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P3_7 Cavorite Pt 3: Varying the Size of the Sheet

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Abstract

A continuation of *The Cavorite Series*, in which we explore the effects of a fictional substance which is "opaque to gravitation". In this paper we examine the effects of varying the radius of the Cavorite sheet. As expected, the point at which the g experienced by a test particle returns to close to normal Earth g increases with the radius of the Cavorite. However, we found that even a Cavorite sheet of 1 km radius would not be enough to vent the atmosphere.

Introduction

In the previous two papers of *The Cavorite Series*, we have explored the effects of a fictional substance that is "opaque to gravitation" known as Cavorite [1]. This substance was conceived of and manufactured by Mr. Cavor, an eccentric scientist from the H. G. Wells novel *The First Men in the Moon*, and used later in the novel to reach the Moon [1]. However, upon the first successful manufacture of a "thin, wide sheet" of Cavorite, all of the air above it becomes instantly weightless, and causes extreme atmospheric effects [1]. Had it not been for the fact that the Cavorite sheet was not fixed to the floor, Mr. Cavor postulates that the atmosphere would eventually vent out into space through the resultant "atmospheric fountain", before returning to "an asphyxiated world" [1].

However, in the previous two papers we have shown that Mr. Cavor's pessimism may have been unfounded; any test particle above the middle of the Cavorite sheet will experience close to normal gravitational acceleration, g, at a height of $h \approx 12$ m above the sheet [2]. Although it would most likely experience a reduced g at some point below this height, this height is negligible compared to the rest of the atmosphere. Hence, it was discovered that the Cavorite effect would be too localised to vent the atmosphere into space.

This result was only found for a circular Cavorite sheet of radius $r_{cav} = 1$ m. This paper will look at varying r_{cav} to see if a larger Cavorite sheet would be a more credible threat to the atmosphere.

The Model

From our first paper, the particle cannot interact with any mass that is hidden from view due to the Cavorite sheet [2]. Hence, the mass of the Earth that the test particle can interact with, M_{eff}, is given in terms of h:

$$M_{eff} = \pi\rho\bigg(-\left[1 + \frac{r_{cav}^2}{h^2}\right]\frac{h_c^3}{3} + \left[\frac{r_{cav}^2}{h} - R_\oplus\right]h_c^2 - r_{cav}^2 h_c\bigg) \tag{1}$$

where $R_\oplus$ is the radius of the Earth, and ρ is the density of the Earth,

$$h_c = \frac{-B - \sqrt{B^2 - 4AC}}{2A} \tag{2}$$

and $A = \left[\left(\frac{r_{cav}}{h}\right)^2 + 1\right]$, $B = 2R_\oplus - \frac{2r_{cav}}{h}$ and $C = r_{cav}^2$ [2].

With these equations, we now plot the behaviour of M_{eff} with h:

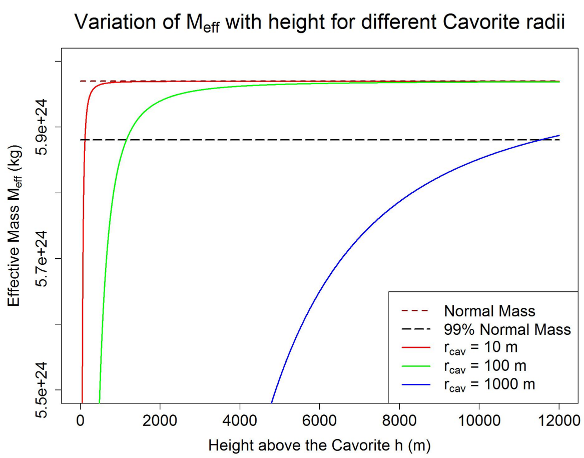

Figure 1: Behaviour of M_{eff} of various r_{cav}.

From Figure (1) the height at which the test particle experiences close to normal g can be deduced from the height at which M_{eff} becomes close to its normal value.

Discussion

Figure (1) shows that there is a general trend between the size of the Cavorite and the height, h_g, at which 99% of the mass of the Earth can be 'seen' by the test particle, and hence close to normal g will be felt. As expected, this height increases with r_{cav}. Even at $r_{cav} = 1$ km, $h_g \approx 12$ km. The edge of space is roughly 100 km, hence this sheet of Cavorite would not present much of a threat to the atmosphere of the planet.

A Cavorite radius of 1 km is the limit of what this model can deal with; at sizes larger than this, the approximation that the Earth is locally flat would likely break down. A possible area of further research is to modify the model to consider the curvature of the Earth, to allow for larger Cavorite sheets.

For completeness, we will now consider what happens if the test particle is not at the axis of symmetry of the Cavorite. Computing M_{eff} is a lot more difficult in this case, however it is logical to assume that if the particle is not over the Cavorite at all, then the solid angle due to the Cavorite would be smaller from the perspective of the particle. Hence, the Cavorite is not as effective. Also, any particle over the Cavorite, but not on its axis of symmetry, will experience an unbalanced force which would attract it to the nearest edge of the volume above the Cavorite.

Conclusion

In conclusion, even at far larger sizes than 1 m, Cavorite is not a credible threat to the atmosphere. There may be some local atmospheric disturbances, but it is unlikely that the atmosphere would vent, unless the radius of the Cavorite is made larger than 1 km, which is considered to be an impractical size to fit in Mr. Cavor's workshop in the book [1].

References

[1] Wells, H.G. *The First Men in the Moon* (The Modern Library, New York, 2003).

[2] C.J. Middleton, H.W. Buttery, C.D.Y. Moore and R.H. Peck *P3_3 On the Atmospheric Effects of Cavorite*, PST 15, (2016).