Visualizing Curved Space

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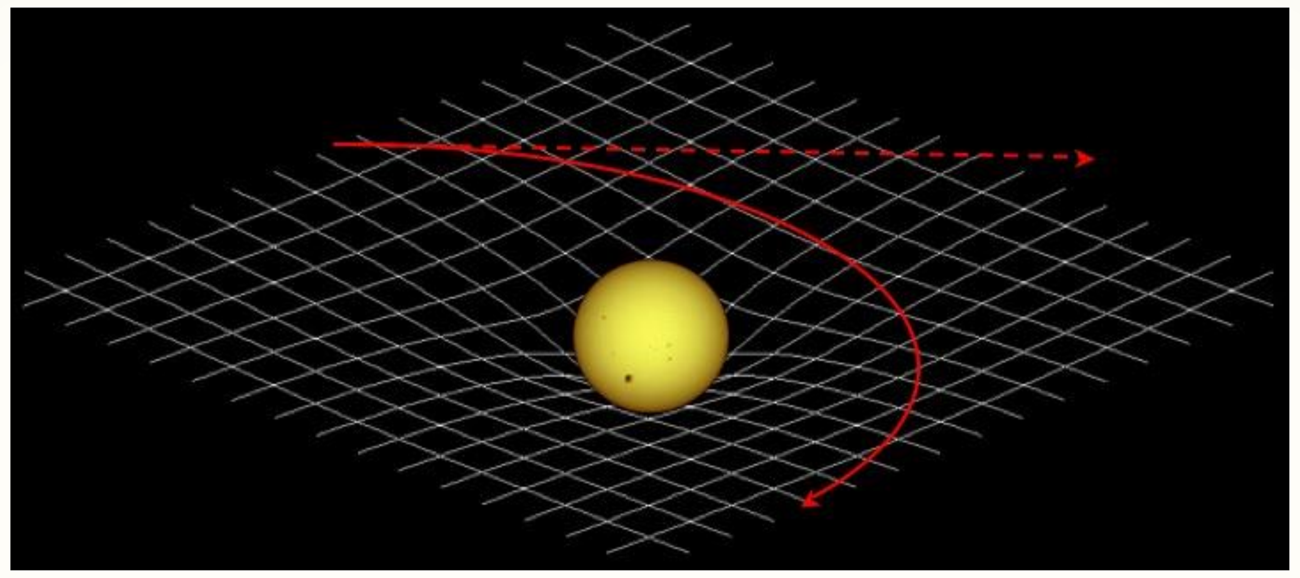


physicsoftheuniverse.com/topics_relativity_curved.html

Introduction & Purpose

Introduction

- General Relativity: Space-time curvature causes gravity
- Geodesics: Shortest distance between two points on curved surface
- Existing models try to explain motion & acceleration
- Fail because they lack geodesics

youtube.com/watch?v=MTY1Kje0yLg

Purpose

- Our model does not rely on motion, only curvature
- Use electric field (E field) mapping to demonstrate curvature

Curvature of Sphere

Equation of Sphere

$$\vec{r} = \langle r\cos u \sin v, r \sin u \sin v, r \cos v \rangle$$

Use Gaussian curvature to compare surface shape to electric field shape.

Gaussian Curvature of Sphere

$$K = \frac{LN - M^2}{EF - G^2} = r^{-2}$$

Model Setup & Procedure

Materials (Fig. 1)

- Semi-conductive paper
- Copper O-rings
- Conductive paint (glue)
- 12V source
- Volt meter

Procedure

- Cut paper into strips. Wrap around sphere. Glue on electrodes. Measure voltages.

