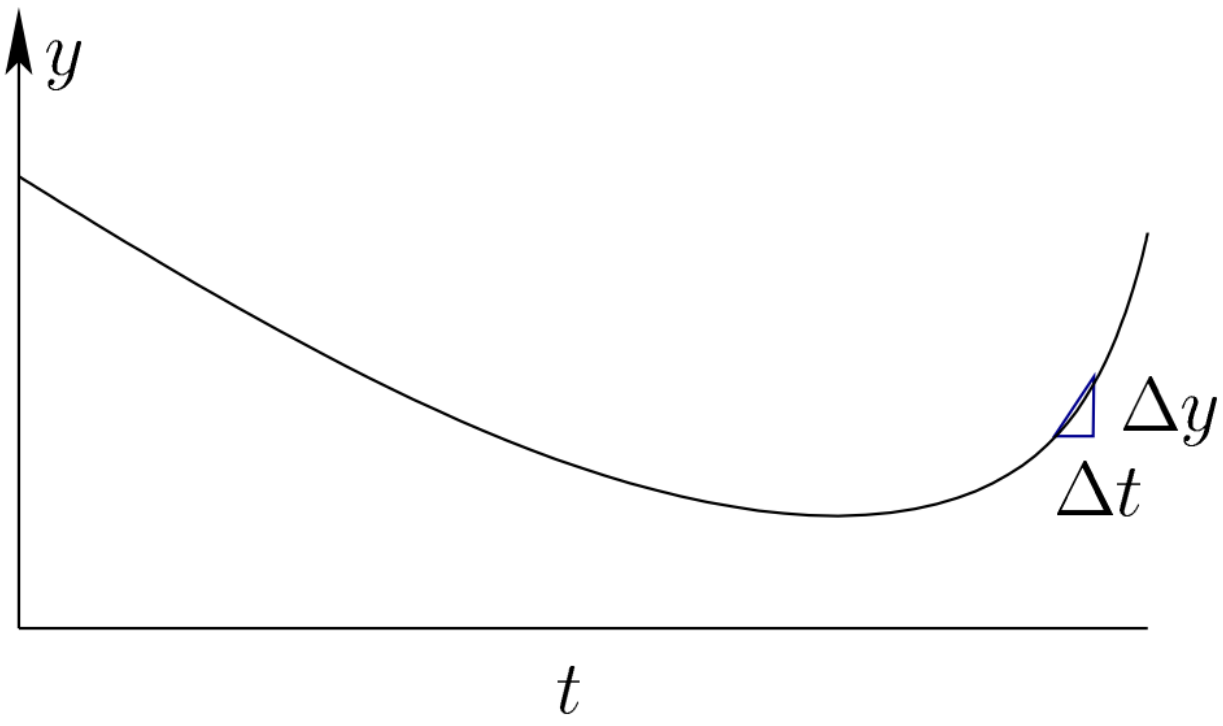
- Velocities and Accelerations
- The Vestibular System
- Physics in the Virtual World
- Mismatched Motion and Vection



