Topology of the curved space-time universe

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Abstract

We show that the instability in Einstein's originally conceived hyper-spherical universe was only seeming, while it is a perfectly stable solution, once there is known the balance of weight and density and the condition of continuity of space, where the explanations of observations (most notably quantum mechanical explanation of redshift) were earlier conducted in Curvature Cosmology by David F.Crawford, while we disagree with few of his explanations. We refute the Big Bang theory as being non-physical, not needed to explain observations, while showing just some of its flaws... We also explain, how such a universe could initially evolve, and give some estimates on its actual size, as determined from the Hubble parameter.

In the following chapter on gravitational acceleration we explain the cause of the gravitational acceleration and force from space curvature, as a centrifugal acceleration due to object's movement in time through the curved space-time (or the rotation of reference frame in the curved time), deducing the original equation for gravitational acceleration from the space-time curvature and angular velocity, and explaining free-fall, orbit and tides.

Topology of the curved space-time universe

Since vacuum is a mere theoretical concept, and even IGM (inter-galactic medium) and inter-cluster medium all contain some matter, the curvature of space is always positive and due to a statistical isotropy, it closes to a **hypersphere**. For an idea of such a hypersphere, if you travel by 2πR in one direction, you come to the same place from the opposite direction (same as if you walked on the Earth surface), regardless if you start in x,y,z directions (hence, contrary to a simple Earth surface, the same happens when starting up...).

The same geometry was originally proposed by A.Einstein [ref Einstein/wiki], but he was later convinced by Lemaitre, Friedman and Hubble to add Λ (lambda) to the equations for a negative pressure (the dark energy), which he later called the Biggest Blunder of his live (rhyming with a Big Bang probably not by a mere coincidence)... The dark energy Λ, or could be called an anti-energy, is in the equation used on the opposite side of matter than a normal energy - whereas even a little of matter is very much of energy (or very much of energy is equivalent with a little of matter, on the same side of curvature equations), then only a little of anti-energy (energy of vacuum) has same-but-opposite effect as a very much of matter... Also, this anti-energy, that should be a property of any space, was never detected, and is postulated together with a dark matter as something, that cannot be detected by a principle, so it cannot be disproved merely by not observing it anywhere... For a case of Inflation, at the time of this writing, wiki mentions expansion on the order 10^{78} at 10^{-32}s. This leads to expansion to many millions of light-years from sub-Planck length, and the front-side of this expansion would have to move by many orders of magnitude faster than the speed of light?! This solution is really a blunder on more detailed inspection...

So, returning to the original Einstein's solution:

$$R = \frac{c}{\sqrt{4\,\pi\,G\,\rho}}$$ Equation used in Einstein's universe (as presented in wiki/Einstein's_universe)

We use just a little different equation:

$$R = \sqrt{\frac{3\,c^2}{8\,\pi\,G\,\rho}} = \frac{2}{3\,\pi}\,r_{S3}$$, where $$r_{S3} = \frac{2\,GM}{c^2}$$

and $\rho = N\,M_H$, where N is an average count of hydrogen atoms in m^3 of IGM and M_H is a mass of proton. R is a radius of curvature, which is also a radius of the hyperspheric universe...

Left part of the equation of curvature radius is used by D.Crawford [ref CC2011], optimized from Friedman equations by setting $\Lambda = 0, \ddot{R} = 0, \dot{R} = 0$ (a static solution with no dark energy) . Right side we will calculate below. Here ρ is a density of IGM only, since galaxies do not contribute to overall curvature, when they are although admirable, but after all rare exceptions in volume (Fig.1). IGM contains approximatelly 1/5 .. 1/2 of the weight of the universe, while spanning >99% of it's volume. The difference of coefficient of 1/4 and 3/8 is only by a constant and is not that much large... Later we will see another equation for curvature radius (from a different source), where it would yield rather 3/4 at this place (but for an "outer" curvature?), which differs more, but still by a constant... The right part is an opposite relation, where a matter weight determines the size, which eliminates the need of Curvature Pressure, offered by D.Crawford.

