Axiomathes (2012) 22:469–507
DOI 10.1007/s10516-011-9178-4

ORIGINAL PAPER

Depth as an Extra Spatial Dimension and its Implications for Cosmology and Gravity Theory

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Received: 14 June 2011 / Accepted: 17 December 2011 / Published online: 22 January 2012

Abstract I develop the idea that there exists a special dimension of depth, or of scale. The depth dimension is physically real and extends from the bottom micro-level to the ultimate macro-level of the Universe. The depth dimension, or the scales axis, complements the standard three spatial dimensions. I discuss the tentative qualities of the depth dimension and the universal arrangement of matter along this dimension. I suggest that all matter in the Universe, at least in the present cosmological epoch, is in joint downward motion along the depth dimension. The joint downward motion manifests itself in the universal contraction of matter. The opposite direction of motion, upward the dimension, would cause the expansion of matter. The contraction of matter is a primary factor, whereas the shrinking of space in the vicinity of matter is a derivative phenomenon. The observed expansion of the Universe is explained by the fact that celestial bodies become smaller due to matter contraction, while the overall space remains predominantly intact. Thus, relative to the contracting material bodies, the total span of cosmic space appears to be becoming vaster. I attempt to explain how the contraction of matter engenders the effect of universal gravity. I use over thirty animated and graphical color visualizations in the text to make the explanation of the proposed ideas more lucid.

Keywords Cosmology · General relativity · Expansion of the Universe · Extra spatial dimensions · Nature of gravity · Nature of mass · Origins of inertia · Scales

Electronic supplementary material The online version of this article (doi:10.1007/s10516-011-9178-4) contains supplementary material, which is available to authorized users.

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1 Introduction

The ideas presented in this paper can be summarized in the following way. There exists a specific and physically real spatial dimension, to be called depth, or scale, in addition to the three well-known spatial dimensions. The depth dimension is considered a dimension proper because it is able to provide matter with an additional degree of freedom of motion. The variants of motion in the depth dimension are upward or downward along the scale axis; the third possible variant is rest. The joint motion of matter that I suggest to take place in reality is downward, that is, to smaller sizes. The downward motion results in the contraction of each material particle and consequently of each celestial body.

The idea of the existence of the dimension of depth is fairly new in science and deserves a thorough exploration. A particular advantage of this idea is that it provides a novel approach to understanding inertia, mass, and universal gravity. One aspect is particularly important: an explanation for the old problem of how material bodies happen to gravitate one toward another at a distance, apparently without direct contact or any other mediator. The concept of the depth dimension helps identify the so far missing mediator of gravitational interaction. The mediator is the lowest, or deepest, level of the matter structure, upon which level all matter is in cohesion. The gravitational interaction of objects is possible because of their attachment to that lowest level. All matter in the Universe is conjoint on its bottom level, whereas on the higher levels, material objects are presented in a disjoint manner.

Within the standard three-dimensional view, celestial bodies in the Universe appear as a multitude of insulated drops or clusters sprayed out over space. Within the three standard dimensions, a material particle, such as an atom, is present as a ball. The addition of the depth dimension makes a particle be presented as a cone-shaped figure. The lower we go downward the hierarchical levels of a particle's structure, the narrower is the cone and the more confined are the cone cross-sections. In the standard three dimensions, metric lines of the coordinate net are parallel to the axes of length, width, and height. This is not the case for the depth dimension. Downward, the metric lines converge, and upward, they diverge.

Taking the depth dimension into account reveals that matter in the Universe as a whole is arranged as a sphere. The center or the focus of the sphere is a point-like spherical object, in which the converging depth dimension metric lines intersect. Being point-like, the central sphere is actually of a non-zero size due to the existing minimal further non-divisible Planck length. That the lowest-level sphere has some non-zero size is depicted by o in Fig. 6b. The vector of the pulling force is directed inward of each of the material objects. The lowest-level sphere moves further downward along the depth dimension while fastening its outwardly and radially directed bonds to the higher levels. The motion of the lowest sphere results in the application of the pulling force to the higher levels.

Although intuitive, the idea of the existence of a special depth dimension and possible motion along it have not yet been put forward either in the explorations of expansion of the Universe (for example, Liddle and Lyth 2000; Lemoine et al. 2008; Wolschin 2010) or in the mainstream discussions of tentative extra spatial dimensions (Bars and Terning 2010; Gubser and Lykken 2004; Wesson 2006).

There are no hypotheses in the literature regarding a connection between motion along such a depth dimension and gravity. In the absence of a scientific paradigm with which to associate my ideas, I am only able to present them in the form of initial and raw hypotheses, drawing to a large extent from descriptive analogies and explanative visualizations rather than elaborations of pre-existing theoretical accomplishments and methods.

One among a few attempts to elaborate the idea of a special scale dimension is the nearly two-decade work of the French physicist Laurent Nottale, which commenced in the early 1990s and is ongoing. In order to provide a concise and authentic presentation of Nottale's theory, I cite a few excerpts from one of his earlier articles.

> The geometry of space-time must be fractal, i.e., explicitly resolution-dependent. This allows us to include resolutions in the definition of the state of the reference system [...] [T]he scale axis is divided in three domains: (i) the quantum, scale-dependent microphysical domain, (ii) the classical, intermediate, scale-independent domain, (iii) but also the macroscopic, cosmological domain which becomes scale-dependent again and may then be described on very large time-scales (beyond a predictability horizon) in terms of a non-deterministic, statistical, quantum-like theory. (Nottale 1997, p. 867)

> We thus need to complete the standard laws of physics (which are essentially laws of motion and displacement in classical physics) by laws of scale, intended to describe the new resolution dependence. [...] In scale relativity, the space-time resolutions are not only a characteristic of the measurement apparatus, but acquire a universal status. They are considered as essential variables, inherent to the physical description. We define them as characterizing the 'state of scale' of the reference system, in the same way as the velocity characterizes its state of motion. The principle of scale relativity consists of applying the principle of relativity to such a scale-state. [...] [T]he Planck length- and time-scale becomes a minimal, impassable scale, invariant under dilations and contractions, which replaces the zero point (since owning all its physical properties) and plays for scales the same role as played by the velocity of light for motion [...] [T]here exists a maximal length-scale of resolution, impassable and invariant under dilations. Such a scale can be identified with the scale... of the cosmological constant... It would own all the physical properties of the infinite. (Nottale 1997, p. 868)

At the later stage of elaboration of his scale relativity theory, Nottale also attempted to "consider some applications of the theory to various sciences, particularly relevant to the questions of evolution and development [:] physics and cosmology... astrophysics... life sciences... Earth sciences." (Nottale 2010, pp. 102–103)

My conception is similar to the Nottale's theory in that both introduce scale as a dimension or, in Nottale's wording, 'scale as space' into the cosmological and physical perspective of the world. In both approaches, the resolution at which we observe space and matter is understood not only as an issue of measurement and of the precision of an observational device, but rather, and more importantly, as an issue of the inherent ontology of space and matter.

