
Overview, Dimensions, and the Scientific Method

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Why do we use special units in astronomy?

Overview, Dimensions, and the Scientific Method

Units, Symbols, and Basic Math

x **Units** (also see your text's appendices)

- Most quantities have units, with the most common exception being ratios
- Common system of units in science: MKS System
 - » meter-kilogram-second
 - » Other units are hybrids of these, e.g.:
 - Newton (N): $\text{kg}\cdot\text{m}/\text{s}^2$ (Force)
 - Joule (J): N·m (Energy)
 - Watt (W): J/s (Power)
- In astronomy, units are chosen to best fit the scale of the object(s) under study (e.g., nm, AU, ly, and Mpc)
- For any problem you solve, treat units separately and cancel/combine appropriately (also, unit conversion)

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What is Science?

- x Some “tools” for scientific progress
 - Error analysis
 - » How well do you know what you know?
 - Contradictory results
 - » Which results do you ignore?
 - Framing questions
 - » Creativity
 - Aesthetics
 - » How do you define simplicity, beauty?

What is Science?

- x Some Common Themes in Astronomy:
 - How far is it?
 - How fast does it move and why?
 - What are its physical characteristics?
 - What allows it to be detected?
 - How are any of the above features related?
 - What created it?

What is Science?

- x Hypothesis – A tentative explanation awaiting further development and testing.
- x Theory – A hypothesis or set of hypotheses that have been well tested and verified.
 - Must be careful to understand the domain of spatial and temporal scales under which the theory is shown to be valid

What is Science?

- x **Laws of Nature**
 - The rules of the game played by nature
 - » Universal
 - Laws cannot be suspended
 - » Good science fiction
 - Laws may be modified with better understanding
 - » e.g. Kepler's Laws → Newton's Laws → Einstein's Special Relativity

What is Science?

- x **A scientific model is a theory that accounts for a set of observations in nature.**
 - For example, stars residing on a giant spinning celestial sphere is a model that explains the rising and setting of the stars (geocentric model).
- x **A scientific model is not necessarily a physical model.**
 - In the above example, the Sun's motion relative to the stars is explained as the motion of the Sun along a path on the celestial sphere, even though the "real" universe is heliocentric.

What is Science?

- x **Three modern criteria of scientific models:**
 - Model must fit the data
 - Model must make predictions that can be tested and be of such a nature that it would be possible to disprove it
 - Model should be aesthetically pleasing - simple, neat, and elegant (**Occam's razor**)