Velocities and Accelerations

In a one-dimensional world

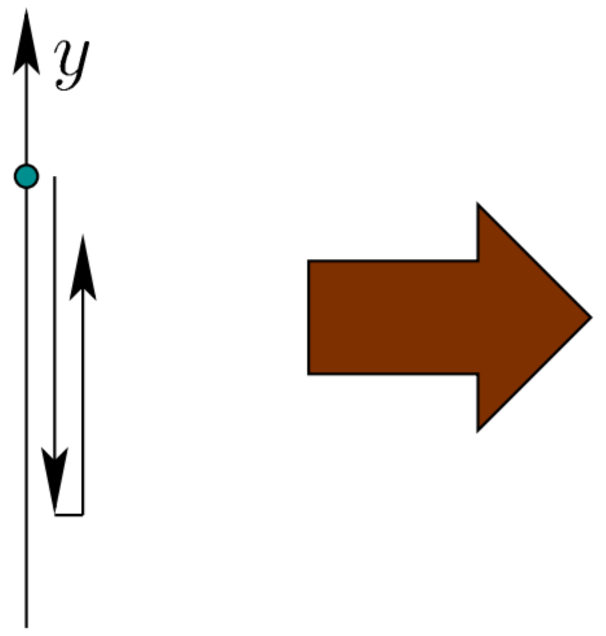


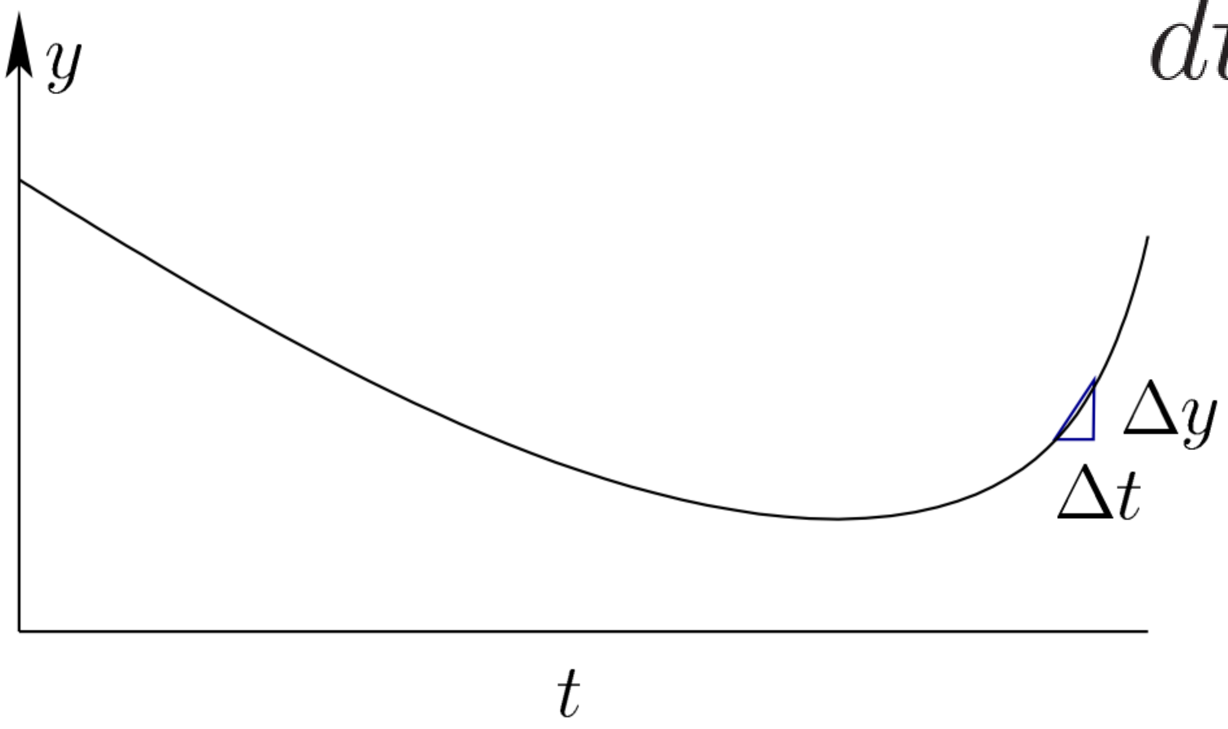


Velocities and Accelerations

In a one-dimensional world

$$v = \frac{dy(t)}{dt}$$





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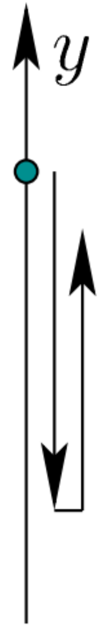
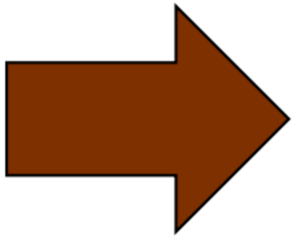
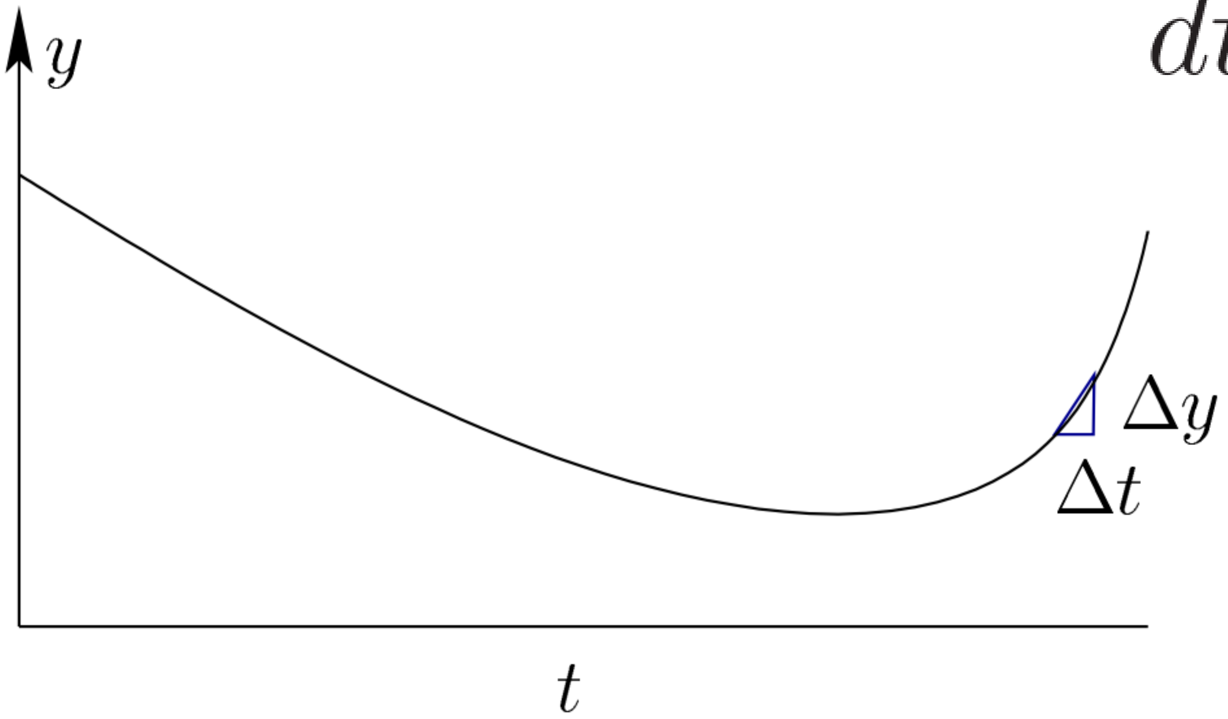