The difference appears when this underlying framework is left behind and further accentuation and specification come into force. The ideas of the relativity of scales and of the factuality of the scale space, which are central for Nottale, do not play any noticeable role in my conception. I do not follow a three-part sectioning along the scale axis into the quantum, scale-dependent; the classical, scale-independent; and the cosmological, again scale-dependent, realms, which is important in Nottale's theory. What differentiates my conception from Nottale's theory in even more essential way is that I imply that the depth dimension provides for an additional degree of freedom of motion of physical matter along it; then, I suppose that such motion does actually take place, namely, at least in the present cosmological epoch, in the direction downward the dimension; and I see the motion downward the depth dimension to result in the universal contraction of matter.

Generally, I would not say that in developing my conception I follow Nottale's train of thought. There are more disparities than semblances, the former being essential, the later superficial. These theories are two separate threads that probably originated from initial similar assumptions.

In the next section of the article, I present my understanding of what the dimension of depth is and why there is a methodological need and the ontological ground to introduce it as a special dimension. In the subsequent sections, I set forth my hypotheses on how the joint matter motion along the depth dimension may proceed, as well as how this motion may engender the effects of inertia, mass, and universal gravity.

2 What the Depth Dimension is and Why it is Worth Being Introduced

The depth dimension is completely real in the physical sense. It is neither a fictional, albeit serviceable, byproduct of mathematical computations nor an artificial geometrical construction of the so-called tesseract type. A tesseract is created by adding an extra dimension of the same type to an existing set, thus generating a four-dimensional hypercube out of a normal three-dimensional cube. The depth dimension is not compactified and hidden in the micro-world, as is the case with the Kaluza–Klein fifth dimension or the multiple dimensions in string theory. The depth dimension is represented at all levels at full value, including in our own macro-world. Moreover, it is due to the nature of this dimension that the scale axis threads together all hierarchical levels of the organization of matter, making them a unified whole. In this sense, the depth dimension is distinguished and determinative. Thus, it would be natural, when taking into account the scale dimension, to describe space as the one-plus-three-dimensional, where the scale dimension stands for this 'one', even better to say, 'first', which the other three mutually equivalent coordinate axes cross orthogonally.

If one takes a three-dimensional coordinate system as an abstract scheme unrelated to the physical world, it will not require the introduction of a fourth axis, that is, depth. However, such a necessity does become apparent if one uses the abstract three-dimensional coordinate system to describe real physical phenomena. The necessity of introducing the additional depth axis is connected to nonidentity between a mathematical point and a physical point when they are understood as centers of a three-dimensional coordinate system. A mathematical point, by definition, has no size, and it is absurd to speak of penetrating into it. A mathematical point also has no physical correlate; it is an absolute abstraction. A physical point is also an abstraction, but it is a relative one. A physical point is a part of space, the size of which can be neglected at the given scale of the description of phenomena, whereas at another scale, the same size expressed in absolute values can be significant.

A small shift along the scale axis can also be described within the framework of the usual three coordinates without invoking the fourth axis. Take, for example, a perfect spherical body, and identify its center with the center of a real, graphical three-dimensional coordinate system related to our medium-scale sizes. Let the body be uniformly contracted such that its volume has been reduced by, say, a factor of two. The change in the location of the body can be described as an equal decrease of the distance along all three coordinate axes from their intersection point.

Now, let us continue to uniformly contract the spherical body toward its center. At some stage, the position of the body and the coordinates that describe it will overcome the visibility threshold of the real, graphical three-dimensional coordinate system. It would seem that the body sunk into the point designating the center of the coordinate system. The body will continue to contract, but the three-dimensional coordinate system relative to absolute values of a certain order, say, of meters, will no longer fix this motion. Let us change the length scale along the axes of our coordinate system to, say, micrometers. The region of the three-dimensional space that had been considered as a point without size on the former scale will acquire a nonzero size on the new scale, allowing us to continue fixing the uniform contraction of the body. At some stage, the body will again disappear beyond the visibility threshold; to render it visible, we will have to change the scale again, eventually reducing it, in principle, infinitely, or, more precisely, to the Planck length. Figures 1 and 2 are very simple graphical images of the depth dimension representing it respectively in the two-dimensional and the three-dimensional perspective.

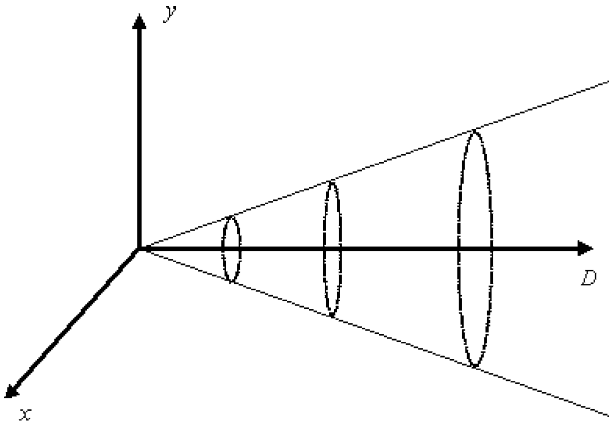

Fig. 1 In the two-dimensional space, the movement along the scale axis will appear as in this figure, where D denotes the depth axis. (*Note*: all graphical and animated materials in this article were designed by the author of the article and were technically implemented with the help of several computer graphics free-lancers)

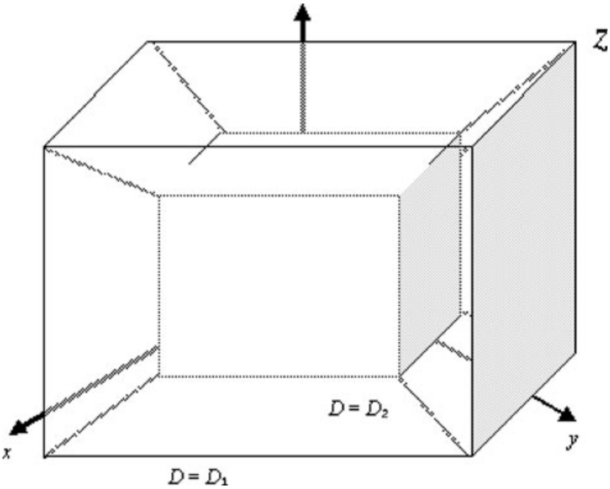

Fig. 2 For our common three-dimensional view, four axes are necessary to demonstrate how the motion along the scale axis affects the position of objects. It is obviously difficult to sketch such a graph, and therefore, I use several level sets in three axes

The shift along the depth axis occurs in a physically real sense, but it cannot be fixed in entirety by the same real, graphical three-dimensional coordinate system that was initially chosen to describe a particular level of scale. The full trajectory of motion along the depth axis of an object, both up to expansion and down to contraction, can be described only by consecutively changing the discernibility grain and the transition between the absolute values of the spatial size that are considered for a physical point at a given level. The scale axis is the additional coordinate axis that connects and unifies the entire continuum of grains of discernibility, making it possible to describe the trajectory of motion within this whole continuum. It is the depth dimension that permits to perform and to reflect the shift back and forth along the whole chain of the different-sized grains of discernibility.

