

New view of gravity explains cosmic microwave background radiation

D. Russell Humphreys

Here I offer a new picture of how gravity works, depicting space as a membrane being greatly accelerated in a fourth spatial dimension. The Unruh effect, which connects acceleration with a blackbody temperature, could then explain the cosmic microwave background radiation. Later papers will apply this accelerating membrane model to galaxy redshifts and the Pioneer anomaly.

In my 1994 book, *Starlight and Time*,¹ I interpreted scriptures mentioning a stretching-out of the heavens as supporting a large expansion of the universe. But in 2011 John Hartnett pointed out a scriptural reason why that interpretation is probably incorrect.² He suggested that the red shifts of light from distant galaxies may have a different cause than expansion. My 2008 cosmology³ allows for a different cause: a slow increase of gravitational potential. What would cause the increase? I plan to show in a later paper how, according to the new view of gravity I present here, it would be caused by the stretching of the fabric of space, without much expansion.

Section 1 below gives scriptures explaining what the fabric of space is, and several of its important features. My 1994 book discussed those ideas. It pointed out how they help to resolve the paradoxes of relativity and quantum mechanics, allowing us to visualize them in a simple way.⁴ Section 2 gives scriptural reasons to think the stretching was a sudden increase of *tension* in the fabric of space. Section 3 gives scriptures implying that the fabric of space is thin in a fourth, unperceived, spatial dimension.

Section 4 shows how these qualities of space contribute to a new picture of how gravity works, explaining what seems to underlie Einstein's gravitational field equations. I depict the fabric of space as being greatly accelerated in the fourth direction. Section 5 shows how the acceleration explains the cosmic microwave background. Section 6 suggests that the acceleration may be centripetal, as on the rim of a rotating wheel.

In the next three sections, I take literally a number of scriptures which many people have regarded as figures of speech devoid of physical meaning. But as we go through those scriptures, note that most of the figures of speech occurring in them are similes. In the Bible as well as in everyday language, a simile usually explains a poorly known *but real* thing by comparing it to a well-known thing.⁵ For example, in 'stretching out the heavens like a tent curtain', the real but poorly known action is the main clause: 'stretching out the

heavens'. The well-known idea is in the adverbial phrase: 'like a tent curtain'. So the similes below are evidence for the reality of the things they describe.

1. The heavens are a real material

The Israelis of Bible times, to whom, and by whom, God wrote the Old Testament, had no way to distinguish between the earth's atmosphere and what we now know is the vacuum of space above it. That distinction did not become clear until after Torricelli invented the barometer in 1643 AD. It would be quite reasonable that God, wanting to be understood accurately, would speak to the Hebrews using the word for 'heavens' just as they used it: as meaning all of the expanse above the earth's surface, both atmosphere and vacuum. He apparently used the word that way when He said that what birds fly in, namely the atmosphere, is merely "the *face* of the expanse of the heavens", Genesis 1:20 (literal reading of the Hebrew text).

Furthermore, Scripture often makes a distinction between 'the heavens' and 'the host of the heavens' (Genesis 2:1, Nehemiah 9:6). The latter are the bodies in the heavens; the former is the space containing those bodies. Genesis 1:1 says that God made the heavens, a seemingly empty space, before He made the sun, moon, and stars four days later (Genesis 1:14–19). So the heavens are space itself.

Generally we think of space as a true vacuum, an empty volume which contains some material here and there, such as air or stars. But Scripture speaks of space as a *real material*. The heavens can be *torn* (Isaiah 64:1), *worn out* like a garment (Psalm 102:26), *shaken* (Hebrews 12:26, Haggai 2:6, Isaiah 13:13), *burnt up* (2 Peter 3:12), and *split apart* (Revelation 6:14). These verses make sense if space is indeed a real material. Many of these verses compare the material to a fabric, hence the phrase 'the fabric of space' (figure 1).

Nineteenth-century physicists, such as the creationist James Clerk Maxwell,⁶ regarded space as pervaded with, or equal to, an intangible material called the æther (or 'ether',

but not the anesthetic gas). Maxwell had noticed that electromagnetic experiments would make sense if the vacuum could be electrically polarized (indicating bound electric charges hidden in it) when one applied an electric field to it.⁷ This involved the idea of ‘displacement’ electric current in a vacuum,⁸ which in turn led him to the discovery that light is an electromagnetic wave propagating through the æther. The properties of this ‘luminiferous medium’, as he called it, determine the speed of light, just as the properties of water in a pond determine the speed of waves moving over it.⁹

In 1905, when Albert Einstein introduced his special theory of relativity, he sought to dispense with the æther.¹⁰ However, in 1920, in a little-known address,¹¹ he came back to the concept of an æther: “According to the general theory of relativity, space without ether is unthinkable.” He had found that his 1916 theory, general relativity, insists on space having physical properties, in particular being bendable in the same way that a solid material is bendable. He hastened to explain that we cannot measure our speed with respect to the æther, but he did not back down from saying it is real.

