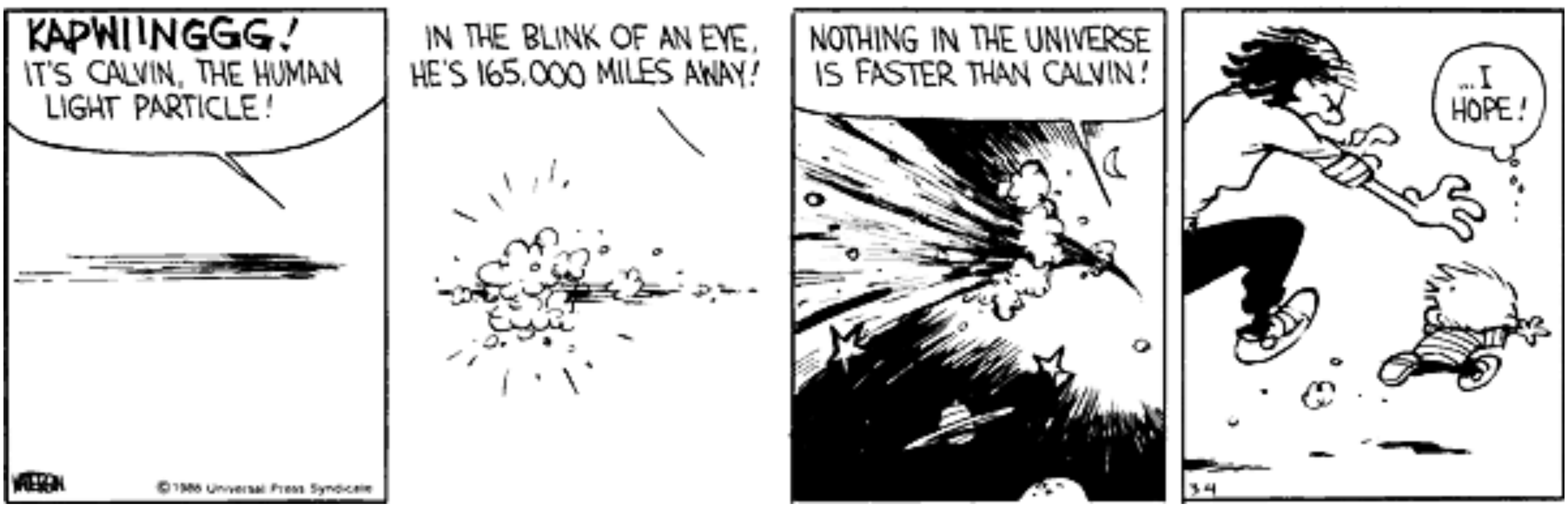
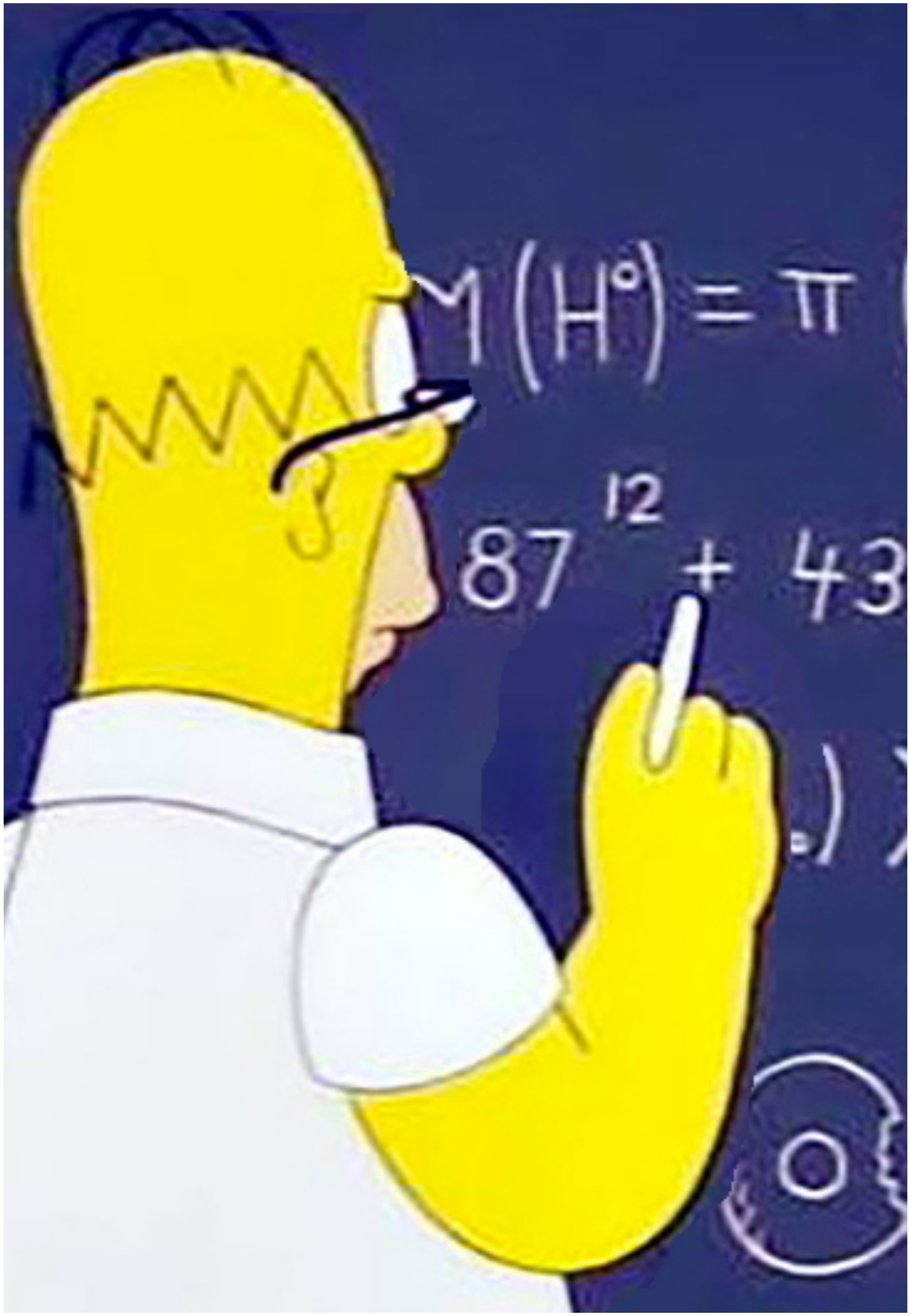
September 14, 2015 Physics 131 Prof. E. F. Redish