The minimal Planck length scale is 10^{-35} m, and the maximal scale of the Universe is suggested to be approximately 10^{27}. An interactive demonstration of shifting along the whole hierarchy of scales from the minimum to the maximum can be seen online in (Huang and Huang 2010).

The conventional three-dimensional coordinate system creates an illusion of embedding or belonging of any object of smaller scale to a larger object if the smaller one is located inside part of the three-dimensional space occupied by the larger object. This viewpoint was shared by Isaac Newton, who wrote as follows:

> Place is a part of space which a body takes up (…) The motion of the whole is the same thing with the sum of the motions of the parts; that is, the translation of the whole, out of its place, is the same thing with the sum of the translations of the parts out of their places; and therefore the place of the whole is the same thing with the sum of the places of the parts, and for that reason, it is internal, and in the whole body. (Newton 1846, p. 78)

However, a description of the world using only the space of three equivalent spatial coordinates is incomplete. It is necessary to take into account the depth dimension, which substantially changes our description. Let us take one of the atoms in our organism, or, more focused, in one of the organism's biological cells. Where is the atom? As it seems, it is nowhere but in the body or, more precisely put, in one of this body's cells; the atom seems to completely belong to them, to be swallowed up in them without a remainder. However, with the introduction of the depth dimension, a more comprehensive profile is developed, within which the relative detachment of an atom from biological tissue is manifested. The atomic and the cell levels are detached via a number of intermediate scale levels. They are remote from each other both spatially and functionally because what is happening at the atomic level can only indirectly affect what happens at the biological tissue level, and vice versa.

It is quite admissible to call the distance between the atom and the biological cell a spatial distance. However, to stress the specificity of the depth dimension, it is more convenient to call this distance a scale distance or a distance in the scale space. Atoms habitually appear to us in their projection on the three-dimensional space frame at our scale level. The planar projection, in the sense that it is deprived of the depth dimension, hides the true remoteness of the atoms from us along the scale axis. The impression is created that the atom exists nowhere else as in the spatial region into which it is projected and that it belongs to all objects of intermediate scales through the contours of which we see its projection.

What Newton implies in the above citation is that the locations and the coordinates of an object 1 and of an object 2, the later nesting entirely, without crossing boundaries, within the object 1, are nothing but equivalent. Being equivalent, they are, thus, interchangeable. The same set of three space coordinates x, y, and z is worth and sufficient to exhaustively identify the location of object 1 as well as object 2. The conception of one depth plus three common space dimensions makes things look differently. With only the three common space dimensions x, y, and z, we are not spotting the exact location, but only delineating it, to imply the literal meaning of the word delineate, which concerns a line, not a spot. That is, we indicate a one-dimensional line, somewhere along the whole extension of which an object is situated. To really spot the location, we have to perform one more operation. We are to notch the one-dimensional line by indicating the fourth coordinate of an object, depth. If we aim inappropriately high on the axis d (depth), although in the same cone-shaped vicinity of x, y, and z, we will miss an atom and see only biological cells. If we aim too low, which allows us to find smaller objects, we will instead miss a biological cell, since our field of view will include only single atoms that constitute the cell.

3 The Motion of Matter Along the Depth Dimension

Moving downward along the depth dimension is similar to penetrating a point; moving upward is like moving outside a point at 360 degrees in all directions at once. Of course, an attempt to visually imagine and rationally comprehend the motion in and out of a point involves a great deal of perplexity. However, the depth dimension is not completely out of the reach of our imagination and rational comprehension, as it might be with some even more exotic dimensions introduced in physics. Visual analogies and imaginary constructions might be helpful in disclosing the nature of the depth dimension and the motion along it, and therefore, I will widely resort to them in the course of my discussion.

An ongoing deepening inside a sphere means that what seems to be the point center of a sphere, upon closer approach itself becomes a sphere inside that larger sphere, with a center again to be attained, and so on, up to Planck length. The radii of a sphere are the coordinate axes along which the shift proceeds. The center as if constantly runs away from us, and we keep on chasing the smaller and smaller center spot deeper inside the sphere. When shifting in the opposite direction, we are directed not inside a sphere but outside it, simultaneously along all the radii lines projected outward beyond the former sphere surface. An image of a discotheque mirror ball with a multitude of hexagonal mirror facets over the surface sending radial rays widely all around can help form the visual analogy. When you move inward, a point in front of you is to become a sphere, swelling up to a sizable span as you become smaller and come closer. When you move outward, the sphere, beyond the surface of which you are shifting by becoming larger, is to be left behind (more precisely, to be left inside the 'fattened' you) as already a point, having squeezed up to an undistinguishable zero-size spot as compared to your new volume.

A remark is called for concerning the notion of motion representing the depth dimension. So far in my exposition, the notions of (1) our imaginative move in chasing the central point and (2) the motion of a material object itself along the depth dimension were not well distinguished. Two completely different things were indicated by 'shift' or 'move', which should be clearly separated now. In the first sense, mostly metaphorical, I spoke of the shift of our focus of attention, permitting this or that level or grain of discernibility to come into our view. Chasing the constantly evading central dot, moving us or our sight downward, only meant moving our level of observation. In other words, it was stated that a different level moved into our observational field to replace that which was previously present. No physical motion or displacement of an object itself was actually in question. In the first sense, we only shift our view up or down between the depth dimension levels. In the second sense, there is the physical movement of matter along the depth dimension. Let me further on be more strict and mean by 'shift' only shifting of our focus of attention, and mean by 'motion' a real physical motion. This second sense, of real physical motion along the depth dimension, is what I am going to introduce in the passage below and mostly address in the remainder of the exposition.

Making an abstract itemization, three variants seem possible with respect to physical motion along the depth dimension axis. The move might proceed upward, downward, or be absent. My assumption is that all matter in the Universe is involved in moving downward along the depth dimension. This idea is the foundation of my whole conception. In the next section, I present arguments supporting my assumption. So far, in order not to interrupt the line of reasoning, I introduce the assumption as is.

If a solid sphere is reduced to a flat circle, the center would look similar to a wheel's hub fastened by the spokes radiating all around from it. In the common two-dimensional or three-dimensional representation, the central dot of a circle (and particularly that of a sphere) seems to be constricted all around and to have no space to move to. However, visual analogies and the power of imagination may help convince us that a sphere's center does in fact have an additional space and degree of freedom to move to, namely, in the directions upward or downward along the depth dimension.