Academics ignored the 1920 address, and while not recanting it, Einstein did not publicize it or repeat its ideas. Hence the idea of an æther remained in the state of disrepute into which Einstein had put it in 1905. However, modern physicists began to find it was essential. Quantum field theory is built on the assumption that all space is filled with ‘fields’ which have mass and oscillate like particles.¹² This ‘quantum vacuum’, a modern code name for the æther, makes forces between metal plates in a vacuum (Casimir effect), affects the orbits of electrons in atoms (Lamb shift, vacuum polarization), explains the appearance of electron–positron pairs from a vacuum (Dirac electron ‘sea’),¹³ and determines the speed of light.¹⁴ Other modern code names for the æther are ‘spacetime’, ‘continuum’, ‘manifold’, ‘substratum’, and ‘plenum’, often in various combinations. Though most modern physicists are reluctant to admit it even to themselves, the bottom line is that they believe that space is a real material, an æther.¹⁵

This modern æther is pervasive. It moves through us as we move through it. The quantum physics of solids offers an explanation of how this could be, based on the Pauli Exclusion Principle. This principle could allow us to move through a material space as freely as an unbound electron moves through a perfect crystal.¹⁶ This medium, space, also offers a reason why there should be a relativistic speed limit, namely the speed of light, on particles moving through it. If space were a truly empty nothingness, why should there be a speed limit at all? Instead, motion through this medium affects our measurements in such a way that, regardless of our speed through the medium, we always get the same number for the speed of light.¹⁷ The existence of a real æther thus

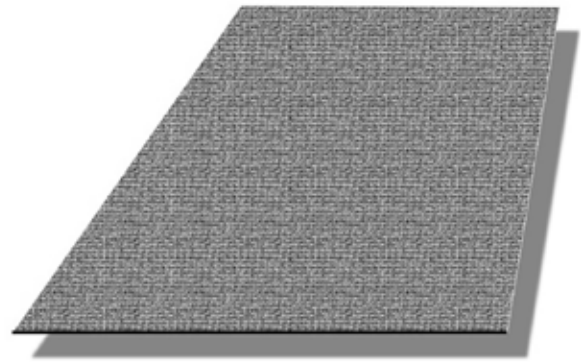


Figure 1. If space is truly a fabric, it must be woven exceedingly fine, with the threads very much closer together than the size of a proton, $\approx 10^{-15}$ metre.

eliminates a number of paradoxes that boggle the minds, not only of students, but also experienced practitioners of physics.

2. God has stretched the material

Starlight and Time pointed out seventeen verses¹⁸ in Scripture which describe a stretching or spreading of the heavens. Here are two of them:

“Who stretches out the heavens like a tent curtain,
And spreads them out like a tent to dwell in” (Isaiah 40:22; NAS),

“Stretching out the heavens like a tent curtain”
(Psalm 104:2; literal Hebrew).

Lately I’ve noticed that ‘spreading’ and ‘stretching’ may be two separate but related types of action, as they are in pitching a tent. But in 1994, I made no such distinction. Because of the phrase ‘stretches out’, I was taking these verses as supporting the idea of a very great expansion of space. In cosmologies of that sort, the redshift of light from distant galaxies turns out to be proportional to the factor by which space expands during a photon’s travel from a distant star to Earth.¹⁹ To explain the redshifts of light from the most distant galaxies we can observe would require that space has expanded by a factor of at least ten. Space would have to be exceedingly stretchable, more so than even some very elastic materials we have today, such as rubber. My second cosmology, in 2008, allowed for such a very great expansion, although it did not insist upon it.

But as I mentioned earlier, early in 2011 John Hartnett pointed out to me that Old Testament readers knew of no highly elastic fabrics. Speaking to such readers, as well as to us today, why would God compare the material being stretched to such materials as tent curtains, which can extend their dimensions by only a few percent before tearing? It is more likely, he said, that the expansion of space has been



Figure 2. The Tabernacle of Israel in the wilderness had its covering stretched taut by applying tension. This full-scale model is in Timna Park, Israel, about 15 miles north of Eilat.

negligible, and that the cause of galaxy redshifts is something else. Late in 2011, he published that idea.²

I soon realized that he was right. Then I began to consider what the ‘stretching’ verses might actually mean, and how that might affect cosmology. When we want to stretch an ordinary (non-elastic) fabric, we put it between our hands and pull it from each side. That makes a *tension* in the fabric, a force at every point within it that tends to pull it apart. The fabric responds by extending its length a small amount. If we increase the pull, increasing the tension, it will extend a bit more. But we cannot extend the fabric’s length more than a few percent without tearing the fabric.

This understanding of the Hebrew verb *natah*, translated ‘stretches out’ in the above verses, appears to fit within its range of meaning in lexicons²⁰ and its usage in such verses as Isaiah 54:2,

“Enlarge the place of your tent; Stretch out the curtains of your dwellings, spare not; Lengthen your cords, And strengthen your pegs.”

It is likely that the outer coverings of the tabernacle in the wilderness were stretched taut, as figure 2 shows, to prevent them from flapping in the wind. This is an example

from Old Testament times of applying tension to a fabric without having much extension of its length or width.

Let us consider when the stretching occurred, or whether it is still occurring. Of the seventeen verses I list in reference 18, nine are like Isaiah 40:22 and Psalm 104:2 above. They appear in English as if the verbs are in the present tense, but in the Hebrew text they are simple participles, which in that language carry no tense information in themselves.²¹ Two other verses, Job 37:18 and Psalm 144:5, do not speak of the original stretching or spreading by God. But the other six



Image: M81, Spitzer Space Telescope.

Figure 3. Rolling up the heavens like a scroll.

verses use the past tense. Two of them (2 Samuel 22:9–10 and Psalm 18:8–9) follow a *qal* perfect verb with a *waw* consecutive prefixing a *qal* imperfect verb, which implies past action. The remaining four (Isaiah 45:12, 48:13; Jeremiah 10:12, 51:15) are *qal* perfect, implying a past action. Many of the seventeen verses connect the stretching with events of the Creation Week. So we can conclude that the stretching (an increasing of tension) occurred during the first six days of creation, and was completed (stopping the increase of tension) during that period. In order to have Newton’s G of eq. (7), in section 4, be constant by the third day of creation, when Earth started functioning as a planet (and certainly before the orbiting heavenly bodies were made on the fourth day), it would be simplest to have the tension τ stop increasing by the end of the second day of creation. The results of the increase, such as a slow increasing of the gravitational potential of the cosmos, could still be continuing to this day.

