Behaviour of a matter torus under the influence of the expanding cosmos model on the Basis of the Projective Unified Field Theory

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Abstract

In some former papers the 5-dimensional Projective Unified Field Theory (PUFT), developed by the author in books and publications, was applied to a corresponding dark matter cosmological model, describing our expanding world. The resulting Hubble parameter led to a satisfying numerical value. Further application to moving bodies in our Galaxis (see anomalous pioneer effect), could be acceptably treated (see literature in [11]).

In this paper the behaviour of a matter torus under the influence of the expanding cosmos model (according to our theory PUFT) is investigated. This task can numerically be treated for the full life time of the cosmos model (from the Urstart to the Finish). As we know from our literature cited, the graphic course of the cosmological scalaric field (occurring in Fig 2) after the Urstart (at value zero) exhibits an increase at nearly $2 \cdot 10^4$ years, followed by a return down to the Finish (with value zero). This curious behaviour of the cosmological scalaric field leads to the suspicion that the shape of the torus during the life time of the cosmos model may be: sphere at the Urstart, transformation of the sphere to a ring with decreasing thickness, return to a sphere at the Finish. It seems that such a theoretically predicted physical effect could perhaps exist in Nature.

The torus was chosen as a test object, since the numerical calculations can be done without approximation procedures. We took this rather simple example to show this cosmological effect for further applications in astrophysics.

1 Historical Remembrance

Aside from my education in physics, particularly in the theory of fluids, at the University of Rostock (Germany) from 1949 (Diploma) to 1956 (Promotion), I devoted my main interest to the start of modem physics at the beginning of the 20th century (quantum mechanics

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1911/12, 1025/26 and 4-dimensional theory of relativity and gravitation 1915/16). Soon after this last mentioned step, done by A. Einstein via his unification of space and time by means of a specific Riemannian geometry, the following idea was born and mathematically treated: Is it thinkable that gravitation and electromagnetism are two phenomena of Nature, resulting from the same 5-dimensional intrinsic source. At this point the basic philosophically deciding question for the future research arose:

- Either keeping the 4-dimensionality, but changing from the Riemannian geometry to a higher structured geometry.
- Or changing to a hypothetical 5-dimensionality with an open specific geometrical type.

In his later life Einstein decided for the first way and developed a very complicated non-symmetric geometry. In contrast to this historically understandable step of Einstein, several researchers opened the way via 5-dimensionality. I followed this path in 1955: starting from a special 5-dimensional geometrical concept, being projected onto the 4-dimensional space-time with the result of new enlarged hypothetical physical effects.

But first we shortly consider the historical development of the 5-dimensional approach.

Basically different from the 5-dimensional field theories of Th. Kaluza [1] and O. Klein [2] and the publications of P. Jordan [3] and G. Ludwig [4] (as well as by different other physicists and mathematicians), I myself began my 5-dimensional research in 1955 and finished this part of my results with my Habil- degree in Jena in 1958 [5]. My special approach to new 5-dimensional field equations and conservation laws brought me to a new understanding of five-dimensionality for our real physical world (from the 5-dimensional projective space onto the 4-dimensional space-time). By this way I arrived at a basic widening of the Einstein theory of General Relativity and Gravitation (1915/16), here including further additional terms of the Maxwell-Faraday theory of electromagnetism. This new view on physics can be studied in my basic lecture at the 9th International Conference of General Relativity and Gravitation (GR 9) in Jena 1980 [6].

Depart from a series of publications [7, 8] my 5-dimensional Projective Unified Field Theory (PUFT) is presented in two summarizing monographs in German language [9]. Fulfilling wishes of international readers, an English survey of the main structure of the essential content of PUFT is offered [10].

Shortly reflecting my way of research on 5-dimenssionality, I would like to remind main steps in getting into this matter: First starting with the 5-dimensional projective space, then projecting its physical contents onto the 4-dimensional space-time, then reformulation and practical application of the new theory proposed, and finally arriving at various empirical facts in astrophysics and cosmology, occurring already in the usual 3-dimensional curved space (in general depending on space and time). For quick information one should use three actual papers of the viXra series, previously published [11].