I present two visual analogies that can facilitate our understanding of how the downward motion proceeds in the depth dimension. The first analogy is visualized in Fig. 3. Imagine a descending parachutist, with a parachute's canopy representing a part of a sphere's surface or, very roughly, a hemisphere, with the shrouds representing the segment's converging lines, and a parachutist, in whose harness all the shrouds focus, representing a center. Now make the following leap of imagination. Take two parachutists falling in opposite directions, facing each other as if on a playing card from top to tail. The two parachutists approach each other,

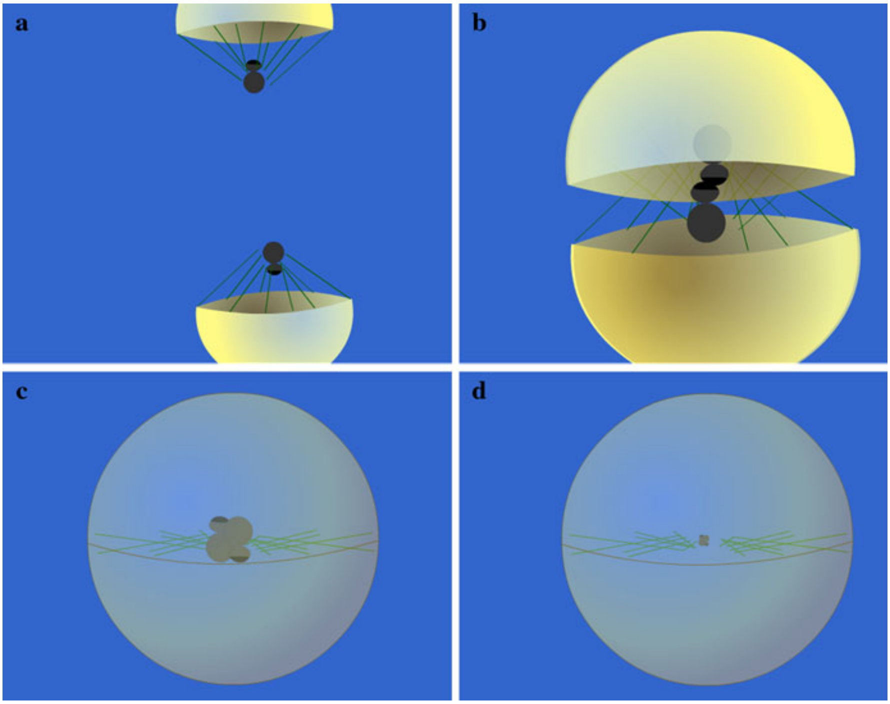

Fig. 3 Explanation with the help of an imaginative analogy of how the movement downward the depth dimension might be conceived. Two parachutists falling in opposite directions, facing each other as if on a playing card from top to tail (**a**). The parachutists approach (**b**); the canopies above them meet, form a globe, and leave the parachutists inside the globe at its center (**c**). The parachutists each continue with their fall in their initial directions, which we observe as moving them away from us further and further into the globe's center, resulting in them getting smaller until they appear as a dot (**d**). Online Resource 1 presents the animated version of this figure

and the nearly hemispheric canopies above them meet, forming a whole globe and leaving the parachutists inside the globe at its center. The parachutists each continue with their fall in their initial directions, which we will observe as moving them away from us further and further into the globe's center, resulting in them getting smaller until they appear as a dot. This description is an approximation of the move downward in the depth dimension.

I agree that two parachutists falling from opposite sides into the center of a sphere formed by their conjoint hemispheric parachutes is too absurd a picture to produce a realistic impression of the existence of a special depth dimension and an additional degree of freedom of motion that it supposedly gives. Therefore, I will provide another analogy that seems to be completely feasible in its implementation and contains no fantastic deviations from common sense physical behavior. I invite the reader to use his or her imagination to assemble a globe of, say, five meters in diameter. Let us make it transparent so that we can watch what is happening inside. There is a smaller round ball, of, say, one meter in diameter, placed inside and strictly in the center of the larger globe. The smaller ball is made of an elastic plastic. The inside sphere is supported in the center via an array of radiating laths linked to the inner surface of the larger sphere. Each lath is telescopically retractable. Fill in the elastic bag ball in the center with a freezant. Steeply freeze that material. The ball with the freezant will shrink noticeably; say by 10 cm in diameter. With the bag's shrinking, a pulling force will be applied radially to all of the laths that are fastened to the bag's outer side, making each of the laths retract in the direction of the center. The shrinking of a bag and the retraction of laths that follow the inward displacement represent the motion along the depth dimension; there is a physically real pulling force involved that is produced by moving the bag inside itself, representing the downward direction in the depth dimension.

Note that although the move appears to proceed equally along all three standard dimensions, only one measure suffices to describe the motion, if it is strictly symmetrical—namely, the measure of the retracted length of any single lath. The measurement is performed in only one depth gauge, rather than in all three Descartes x, y, and z coordinates. When vaster scale distances are involved, measurement is performed in the orders of magnitude of 10^{n} m and 10^{-n} m form, which also avoids separate measurement along each of the three of the Descartes coordinates. The mentioned methodological specificity of the way of measurement may in a sense support the ontological specificity of the depth dimension.

4 The Overall Arrangement of Matter Along the Depth Dimension: 'The Broccoli Universe'

In the passages above, I attempted to visually describe a motion in the depth dimension. This picture was dynamic. Now, I will try to visually reproduce a material object presented unfold in the depth dimension. This picture will be static, manifesting the depth dimension in the span of the hierarchy of levels. The general difficulty with describing the depth dimension is that it is protracted inside a material object, being nested in and covered up within the embracing shells.

Placement of objects along the depth dimension doesn't yield to observing from the outside and even evades a definite visual representation in our imagination. It is like an attempt to describe a stick or a flying arrow while only being able to view them from their reverse, which is projected to us as a dot. Our task is similar to that of picturing a stick or an arrow turned about at 90 degrees, so that we see them in an imaginary way from their protracted lateral side, not only from the point rear side. Imaginational turning about is shown in Fig. 4.

Let us consider an atom. Atoms may be understood as the preferential objects with respect to the depth dimension because the atoms' entrails border the Planck length at the bottom level; as we look upward the scale, all material objects of larger size, be they molecules, stars, or galaxies, all consist of clusters and patterned configurations of atoms.

In the trivial common sense representation, an atom is viewed as a ball (pictured in Fig. 5a). In order to produce a visual representation of a pile of micro-levels descending into a seeming atom-only-as-a-ball's deeper interior, let us make the similar imaginary operation with the ball as it was with turning a stick about to see it protracted laterally. Let us unroll in an imaginary way the ever thinning tail of an atom's interior and throw it over from under the ball's surface to let it dangle on our outer visible side. The result of an attempt to perform this imaginative operation is presented in Fig. 5b. The turned-inside-out atom ball would be presented in the volumetric representation as a cone (pictured in Fig. 5c) and in the planar representation as a cone flattened to a triangular segment (pictured in Fig. 5d). Visual analogy comes to mind here again. There is often a hood compactly rolled up inside the collar of a windbreaker jacket. With the unrolling of such a hood, a two-dimensional triangle first appears out of a nearly straight rolled-up sheet of fabric; after that, a three-dimensional bell-mouth cone emerges. Eversion of a ball would resemble the unwrapping of a hood out of a collar; in the case of a ball, however, the unwrapping is that of a zero-dimensional dot rather than that of a straight, tightly wound unit conventionally taken as one-dimensional.