Volume of hyperspheric universe (3D surface of a 4D hypersphere) :

$$V = 2\pi^2 R^3 = \frac{2\pi^2 3^{\frac{3}{2}} c^3}{(8\pi G)^{\frac{3}{2}} \rho^{\frac{3}{2}}}$$

Mass of IGM, contained in hyperspheric universe:

$$M = V\rho = \frac{2(3^{\frac{3}{2}})\pi^2 c^3}{(8\pi G)^{\frac{3}{2}} \rho^{\frac{1}{2}}}$$

rearranged as:

$$\rho^{\frac{-1}{2}} = \frac{(8\pi G)^{\frac{3}{2}} M}{2(3^{\frac{3}{2}})\pi^2 c^3}$$

and substituted into the original equation for R, gives:

$$R = \frac{4GM}{3\pi c^2} = \frac{2}{3\pi} r_{S3} \quad \text{, where} \quad r_{S3} = \frac{2GM}{c^2}$$

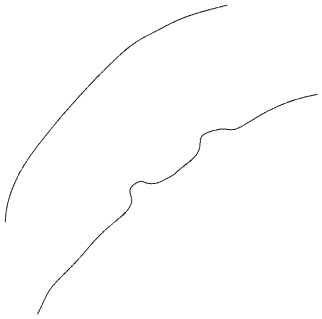
Getting mass into the curvature equation instead of density, it reveals a common 3-dimensional Schwarzchild radius r_{S3}, multiplied by $\frac{2}{3\pi}$ (cca 0.212 r_{S3}).
With the original Einstein's universe equation (using coefficient 1/4 instead of 3/8), the other side would be: $R = \frac{r_{S3}}{\pi}$ (cca 0.318 r_{S3}) . In the case of equation, shown later, matching gravity acceleration near the Earth (using coefficient 3/4 instead of 3/8, and using centrifugal acceleration equation for gravity), the other side would be: $R = \frac{r_{S3}}{3\pi}$ (cca 0.106 r_{S3}) .

Ratio of 3-sphere (4D hypersphere) surface volume ($2\pi^2R^3$) to 2-sphere (normal 3D sphere) volume ($4/3\pi R^3$) is $\frac{3\pi}{2}$, which looks somehow similar as the ratio of 3-dimensional Schwarzchild radius to curved universe radius with the Crawford's coefficient 3/8... Will there be a different 4-dimensional Schwarzchild radius ?

The curvature radius and total volume are constrained both by density and by mass of IGM, so collapse toward higher-density smaller-radius or toward lower-density bigger-radius is both protected by a constancy of mass of IGM. On the other side, the overall curvature radius and total volume of the universe can be modulated by galaxies, by absorbing or expeling mass into IGM - the matter in the IGM is recycled these ways... Instability, reminded to Einstein's version of the universe due to conversion of matter to energy or back, is groundless - in the IGM, the conversion between matter and energy is probably very rare and if it is not impossible, it can be ignored on large scales... Instability due to a bad choice of ρ value [ref. EiProblems] is also groundless.

Since there is no boundary, there is also no center of mass, toward which the matter could collapse gravitationally, since if the galaxy distribution is almost isotropic, all galaxies and IGM have equal amount of other galaxies and IGM on all sides, so this can be considered a stable solution, which is probably much older than 13.8e9 years, postulated rather dogmatically by ΛCDM model (the age, originally calculated by 1 / H_0 was not adjusted, when H_0 was adjusted, so the age became rather a dogma than a result in ΛCDM model!). Even in our galaxy, some stars of (at least) second generation (for ex. BD +17° 3248, HE0107-5240) are estimated to be almost 14e9 years old...

The topology is closed regardless, if the individual point-mass curvature geometry is hyperbolic or elliptic, same as in planar geometry, even many connected hyperbola segments may close to a deformed circle (Fig. 2, 2). The closure of the topology is a result of endlessness to a certain (circumference) distance and of the same sign of curvature at every place.

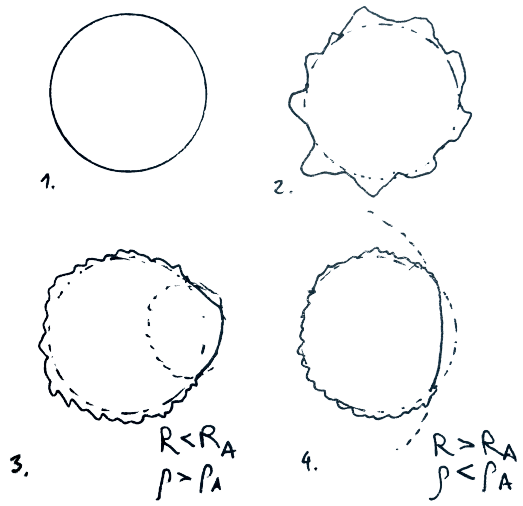


A sketch drawing of curved space-time, reduced by 2 dimensions, showing, why mostly only IGM contributes to overall space curvature.