2 Mechanical continuity equation as basis for the balance of the mechanical mass

Here for later considerations it is opportune to mention the usual continuity equation (conservation law), also guilty for the mechanical matter of our cosmos model:

$$\text{a)}\quad \operatorname{div}(\mu\boldsymbol{v}) + \frac{\partial\mu}{\partial t} = 0 \quad \text{or} \quad \text{b)}\quad \operatorname{div}\boldsymbol{v} + \frac{\partial \ln\mu}{\partial t} = 0 \tag{1}$$

(μ mass density, $\boldsymbol{v}$ velocity of mass, t time used for the treatment of the whole existence of the cosmos).

Furthermore we remember that our PUFT leads to the new concept of the scalaric mass of a mechanical body: $m(\sigma)$ extends the usual notion of the rest-mass m_0 (here in case of motion the relativistic and gravitational effects are included in the rest-mass):

$$\text{a)}\quad m(\sigma) = \frac{m_0}{\sqrt{2}}\sqrt{1+\exp(-2\sigma)} \quad \text{with} \quad \text{b)}\quad \sigma = \sigma(\eta)\,. \tag{2}$$

In order to simplify our further calculations, it is useful to introduce the dimensionless cosmological time- parameter η which is related to the physical time t (needed for the physical interpretation):

$$\text{a)}\quad \eta = \frac{c\,t}{A_0} = 10^{-9}t/\,\mathrm{y} \quad \text{with} \quad \text{b)}\quad t = \frac{A_0\eta}{c} = 1.057\cdot 10^{9}\eta\ \mathrm{y}\,, \tag{3}$$

the constants being:

$$\begin{array}{ll} \text{a)} & \begin{array}{ll} A_0 = 10^{27}\,\mathrm{cm} & \text{(cosmological radial rescaling constant),} \\ c = 2.9979\cdot 10^{10}\,\mathrm{cm/s} & \text{(vacuum light velocity) ,} \end{array} \\ \text{b)} & \mathrm{y} = 3.1558\cdot 10^{7}\,\mathrm{s} \qquad \text{(year).} \end{array} \tag{4}$$

Here a better immediate physical understanding results from the simple fact that $\eta = 1$ means $t = 10^9$ y. Applying these basic procedures to the above explained mass problem, we arrive at the following statement:

For the temporal course of the graphic presentation of the scalaric mass of a body (particle) we simplify the situation by applying the relative scalaric quantity

$$m_{\mathrm{rel}}(\eta) = \frac{m(\eta)}{m_0} = \frac{1}{\sqrt{2}}\sqrt{1+\exp[-2\sigma(\eta)]}\,. \tag{5}$$

The graphic presentation of this mentioned relative scalaric mass is shown in the Figure 1.

3 Basie cosmological field functions and important events in the course of time of our cosmos model

3.1 Scalar field, scalaric field (scalaric world function) and numeric value of the scalaric constant of Nature S_0

In the next subsection we firstly present the detailed results received from our alternative cosmology. Particularly our main aim of this paper is to get an impression of the expansion

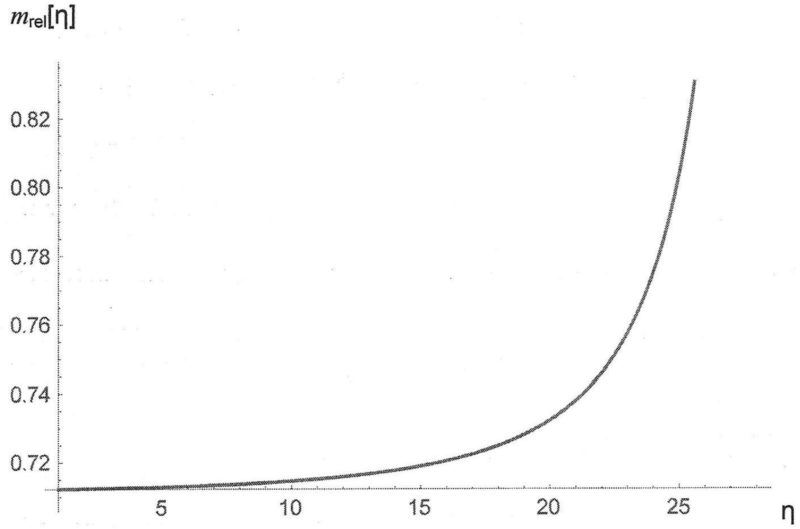

Figure 1: Temporal course of the relative scalaric mass, depending on time during the full time era of our cosmos model (see at abscissa: dimensionless time-parameter).

in connection with this simple application using a torus (ring circle), by the effect of cosmological expansion. Of course a deeper treatment of the influence of the expansion on a real astrophysical body will be proposed later.

