Goldilocks and the Three Planets
(Poster E16)

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Goals

• Just after their formation, the atmospheres of Venus, Earth, and Mars are thought to have been very similar. Why are they so different today?

• Our goal is to develop a (series of) presentation(s) that investigates the differences in the atmospheres of Venus, Earth, and Mars, and how these differences arose.

• The target audience is (initially) elementary school age children (with additional presentations targeting middle school and high school age students).
Methodology

• The presentation(s) is (are) a combination of planetary images displayed on engaging spherical displays and hands-on activities about the phases of matter.

• We recently tested and evaluated our first preliminary presentation on the Lawrence Hall of Science's 6-foot diameter Science on a Sphere®.

• Our future plans include transferring this presentation onto a portable, table top spherical display system to take into classrooms.
Presentation, or
Goldilocks and the Three Planets

• Venus is too hot. Mars is too cold. Earth is just right!

• How are the atmospheres of these three planets different?
  → Thickness, temperature, composition (“poison content”)

• If they started the same, why are they so different now?
  → Distance from Sun
    Venus: too close, Mars: too far, Earth: just right
  → Presence and stability of liquid water
    Venus: no, Mars: no (not anymore), Earth: yes!

• Demonstration about phases of matter:
  gas (water at Venus), solid (at Mars), liquid (at Earth)
Presentation, or Goldilocks and the Three Planets

- Display images on *Science on a Sphere*® at the Lawrence Hall of Science, University of California, Berkeley (thanks to Sue Guevara and Gretchen Walker at LHS for assistance!)

![Image of Earth projection]

![Image of people in front of Science on a Sphere]
Presentation, or Goldilocks and the Three Planets

• Formative evaluation during “test presentations” (by Maia Werner-Avidon from the Center for Research, Evaluation & Assessment at the Lawrence Hall of Science)

• What we did well: the target audience understood that Venus is too hot. Mars is too cold. Earth is just right!

• What we did not do well: the audience did not understand the connection between water and atmosphere?

• Address this deficit by adding a demonstration: 
  $\text{CO}_2$ dissolves in liquid water and can form carbonate rocks
  $\text{vinegar + limestone} = \text{bubbles of CO}_2 \rightarrow \text{Earth’s early CO}_2$!
Future Presentations

• Our future plans are to develop (at least) two additional presentations for higher level students.

1. Middle school age target audience
   • Focus on differences in Earth’s and Mars’s magnetic fields
     Earth: global “dipole” magnetic field
     Mars: small “magnetic anomalies” (buried magnets)
     (FYI: Venus has no significant global magnetic field)
   • Why are they different?
     → Depends upon how the magnetic fields are formed
       Earth: magnetic field is generated in deep interior
       Mars: magnetic field is “trapped” in surface rocks
       (The interior of Venus is “different” than Earth’s)
Future Presentations

2. High school age target audience
   • Content of future presentation 1 (above) plus
   • What is the effect of differences in the magnetic fields?
     → Global (Earth-like) magnetic fields can protect an atmosphere from the solar wind
     → In the absence of a global magnetic field (Mars-like), the solar wind can slowly strip away the atmosphere
     → The current thin atmosphere of Mars (over 100 times lower pressure than Earth’s) may be due to this effect
     → Planetary magnetic fields are important for long term atmospheric and climate evolution
Future Presentations

- Transfer these presentations from the 6-foot diameter *Science on a Sphere®* to a portable, table top spherical display system for traveling presentations.

- *Magic Planet®* digital video globe from *Global Imagination®*
Models

• Our future plans also include constructing rigid, 3-D wire models of the magnetic fields of Venus, Earth, and Mars

• For example, Venus (from Podgorny et al., 1980):
Models

- Earth (from Podgorny, 1976):
Models

• Mars: the most complex case

• A work in progress

• Requires a synthesis of models/visualizations like these 3