First line is IGM without galaxies. Second line shows two galaxies. Their space curvature reduces with distance and diminishes, while the omnipresent IGM curvature prevails in longer distances from galaxies...

Fig. 1

Another factor of stability is the continuity of the space. See Fig. 2. describing local inhomogenities. The space is so big, that the possible local inhomogenities cannot level off on the overall scale...



1. Homogenous isotropic space with constant curvature
2. Space with matter clumps (galaxies).
3. On the right there is a place with more dense IGM matter than average. The radius of curvature is smaller, and yet the volume is bigger than average, which tends to balance the matter condensation to some degree. Possibly it will condense to make a new galaxy...
4. On the right there is a place with less dense IGM matter. The radius of curvature is bigger, and yet the volume is smaller than average, which tends to balance the low density by decreased volume...

here index A means "Average"

Fig. 2

The black-hole density shrinks with growing mass, and a black-hole of a mass of all universe would be even less dense than current IGM, and bigger than current radius of the universe. It could rather be said, that we are living inside a Schwarzchild radius of the universe... With current estimates of mass ratio of IGM to galaxies, it can be said, that even when before the galaxies formed, the space was smaller or equal to a black hole size of its mass... (A common notice of switching space and time axis inside a black-hole [ref. EiOnline] is a misuse of external solutions and incorrect coordinate system inside an event horizon and would need to be corrected... Another example of incorrectness of using an exterior solution for an interior is the seeming singularity at the center: for example the center 1mm of the Earth or central 2km of the Sun should have a black-hole geometry from Schwarzchild solution, but instead the gravitational acceleration there is almost negligible, while acceleration of the "left" part is balanced and canceled by the acceleration due to the "right" part - if the acceleration is proportional to the "slope" of the curvature, which at the center (turning point) is 0, or in the Newtonian model of gravity... In the model, where the gravity is proportional to the radius of curvature caused by density, in the center could be just the same gravitational acceleration as below the surface, if the density was same... So even an ordinary black-hole does not have any singularity at it's center. Simplifying an object to a point-mass is valid only outside it's boundary...)

This universe geometry could not be reached by any type of Big Bang from a single place...

It could also be said, how it all could start: At the beginning, the space was filled with sparse hydrogen atoms in thermal equilibrium without any density fluctuations, and was bigger than current universe - a very big black hole... The entropy was infinite, no chaos at all - the space was "dark and void" [ref Gn1]. Applying an acoustic wave to such a medium would create condensation nuclei, which would gravitationally collapse to form stars and galaxies (see wiki/Stellar_nursery, "*triggered star formation"*, [ref ap040927], [ref ap990407], wiki/SSPSF_model, wiki/Jeans_instability, wiki/Galactic_spheroid, how can an acoustic wave in a hydrogen cloud cause a star formation). Such an acoustic wave would have a size of the universe, and a tone frequency on the size of separation of galaxies, and/or separation of stars. This started the "lights" - stars and galaxies. Further absorption of hydrogen from IGM into galaxies (divided "waters" of the sky from "waters" of the grounds) made mass of IGM smaller and the space contracted to its present size... If it could happen this way, it is one of proofs, that old

Hebrew were somehow "*inspired*" (while writing this solution in the first 10 rows of Genesis) by any entity, that could understand this, since they could not understand this by themselves, having no terms in their language to describe it or think about that. It is also a proof, that any entity, that could make an acoustic wave into equilibrium space, exists outside of that space...

Consider, that the 2nd law of thermodynamics applies to thermodynamic processes (that an entropy of an isolated system can never decrease), and neither to the gravitational collapse nor to the stellar nucleo-synthesis and high-temperature IGM nuclear fission, which are not thermodynamic processes. Also consider, that the eternal universe would not collapse to black-holes - as you may see in the center of the Milky Way, only the nearest stars are captured by the central black-hole, and even those rather orbit it than fall in - a same statement, that planets in Solar system do not fall into Sun... Consider, that a continuous creation of matter, proposed for some static cosmological models, is a nonsense, and is not needed...