Let us now sketch the mathematical situation with respect to the mathematical system of coupled non-linear differential equations. For understanding the following figures one should remember our assumption of a homogeneous, spherically symmetrical cosmological model. The mathematical situation of this model reads:

The basic 4-dimensional laws of cosmological physics finally are four nonlinear differential equations of second order for the three dependent quantities:

$$\begin{aligned} &\text{a)}\quad \text{dimensionless world-radius } L = K/A_0\,, \\ &\text{b)}\quad \text{dimensionless scalaric world function } \sigma\,, \\ &\text{c)}\quad \text{cosmological mass density } \mu\,. \end{aligned} \tag{6}$$

The scalaric world function σ is defined by the equation

$$S = S_0 \exp(\sigma)\,. \tag{7}$$

This scalar field S, resulting from the 5-dimensionality and being distinguished from the scalaric world function, is related to the radius of the spherical cosmological model. Up till now we considered and interpreted the constant S_0 as a fundamental constant of Nature, called elementary scalaric length constant which occurs in the mathematical calculations as

$$S_0 = e_0 \sqrt{\frac{\varkappa_0}{2\pi}} = \frac{2e_0}{c^2}\sqrt{\gamma_{\mathrm{N}}} = 2.763 \cdot 10^{-34}\,\mathrm{cm} \tag{8}$$

(γ_{N} Newton gravitational constant, $\varkappa_0$ Einstein gravitational constant, e_0 electric elementary charge). Remarkably for this constant is the fact that it couples the phenomena electromagnetism and gravitation.

3.2 Numerical values at the cosmological Urstart

Initial conditions:

$$\begin{aligned} &\eta = 0\,, \quad t = 0\ \mathrm{y}\,, \quad L(0) = 4.88 \cdot 10^{-5}\,, \quad \sigma(0) = 0\,, \\ &\mu(0) = 6.3 \cdot 10^{-11}\ \mathrm{g\,cm^{-3}}\,. \end{aligned} \tag{9}$$

3.3 The maximum of the scalaric world function

The temporal course of this function is partially demonstrated by the Figure 2.

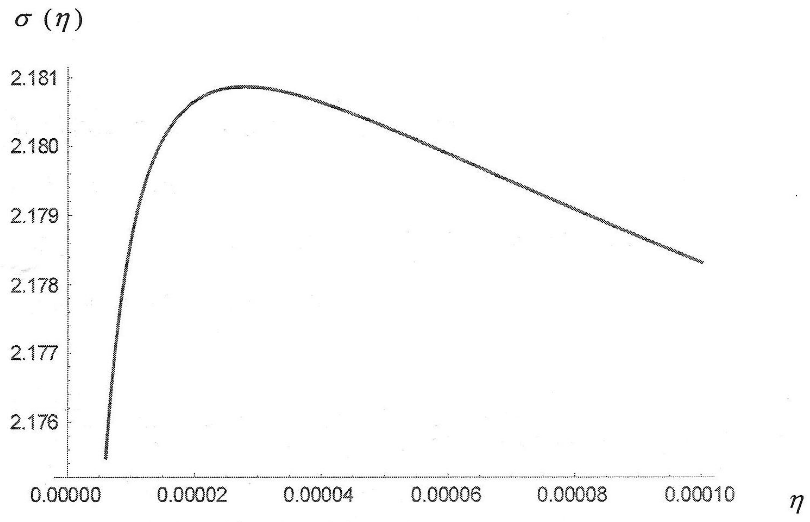

Figure 2: Temporal maximum of the scalaric world function at about 20000 years after the cosmological Urstart.