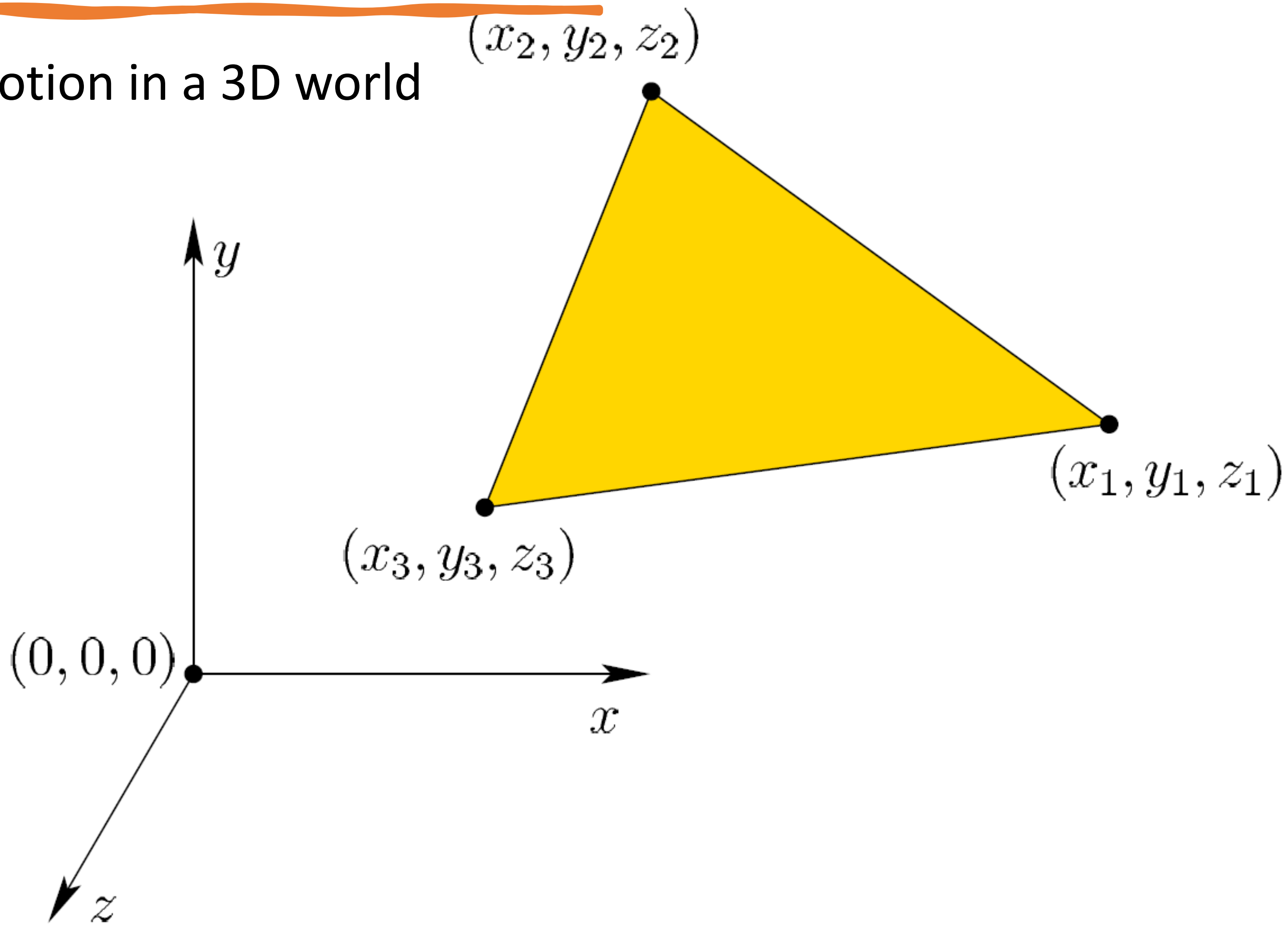




$$a = \frac{dv(t)}{dt}$$

Velocities and Accelerations

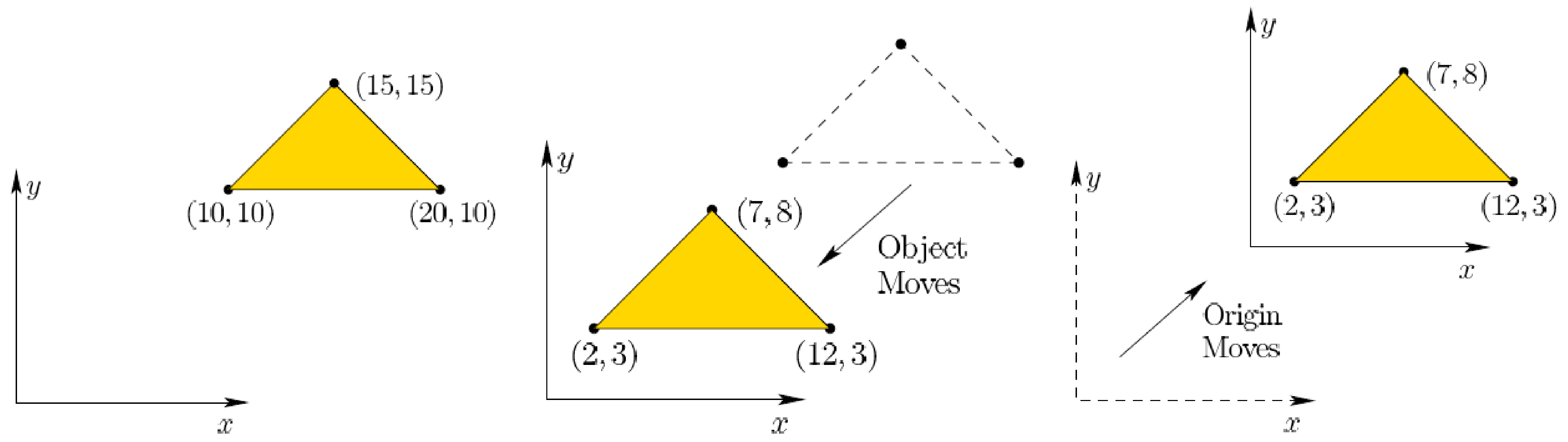
Motion in a 3D world



- A moving point
    - x(t), y(t), z(t)

