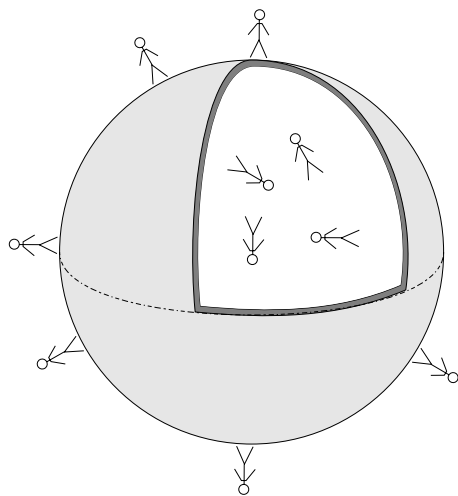


# THE GRAVITATIONAL FIELD OUTSIDE A HOMOGENEOUS SPHERICAL MASS



## THE GRAVITATIONAL FIELD OUTSIDE A HOMOGENEOUS SPHERICAL MASS

by  
P. Signell and J. S. Kovacs

<b>1. Introduction</b> .....	1
<b>2. Study Material</b> .....	1
<b>Acknowledgments</b> .....	2

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Evaluation: Stage 0

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**Input Skills:**

1. Explain the meanings of the symbols in the Law of Universal Gravitation (MISN-0-101).
2. Calculate the gravitational potential due to a distribution of sources (MISN-0-107).
3. Calculate the gravitational field from the gravitational potential (MISN-0-108).

**Output Skills (Knowledge):**

- K1. Derive the gravitational field and potential outside of hollow and solid spheres, hence justify use of the point-mass Law of Universal Gravitation near a mass that has spherical symmetry.

**External Resources (Required):**

1. M. Alonso and E. J. Finn, *Physics*, Addison-Wesley, Reading (1970); For availability, see this module's *Local Guide*.

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by

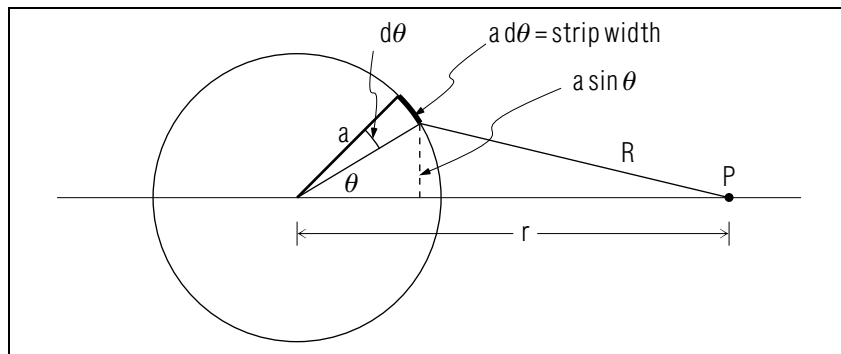
P. Signell and J. S. Kovacs

## 1. Introduction

One of the remarkable features of an inverse-square-law force field is that it is zero inside a spherical shell of sources, and that outside the shell it is exactly that which would be produced by a point source at the origin. The latter result is rigorously derived in this unit, using straightforward summation of the forces due to all sources. In turn, the field and potentials outside homogeneous spherical masses are derived and used to justify the method used elsewhere<sup>1</sup> for finding  $G$  from  $g$ .

## 2. Study Material

In AF<sup>2</sup> study Section 15.8 (p. 318-322), which contains the derivation. This sketch may be helpful:



Just as remarkable as the theorems proved above is the fact that the gravitational field is exactly zero inside a spherical mass shell. You may wish to show this also, while you are at it. However, a very simple, very elegant, but somewhat subtle proof of these theorems can be given in

<sup>1</sup>In MISN-0-101.

<sup>2</sup>M. Alonso and E. J. Finn, *Physics*, Addison-Wesley, Reading (1970). For availability, see this module's *Local Guide*.

terms of Gauss's Law.<sup>3</sup>

## Acknowledgments

Preparation of this module was supported in part by the National Science Foundation, Division of Science Education Development and Research, through Grant #SED 74-20088 to Michigan State University.

<sup>3</sup>See "Gauss's Law Applied to Spherically Symmetric Charge Distributions" (MISN-0-132).

## LOCAL GUIDE

The readings for this unit are on reserve for you in the Physics-Astronomy Library, Room 230 in the Physics-Astronomy Building. Ask for them as “The readings for CBI Unit 109.” Do **not** ask for them by book title.