Now we calculate the numeric value η of the maximum position by postulating vanishing of the first derivative of $\sigma(\eta)$. The result reads:

$$\eta = 2.2 \cdot 10^{-5}\,, \quad t = 1.056\,\eta \cdot 10^{9}\,\mathrm{y} = 2.23 \cdot 10^{4}\ \mathrm{y}\,, \quad \sigma = 2.181\,. \tag{10}$$

Later we show more insight on the influence of the scalaric world function $\sigma(\eta)$ for our cosmological model.

3.4 Numerical values at present time

Concerning this cosmological model, the following numerical values result:

$$\begin{aligned}
&\eta = 13\,, \quad t = 13.7 \cdot 10^9\,\mathrm{y} \quad (\text{present age of our cosmos})\,, \\
&L(13) = 35.5\,, \quad \sigma(13) = 1.8\,, \quad \mu(13) = 3.34 \cdot 10^{-30}\,\mathrm{g\,cm^{-3}}\,, \\
&H(13) = 70.26\,\frac{\mathrm{km/s}}{\mathrm{Mpc}}\,.
\end{aligned} \tag{11}$$

Compared with the empirical today's results, the Hubble parameter $H(13)$ is quite reasonable.

3.5 Values at the Finish of our cosmological model

Final conditions:

$$\eta = 27.2\,, \quad t = 28.7 \cdot 10^9\ \mathrm{y}\,, \quad \sigma = 0\,. \tag{12}$$

Here one should recognize the theoretical prediction of the approximate life time of our cosmological model:

$$f_{\text{Finish}} = \ \text{about 29 billions of years.} \tag{13}$$

This result challenges to the definition of the Finish of our cosmos. According to our theory the best commitment seems to be: vanishing of the (slowing down) scalaric world function: $\sigma = 0$, being equivalent to the initial condition at the Urstart.

4 An orthogonal rotation-symmetric torus and its projection onto a suitable plane

Furthermore to this essentially graphical part of this paper is the interesting property of a torus (ring-circle) changing its pictorial shape by the expansion of the cosmos considered. A torus can be defined parametrically by:

$$\begin{aligned}
x(\varphi, \psi) &= (R + r\cos\varphi)\cos\psi\,, \\
y(\varphi, \psi) &= (R + r\cos\varphi)\sin\psi\,, \\
z(\varphi, \psi) &= r\sin\varphi\,.
\end{aligned} \tag{14}$$

The formula (14) for the 2-parametric torus contains two angular coordinates φ and ψ ($\varphi \in [0, 2\pi]$, $\psi \in [-\pi, \pi)$) and further the two distance parameters R and r (free parameters for changing the form of the torus): R is the distance from the center of the tube to the center of the torus, r is the radius of the tube.

4.1 Formula and picture of the 2-parametric torus

As an example we choose in the formula for the free parameters the values $R = 2$ and $r = 1$. Hence results by plotting the corresponding shape of the 2-parametric torus intended (Figure 3).

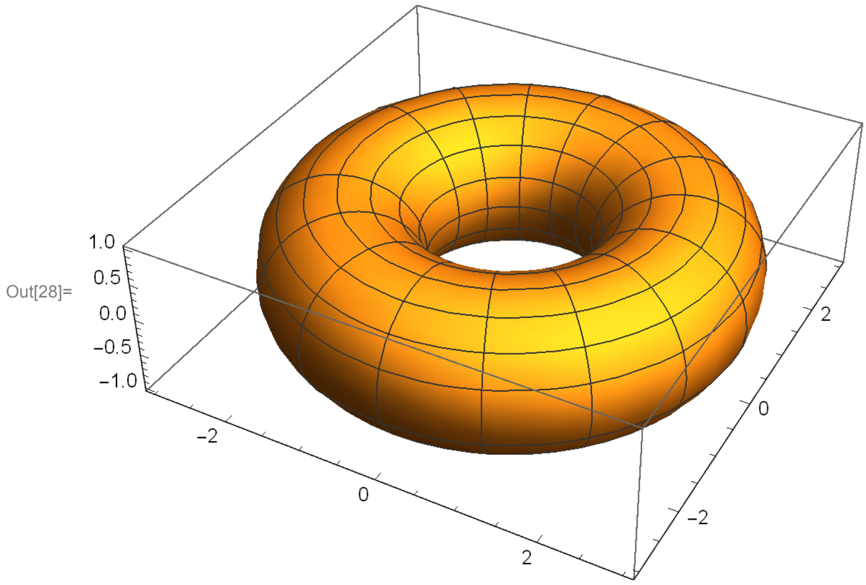

Figure 3: Rotation-symmetric 2-parametric torus as an abstract example.