$$v = \frac{dy(t)}{dt}$$

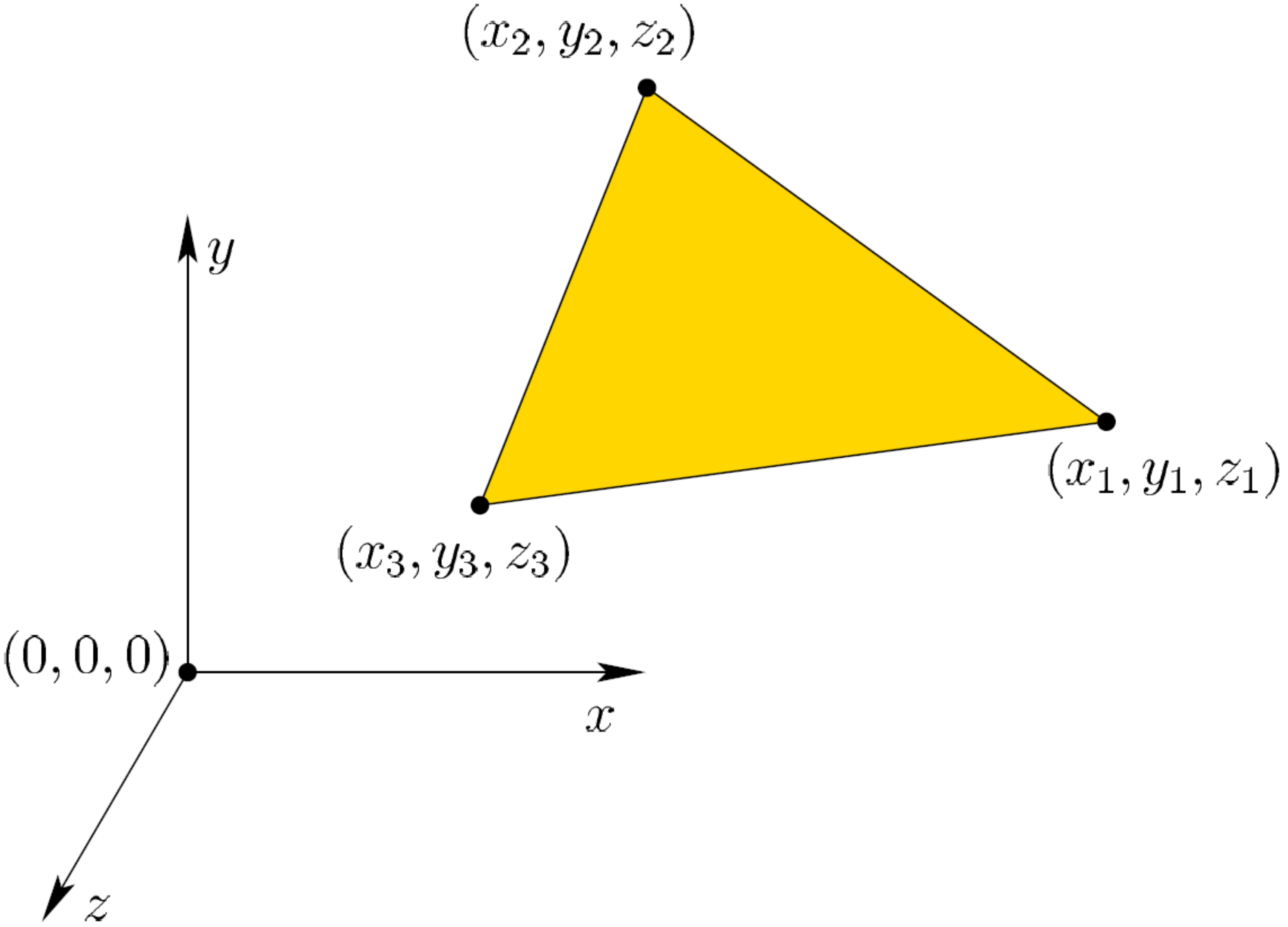
$$a = \frac{dv(t)}{dt}$$



(a) Original object (b) Object moves (c) Origin moves