3. The heavens have a fourth dimension

Think about the shape of this fabric, the space we live in. It appears to have only three dimensions (directions): length, width, and height. Lay a sheet of paper flat on a table. It is 8.5 inches (22 cm) wide by 11 inches (28 cm) long, but it is only 0.003 inches (0.008 cm) thick. It doesn’t occupy much of the height direction at all. Now roll up the paper like a scroll. You used the third dimension, height, in the air above the table, to roll it up, and the thinness of the paper in that dimension allowed you to do so. So if an object is thin in one of its dimensions, you can roll it up. But here is an amazing thing ... Scripture says the same thing about the heavens:

“And the heavens shall be rolled up like a scroll”
(Isaiah 34:4; NKJ),

“And like a mantle You will roll them [the heavens] up” (Hebrews 1:12; NAS).

Here again God depicts the heavens as a real material that He can manipulate. In the three directions we can see, the heavens are very thick. Yet God says He will roll them up like a scroll (figure 3). That implies that the heavens are thin in a fourth direction that we can’t see. The biblical analogies with a curtain of fabric support that idea. Moreover, there must be more room in that fourth direction, which allows the rolling-up to occur. The future tense of these verses implies the heavens are not in a rolled-up condition at present. In the fourth dimension we can’t perceive, space is nearly flat, like an unrolled scroll or cloak. The three dimensions we can see would exist as a thin sheet within a larger four-dimensional space, for which I would like to borrow the theoretical term ‘hyperspace’.²² As I pointed out in *Starlight and Time*,²³ the extra dimension makes sense of the equations of Einstein’s General Theory of Relativity by giving room and a direction

in which the ‘spacetime continuum’ can be bent. Einstein’s first cosmology, in 1917, made explicit use of four spatial dimensions.²⁴ Later cosmologies, such as the big bang theories, use four spatial dimensions implicitly. But most theorists avoid thinking of the extra dimension as anything more than a mathematical convenience.²⁵

The interpretive principle in the last paragraph of my introduction takes the verses above as meaning the heavens will be rolled up physically—not figuratively. For if either ‘the heavens’ or ‘rolled up’ were figurative, the similes would be almost meaningless. They would be saying, ‘something figurative will have something else figurative done to it like a scroll or a mantle’. But what the figures would be depicting would be a total mystery. It makes much more sense to think that the words mean what they say, that the physical heavens will be rolled up physically like we roll up a scroll or mantle.²⁶ Such a rolling-up apparently requires an extra dimension, an extra direction.

This fourth direction is not time. Relativity theory treats time as a real dimension, in our case, a fifth dimension. That is, the fabric is really *spacetime*. Its time dimension, or direction, differs from the space directions in several ways. First, we only observe a narrow slice of time, the present. Second, the slice seems to be moving through time, from the past into the future. Third, physical phenomena can only develop in one direction of time, toward the future. For example, if we toss a stone into a pond, we only see waves coming *from* the impact, forward in time, even though all the equations we know would allow waves to travel backward in time also. If that were the case, we would first see waves in the pond converging on the future point of impact, then the stone hitting the water, and finally waves radiating outward from the impact. In real life, something seems to

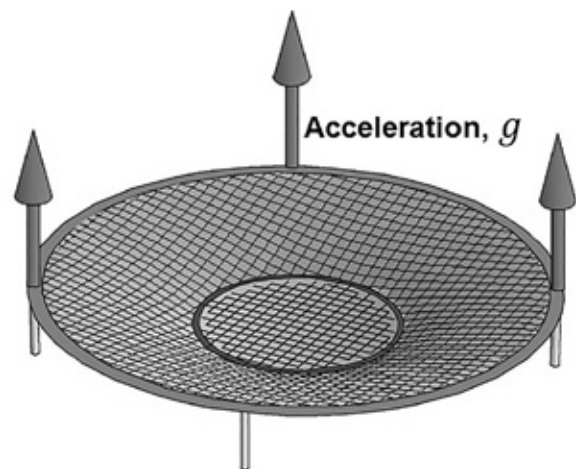


Figure 4. A trampoline far out in space needs to be accelerated in order for an object to make a dent in it.

compel the waves to travel only futureward. But in spite of the special nature of time, the equations of relativity seem to say that the past and the future physically exist, and that the timeward direction is just as real physically as the space directions. This, of course, is an *interpretation* of time that is open to question, discussion, and further research. I will apply this interpretation in section 6.

Why can't we see the fourth spatial direction? We are creatures confined within a fabric which is very thin in the fourth direction (so we also are very thin in the fourth direction). It appears that we usually see light coming at us only from within the fabric, not from outside it.²⁷

But why can't we *imagine* it, visualizing it as a direction perpendicular to the three directions we can see? I don't know. Speaking for myself, my imagination is limited to the kinds of things I can see in three dimensions. I have a similar problem with time as a dimension. I can't see either my past or my future, or point to a direction for them. But I do perceive myself moving through time, out of the past and toward the future. Perhaps we can imagine the fourth space direction similarly.

In practice, the way to imagine the fourth dimension is by an *analogy*: eliminate one of the three space directions you can see, and replace it with the fourth direction. For example, call the east-west direction x , the north-south direction y , and the up-down direction z . Now, imagine everything as being compressed in the z -direction down to a flat sheet, the x - y plane. Now tack a vertical axis onto the x - y plane and call it w .

