

ED23A-0713  
 NASA's Year of  
 the Solar System:  
 Science Isn't Done  
 Until It's Shared!

# Goldilocks and the Three Planets

M. O. Fillingim<sup>1</sup> ([matt@ssl.berkeley.edu](mailto:matt@ssl.berkeley.edu)), D. A. Brain<sup>1</sup>, L. M. Peticolas<sup>2</sup>, D. Yan<sup>2</sup>, K. Fricke<sup>2</sup>

<sup>1</sup>Space Sciences Laboratory, University of California, Berkeley

<sup>2</sup>Center of Science Education, Space Sciences Laboratory (CSE@SSL), University of California, Berkeley

ED23A-0713  
 NASA's Year of  
 the Solar System:  
 Science Isn't Done  
 Until It's Shared!

## 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.

## Year of the Solar System

- We plan to tie our current and future presentation schedules to Year of the Solar System themes
- For example: Dec 2010/Jan 2011 YSS Theme: "A Family Affair"
  - Compare Earth to planetary neighbors Venus and Mars
- April 2011 YSS Theme: "Water, Water, Everywhere!"
  - Water is important in the early evolution of atmospheres (see our current presentation just to the right)
- Nov 2011 YSS Theme: "Magnetospheres: Planetary Shields"
  - The presence (or absence) of magnetic fields is also important for the continued evolution of atmospheres (see our future presentations a little further to the right)

## Presentation, or

## Goldilocks and the Three Planets

### Content

- 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)

### Display

- 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!)



### Evaluation

- 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<sub>2</sub> dissolves in liquid water and can form carbonate rocks
  - vinegar + limestone = bubbles of CO<sub>2</sub> → Earth's early CO<sub>2</sub>!

## 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' 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)
- 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