If we take an atom as it really exists in the one depth plus the common three dimensions and project it on the simplified two-dimensional space, an atom will be represented as a flat segment with at least four levels of matter structure distributed along the depth dimension. The crossbars of ever shorter length drawn between the converging side lines of a segment would represent the level of electrons, the nucleus, the quark level, and the bottom level of hypothetical units of Planck length. With respect to the existence of the non-zero Planck length at the bottom level, a triangular segment would in fact be a trapezoid, with the upper and the lower level

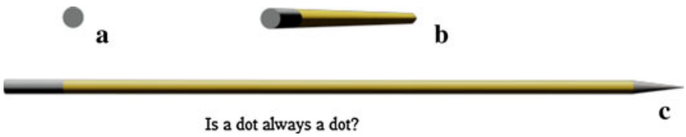

Fig. 4 Placement of objects along the depth dimension evades a definite visual representation. It is similar to an attempt to describe a stick while only being able to view it from its reverse, as a dot projection. Imaginatively we have to turn it about at 90°, so that we see the stick from the protracted lateral side. Online Resource 2 presents the animated version of this figure

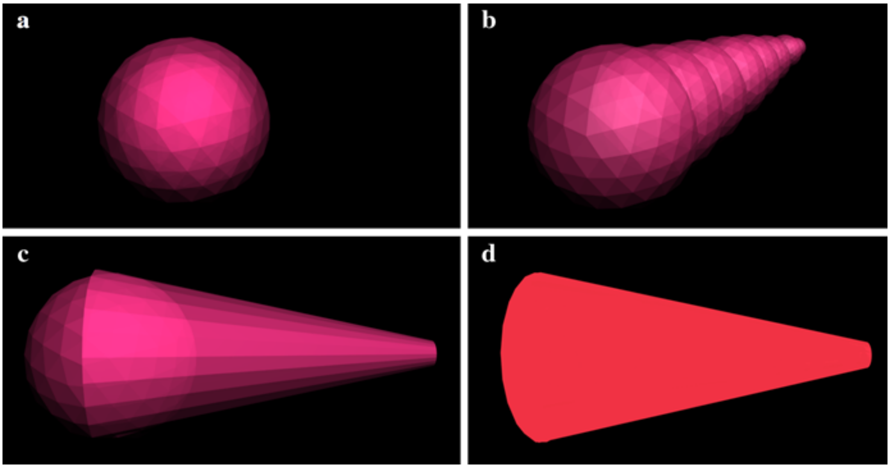

Fig. 5 To visually transform an atom that is habitually seen as a ball (**a**) into its real depth dimension protraction, we make the similar imaginary operation with the ball as it was above in Fig. 4 with turning a stick about to see it protracted laterally. We unroll in an imaginary way the ever thinning tail of an atom's ever deeper interior and throw it over from under the ball'*s* surface to let it dangle on our outer visible side (**b**). The turned-inside-out atom gets now presented in the volumetric representation as a cone (**c**) and in the planar representation as a cone flattened to a triangular segment (**d**). The simplified geometric figure of a triangular flat segment is the most convenient object to start with our explication of the real spherical arrangement of matter in the Universe. Online Resource 3 presents the animated version of this figure

crossbars roughly considered as parallel, and with the side lines converging to the bottom Planck-length crossbar. When the one depth plus the common three-dimensional figure is projected not on the two-dimensional space, as discussed above, but on the three-dimensional space, the flat trapezoid would turn into a truncated cone. In this case, the hierarchical matter levels would be represented by horizontal cone cross-sections placed lower and lower and becoming smaller and smaller squares as they approach the bottom truncation.

In the passages above, I spoke of an atom in a too broad sense. I meant not only an atom proper, but an atom's constituent parts and the parts of these constituent parts. This was because I wished to designate the whole column descending from the very atom's upper and covering the whole space beneath the upper all the way down to the very bottom matter levels. Meanwhile, an atom proper is neither its quarks nor the hypothetical Planck units. An atom in its own realm is only an electronic shell and nucleus; the lower levels are not the entity of an atom proper. If we look at an atom with the lower non-atomic levels factored out, as it properly should be, we see, nevertheless, basically the same picture as described in the passage below.

An electronic shell and a nucleus would be presented to us as also distanced by levels. Atomic nuclei are visible to us through the contours of substantially larger electronic shells, in a projection onto them. An atom extended along the depth dimension would have the shape of a tornado: a wide ring at the top and a small and dense core at the bottom. When observing a real tornado straight from above, let us say, from a satellite, hence, in a two-dimensional projection, we see that the core is embraced by the ring from all sides and is thus as if inaccessible from any side.

However, in the three-dimensional representation of a real tornado, we start to see that the core is not located completely inside the ring; the core and the ring are spatially separated, although united by stable interactions that make them exist and act as a whole and conjoint entity.

Let us consider how a multitude of atoms arrange themselves as existing not only in the three standard dimensions but, in reality, also in the depth dimension. If we suppose that atoms lean against each other along their whole extension in the depth dimension, some multitude of segments or cones (more strictly, trapezoids and truncated cones), would naturally add themselves up into a two-dimensional semicircle fan (Fig. 6a) or in a three-dimensional volumetric fantail. The fantail would widen to the upper level, marked by x in Fig. 6a and narrow to the lower level, marked by z in Fig. 6a. The entire existing multitude of atoms, while self-arranging according to the initiated pattern, would naturally end up rounding themselves into a circle (Fig. 6b) or a sphere (Fig. 6c). I assume that the multitude of atoms in the Universe, in its arrangement along the depth dimension, form a spherical body. That the sphere is closed and thus has no niche on one side can be suggested from considerations of symmetry and from the observed isotropic distribution of the star matter across the Universe.

I will consider the two possible critical remarks to the idea of the spherical arrangement of all matter in the Universe along the depth dimension.

First, one might contend that if to suggest the number of atoms to be infinite, the size of the Universe should be also infinite, not only on the upper level but on the lowest level as well; thus, sizes all along the depth dimension should be considered equal. Hence, there is no narrowing to the bottom. My reply is that the supposed infinite number of atoms and, thus, the infinite size of the Universe do not preclude its being rounded into a sphere. In that case, we may apply Cantor's notion of infinities of greater and lesser cardinality.