Curvature redshift has been successfully explained by D.Crawford [ref. CC2011], due to light traveling over curved space-time getting less energy (due to geodesic focusing, it gradually changes cross-sectional area of the photon wave, then angular momentum and spin, which can be tolerated only for a finite time), when after some time the original photon splits into 3 new photons, 1 contains almost all energy of the original photon and the original direction, while the other 2, one to each side, are low-energy photons, which get absorbed by IGM plasma, further causing CMBR radiation from plasma electrons, which is predicted/calculated with a correct observed temperature. Hence, anisotropies of CMBR are explained by a minor anisotropy of IGM arround our galaxy. The lack of redshift inside the galaxy is explained by other processes in rather dense ISM (inter-stellar medium), competing with the curvature redshift process and so inhibiting it. The light-curves of Type Ia supernovae are explained by the fact, that not the peak magnitude, but the total energy of Type Ia supernova is constant, and so more dim ones shine longer, and also by an intentional selection of what is and what is not a Type Ia supernova. The observed temperature of IGM is also explained from the redshift process, with a correct temperature prediction.

The rotation curve of galaxies is also explained in Curvature cosmology by D.Crawford (due to the IGM halo around the galaxy), but we offer another solution (which may combine with the explanation of D.Crawford) - galaxy cannot be simplified to a point mass in any way, and local attraction inside the spiral arms (by stars and by ISM) is bigger, than the central attraction, and so the galaxy rotates much more as a fixed object, than previously estimated by Keplerian orbit models. Consider, that in the Milky Way, the space curvature due to the central bulge at the distance of the Sun is estimated only 40% the amount of space curvature of local ISM gas of density 10^5 protons in m^3 (or 1/30 with gas density 10^6), not even counting neighbour stars (see also wiki/Gravitationally_aligned_orbits). Thereby we eliminate the need for any mystical dark matter. The Lyman-alpha forest we also explain differently from [ref. CC2011] - the high-redshift quasars are very probably polar light-beams from accretion disks of black holes (the strongest known light-sources), and the light climbs from a strong gravitational field through regions with successively lower gravitational time dilation. For a super-massive black hole, if the region even few hundreds of AU from the source of the light could be filled with a molecular hydrogen, it would create Lyman-alpha forest just as observed (and such quasars would therefore be more near, than expected from their red-shifts...). The same could probably apply to "galaxies", observed by HST at very-high redshifts - the resolution of those images is quite far from the possibility to distinguish a galaxy from a heavy-point source...

To measure the space curvature would need for ex. to measure angles of a triangle, which sum to more (or less) than π (180°), but the difference is very tiny and the triangle would have to be very large to detect anything. This would require to know exact positions of all three points, best if far from Solar system or Milky Way galaxy, which cause bigger curvature. The supposed measurement of WMAP with the angle and frequency of CMBR anisotropies is a deception, since they absolutely may not know the exact distance "there far away"! More even if the CMBR source is not that far anyway... (But there is an object "far away", whose distance "there" and our local angle is known - the light echo of V838 Mon outburst, just the distance from us toward there is not certain? You may also see on the V838 Mon image, what it is, which has been previously thought about as "dark matter" - there is a lot of matter in the interstellar space, which is not visible by itself, and yet it is an ordinary baryonic matter...)

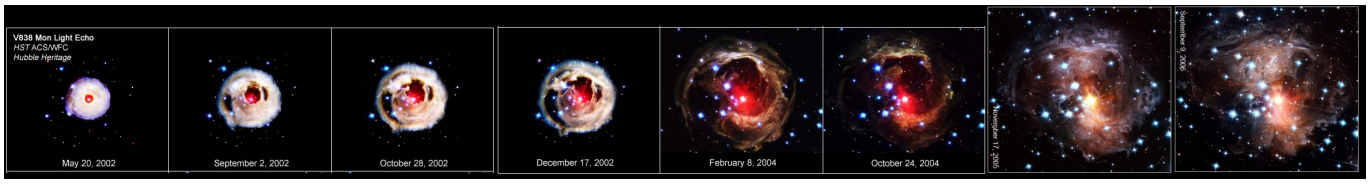


Fig. 3 - V838 Mon outburst light echo, illuminating interstellar dust, that could have been thought of as a dark matter...
(Publicly released images by NASA and STScI , Hubble space telescope, 2002-2006…)

D.Crawford shows these equations for hubble constant and distance redshift:

$$H = \frac{\sqrt{3}\,c}{R}$$

and

$$z = \exp(\sqrt{3}\,\alpha) - 1$$

where α is an angle, travelled over the hyperspherical space, or the other side:

$$\alpha = \frac{\ln(1+z)}{\sqrt{3}}$$ and distance is $D = \alpha R$

The maximum angle α is 2π. CC states a maximum of π, since the object more far away would be visible on the other side more near to us. Maximum redshift for α=π would be 229.7, which would be 75-80 Gly away, which is by far more distant, than current observational possibilities and also it may be older (more far away) than the current age of universe, and also the light would be so redshifted, that it looses too much frequency and gets absorbed on the way...?

