Beyond our universe lies our future

What lies beyond our universe has intrigued many of us. The authors will argue that, once you take space-time seriously, a vision arises of our future. It is hard to take space-time seriously. Even though Einstein demonstrated to us that space and time are strongly related, that message has still not been fully understood. In the words of Minkowski: “The insight is radical, from now on, space itself and time itself disappear in mere shadows, while the union of the two will maintain its independence”. The authors want you to think in space-time when looking at the universe and beyond.
A wonderful picture of the universe will emerge when you think in space-time instead of space only. We are going to look at space-time in four-dimensional shapes. Since we cannot imagine four-dimensional shapes, we will use two-dimensional sections to understand the universe. We will then understand why the future lies beyond the universe.

Strong relation between space and time

Time is measured with a clock. Time is measured on a (cesium) clock, indicating the progress of physics locally. Putting a cesium clock in a plane, demonstrates the tiny differences in the progress of time locally compared to the synchronized clocks on earth (Hafele-Keating experiment). Space is measured with clocks too. Your location on earth is determined with clocks on satellites (GPS, Galileo). The unit meter is the distance light travels in vacuum in 1 / c seconds, in which “c” is the speed of light. The SI organization has kept up with the unity of space and time.

Space and time are both measured with clocks. From physics point of view, space-time is four dimensional and measured with a single type of measurement equipment: clocks. That puts physics aside from mathematics. Mathematically, more dimensional “spaces” can be thought of, a ten dimensional “space” is found in some string theory models. However, we can only *measure* four out of those ten dimensions. The string theory can be verified as a theory of physics when measurable results in our four-dimensional space-time are presented. Anyway, a four-dimensional universe is already hard to imagine, let us do so by two-dimensional sections.

Space-time in a two-dimensional section

Dropping a coin from a height of five meters results in a space-time trajectory as in figure 1:

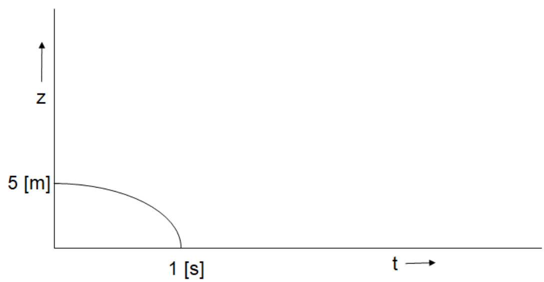

Figure 1: space-time diagram of falling coin

Note that the time axis “t” is drawn perpendicular to the space axis “z” as if it is space too. You cannot draw the “x” and “y” axes in figure 1, there is no way to imagine space-time as four space dimensions. To begin to understand the universal space-time, let us begin to look at Einstein’s first model, the 3-sphere.

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Einstein's 3-sphere universal model

Although Einstein was co-inventor of space-time (together with Minkowski), his first cosmological model was a *static* model, a 3-sphere described in four space dimensions, see his book "my theory". Later, he designed another model with de Sitter, which was Euclidean (flat), but this model did not answer to the cosmological principle. The cosmological principle states that the universal model must be homogenous (the same everywhere) and isotropic (the same in all directions). The authors find his first model a good start, it answers the cosmological principle, but it needs to get time involved. Let us first look at that first model in detail.

Because of the gravitational attraction, he introduced the "cosmological constant" to counteract the gravitation. The 3-sphere is the 3D "surface" in [m^3] of a hypersphere in 4D in [m^4]. The two-dimensional (2D) section results in a circle. A 3D section results in a normal (hollow) sphere. A 2D) section is drawn in figure 2:

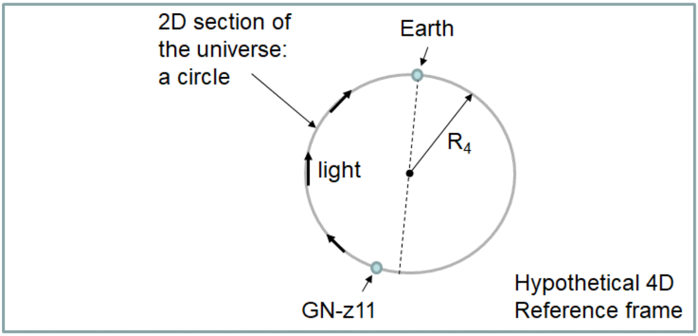

Figure 2: A circle as two-dimensional section of Einstein's static 3-sphere

Note that the word "surface" is a mathematical term, physicians talk about a volume of course. That volume amounts to $2\pi^2.R_4^3$ [m^3] see Einstein's book "my theory". The essence of the 3-sphere is its roundness in 4D. Light goes around in 4D in a circle (the geodesic, the shortest route, is part of a grand circle) in a way that we cannot really imagine. In figure 2 you see the circle (geodesic) on which the earth and our furthest galaxy called GN-z11 is located. Light propagates over this grand circle.

How did Einstein get to this model? When you consider a limited universe and abide by the cosmological principle, you have no choice but choosing a 3-sphere model. We know that the universe is limited in volume by its limited light at night from stars and from the limited gravitational forces. Once you accept that the volume of the universe is limited, the cosmological principle applies.

The only shape that is both homogenous and isotropic, is the 3-sphere, Einstein called it "limited but borderless" in his book "my theory". This model also explains why the cosmic background radiation comes from all sides. We look at the Big Bang of the other side, just like the other side looks at the Big Bang at our location in the distant past.