The second critical remark to the spherical model of the Universe might be as follows. Atoms evidently lean together on the upper electronic level, where they unite to share electrons to form molecules. But it is not evident that they likewise continue leaning on each other on the lower levels of the same physical body. Thus, the real placement of atoms along the depth dimension might be not similar to rays radiating from or to the center (like in Fig. 7a), but rather resemble a group of Portuguese men-of-war medusa, the feelers of each single one dangling straight to the bottom without biasing to neighbors (this is shown schematically in Fig. 7b). The space that each atom occupies along the depth dimension up to the very bottom level might be cylindrical and not conical; as to an atom itself as material object, it might remain a cone within its allotted cylindrical slot of space. It follows that there is more free space and matter is displaced more loosely the lower and closer to the bottom level we come.

I have two counter arguments in favor of the idea that atoms do not occupy the same amount of space on the deeper levels that they do on the higher levels. First, a very speculative and trivial thought is that nature abhors a vacuum. Second, no absolute space exists by itself and irrespective of matter; matter moulds the space according to its structural arrangement.

As a summary of the above sections, the following cosmological model can be schematically outlined. There is a largest sphere and a number of concentrically

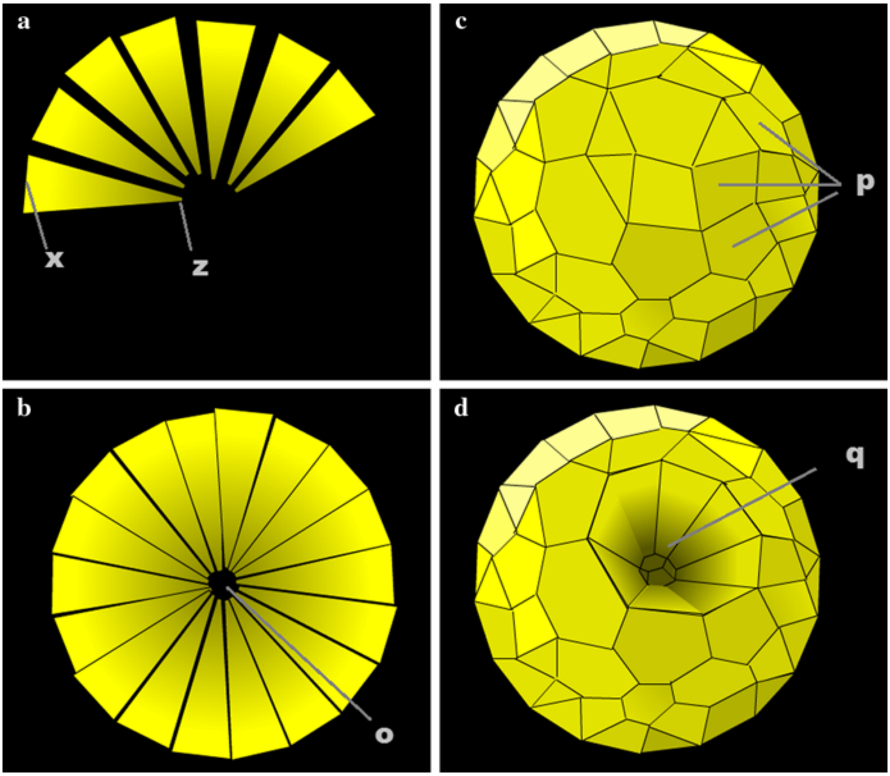

Fig. 6 A set of triangular and leaned-to-each-other segments would plainly, by virtue of their common geometrical shape, add themselves up into a two-dimensional semicircle fan (**a**) or, in three-dimensional representation, into a volumetric fantail. If the entire multitude of atoms in the Universe were to self-arrange themselves according to the initiated geometrical pattern, they would naturally end up in rounding into a circle (**b**) or a sphere (**c**). The images in this figure can also be conveniently used to illustrate some other topics mentioned in this article, as follows: (1) What is marked as *q* in **d** refers to a later topic of subsidence of space in the presence of mass, similar to that shown in Fig. 19. (2) The object marked as o in **b** denotes a smaller, bottom-level sphere formed by added-up basic Planck units of non-zero size. This topic will be explicated in the text below and accompanied by Fig. 8. (3) The object marked as *p* in **c** refers to the notion of a fluffy 'Broccoli Universe' discussed in the final passages of Sect. 4 of the text. Online Resource 4 presents the animated version of this figure

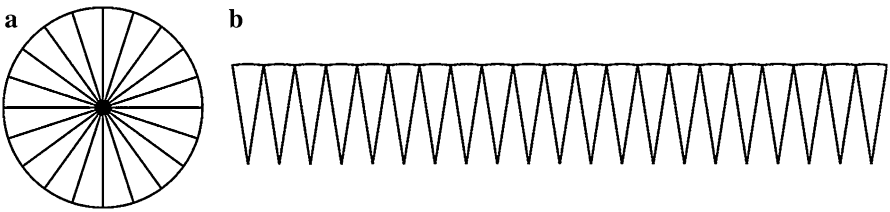

Fig. 7 Visualized critical reservations concerning the statement that matter is arranged as a sphere in the protraction of the depth dimension. It is not sufficiently evident that atoms lean to each other on the bottom level as they do on the higher atomic level, where electrons participate in valence binding. Variant (**b**), rather than variant (**a**) might take place in reality

nesting spheres, all representing respective levels of the structure of matter, and there is a smallest sphere within the larger ones that represents the very bottom level of the structure of matter. The bottom sphere is moving further downward along the depth dimension; that is, it is moving inside itself. The motion of the bottom sphere exerts a pulling force upon matter in the upper levels. Matter in the upper levels is not firmly conjoint; it appears porous and 'fluffy', so that celestial bodies exist and move as evidently separate bodies. Further in the downward direction, matter converges. At its bottommost level, all matter is in cohesion. I suppose that the utmost bottom sphere is composed of elementary Planck-scale units in their mutual gapless conjunction. From the bottom level to the upper level, the overall scheme has a broccoli-like appearance; therefore, I call this model 'the Broccoli Universe'.

5 Inertia and Mass

The conception of the depth dimension and of the matter downward movement provides a novel understanding of inertia and mass. To explain both notions in terms of the depth dimension, I describe more explicitly the proceedings on the bottom level of the spherical arrangement of matter.

I assume that the bottom level consists of the hypothetical basic units of Planck length that, probably, have the form of two-dimensional polygons. The prototype is Plato's idea, as presented in 'Timaeus', that elementary geometrical figures constitute the foundation of the Universe. Added up together, the polygons comprise a square. Due to the above explicated fantail structure of matter arrangement along the depth dimension, the square would be bowed outside, supposedly up to become closed and looped onto itself, and thus form a two-dimensional surface of an empty volumetric polyhedron, each facet of the polyhedron being a basic polygon of Planck length. A polyhedron with a huge or infinite number of facets, as in the case with the supposed quantity of basic matter units in the Universe, approximates a sphere.