D.Crawford offers an estimate on average density of IGM (the only parameter to the size of universe etc) as N = 1.55 ± 0.01 m^{-3} (average count of hydrogen atoms in 1 m^3 of IGM plasma), which yields H = 64.4 ± 0.2 km s^{-1} Mpc^{-1}, and R = 26.3 Gly from $R = 3.100 * 10^{26} N^{-1/2} m$ ...

Matching observations of H = 70 km s^{-1} Mpc^{-1} (ignoring more recent results from WMAP and Planck, which measure something else than H), yields R = 24.2 Gly and N = 1.837 m^{-3} , while using H=62 km s^{-1} Mpc^{-1} yields R = 27.3 Gly and N = 1.44 m^{-3} ...

The space outside of the universe black-hole could be described by a conventional Schwarzchild solution. [ref Schwarzchild]

The most interesting feature, that could be guessed (from similarity with normal black holes [ref. Photon_sphere]) outside, is a photon-sphere at $\frac{3}{2} r_s$, the **Sphere of Eternal Light**, where the space is so curved, that the light orbits in a circle. In a case of Kerr solution [ref. Kerr] of rotating universe (black-hole), there is a region instead of a single surface (and indeed, the universe rotates at least in the time dimension). Since the light moves at the speed of time (speed of light), it's proper time is 0 and its proper velocity is infinite, so it can experience the whole duration of the universe in one moment... Any existence of possible inteligent "energetic" Being inside this region cannot be proved or disproved from Earthly perspective... [Ref. Rev4, OES]

What is "below" the surface of 4D hypersphere (inside) we cannot tell, but very probably it would be dark and cold... (if there is some "below surface"?)

If there were "spiritual" beings above and below the hypersphere surface, we could not detect them, neither to prove nor disprove, by no 3D physical means... They probably can have some means to comunicate into our "surface" universe, if they could "inspire" writing of Gn1, and tell μάγοι about the Bethlehem star (the David Star in year 3BC was a planet configuration, which included all far planets including Neptune and Pluto, with Jupiter and Sun standing out from the "star" ("above" the star) - a configuration which could have been interpretted to mean "King God of Jews", but which the μάγοι absolutely could not "see" by themselves (and hence the story of 3 Kings is one of exact proofs of spiritual beings or "angels", beside Gn1 writing). It occured in May -2 (3 BC) both on Earth and Sun, being the best superposition of those two "stars" during the recent history. It again occured on Christmas (that with the Sun and Jupiter standing "above"), from Earth perspective only. Such a configuration happens time by time, by far the most exact configuration was in the year when Jews exiled to Babylon, at the end of Bar Kokhba revolt, it also happened, when David started rule, etc... If the Bethlehem (David) star was any phenomenon visible on the sky, or if it was visible directly above Bethlehem, they would have got no reason to go to ask into Jerusalem first...)

Gravitational acceleration

Gravitation is centrifugal acceleration due to movement in curved time.

Equation for calculating the radius of curvature in the vicinity of a point mass (far from it's Schwarzchild radius) is given by dr.M.Hendry in his lectures [ref Hendry2007] as

$$R_c = \sqrt{\frac{R^3 c^2}{GM}}$$

where R is a distance from the object, M is it's mass, the other are common constants ("c" the speed of time and "G" the ratio of space curvature in response to mass - my own definitions...). See [ref Hendry2007] ...

But the observed bending of stars arround the massive point, for ex. during total Solar eclipse, would be much larger, than is observed, if the ray would travel on a trajectory with this curvature radius.
Observed curvature corresponds better to the curvature radius with equation:

$$R_c = n\frac{R^2 c^2}{GM} = 2n\frac{R^2}{R_s},\ pro\ R_s = \frac{2GM}{c^2}$$

where probably the constant *n=1* , but in the range of (un)exactness of measuring the bending of stars during Solar eclipse another values of this constant are also possible, for ex. *n=2* or *n=0.5* ...