That's the extra direction, the fourth dimension. The plane is very thin in the w -direction. You and I are embedded in that plane, so we also are very thin in the w -direction. The total number of space coordinates describing the real world would be four (w, x, y, z), but to visualize things we only show three (w, x, y), making the world into a 'flatland' as a model. If you noticed, that is what I depicted in figure 3. Edwin A. Abbot's entertaining nineteenth-century novel, *Flatland*, shows the usefulness of this method for imagining the fourth dimension.²⁸

4. Adding acceleration gets gravity

If the heavens are a flat sheet of fabric existing in a large empty 'hyperspace', then there exists the possibility that the sheet may be moving within the hyperspace. Imagine a force pushing the sheet 'upward' in the w -direction. If the force is spread uniformly throughout the sheet, then the whole sheet will remain flat and accelerate perpendicular to the sheet, 'upward' in the w -direction, at a rate determined by the ratio of force to the inertial mass of the sheet.

Inertial mass is an object's property of resisting acceleration. That makes room for a possible distinction with the object's *gravitational* mass, its property of attracting other

objects or being attracted by them.²⁹ I will discuss this possible distinction later.

Now imagine yourself riding along with the sheet in its accelerating frame of reference. Assuming the sheet is like most fabrics, somewhat stretchable, let us call it a membrane. Put an object on the membrane. It has its own inertial mass (in addition to the mass of the sheet), and the additional mass resists being accelerated. As the membrane accelerates upward, the object sinks into the sheet. At and beyond the perimeter of the object, the membrane tilts down, and the tension in the membrane around the object now has a small component in the upward direction. That applies an additional upward force to the object which slows its sinking into the membrane. Eventually (rather rapidly for all but very large objects) the depth of the object reaches a point where the tensional force makes the object accelerate upward at the same rate as the membrane.

You can visualize all this by imagining a trampoline with a massive object, say a large iron ring, on it ... but put them far out in space where there is little or no gravity; then the ring will make no dent in the trampoline, because it has no weight in zero gravity. But if you now accelerate the trampoline perpendicular to its plane, the ring will now make a dent, as in figure 4. There will be a sloped region around the ring. A smaller object in the sloped region will slide toward the ring. It will slide faster as it approaches the ring, because the slope gets steeper. This suggests that we can get an explanation for gravity from this simple picture of an *accelerating membrane*.

That turns out to be true. One can derive Einstein's General Relativity equations for gravity from it. But here I will be more approximate and show how it results in Newton's gravity. Many textbooks show how a distribution of force f will deform a stretched string or membrane having a tension τ . For a membrane the deformation w , the deviation from flatness, fits the two-dimensional Poisson equation:³⁰

$$\nabla^2 w = \frac{\partial^2 w}{\partial x^2} + \frac{\partial^2 w}{\partial y^2} = -\frac{f(x,y)}{\tau} \tag{1}$$

To derive that, the author (Richard Feynman) took the force f to be in the positive direction, upward. In our case, we want the force to be downward, and produced by the inertia of a mass distribution ρ accelerated upward by the membrane with the acceleration g :

$$f = -\rho g \tag{2}$$

Let us call g the *cosmic* acceleration.³¹ As we will see later, it is a very large number, not the 9.8 m/s² acceleration of gravity at Earth's surface often denoted by the same symbol. Putting (2) into (1) and generalizing to a membrane

with three dimensions (x, y, z) being deformed in a fourth dimension w , we get

$$\nabla^2 w = \frac{\partial^2 w}{\partial x^2} + \frac{\partial^2 w}{\partial y^2} + \frac{\partial^2 w}{\partial z^2} = \frac{\rho(x, y, z)g}{\tau} \quad (3)$$

As textbooks show, the potential Φ (energy per unit mass) associated with the deformation w in this situation is

$$\Phi = gw \quad (4)$$

Multiplying eq. (3) by g and substituting eq. (4) gives us an equation for potential,

$$\nabla^2 \Phi = \frac{g^2}{\tau} \rho(x, y, z) \quad (5)$$

Compare this with Poisson's equation as applied to gravitational potential,³²

$$\nabla^2 \Phi = 4\pi G \rho(x, y, z) \quad (6)$$

where G is the Newtonian gravitational constant, $6.673 \times 10^{-11} \text{ m}^3/\text{kg}\cdot\text{s}$. Eqs. (5) and (6) become the same when we let

$$G = \frac{g^2}{4\pi\tau} \quad (7)$$

Poisson's equation (6) leads directly to Newton's law of gravity, which we can now visualize. The slope of the depression around a large mass causes a small mass on the slope to slide toward the large mass. Its acceleration will be the component of the cosmic acceleration g which is lined up with the slope; only a very small fraction of g . Being very thin in the fourth direction, we don't feel g at all when space is flat. But two masses will feel an attractive force toward each other which increases as they get closer together.

This simple picture of an accelerating membrane, which I hesitate to call a 'theory', explains several puzzles about gravity and one about quantum field theory:

1. It explains Einstein's *equivalence principle*, the initial assumption on which he based general relativity.³³ The principle says that in a small locality one can replace a gravitational field with an equivalent accelerating reference frame. The principle requires that gravitational mass, the mass that produces and responds to gravitational field, be equal to inertial mass. Newton, on the basis of Galileo's experiments, also assumed equivalence of the two sorts of mass. Experiments have so far shown it to be true for all sorts of matter and even for energy.³⁴ But it has never been clear why it should be so. In the accelerating membrane model, inertial mass produces and responds to gravity, so it is equal to gravitational mass.