The Geometry of XR Worlds

- Rigid-body motion
- 3D angular velocity
- Angular acceleration



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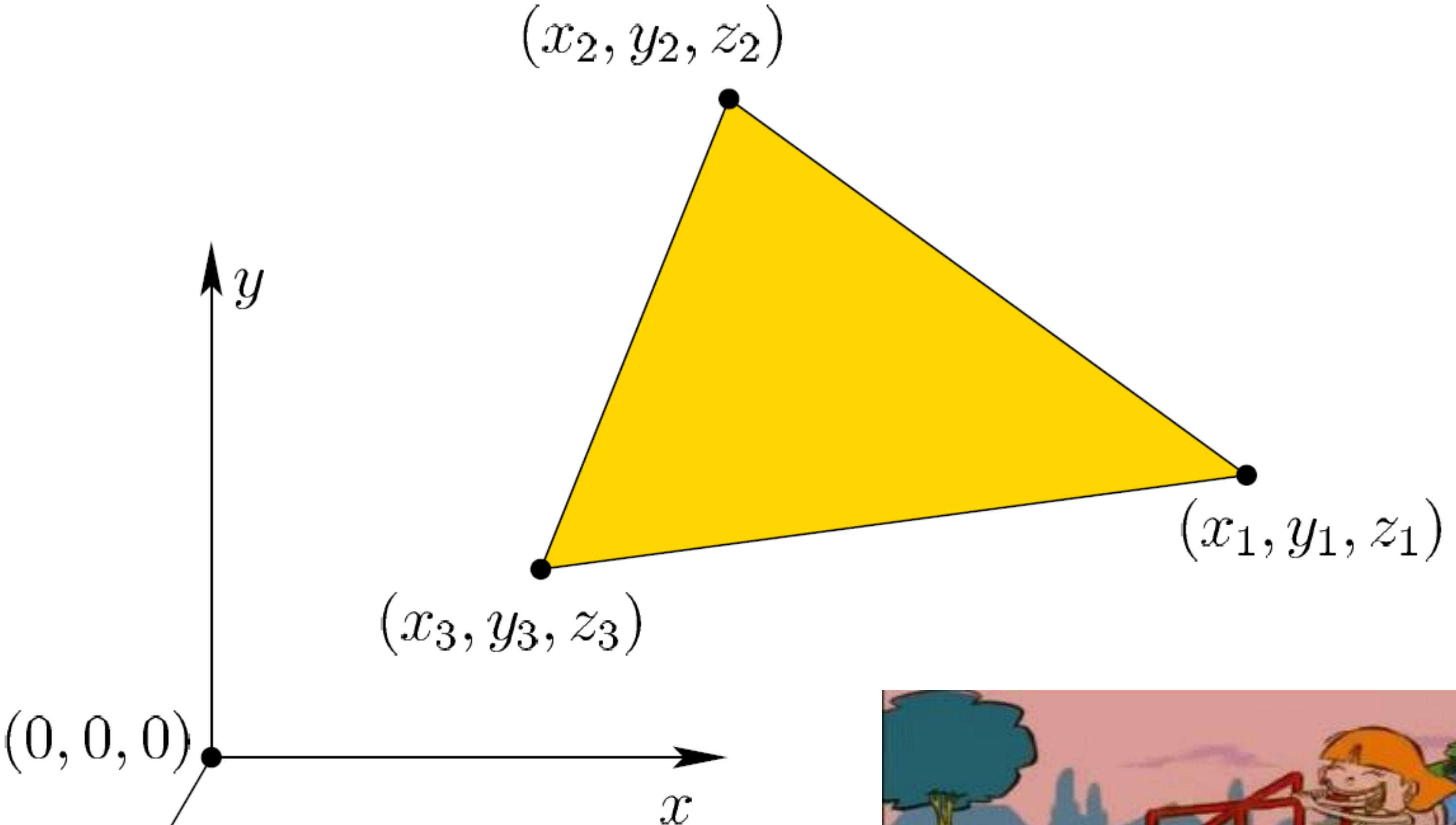
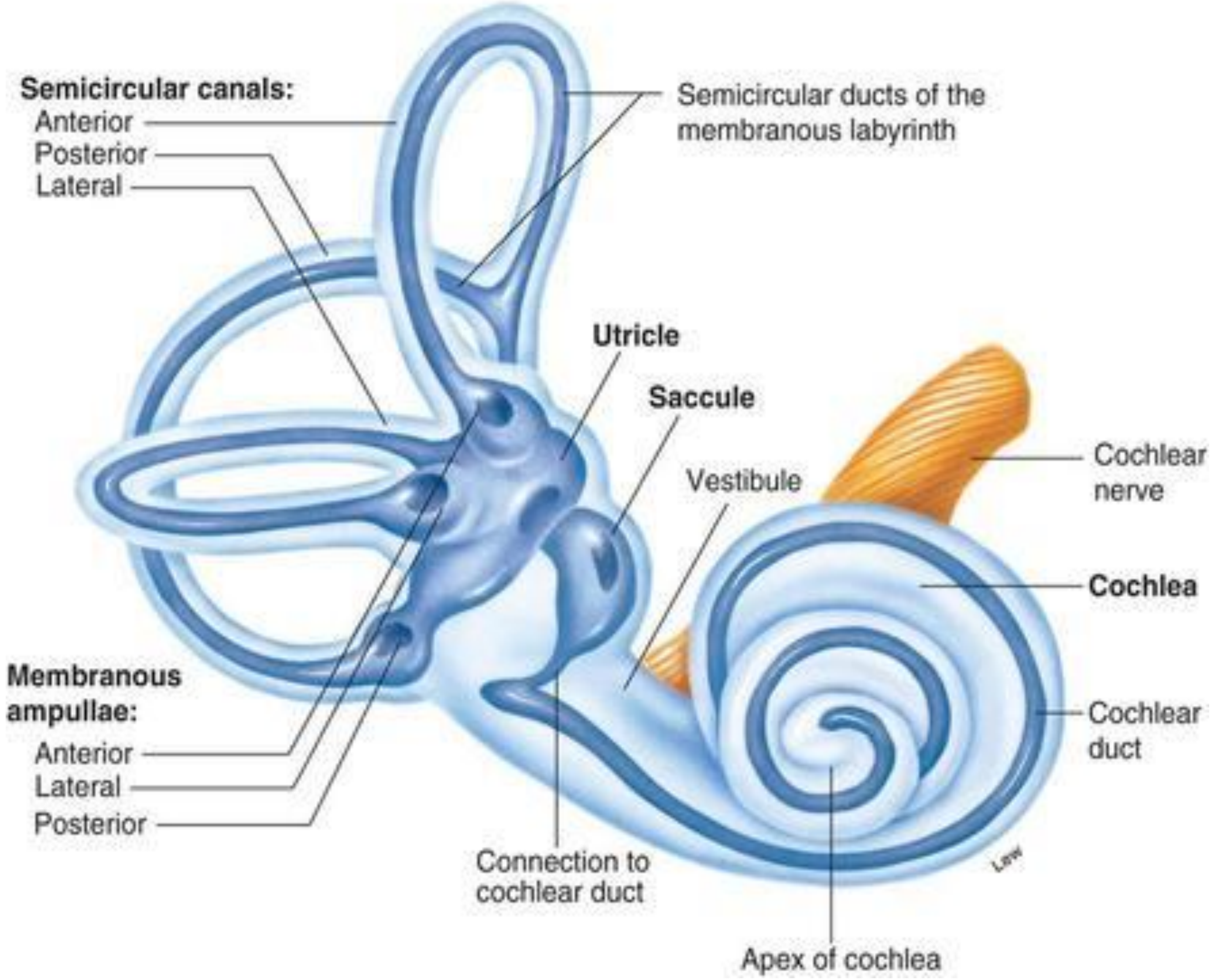
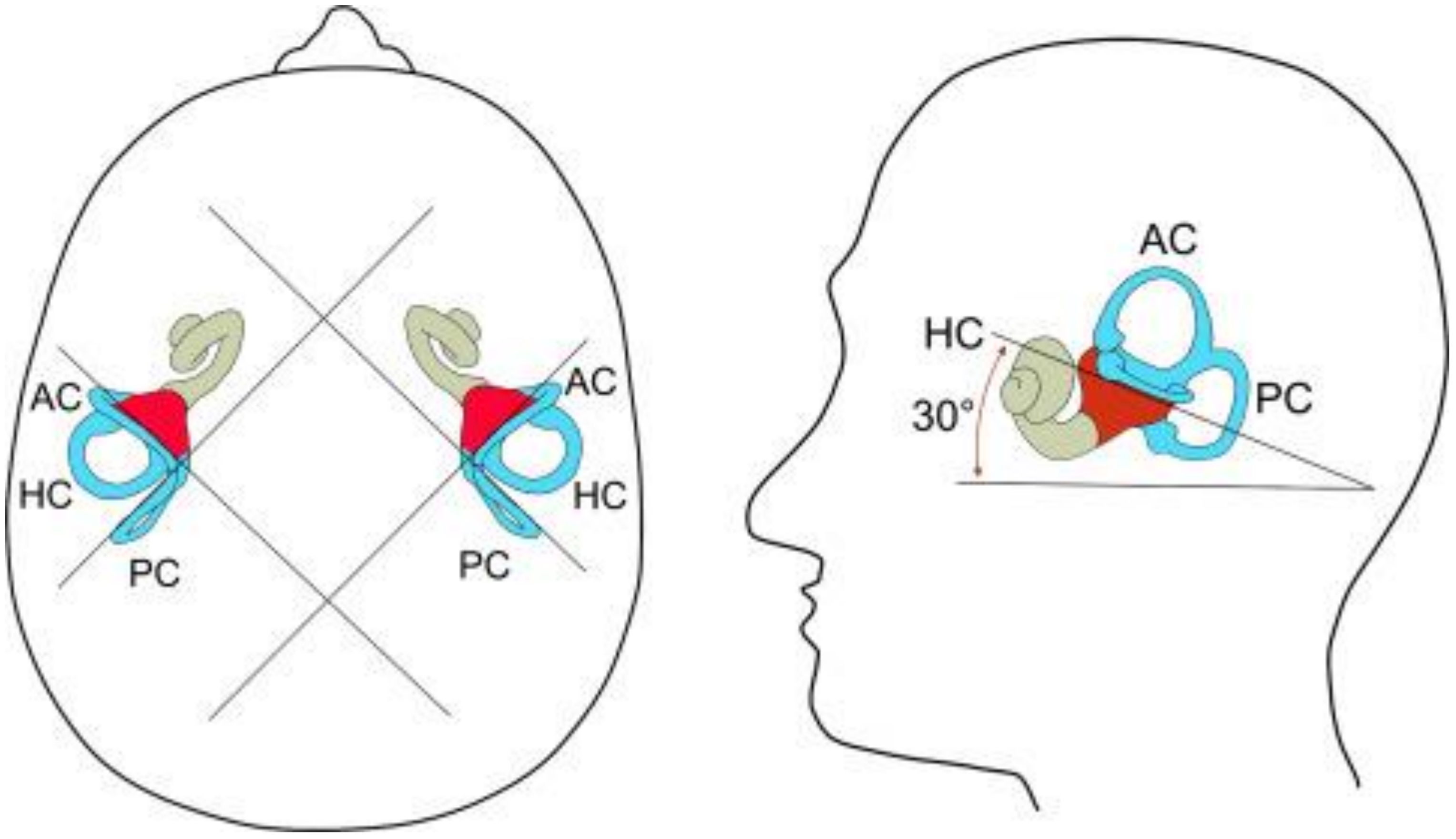