With respect to applications, in the last picture the basic plane is used as $x-y$-plane. The orthogonal z-direction together with this $x-y$-plane reflect the 3-dimensional Newtonian space, spanned by the three strait lines described by the three orthogonal coordinates x, y, z.

Let us further explain the geometrical meaning of both the important constants R and r fixing the concrete shape of the torus at Figure 3. Since the description by words is less understandable, we take the way by orthogonal projection of the above described torus onto the $x-y$-plane. We receive the Figure 4.

The distance parameters R and r are taken over from Figure 4 (orthogonal projection of the torus onto the $x-y$- plane), where the bisection of the projection ring into two radial parts: $r+r$, can be seen. Closing this subsection, we remember that the volume V of the torus treaded, usually is calculated with the result: product of the cross-section of the tube and the length of the circular tube:

$$V = \pi r^2 \cdot 2\pi R = 2\pi^2 r^2 R\,. \tag{15}$$

The mass M of the torus reads:

$$M = \mu V = 2\pi^2 \mu r^2 R\,. \tag{16}$$

Further for the surface of the torus results:

$$A = 2\pi r \cdot 2\pi R = 4\pi^2 r R\,. \tag{17}$$

4.2 Formula and picture of the 1-parametric torus (r free to choose)

For this case we choose the values $R = r$ and $r = 1$. Hence by plotting the corresponding shape of the 1-parametric torus we arrive at the picture (Figure 5).

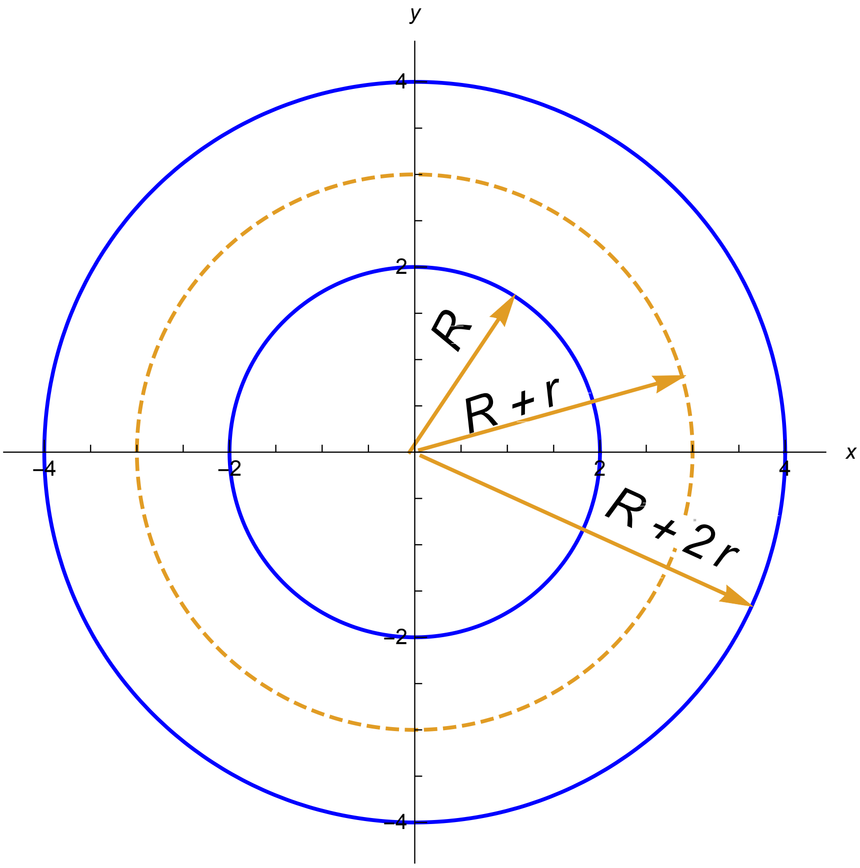

Figure 4: Orthogonal projection of the torus (Figure 3) onto the $x-y$-plane.