2. It explains why mass should deform the fabric of spacetime.
3. It explains why deformed spacetime should affect particles with mass, producing gravitational force, and compelling objects to follow geodesic (shortest or longest possible) paths in spacetime. The latter is usually assumed in general relativity, and derivations of it from first principles have never found wide acceptance.
4. It provides the action (energy-time) principle from which one can derive the Einstein gravitational field equations.³⁵ The derivation of Newtonian gravity, above, stems from the same kind of considerations.
5. It resolves the *cosmological constant* problem, the contradiction between (1) the requirement by quantum field theory that the vacuum have a very high mass density, and (2) the requirement from gravity observations that the vacuum have a mass density (proportional to the famous cosmological constant) that is either very small or without significant gravitational effect. The discrepancy is huge, nearly 120 orders of magnitude!³⁶ I am proposing that the force accelerating the membrane of spacetime is the same everywhere. This makes the membrane flat wherever there is no additional mass from objects, so the mass of the membrane does not contribute to gravity. Only additional mass from objects produces deformations which cause gravity. Thus the accelerating membrane idea allows the mass density of the vacuum to be quite large, resolving the problem.

Last, textbooks show³⁷ that allowing time variations in the membrane expands eq. (6) into a wave equation:

$$\nabla^2 \Phi - \frac{1}{c^2} \frac{\partial^2 \Phi}{\partial t^2} = 4\pi G \rho(x, y, z, t) \quad (8)$$

where c is the speed of the waves, given by the ratio of tension to the mass density ρ_m of the membrane³⁸

$$c^2 = \frac{\tau}{\rho_m} \quad (9)$$

As I mentioned in point (5) above, the invisible mass density of the vacuum, i.e. the membrane, is very large; much larger than any visible mass density:

$$\rho_m \gg \rho(x, y, z, t) \quad (10)$$

Eq. (8) will fit relativity (be Lorentz-invariant) if the speed c of waves in the membrane is also the speed of light. Then eq. (8) will be the moderate-gravity approximation of the most important component of Einstein's gravitational field equations.³⁹

5. Acceleration gives the cosmic microwave background

Is there any evidence that the fabric of space is accelerating in the fourth direction? I think so. In 1976, William Unruh⁴⁰ showed that an accelerating particle would experience blackbody radiation with a temperature T given by⁴¹

$$T = \frac{\hbar g}{2\pi c k} \tag{11}$$

Here \hbar is the reduced Planck constant ($h/2\pi$), 1.0545×10^{-34} J s, g is the acceleration in m/s^2 , c is the speed of light, 2.9979×10^8 m/s, and k is the Boltzmann constant, 1.3807×10^{-23} J/K. In this case, bound and unbound particles in the fabric of our space would be accelerating through the quantum vacuum of hyperspace, and the particles would experience blackbody radiation having temperature T .⁴² They would oscillate and emit, within the fabric of our space, blackbody microwaves of the same temperature, which we could then detect. A few theorists disagree that the particles would radiate,⁴³ but a very detailed review article cites many authors who disagree with that.⁴⁴

The fabric of space is exceedingly transparent, because we can see through it for billions of light-years, over a wide range of wavelengths. So the invisible bound particles of the medium must have very low cross-sections for absorption and scattering, which would be expected if the binding forces are very high. However, in a real medium the emission cross-section would not be zero, so we would receive radiation from bound sources in the vacuum, from a wide range of distances. If the cosmic acceleration is large enough, we should be able to detect such radiation, and it should have the spectrum of a black body. It happens that we observe such radiation, namely the famous cosmic microwave background (CMB). It fits a blackbody spectrum very precisely (figure 5), giving a temperature of $2.72548 (\pm 0.00057)$ Kelvin.⁴⁵ This would be the temperature of the fabric of space, which would be heated by the Unruh effect. The small Doppler-like shift we observe in the CMB⁴⁶ thus appears to be caused by our velocity with respect to the fabric of space.

If indeed the CMB is caused by cosmic acceleration, then we can calculate the amount of acceleration by solving eq. (11) for g :

$$g = \frac{2\pi c k T}{\hbar} \tag{12}$$

Using the CMB temperature for T gives us the cosmic acceleration:

$$g = 6.721(\pm 0.001) \times 10^{20} \text{ m/s}^2 \tag{13}$$

This, of course, is an exceedingly great acceleration. It needs to be great in order for general relativity derived from

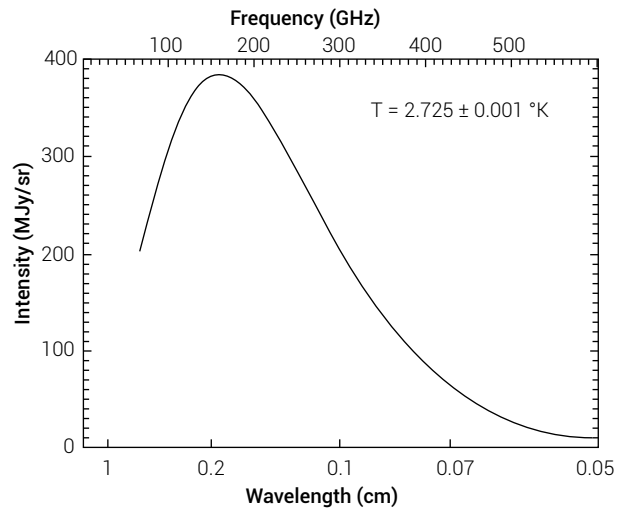


Figure 5. Spectrum of cosmic microwave background observed by WMAP satellite. The curve is the theoretical black-body spectrum for the listed temperature. Data points and error bars all fall within the thickness of the curved line in both absolute intensity and wavelength. (Graphic after WMAP/NASA).

this picture to be accurate for the largest gravity we might observe. For example, the gravitational acceleration near the event horizon of a black hole with the mass of the sun would be $1.5 \times 10^{13} \text{ m/s}^2$ (times a relativistic factor greater than one).⁴⁷ In such regions the high value of g would make general relativity accurate to better than one part in ten million. Also, g represents a maximum possible gravitational acceleration, which might help resolve some of the paradoxes associated with black holes.