However, when Einstein saw the work of Hubble and Humason about an expanding universe, he withdrew the cosmological constant and called this his "biggest blunder". Out went his *static* 3-sphere model of the universe.

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A 3-sphere space-time model

Could Einstein have saved his first model? Yes, according to the authors. If he could have seen that the 4D radius "R_4" of the 3-sphere is the same as time! The formula is simple: $R_4 = c.t / \pi$. Mathematicians: Note that in a 4D polar coordinate system, this radius is a scalar, just like time, confirming the proper mathematics of the 3-sphere *space-time model*. This 3-sphere space-time model of the universe is the model of the authors. Figure 3 shows a 2D section of this model:

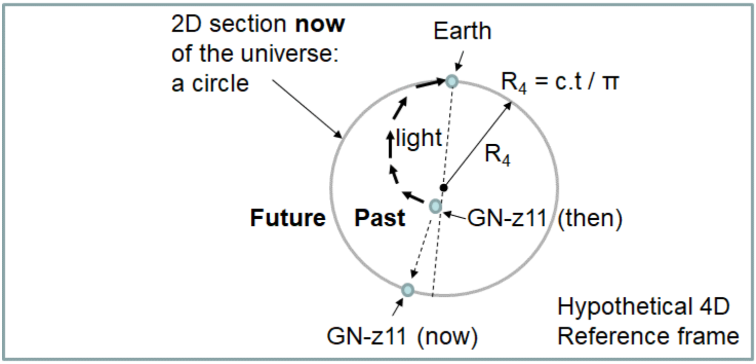

Figure 3: two-dimensional section of author's 3-sphere space-time model

In figure 3, you see galaxy GN-z11 move from close to the Big Bang, shortly after the Big Bang, to its likely location at present on nearly the other side of the universe. The circle in figure 3 represents the universe now, although our observations look into the past. In a space-time diagram of the light going from GN-z11 to earth you see an outward spiral drawn, not a circle.

So what lies beyond the universe?

Figure 3 shows it clearly, beyond our 3-sphere space-time lies the future! The past lies on the inside of the current 3-sphere, while the Big Bang lies in the origin. That is thinking in space-time instead of thinking in space only. *Locally, we live surrounded by space, but on the edge of time*. Locally, a small variation in time and space (dt,dx,dy,dz) are variations that are perpendicular to each other. In other words, putting time in a space-time diagram as in figure 1 is physically justified!

Supporting principles of the 3-sphere space-time

1. perfect cosmological principle,
2. comoving coordinates of the universe (Robertson-Walker),
3. energy-momentum conservation (Noether).

The 3-sphere space-time is supported by the *perfect* cosmological principle. In the perfect cosmological principle, both space *and time* are homogenous and isotropic. This model is consistent over time. The real world is neither homogenous, nor isotropic; neither in space, nor in time. We need to separate the simplified model of the universe from the endlessly complicated real word. We can see the differences in the real world by our astronomical observations. However, the 3-sphere space-time model is the only universal model that adheres to the *perfect* cosmological principle.

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Secondly, the model is supported by Robertson and Walker's comoving coordinates. Even though the universe expands, the space-time coordinates remain the same for galaxies without movement relative to the background radiation (no peculiar speed).

Thirdly, the model is supported by Noether's theorem of energy and momentum conservation. Although Noether warned Einstein that his theory is not always guaranteeing energy conservation, he never fully implemented her theorem in his theory. The 3-sphere space-time implemented Noether's theorem fully.

Supporting observational evidence of the 3-sphere space-time

1. distribution of galaxies over the universe,
2. star formation of far galaxies seeming to go redshift plus one faster,
3. cosmic background radiation redshift and coming from all sides,
4. Hubble's relation between *distance* and redshift of galaxies.

The 3-sphere space-time is supported by the distribution of galaxies, showing a peak at a redshift of about one, see our book "Repairing Robertson-Walker's Solution".

Secondly, as a consequence of comoving coordinates and Noether's theorem, star formation seems to go redshift plus one faster at far galaxies. This is confirmed by the Hubble Space Telescope for galaxies with a redshift of about nine, star formation seemingly going ten times faster.

Thirdly, the cosmic background radiation confirms both the roundness of the universe and the smaller units of the past, confirming comoving coordinates and Noether's theorem yet again.

Finally, Hubble formula of redshift versus *distance* is supported by this model. The assumption that this is caused by speed only, is too simple and incorrect for far galaxies. Noether's theorem does not allow for ever increasing energy of the universe. Note that Hubble *measured redshift* and estimated *distances*, while *not a single speed was measured*. Redshift of galaxies is caused by comic inflation as a consequence of the comoving coordinates and Noether's theorem.

Consequences and implications

A 3-sphere has a lower volume than a Euclidean (flat) universe. This results in a higher density (about 20 times). The higher density wipes out the need for dark energy. The curvature of the universe (partially) explains the orbit of far stars, making dark matter less necessary as explanation. Also, the Pioneer 10&11 anomaly is solved, the deceleration amounts to c.H. The Milky Way (without dark energy and less dark matter) is a pretty average galaxy in the 3-sphere space-time model.
For more info: "Repairing Robertson-Walker's Solution" at www.loop-doctor.nl. We hope you get as many "aha" experiences as we did,

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