An idea of how a small fragment of a spherical object composed of Planck basic units may appear is visualized in Fig. 8. One should not, however, accept this image too readily. We are dealing with a world in reference to which notions based on our common-sense perception are probably inadequate. The difficulties with visual representation are expressed, for example, in the question concerning which of the elements drawn in Fig. 8 should as a matter of fact represent these very Planck scale underlying units we are talking of? Are they flat two-dimensional triangles, hexagons as wholes, nodes, the graph lines that connect nodes; or are they the threedimensional objects through which some minimal voluminosity of each single object is engendered by the overall curvature of the field of basically two-dimensional polygons? The topic remains open.

I suggest that the basic bottom level sphere composed of the basic Planck scale units is moving downward, that is, contracting. By its own moving downward along the depth dimension or contracting, each basic matter unit exerts a standard quantized momentum of a pulling force up to the higher levels. In Fig. 9, the arrows

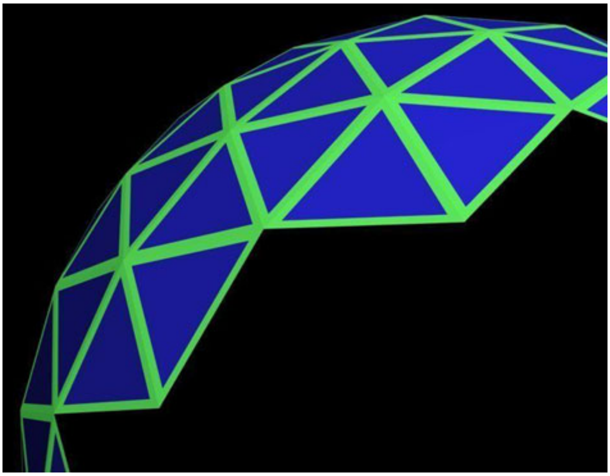

Fig. 8 I assume that the very bottom level of the matter structure is composed of the hypothetical basic units of Planck length, possibly having the form of two-dimensional polygons. The prototype is Plato's idea, as presented in 'Timaeus', that elementary geometrical figures constitute the foundation of the Universe. Added up together, the polygons comprise a square. The square is bowed outside, supposedly up to become closed onto itself, and thus to form a two-dimensional surface of an empty volumetric polyhedron. A polyhedron with a huge or infinite number of facets approximates a sphere

marked as F_i designate the inward directed motion and the force associated with that motion; the arrows marked as F_o designate the collateral force applied to material objects at the higher levels, all the coherently moving bundle much resembling a locomotive running in some direction and pulling a carriage chain behind it. Because all the basic units and larger material bodies comprised of them participate in the joint and uniform motion, sizes of material objects remain the same relative to each other. The shrinkage, of the Planck values included, is directly unobservable within the media of the material objects.

I now address the topic of inertia. There is a constant and a uniform rate of force permanently applied from each elementary unit up the higher level. The more units an atom includes according to its chemical type, the higher the total force applied from an atom's interior in the upward direction. For a single whole material body, like an iron weight disk, the sum of the momenta of the applied force equals the number of elementary matter units that comprise an iron atom multiplied by the total number of the iron atoms comprising the weight disk.

In the representation including one depth plus three common dimensions, the direction of the pulling force is downward along the atoms, presented in that case in the form of cones. In projection on the space of only three standard dimensions, where no cones are unwrapped and only balls are manifested, the force looks to be directed inward a ball or any material body, to its center of mass. The action of the force is similar to tightening up a body from the inside. Being strictly symmetrically inward and center bound along the depth (d) coordinate, the vector of the force has no biases along the x y, or z coordinates. The real motion of a body downward in

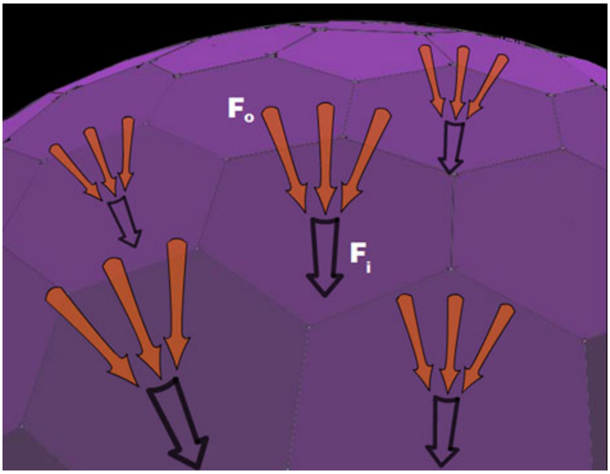

Fig. 9 I suggest that the basic bottom level sphere composed of the basic Planck scale units is moving downward, that is, contracting. By its own moving downward along the depth dimension, each basic matter unit exerts the pulling force up to the higher levels. The arrows marked as F_i designate the inward directed motion and the associated force. The arrows marked as F_o designate the collateral force applied to material objects at higher levels

space is noticeable only in the one depth plus three-dimensional representation; in only three-dimensional representation, the body seems to be perfectly at rest.

Now, look what happens when any of those familiar mechanical forces acting in our habitual three-dimensional space frame gets applied to the body that has already the pulling force permanently exerted to the body from within, that is, along the depth (d) coordinate. Suppose that the iron disk has been hit by a hammer from left to right—that is, a force has been applied with the vector along the x coordinate. The body being permanently pulled from and into its interior already has the selected vector and trajectory of movement; the body is on the permanent move in its depth dimension groove. Moving to its own center means 'unwillingness' to being displaced along x, y, or z coordinates, because any of these three coordinates equally offers an orthogonal direction that deviates by 90 degrees from the depth-bound direction of movement already being followed. Whatever strong the mechanical force acting in the frame of the familiar three dimensions is and irrespective of where to within the x, y, z space frame this force is attempting to drag the body, there is the downward (d) force immutably present and always acting in the orthogonal, thus automatically contesting any of x, y, and z forces. That leads to the fact that no force would be able to displace the body instantaneously; the two forces first have to add up in a parallelogram of forces as shown in Fig. 10; time is required to absorb (not eliminate) the downward (d) force and to accelerate the body along the x coordinate to a new constant direction and velocity.

This is inertia; more precisely, this is one of its manifestations, namely, counteraction of any material body to the force that attempts to change that body's velocity and a related time delay in that object's fully acquiring a new velocity.