5 Temporal behaviour of the scalaric mass of a torus during the course of time between Urstart and Finish

5.1 Conservation of the mass content within the torus

By volume integration of the equation (1a) over the interior of the torus, using Green's method, we receive the following result:

$$\frac{\mathrm{d}}{\mathrm{d}t} \int\limits_V \mu \, \mathrm{d}V = - \int\limits_V \mathrm{div}(\mu \boldsymbol{v}) \, \mathrm{d}V = - \int\limits_A \mu \boldsymbol{v} \, \mathrm{d}\boldsymbol{f} \, . \tag{18}$$

For further calculation we suppose homogenous matter distribution and following property of the matter velocity at the surface of the torus:

$$\text{a)} \quad \mu = \mu_0 \, , \quad \text{b)} \quad \int\limits_A \mu \boldsymbol{v} \, \mathrm{d}\boldsymbol{f} = 0 \, . \tag{19}$$

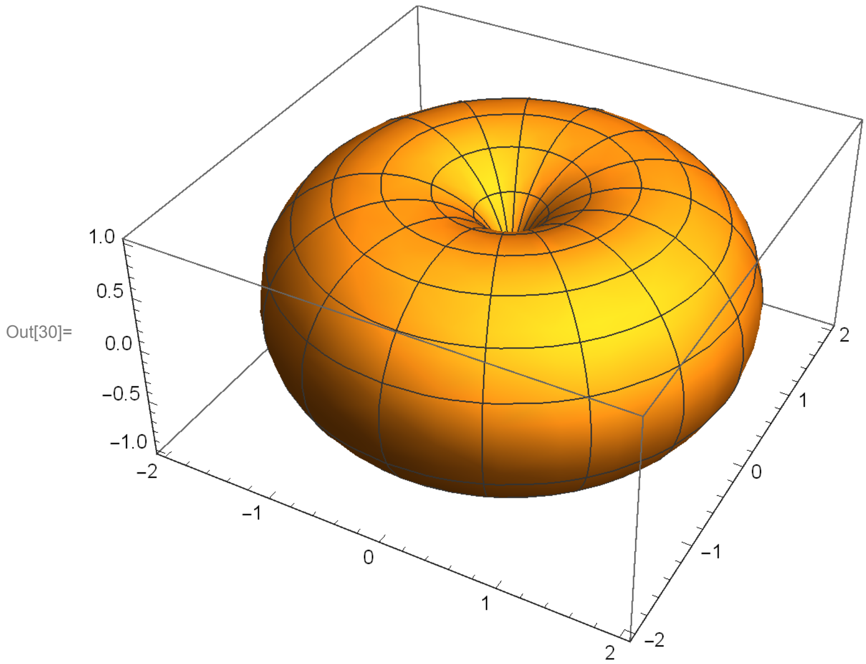

Figure 5: 1-parameter torus, perhaps suitable for test calculations in astrophysics (galaxies or stars).

Hence from (16) the formula for the mass of the torus reads:

$$\text{a)}\quad M_0 = 2\pi^2 \mu_0 r^2 R \quad \text{or} \quad \text{b)}\quad r^2 R = \frac{M_0}{2\pi^2 \mu_0}\,. \tag{20}$$

5.2 Torus under the influence of the expansion of the cosmological model

The main idea of the above study of the behaviour of a torus in our time-dependant cosmology has its origin in the fact that the used torus could be treated without needing approximations of the astrophysical bodies (suns, galaxies, etc.). Now we are confronted with the task, how to manage the influence of the time- dependence of the expanding cosmos model on the torus.

