

# Preface

In the present work, “The Pythagorean Theorem and Physics,” we develop the thesis that the multivectors of space-time algebra, which follow from the Pythagorean Theorem, are tools and building blocks of nature and use them to explain the advance of the precession of the orbit of Mercury of 43 seconds of arc per century not included in the 5600 seconds calculated from Newtonian theory.

If the gravitational constant  $G$  is changed to  $G(1 + 6v^2/c^2)$ , it yields the unexplained advance of 43 seconds of arc per century. It is shown that there are several sources of  $v^2/c^2$  that add to a total of  $6v^2/c^2$  and therefore contribute to this result.

Multivector algebra may be used to calculate the 1.75 seconds of arc deflection of starlight as it passes the sun which is twice that predicted by Newtonian theory. The algebra predicts the measured value of the gravitational red shift which is observed to be twice that predicted by Newtonian gravity. Corrections for these effects follow, by a different procedure, from Einstein’s theory of general relativity and were general relativity’s first great success. The corrections to  $G$  apply to all the planets where the effects, however, are negligible. Applied to Mercury, they can be measured because of its proximity to the sun. They become significant, in general, when two stars are interacting.

In the process of accounting for the above, we obtain equations for gravitation that are similar to those for electromagnetism and which therefore may be quantized similarly.

It is shown how the algebra is useful in obtaining various standard results in special relativity and electromagnetism.

**SUMMARY:** The text contains a partial treatment of Special Relativity using space-time algebra. This inclusion is to enable the reader unfamiliar with Clifford Algebra to observe its usefulness when applied to a familiar subject. Here, and in its application to gravity, it is verified that Newton's Third Law is a series expansion in  $v^2/c^2$  which is all that is needed for the gravity work.  $v$  is the velocity of Mercury and  $c$  is the velocity of light. Whether Newton's Third Law holds for higher order terms has not been checked. In texts on Special Relativity, it is often stated that the third law does not hold.

The mechanisms that contribute to Mercury's perihelion advance is given in Section 2.4 which in turn specifies where in the text the calculation is completed. The first 21 chapters are devoted to the above problems.

It is shown that all we know about nature follows from the Pythagorean Theorem. The Pythagorean Theorem leads to space-time algebra so that space-time algebra, in effect, leads to all of Physics.

As an application, we derive the first three successes of Einstein's General Theory of Relativity: the advance in the perihelion of Mercury; the deflection of light by the sun; and the gravitational red shift. The Schwarzschild Metric, which describes the local curvature of space by a massive body, the sun, is derived from classical physics in the process. The gravitational field has the same formal structure as the electromagnetic field and therefore may be quantized in the same way as the electromagnetic field. When discussing gravity, we use the terms "electric field" and "magnetic field" for brevity without the qualifying adjective "gravitational." The gravitational field quantities have nothing to do with electromagnetism but the latter provides a convenient and familiar terminology.

In Chapter 15, it is shown that space-time algebra predicts the appearance, at the time of the Big Bang, of two gravitational forces, one positive, the traditional Newtonian force and the other a negative gravitational force between masses. Both forces have the usual  $1/r^2$  dependence. So-called dark matter and dark energy are not explained, we simply dispense with them. Their role is replaced by a real force. The present work has been limited to gravity. There are other unexplored applications.

The force eliminates the need for the presence of fictitious "dark matter and dark energy" that allegedly exert a gravitational expansive force on stars and thereby accounts for the anomalous expansion of the galaxies. The force also eliminates the need for the ad-hoc assumption of the presence of "dark matter and dark energy" to account for the observed rate of recession of the galaxies as a whole. See sections 10.3, 10.41, and 14.3 for examples of direct forces. For the correction term for gravity,

we do not have an experimental normalizing constant such as  $G$ , the Newtonian gravitational constant for positive gravity. Therefore we are only able to show the existence of a gravity negative correction factor and infer that it has a significant role in explaining gravitational anomalies. For a different discussion of multivector forces see Section 15.1.

When galaxies began to form, a billion or more years after the Big Bang, one would expect them to take on a 3-dimensional "rotation curve" configuration with more mass appearing at the out regions of space just as more mass accumulates at the outer regions of the individual galaxies (See Ch. 15). The negative gravitational force would be the causative agent just as it is responsible for star accumulation at the outer regions of the galaxies (Section 15.1).