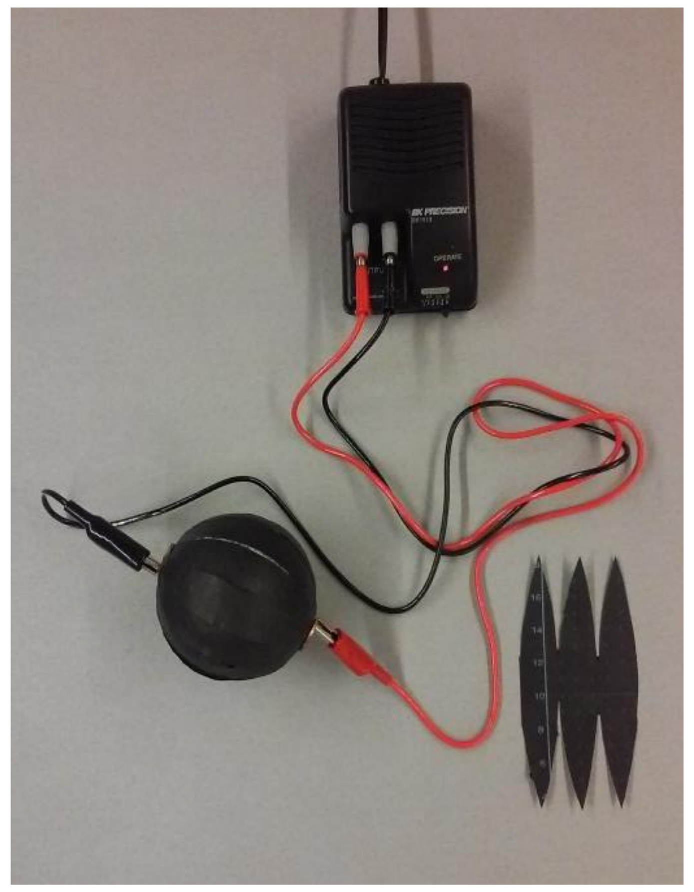


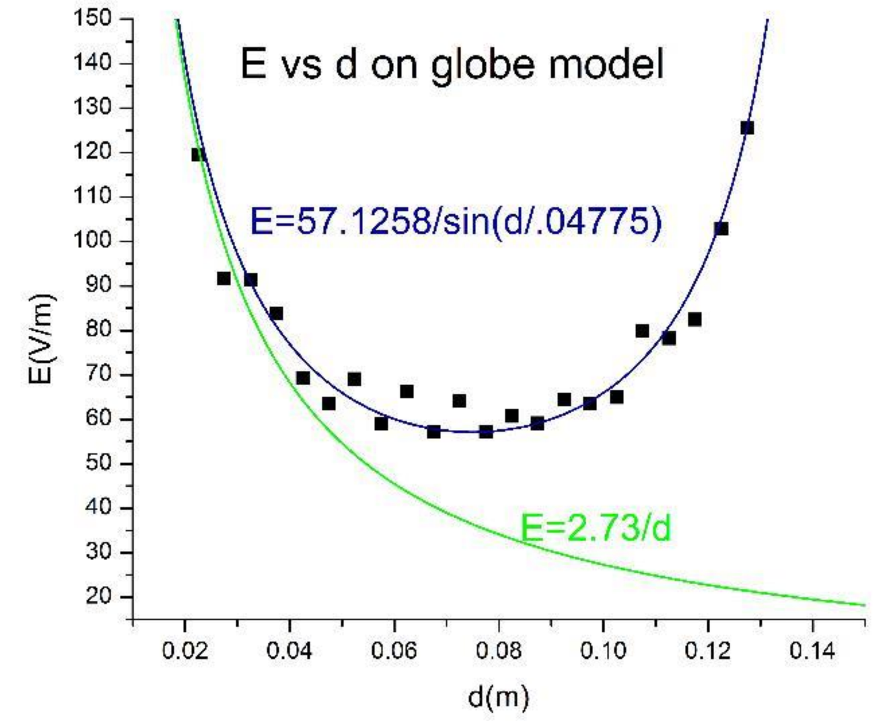
Figure 1

E field at each point

$$E = \frac{\Delta V}{\Delta s}$$

Results

Electric Field Behavior



From Gauss's Law and Gaussian Curvature we conclude:

$$E = \frac{\Phi\sqrt{K}}{2\pi \sin\theta}$$

Discussion

- Relating E and K is more difficult for other shapes
- Depends on placement of charge since K is not constant
- Data does not need more precision.