Equation $R^2c^2 / GM = 2R^2 / R_S$ corresponds to optical bending of light by 2.26 arcsec arround the Solar surface (if there could be any star seen, but through the solar corona there is no star visible), from that 1.385 arcsec is bending due to movement in curved space and 0.88 arcsec is refraction due to movement in dilated time (gradient index optics), and if the refraction is rather subtracted, the difference is 0.506 arcsec. In the distance of double Solar radius from center (where there could be stars visible), the bending is only 1.126 arcsec, from that trajectory bending 0.688 arcsec and refraction 0.439 arcsec, their difference only 0.249 arcsec.
For *n=0.5*, the equation simplifies to $R^2 / R_S = R^2c^2 / 2GM$, where R_S is Schwarzchild radius of the central body. Bending of stars just arround the Solar surface would be 3.65 arcsec, from that bending due to space curvature 2.77 arcsec and refraction 0.88 arcsec. If the refraction is rather subtracted, their difference would be 1.89 arcsec. Bending in double radius distance from center of Solar disc would be 1.813 arcsec, from that bending due to space curvature 1.374 arcsec and refraction 0.439 arcsec, their difference 0.936 arcsec.
For comparison, with the original equation $R^{3/2}c / (GM)^{1/2}$ light bending just arround the Solar surface would be 1532 arcsec, in double radius from Solar disc center bending would be 1065 arcsec and only here the stars would start to be visible...
Nothing like that is observed.
(I mention particular values here, so they can be experimentally verified during some following Solar eclipse.)
[Remark - does refraction add to gravity deflection of light? Probably not "gravity" attraction, light is mass-less? Integration values to be updated]

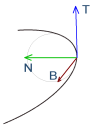
(Simplifying an object to a point mass is valid only outside its boundary. Inside the object, one must consider, which parts of the object are on which side, so the interior solution would be more difficult, and would need to integrate over object's parts...)

The $R^{3/2}$ in the curvature equation strongly resembles hyperbolic curvature, and indeed, the "straight" line (a geodesic) through the space with this curvature (due to a single mass point), is similar to an (possibly inverse) hyperbola, and is longer than it would be in euclidean space. With sufficient curvature, two paralel lines arround each side of the object will meet behind the object (gravitational lensing). Indeed, if the otherwise empty universe was occupied by a single mass point, it would have a hyperbolic geometry. But same, as if you connect many sections of 2-dimensional hyperbolas, it forms a deformed circle (see Fig 2 above), the same is with a universe almost-isotropically filled by many massive points.

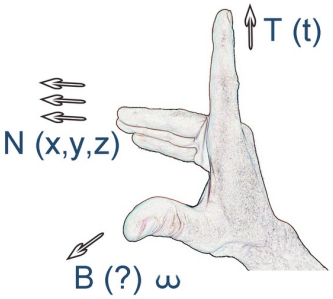
And curved is not only the space, but the time also...

Every object is moving in space-time with four-velocity $\vec{U} = (\gamma ic, \gamma \vec{u})$, where the vector $\vec{u}$ is movement in 3D-space, for a stationary object it is a null vector. Movement in time is by an imaginary speed *i c*, and so the space-time interval is $ds = \sqrt{-c^2 dt^2 + dx^2 + dy^2 + dz^2}$, or possibly $s^2 = \Delta r^2 - c^2 \Delta t^2$ and proper-time interval is $\Delta\tau = \sqrt{\Delta t^2 - \frac{\Delta r^2}{c^2}}$, Minkowski metric -+++ is caused by using power of 2 with imaginary speed of movement in time *i c*, because $i^2 = -1, (ic)^2 = -c^2$. Value γ (Lorentz factor) depends only on vector $\vec{u}$ as $\gamma = \frac{1}{\sqrt{1 - v^2/c^2}}$, where $v = |\vec{u}|$ and for stationary object it is $|\vec{u}| = 0, \gamma = 1$.

Movement in time through the curved space-time (movement of 3D-stationary object in the direction of time axis through the curved space-time) can be described using Frenet-Serret frame [ref. FSf], vector $\vec{T}$ (tangent) is the four-velocity movement (in imaginary time with speed *ic*), vector $\vec{N}$ (normal) is 3D-gradient of gravitational field, bivector $\vec{B}$ (binormal) is a vector of angular velocity and that can cause centrifugal acceleration, in direction toward center of mass.