Last, let us calculate the mass density ρ_m of the membrane from the value of g above. Putting eqs. (7) and (9) together gives:

$$\rho_m = \frac{g^2}{4\pi G c^2} \tag{14}$$

This gives the mass density of the membrane:

$$\rho_m = 5.993 \times 10^{33} \text{ kg/m}^3 \tag{15}$$

From eq. (9), the tension, which is the same as the energy density, of the membrane is

$$\tau = \rho_m c^2 = 5.386 \times 10^{50} \text{ J/m}^3 \tag{16}$$

The above values are well within some (very broad) limits given by theorists for the mass and energy density of the quantum vacuum.⁴⁸ Converting the units of eq. (16) to units more familiar to me, the tension is 5.386×10^{45} Bars (1 Bar is about 14.7 pounds per square inch). The membrane, the fabric of space, must be exceedingly strong in order not to tear under such

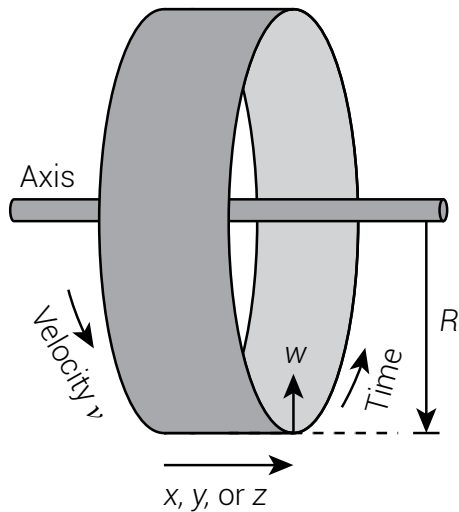


Figure 6. Fabric of spacetime as a rotating wheel in hyperspace.

an enormous tension. That could be why Psalm 150:1 (NAS) says the expanse of the heavens (Genesis 1:8 NAS) is ‘mighty’.⁴⁹

6. The acceleration may be centripetal

If the cosmic acceleration were linear, in a straight line perpendicular to the plane of the membrane, we would have travelled a very large distance in 6,000 years of our time. Hyperspace would have to be very large to accommodate the motion. That may be possible, but I suspect that the acceleration may be *centripetal*, such as one would experience on a rotating wheel. That would mean that we, and the fabric of space, have a very high velocity v in hyperspace, in a direction perpendicular to the cosmic acceleration. This velocity could be in the fifth direction, *timeward*, in the direction of our future (figure 6). See my remarks on time in section 3. Spacetime would have a principal radius of curvature R in the timeward direction. The accelerating force would then be the tension τ that holds the fabric rim of the wheel together. That would make the accelerating force uniform throughout space. The cosmic acceleration g in the rotating frame of reference would be simply

$$g = \frac{v^2}{R} \quad (17)$$

This picture leads straightforwardly to Einstein’s gravitational field equations. There are some interesting scriptures that hint at a rotation through time, but I don’t have the space in this article to discuss the idea further. It is sufficient for now that a cosmic acceleration exist, whether linear or centripetal.

7. Conclusion

It is difficult for most people to imagine space as a physical material with a tension and a fourth spatial dimension. It may help to remember that those ideas come directly from taking Scripture straightforwardly. Adding a cosmic acceleration yields a simple picture that underlies the equations of gravity and solves five long-standing mysteries about it. One of them is the well-known conflict of the cosmological constant with quantum field theory. Last, the acceleration leads directly to an explanation for the cosmic blackbody radiation, which should help creation cosmology. In one or two future papers I plan to apply this new view of gravity to (1) galaxy redshifts,³ and (2) the Pioneer anomaly⁵⁰ and recent developments about it. I hope this new view of the heavens will help us see the glory of God in them better.

