Goldilocks and the Three Planets

(Poster E16)

Matt Fillingim[1], Dave Brain[1], Laura Peticolas[2], Darlene Yan[2]

[1]Space Sciences Laboratory, University of California, Berkeley
[2]Center for Science Education (CSE@SSL), UC Berkeley

Goals

- Just after their formation, the atmospheres of Venus, Earth, and Mars are though 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!)

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:
  CO_2 dissolves in liquid water and can form carbonate rocks
  vinegar + limestone = bubbles of CO_2 → 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

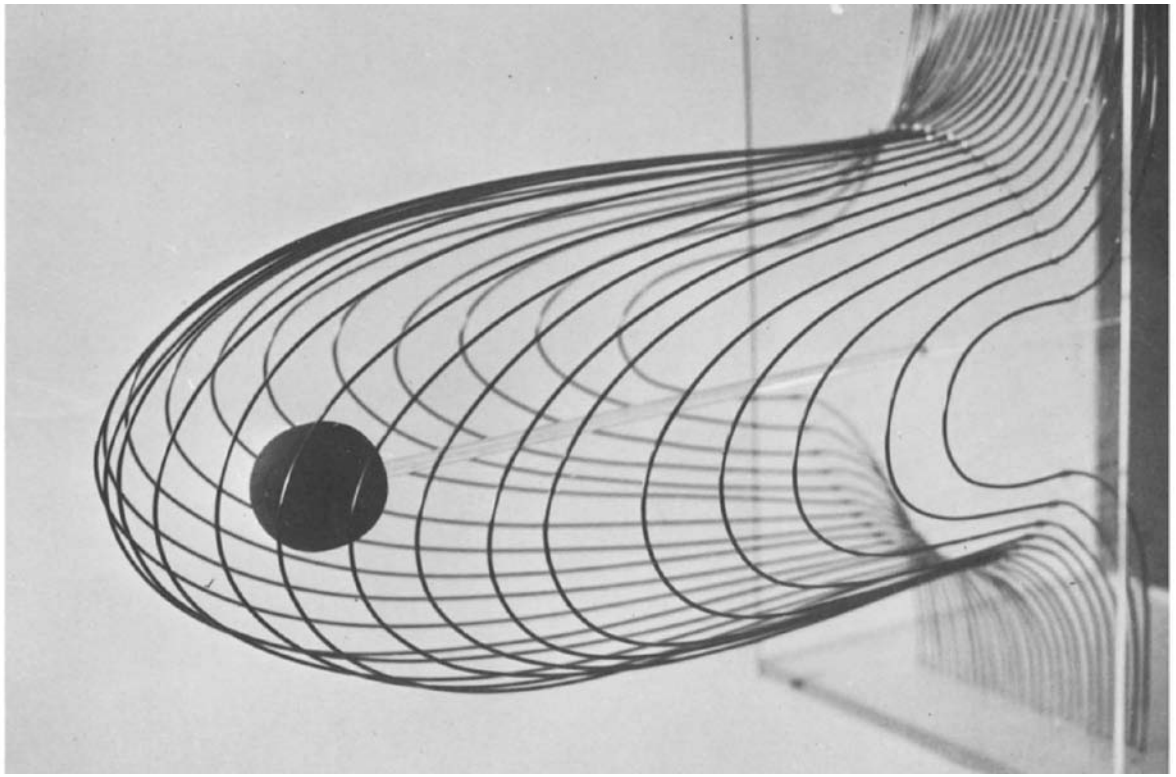
Future Presentations

- 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*®

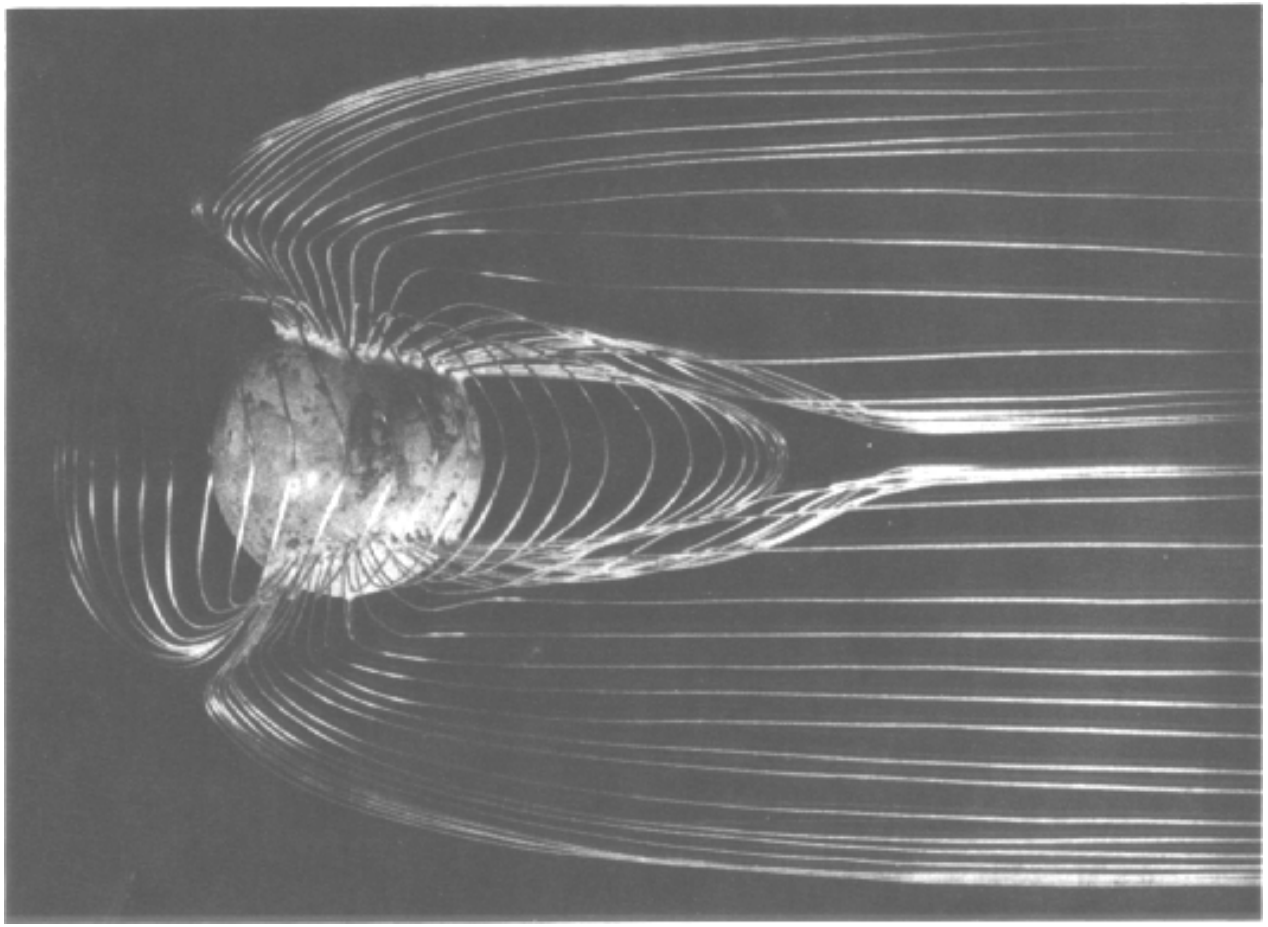
Models

- 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