The Vestibular System



The Vestibular System

- Sensing linear acceleration
- Angular acceleration



The Vestibular System

- Impact on perception

Physics in the Virtual World

- Tailoring the Physics to the Experience

Physics in the Virtual World

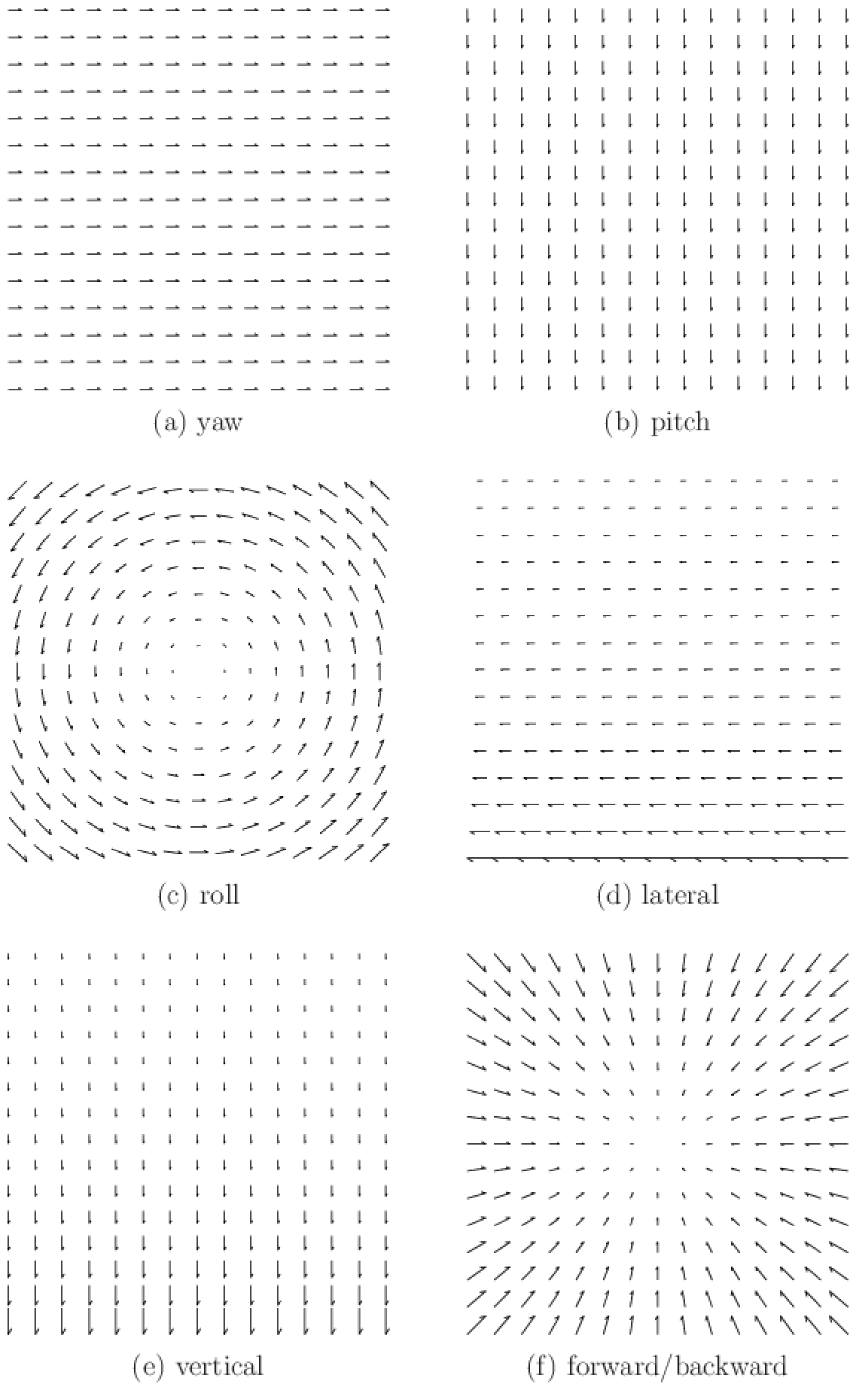
- Will the matched zone remain fixed, or will the user need to be moved by locomotion? If locomotion is needed, then will the user walk, run, swim, drive cars, or fly spaceships?
- Will the user interact with objects? If so, then what kind of interaction is needed? Possibilities include carrying weapons, opening doors, tossing objects, pouring drinks, operating machinery, drawing pictures, and assembling structures.
- Will multiple users be sharing the same virtual space? If so, then how will their motions be coordinated or constrained?
- Will the virtual world contain entities that appear to move autonomously, such as robots, animals, or humans?
- Will the user be immersed in a familiar or exotic setting? A familiar setting could be a home, classroom, park, or city streets. An exotic setting might be scuba diving, lunar exploration, or traveling through the human body.