References

- Humphreys, D.R., *Starlight and Time: Solving the Puzzle of Distant Starlight in a Young Universe*, Master Books, Green Forest, AR, pp. 66–68, 1994.
- Hartnett, J.G., Does the Bible really describe expansion of the universe? *J. Creation* 25(2):125–127, August 2011; creation.com/images/pdfs/tj/j25_2/j25_2_125-127.pdf.
- Humphreys, D.R., New time dilation helps creation cosmology, *J. Creation* 22(3): 84–92, 2008, see pp. 88–90 for the cosmology and eq. (21) for the redshift; creation.com/images/pdfs/tj/j22_3/j22_3_84-92.pdf.
- Humphreys, ref. 1, p. 84.
- Bullinger, E.W., *Figures of Speech Used in the Bible: Explained and Illustrated*, Eyre & Spotteswoode, London, 1898, reprinted by Martino Publishing, Mansfield Centre, CT, pp. 726–733, 2011.
- Morris, H.M., *Men of Science—Men of God: Great Scientists who Believed the Bible*, Creation-Life Publishers, San Diego, CA, pp. 89–91, 1982.
- Maxwell, J.C., *A Treatise on Electricity and Magnetism*, vols. 1 and 2, Clarendon Press, Oxford, Unabridged 3rd edn, 1891. See, vol. 1, article 62, p. 68, for the first mention of electrification and polarization in “even what is called a vacuum”.
- Maxwell, ref. 7, vol. 2, article 610, p. 253.
- Maxwell, ref. 7, vol. 2, chapter XX, pp. 431–450. On the necessity for a medium, see his concluding remarks in vol. 2, article 866, pp. 492–493.
- Einstein, A., On the electrodynamics of moving bodies, in *The Principle of Relativity: A collection of original papers on the special and general theory of relativity*; in: Lorentz, H.A., Einstein, A., Weyl, H. and Minkowski, H., Dover Publications, New York, pp. 37–65, 1952. Translated from, Zur Elektrodynamik bewegter Körper, *Annalen der Physik* 17, 1905. Note comment on the ‘luminiferous ether’ on p. 38 of the English translation.
- Einstein, A., Ether and the theory of relativity: An address delivered on May 5th, 1920, in the University of Leyden, in *Sidelights on Relativity*, by Albert Einstein, translated by Jeffery G.B. and Perret, W., E.P. Dutton and Company, New York, 1922. Reprinted by Dover Publications, New York, 1983. See pp. 3–24 of reprint, esp. pp. 13, 15, and 23. Also see Humphreys, ref. 1, p. 84.
- Henley, E.M. and Thirring, W., *Elementary Quantum Field Theory*, McGraw-Hill Book Company, p. 8, 1962: “Space is spanned by the continuous background of the fields of elementary particles; in some respects this is the sequel of the ether concept of the last century. Matter is just a local excitation of this background ...”
- Milonni, P.W., *The Quantum Vacuum: An Introduction to Quantum Electrodynamics*, Academic Press, New York, pp. 54–58, 82–86, 310–312, 1994.
- Urban, M., Couchot, F., Sarazin, X. and Djannati-Atai, A., The quantum vacuum as the origin of the speed of light, *European Physical J. D* 67:58–64, 2013; preprint at arxiv.org/abs/1302.6165.
- Dirac, P.A.M., Is there an Ether? *Nature* 168:906–907, 24 November 1951. Dirac, one of the founding fathers of modern quantum theory, answers in the affirmative to the question in his title.