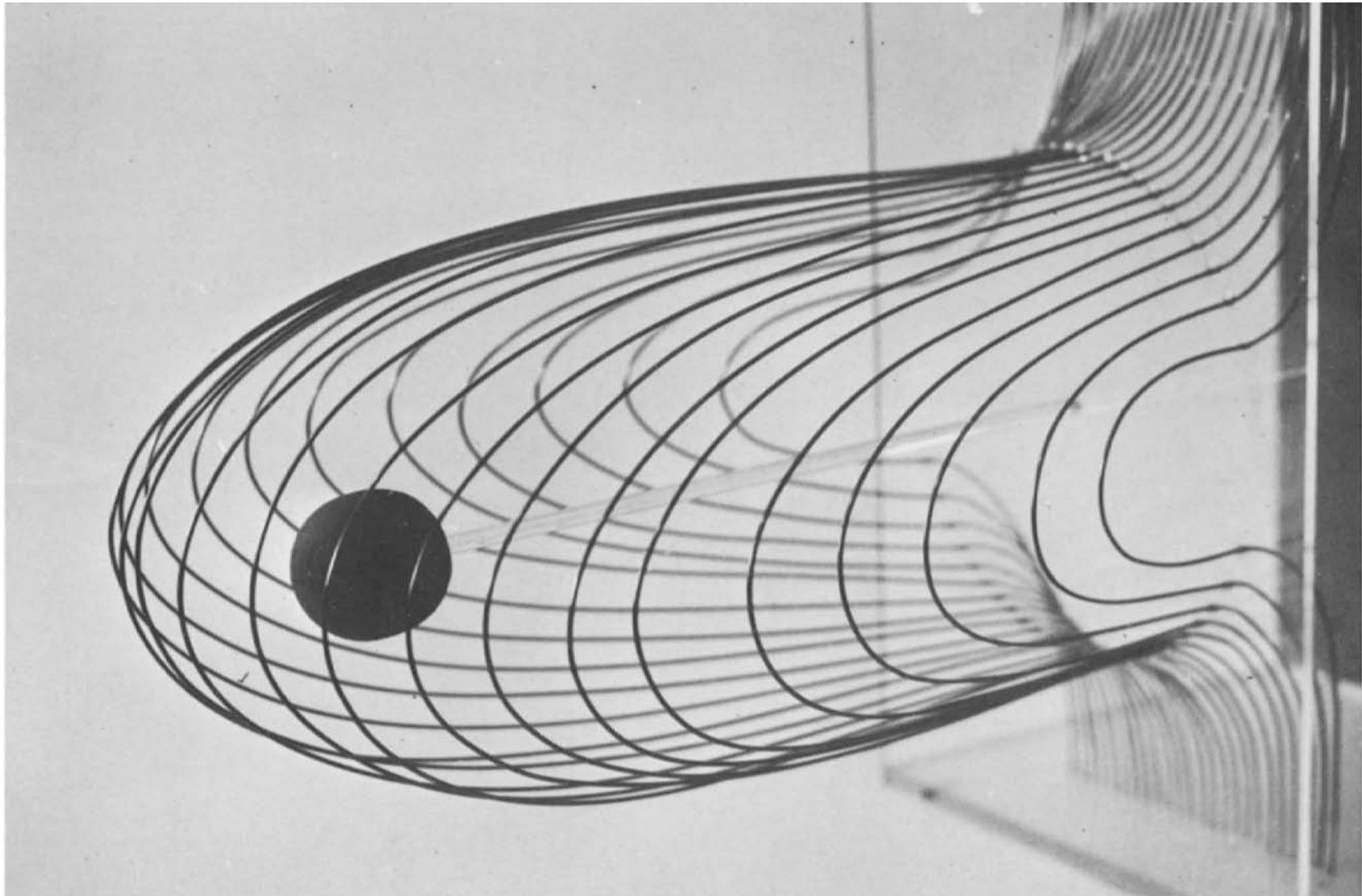
### Display

- 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®*

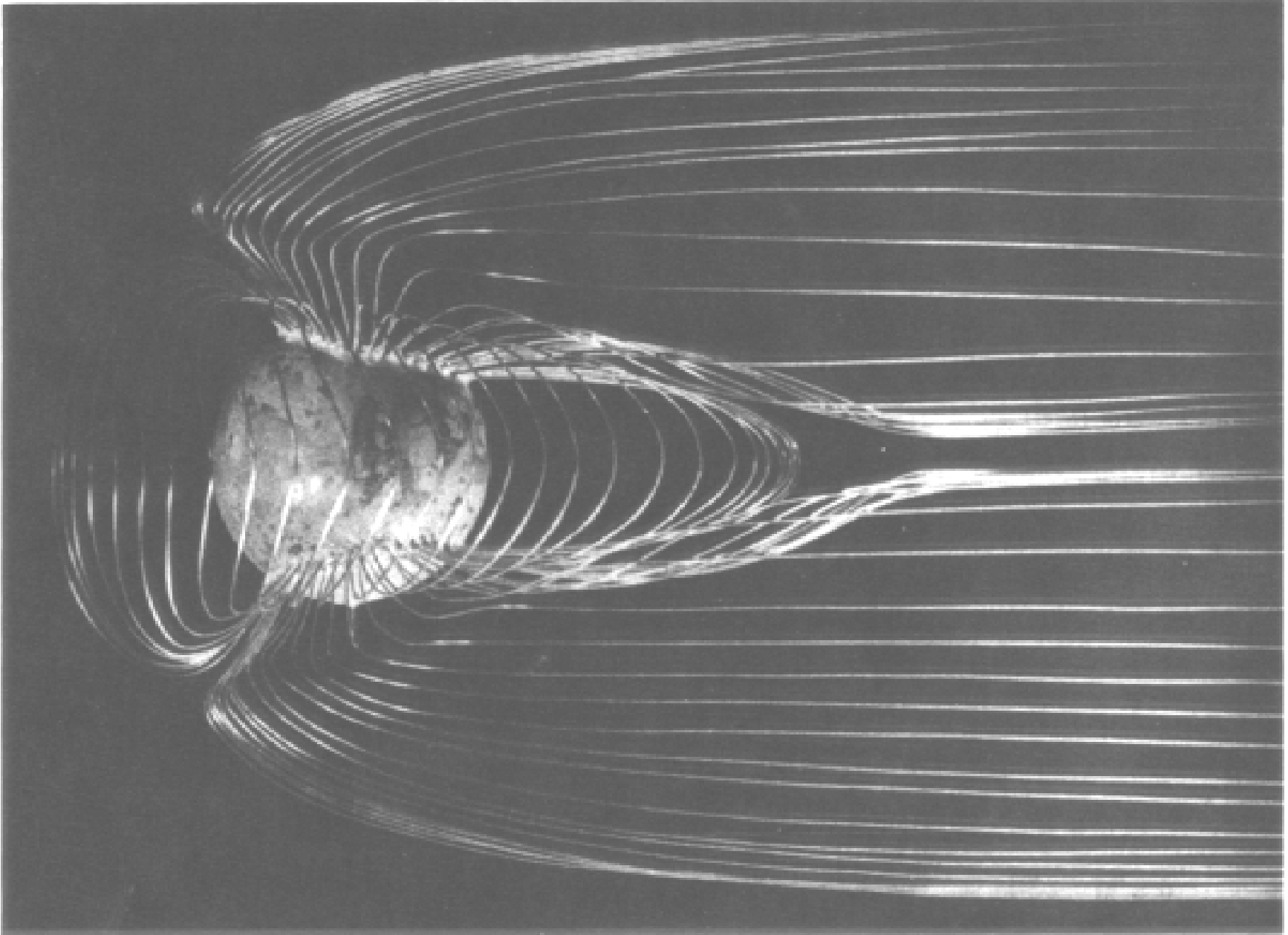


## Models

- 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):



- Earth (from Podgorny, 1976):



- Mars: the most complex case
- A work in progress
- Requires a synthesis of models/visualizations like these 3