The imagination of the author lies in following direction: At the Urstart (beginning of the world) the torus has a spherical shape, next going over to a rotation-symmetric torus, as above pointed out. The situation at the return of the scalaric world function σ (see Figure 1) at about 20000 years also influences the torus studied above. Thinking at the property of the scalaric cosmological world function at the Urstart, it could be that the torus ends at Finish as a sphere, similar to the Urstart situation. Perhaps the interesting behaviour of the torus during the full temporal existence of the cosmos may be sketched by the eras:

$$\text{Urstart} \quad \cdots, \quad \text{maximum of the scalaric world function}\,, \quad \cdots, \quad \text{Finish.}$$

In connection with these thoughts on the fate of a special matter body caused via temporal cosmological expansion, let us finally consider the last 1-parametric figure being a sphere instead a ring circle. For simplification we refer to the only free parameter: $R = 0$, $r = 1$ (Figure 6).

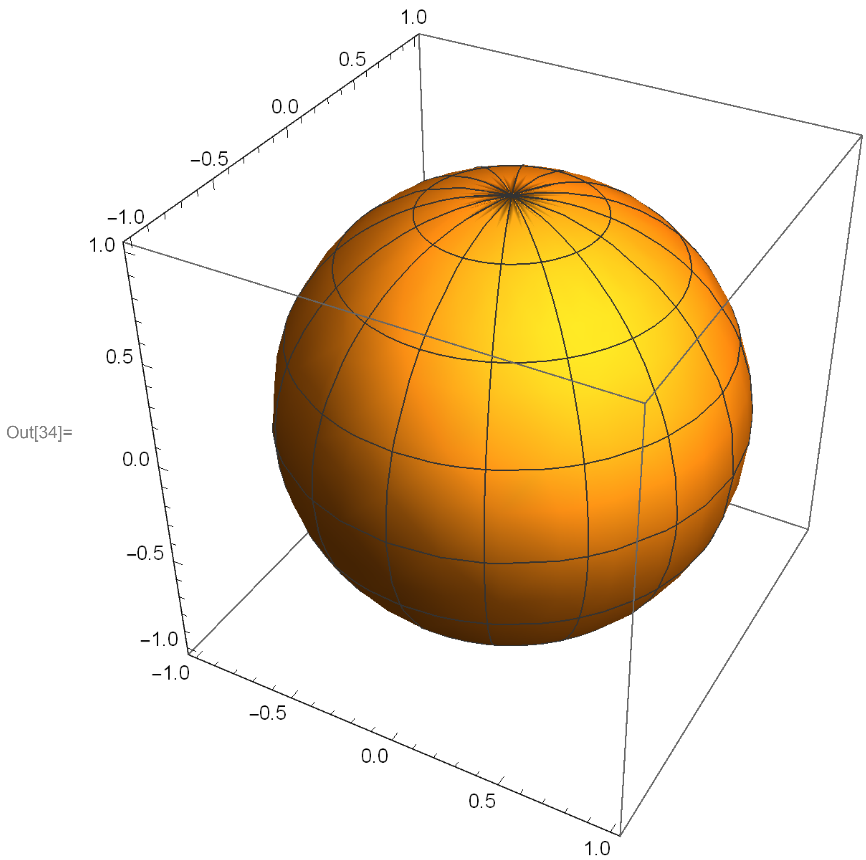

Figure 6: Perhaps at Finish the torus may have the shape of a sphere.

The formulation of our final opinion reads:

Essentially our exposition on the different pictures of the torus in section 5 depends on using the free parameter r as a numeric constant, arriving at a static situation. But according to our aim we wanted to take into account the temporal expansion of our cosmos.

In application to our cosmological model treated above, this means that the numerically constant torus parameters have to be connected with the theoretically expected time-dependent scalar function/scalaric function (new functions of our 5-dimensional projective Theory PUFT). One of our different possible Ansatzes, having been investigated, could be:

Obviously the demand means to find a relationship between the torus mathematics (perhaps r) and the cosmological model investigated in our papers quoted (perhaps the scalar world radius S or in 4-dimensional sight) the world radius K (6a). As a first trial one could think at a linear coupling equation by respecting the same physical dimension on both sides of the identification equation.

We close our reflections with an example: by means of (7) proposal of the equation

$$r = \mathrm{const} \cdot K = \mathrm{const} \cdot A_0 \cdot L \,. \tag{21}$$

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