16. Feynman, R.P., Leighton, R.B. and Sands, M., *The Feynman Lectures on Physics*, vol. III, Addison-Wesley Publishing Company, Reading, MA, pp. 13–21, 1965.
17. Lorentz, H.A., Electromagnetic phenomena in a system moving with any velocity less than that of light, *Proceedings of the Academy of Sciences of Amsterdam* 6, 1904. Reprinted in Lorentz *et al.*, ref. 10, pp. 11–34. Here Lorentz correctly showed that an ionic lattice moving through an æther would physically contract due to changes in the electromagnetic field (pp. 14–15, 18). He also found time dilation, but, not realizing its profound significance, called it ‘local time’ (p. 15). He had discovered the Lorentz transformations, the core of special relativity, a year before Einstein did, and he did it while remaining entirely within an æther theory.
18. Humphreys, ref. 1, pp. 66–68. The 17 verses are: 2 Sam. 22:10, Job 9:8, Job 26:7, Job 37:18, Psa. 18:9, Psa. 104:2, Psa. 144:5, Isa. 40:22, Isa. 42:5, Isa. 44:24, Isa. 45:12, Isa. 48:13, Isa. 51:13, Jer. 10:12, Jer. 51:15, Ezek. 1:22, Zech. 12:1.
19. Humphreys, ref. 1, p. 121, eqs. (22) and (23).
20. Brown, F., *The New Brown-Driver-Briggs-Gesenius Hebrew and English Lexicon*, Hendrickson Publishers, Peabody, MA, pp. 639–641, 1979, entry for הנה.
21. Yates, K.M., *The Essentials of Biblical Hebrew*, Revised edn, Harper & Row, Publishers, New York, p. 152, 1954.
22. Kaku, M., *Hyperspace*, Oxford University Press, New York, 1994. Because of the scriptural clues, I think of hyperspace as something real, not a mathematical convenience, consisting of only four spatial dimensions instead of ten or twenty-two (most of which are ‘compactified’, i.e. rolled up into a very small size). The extra dimension, which in section 4 I call *w*, often appears in the metrics and other equations of general relativity as gravitational potential Φ . I take Φ as being proportional to *w*, eq. (4).
23. Humphreys, ref. 1, p. 93.
24. Einstein, A., Cosmological considerations on the general theory of relativity; in: Lorentz *et al.*, ref. 10, pp. 177–198, esp. p. 185 and eq. (9). Translated from A. Einstein, Kosmologische Betrachtungen zur allgemeinen Relativitätstheorie, *Sitzungsberichte der Preussischen Akademie der Wissenschaften*, 1917. Also see Humphreys, ref. 1, p. 94.
25. Misner, C.W., Thorne, K.S. and Wheeler, J.A., *Gravitation*, W.H. Freeman and Company, New York, p. 704, 1973. Note ^a in middle of page: “Excursion off the [hyper]sphere is physically meaningless and is forbidden. The superfluous dimension is added to help the reason in reasoning, not to help the traveler in traveling.” Also see Humphreys, ref. 1, pp. 94–95.
26. Bullinger, ref. 5, p. 727, gives very simple instructions as to how to interpret the type of figure of speech called a simile: “They require no explanation. They explain and are intended to explain themselves.” Personal inquiries I have made of conservative theologians have yielded no better principles for interpreting similes, or other types of figure of speech. They all seem to avoid detailed examination of such scriptures, implying that they can learn nothing about the physical world from figures of speech. They were not able to supply me with a scholarly Bible study backing up that opinion.
27. One reason for the confinement of light to within the fabric of our space could be that the speed of light in hyperspace is very much greater than in the fabric of our space. Thus, almost all light emitted from within our space would suffer total internal reflection, as in an optical fibre. Or, the two boundaries of the fabric in the *w* direction could reflect photons for some other reason. The same kind of constraint might be what prevents matter in the membrane from leaving it. In either case, light would effectively propagate only in the *x*, *y*, and *z* directions, not in the *w* direction. The blocking of light would also apply to light coming from hyperspace toward us. It may be that occasionally God enables light and matter from hyperspace to enter the fabric of our space, which could explain the instances of the heavens being ‘opened’ in Scripture.
28. Abbott, E.A., *Flatland: A Romance of Many Dimensions*, Princeton University Press, Princeton, NJ, 1991, with a new introduction to the second and revised edition of 1884.
29. Jammer, M., *Concepts of Mass in Classical and Modern Physics*, Harper & Row, New York, p. 125, 1961.
30. Feynman, ref. 16, vol. II, pp. 12–5, 12–6.
31. More precisely, the cosmic acceleration *g* is as measured in the accelerating frame of the membrane. I assume it to be constant with time and all four spatial dimensions. For extremely large deformations in the *w*-direction, the latter might not be strictly accurate.
32. Poisson’s equation, 2014, at en.wikipedia.org/wiki/Poisson’s_equation.
33. Einstein, A., *The Meaning of Relativity*, 5th edn, Princeton University Press, Princeton, NJ, pp. 56–59, 1956. For historical insight, see Pais, A., ‘*Subtle is the Lord ... The Science and Life of Albert Einstein*’, Oxford University Press, Oxford, England, chap. 9, 1982. ‘The happiest thought of my life’, pp. 177–180.
34. Ohanian, H.C. and Ruffini, R., *Gravitation and Spacetime*, 2nd edn, W.W. Norton & Company, New York, pp. 21–33, 1994.
35. Landau, L.D. and Lifshitz, E.M., *The Classical Theory of Fields*, 4th revised English edn, Pergamon Press, Oxford, England, Section 95, pp. 274–279, 1975.
36. Weinberg, S., The cosmological constant problem, *Reviews of Modern Physics* 61(1):1–23, January 1989; pp. 2–3.
37. Morse, P.M. and Feshbach, H., *Methods of Theoretical Physics*, part I, McGraw-Hill Book Company, New York, pp. 124, 304, 1953.
38. Humphreys, ref. 3, p. 91.
39. Ohanian, ref. 34, p. 388, eq. [49] with $\mu = \nu = 0$, $\Lambda = 0$, and $\Phi = \frac{1}{2} \kappa h_0$ (text below eq. [49]).
40. Unruh, W.G., Notes on black-hole evaporation, *Physical Review D* 14(4):870–892, 15 August 1976.
41. Boyer, T.H., Thermal effects of acceleration for a classical dipole oscillator in classical electromagnetic zero-point radiation, *Physical Review D* 29(6):1089–1095, 15 March 1984.
42. Alsing, P. and Milonni, P.W., Simplified derivation of the Hawking-Unruh temperature for an accelerated observer in vacuum, *American J. Physics* 72(12):1524–1529, December 2004.
43. Ford, G.A. and O’Connell, R.F., Is there Unruh radiation? *Physics Letters A* 350(1–2):17–26, January 2006. Preprint archived at arxiv.org/pdf/quant-ph/0509151.pdf. This paper shows that an accelerating particle would come to thermal equilibrium, absorbing as much energy as it radiates. That would be expected even in classical thermodynamics. However, the authors then puzzle me by implying that the particle does not radiate energy!
44. Crispino, L.C.B., Higuchi, A. and Matsas, G.E.A., The Unruh effect and its applications, *Reviews of Modern Physics* 80(3):867–838, July 2008. Preprint archived at arxiv.org/pdf/0710.5373.pdf. This review cites Ford and O’Connell above in its footnote 28, on page 25 of the preprint, then follows with other authors reaching the opposite conclusions. Finally the reviewers offer some opinions as to why there is a difference.
45. Cosmic microwave background, Wikipedia, 2014, at en.wikipedia.org/wiki/Cosmic_microwave_background.
46. Humphreys, D.R., Our galaxy is the centre of the universe, ‘quantized’ red shifts show, *J. Creation* 16(2):95–104, August 2002. creation.com/images/pdfs/tj/j16_2/j16_2_95-104.pdf. See p. 103, endnote 28.
47. Rindler, W., *Essential Relativity: Special, General, and Cosmological*, Revised 2nd edition, Springer-Verlag, New York, p. 48, 1977, eq. (8.71), which has $G = c = 1$ units.
48. Schwarzschild, B., Why is the cosmological constant so very small? *Physics Today* 42(3):21–24, March 1989. See estimates on p. 22 of 10^{37} and 10^{114} GeV/cm³, which convert to $\sim 10^{33}$ and $\sim 10^{10}$ J/m³. These estimates depend on the high-frequency cutoff chosen for the invisible oscillating particles in the quantum vacuum.
49. Humphreys, D.R., God’s mighty expanse, 26 February 2009, creation.com/gods-mighty-expanse.
50. Humphreys, D.R., Creation cosmologies explain the anomalous acceleration of Pioneer spacecraft, *J. Creation* 21(2):61–70, 2007; creation.com/images/pdfs/tj/j21_2/j21_2_61-70.pdf.

D. Russell Humphreys Ph.D., is a physicist. In 2001, after 22 years, he retired from Sandia National Laboratories to work for the Institute for Creation Research, and then Creation Ministries International, until 2010. He resides in Chattanooga, TN, USA, writing and doing creation science research. He is a long-time board member of the Creation Research Society and occasionally speaks on its behalf.