Mismatched Motion and Vection

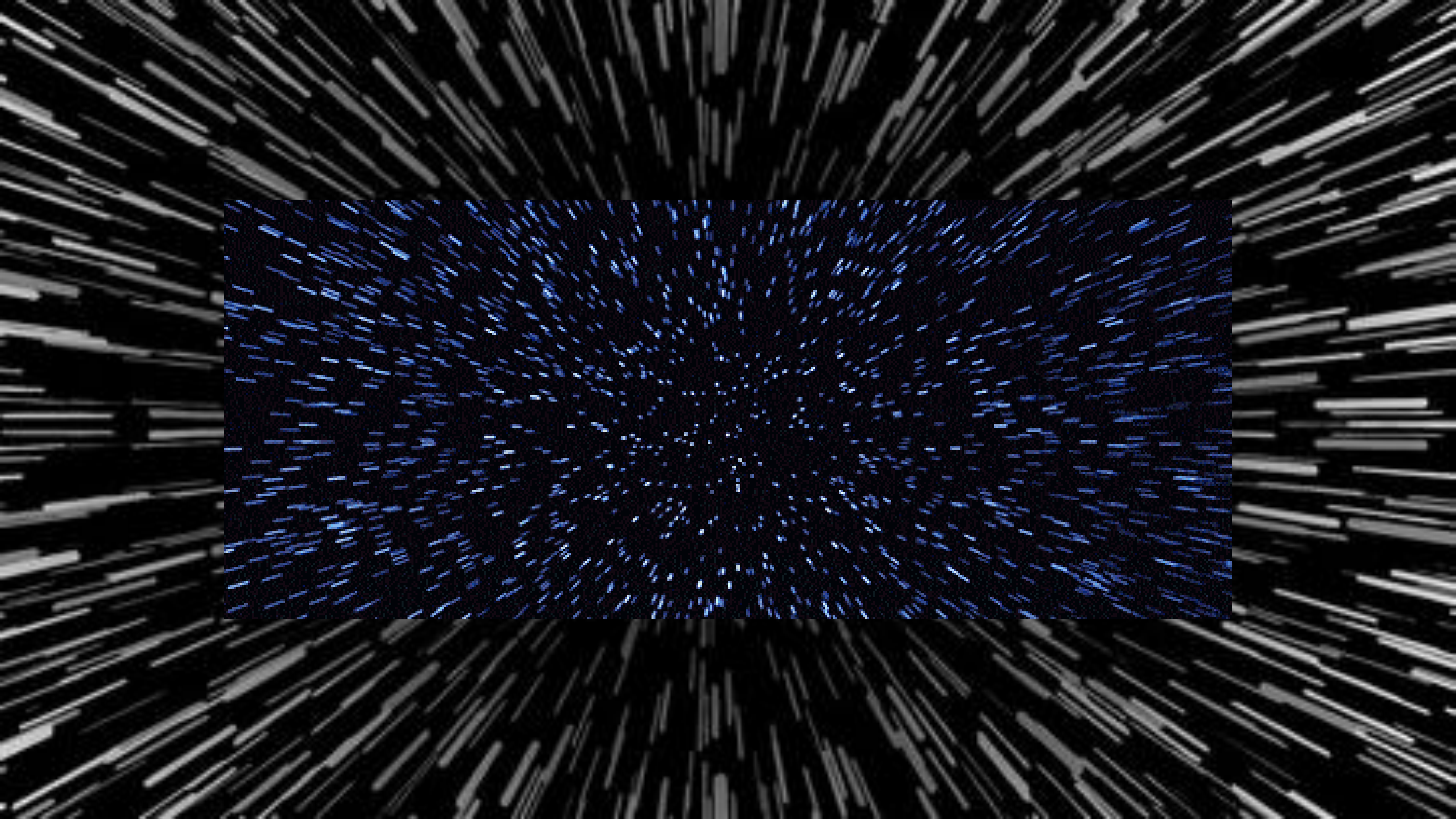
If a headset is better in terms of spatial resolution, frame rate, tracking accuracy, field of view, and latency, then the potential is higher for making people sick through vection and other mismatched cues.

Mismatched Motion and Vection

Types of vection



(a) yaw (b) pitch (c) roll (d) lateral (e) vertical (f) forward/backward



Factors that affect sensitivity

- Percentage of field of view
- Distance from center view
- Exposure time
- Spatial frequency
- Contrast
- Other sensory cues
- Prior knowledge
- Attention
- Prior training or adaptation

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Further Reading

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