If the cross product would be defined in 4-dimensional space, it would be simply $\vec{B}=\vec{T}\times\vec{N}$, where cross-product is an abbreviation for exterior product and resulting pseudo-vector is actually a bi-vector, same as vector of angular velocity is actually a bi-vector, but for multi-dimensional space it is better written using vector algebra as $\vec{B}=\vec{T}\wedge\vec{N}$ (and a multi-dimensional cross-product we will understand as a synonym for exterior product) , where again the bi-normal $\vec{B}$ is a direction of bi-vector of angular velocity (Darboux vector):



$$\vec{\omega}=\kappa\hat{\vec{B}}+\tau\hat{\vec{T}}=\kappa(ic,\vec{0})\times\hat{\vec{N}}_{\odot}+\vec{0},\quad \kappa=\frac{1}{R_c},\tau=0 \quad .$$

Time curvature κ corresponds to radius of curvature, geodesic torsion τ during the normal movement in time does not happen, but possibly it could, in the case of a remarkable rotation of the assymetric source of the field?

If the vector $\vec{T}$ is in direction of imaginary time, vector $\vec{N}$ in the direction of gravitational gradient (direction toward the Sun) in all space dimensions x,y,z (and possibly also in imaginary ix,iy,iz ?), there rests for the bivector $\vec{B}$ probably only direction in real time (perpendicular to common imaginary time) ? Or other space dimensions?

Centrifugal acceleration (in the direction of trajectory normal, named "fictitious centrifugal acceleration") is defined:

$\vec{a}=\frac{\vec{F}}{m}=-\vec{\omega}\times\vec{\omega}\times\vec{r}$, where $\vec{r}$ is a position vector relative to center of curvature,

and so

$$|\vec{a}|=-\frac{ic}{R_c}.\frac{ic}{R_c}.R_c=+\frac{c^2}{R_c}=\frac{c^2GM_{\odot}}{nR^2c^2}=\frac{GM_{\odot}}{nR^2}$$

in the direction toward center of space-time curvature.
(Centrifugal acceleration due to movement with imaginary speed is negative, and so toward the center.)

For the constant n=1 it is a common equation of gravitational acceleration.
It should be possible to measure the constant n, for ex. during Solar eclipse measure bending of star positions, presuming, that radius of time curvature is same as radius of space curvature...

Therefore:
Gravity is negative centrifugal acceleration due to movement in curved time with the imaginary speed ic.
In order to explain it there is no need for Newton's mystical "*action at distance*" and neither a not any less mystical speaking space of "space *tells* matter, how to move" of 20. century...

The observed acceleration in the rotating reference frame can be expressed by [ref. wiki/Fictitious_force]

$$\vec{a}_B = \vec{a}_A - 2\vec{\Omega}\times\vec{v}_B - \vec{\Omega}\times(\vec{\Omega}\times\vec{x}_B) - \frac{d\vec{\Omega}}{dt}\times\vec{x}_B$$

where $\vec{a}_A$ is the "physical" acceleration in a hypothetical inertial frame, $-2\vec{\Omega}\times\vec{v}_B$ is Coriolis acceleration due to movement relative to the reference frame B (if the only movement is in the time direction, then the reference frame moves same as the object, on which the fictitious forces apply, so here $\vec{v}_B$ is 0), $-\Omega\times(\Omega\times\vec{x}_B)$ is a centrifugal acceleration known as gravity, and the last term is Euler acceleration due to change in $\vec{\Omega}$, which is 0, unless the central mass changes, which also changes the curvature and hence the $\vec{\Omega}$.

The direction of the Coriolis acceleration due to movement $\vec{v}_B$ is not immediatelly clear, since the direction of $\vec{\Omega}$ is not well defined above, whereas the direction of centrifugal acceleration due to rotation with a centerward curvature (there is more space "inside" then there should be in Euclidean model, so the curvature is actually centerward) is known centerward. The magnitude of Coriolis acceleration near Earth surface would be $0.0024786*|\vec{v}|$ for a movement perpendicular to $\vec{\Omega}$ (and smaller for non-perpendicular directions), for a case of airplane flying 1000 km/h or 277m/s it would be 0.688498 m/s^2 which is 14.2x smaller than gravitational acceleration... But if the vector $\vec{\Omega}$ was actually equally in <u>all</u> directions perpendicular to the centerward direction and curvature, it would cancel out the Coriolis effect...?

Gravitational attraction between two objects can be explained: One object causes a spacetime curvature, which causes "time" acceleration of the second object toward the first. The force, caused by acceleration onto the second object is $F_2=g_1M_2$. The second object also causes a space curvature, which causes an acceleration of the first object. The force, caused by acceleration onto the first object is $F_1=g_2M_1$. By chance, they are same, but in opposite directions... (The curvatures, caused by both objects, add to the total curvature...)