- **Theme Music:** **Johann Strauss II**
  Acceleration Waltz
- **Cartoon:** **Bill Waterson**
  Calvin & Hobbes





The Equation of the Day

Average and instantaneous acceleration

$$\langle a \rangle = \frac{\Delta v}{\Delta t}$$

$$a = \frac{dv}{dt}$$

Reading questions

- If acceleration is the second derivative of position, can you see acceleration in a position graph?
- Why does physics have so much focus on constant acceleration when in most cases acceleration is not constant?
- Why are we focusing so much on symbols?

What have we learned? Representations and consistency

- Visualizing where an object is at different times → a position graph
- Visualizing how fast an object is moving at different times → a velocity graph
- Position graph → velocity graph

slopes $\langle v \rangle = \dfrac{\Delta x}{\Delta t}$ $v = \dfrac{dx}{dt}$

- Velocity graph → position graph

areas $\Delta x = v\, \Delta t$ $\Delta x = \int v\, dt$

Graphing Velocity: Figuring it out from the motion

- An object in uniform motion has constant velocity.
- This means the instantaneous velocity does not change with time. Its graph is a horizontal line.
- You can make sense of this by putting your mind in “velocity mode” and running a mental movie.

The sonic ranger (motion detector)

- The sonic ranger measures distance to the nearest object by echolocation.
  - A speaker clicks 30 times a second.
    A microphone detects the sound bouncing back from the nearest object in front of it.
  - The computer calculates the time delay between and using the speed of sound (about 343 m/s at room temperature) it can calculate the distance to the object.

Foothold ideas: Acceleration

- Average acceleration is defined by

$$\langle \vec{a} \rangle = \frac{\Delta \vec{v}}{\Delta t} = \frac{\text{change in velocity}}{\text{time it took to do it}}$$

Note: an average acceleration goes with a <u>time interval</u>.

- Instantaneous acceleration is what we get when we consider a very small time interval (compared to times we care about)

$$\vec{a} = \frac{d\vec{v}}{dt}$$

Note: an instantaneous acceleration goes with a <u>specific time</u>.

Technical term alert!

- Note that in physics we use the term "**<u>acceleration</u>**" in a technically defined way:
  - "acceleration" = changing velocity
- The object may be speeding up or slowing down or keeping the same speed and changing direction. We still say "it is accelerating."
- In common speech
  "*acceleration*" = speeding up,
  "*deceleration*" = slowing down, and
  "*turning*"=changing direction.
- How many (physics) accelerators are there on your car?