Falling and orbiting objects - in the inertial reference frame - are accelerating toward the center of mass. The difference in their trajectories (different ellipses or hyperbolas) is due to initial conditions (initial velocity). In the accelerated (rotating) reference frame of the falling object, the force due to centripetal acceleration is balanced by the fictitious centrifugal (inertial) force, so that no net acceleration remains. They are not moving straight along the space curvature, only the light and waves do... (consider, that the space curvature is intrinsic property of the curved space arround the central mass, and does not depend on the speed of moving object in normal range of (non-relativistic) velocities, so <u>no</u> orbiting object is moving along the space curvature, on a geodesic...) If there could be a small difference between centripetal acceleration and centrifugal force in the accelerated reference frame remains an open question here. If there is additional force applied to some part of the system (like rocket engines), the other parts (the rocket crew) feel the difference in acceleration of their reference system as their own centrifugal (fictitious) acceleration, while in inertial reference frame it is their moment of inertia, that resists the reference frame acceleration.

<u>Tidal force</u> is caused by <u>adding</u> centrifugal force due to the objects orbiting the common center of mass (the place with a least torque of the system... the centrifugal force is shown on Fig. 4 as green arrows) - which is same over all the body, and the gravitational force caused by the second body, which differs with distance from the body. In the rotating (orbiting) reference frame of the planet the fictitious centrifugal force may have very real and observable consequences. In the inertial reference frame, that what is observed as centrifugal force is the object's inertial moment to move the original way, while it is forced by centripetal force to turn. Due to the possible difference in centrifugal force and centripetal force, which may exist due to the orbit elipticity and possible other influences, such tidal force can be little asymmetric...

In wikipedia, there is an alternative explanation of the tidal force, that on a rather solid body it is caused by <u>subtracting</u> the average gravitational acceleration on the body (same as acceleration at the center) from the local acceleration, differing due to the field gradient with distance from the body. On a rather gaseous body with a little own gravitational cohesiveness (for ex. a comet halo), where the body center would have got almost no influence on the body sides, only the field gradient would exist then... Such a tidal force is calculated as exactly symetric.

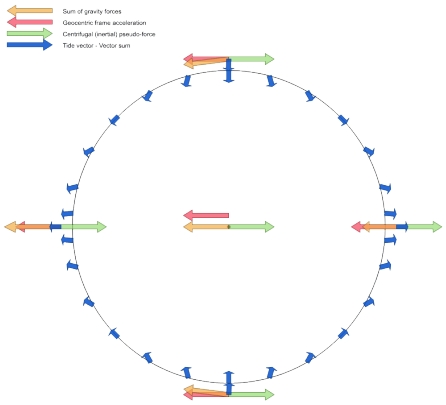


Fig. 4 - Tidal force explained.
Orange arrows show gravitational field, red acceleration of the reference frame, green fictitious centrifugal acceleration (oposite to reference frame acceleration), blue is sum of gravitational and centrifugal acceleration.

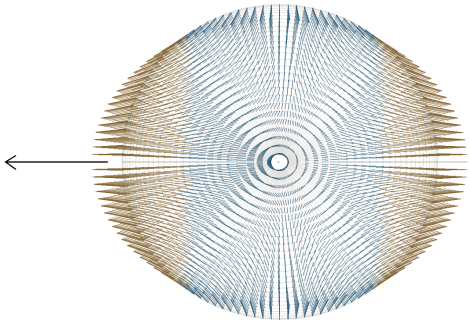


Fig. 5
Tidal force on Earth due to Moon only, view from above north pole, moon little above equator. Arrow points toward moon. Brown vectors are pointing outside, blue vectors are pointing inside.

Discussion

I still doubt, if this second part (about gravity) is correct... Anyway, it should not influence the first part, which is only little related to the second one. This work presents various aspects for further thought and investigations, presents more concurrent ways to calculate space curvature from different sources (similar, differing only by a constant). While learning tensor math, I found, that it hardly can be used to really practically calculate space curvature yet, and indeed, the numerical relativity is currently very limited in its scope... Both this solution, and tensor math solutions, are too much simplifying rather complicated reality...

This work intentionally excludes more complicated space curvatures due to multipoles (which cause deviations from the simple gM_1M_2 / r^2 gravity relation), leaving this topic for a further research...

It is also possible, that the centrifugal attraction toward center of curvature is due to yet another space rotation in some higher dimension, but it fits with the rotation in speed of time & light c...

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