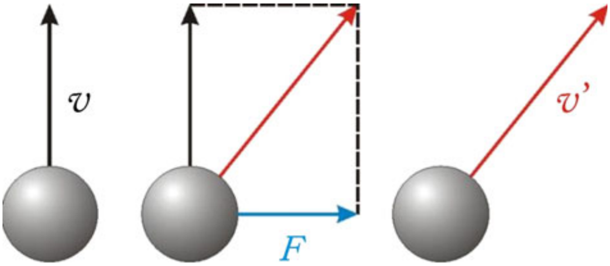

Fig. 10 The downward force has no preferred direction in the *x*, *y*, *z* space, and therefore, after an acceleration stage and switching to a move in a new direction with a new constant velocity, the body would experience no further counteraction from the downward force and would follow the newly accepted straight *x*, *y*, *z* vector. In fact, the picture is not entirely relevant to the explication in the text; the downward force is not shown and marked here; just a sample parallelogram of forces acting in the standard three-dimensional space is shown to demonstrate a retardation time needed to accelerate a body to a new rectilinear direction from v to v' with the help of a transient force marked as F

Logically, for a counter action to appear at all, some force should already be in action in a body. What is that force? The presented conception provides a clear and definite answer: this force is the downward pulling force acting along the depth dimension. The more mass has the body, the higher its counteraction to any force acting in the common x, y, and z coordinate frame, so the greater the inertia. The d force acts here as a centripetal force, whereas in changing the body's previous velocity, any of the x, y, z-vector forces act as a centrifugal force, counteracting the d force. The d force has no preferred direction in the x, y, z space, and therefore, after an acceleration stage and switching to a move in a new direction with a new constant velocity, the body would experience no further counteraction from the d force and would follow the newly accepted straight x, y, z vector. The body would proceed to move rectilinearly until the new accelerating impulse from somewhere in the three-dimensional space frame arrives.

Rectilinearity of once-initiated motion, under the condition that no force further interferes, is another manifestation of inertia. The conception of the depth dimension provides an explanation for the rectilinearity of a non-interfered motion as well. The explanation is as follows. The depth dimension taken into account, the center of mass of a body or a system of bodies is presented not as a point, as is commonly supposed, but as a two-dimensional axis. The axis of mass of a certain body or system of bodies is formed by at least two base points—not one point as a center of mass, as is commonly believed. The two points constitute a straight line; the line stretches from the bottom level from which the pulling force is exerted (the first base point) to the center of mass as a commonly observable point in the space of the three standard dimensions (the second base point). The straight line with at least two base points that constitute the axis of mass is geometrically bound to move in the parallel to itself and to avoid divergence from the originally set direction, thus, to keep rectilinearity.

Meanwhile, if to follow the traditional belief that the center of mass is only a point, and to waive a suggestion that rather the directing groove of at least two base points exists, the rectilinearity of inertial motion is to be left unexplained. Two-dimensionality of the mass axis that inhibits divergence from the straight trajectory is the geometrical ground for the second of the mentioned manifestations of inertia. Figure 11 explicates by visualization why the one-dimensional axis naturally tends to move rectilinearly, while a single point in the absence of a second bearing point naturally tends to sporadic and contingent roaming.

According to Ernst Mach, inertia is determined in an integrative way by all bodies in the Universe and should be understood in relation to 'fixed stars' (according to his own term). In the 'Science of Mechanics', Mach wrote as follows:

> When… we say, that a body preserves unchanged its direction and velocity in space, our assertion is nothing more or less than an abbreviated reference to the entire universe." (Mach 1919, p. 233) "In point of fact, it was precisely by the consideration of the fixed stars and the rotation of the earth that we arrived at a knowledge of the law of inertia as it at present stands, and without these foundations we should never have thought of the explanations here discussed… The consideration of a small number of isolated points, to the exclusion of the rest of the world, is in my judgment inadmissible…" (Mach 1919, p. 546) "I have remained to the present day the only one who insists upon referring the law of inertia to the earth, and in the case of motions of great spatial and temporal extent, to the fixed stars. (Mach 1919, p. 568)

My conception resembles Mach's idea. However, I consider the micro-level to be decisive in determining inertia, rather than the macro-level of the fixed stars. I explain inertia by qualities of matter on the micro-level, namely by the permanent, though hidden, presence of the downward-pulling force, the vector of which sets the background and preferential coordinate system for all matter motion on the macro-level. For discussions of Mach's conception of inertia, see Graneau and Graneau (2006).

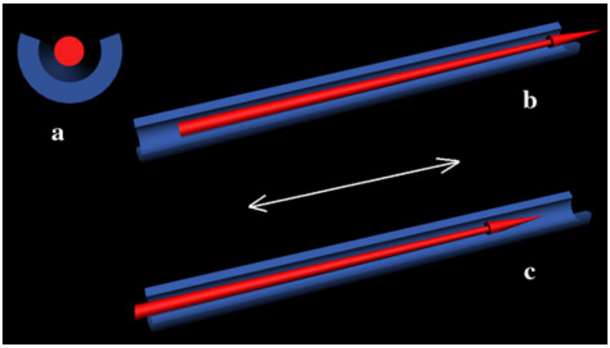

Fig. 11 The existence of the line axis of mass, rather than only a point center of mass, inhibits divergence from the straight trajectory and is the geometrical ground for that a body inertially moves rectilinearly. The picture demonstrates why the axis line of mass naturally tends to guide a material body rectilinearly, while a single point center of mass in the absence of a second supportive point would naturally tend only to sporadic and contingent roaming. Note that **a** is not a roaming point mentioned in the above sentence; it is a flat rear projection of the axis line of mass marked under (**b**) and (**c**). Online Resource 5 presents the animated version of this figure

Basing upon the notion of inertia developed above, we can explain the notion of mass. A basic Planck unit in its motion exerts a constant rate of the downward directed (d) force. The quantity of mass corresponds to the number of basic Planck units. The greater the number of units, the greater the d force the units exert together, the greater the body's ability to counteract the x, y, and z displacements, the greater the inertia of a body, and the greater the mass the body manifests.

In order of priority, the factors in the causation chain are as follows: (1) the downward motion, (2) the rate of the pulling force produced by that motion, (3) the rate of the force of inertia (being, more precisely, a counterforce to any of the vector redirections in the x, y, z space frame, and (4) the rate of mass. Mass is the derivative factor and has no physical essence of its own. Mass is only a measure of the downward pulling force, hence of inertia. To say that a body has n-quantity of mass is to say that there are n basic Planck units in the entire body, each of them exerting a minimal, further indivisible, and uniform momentum of force f, summing in their entirety to n times f.

6 Expansion or Contraction? Convergent or parallel? What Lies Beyond Micro?

In the following passages, I discuss three issues that accompany the chief topic of the nature of the depth dimension.

The first issue is a discussion of whether the Universe actually expands or contracts. My stance is as follows. The downward motion along the depth dimension results in the contraction of each material particle and each celestial body. Space, in the sense commonly referred to as an 'empty space', is not comprised by the elementary units of the polygon type, as matter supposedly is, therefore, the force cannot grip on an empty space as such; so, the pulling force is directly applicable only to matter. It follows that space does not shrink by its own virtue as matter does. The ongoing shrinkage of all celestial bodies while the spatial distances between them rest predominantly intact gives the impression that the Universe is expanding. Why I say 'predominantly', and not completely, will be explained in the later sections when I discuss gravity. Relative to the bodies actually becoming smaller, the span of cosmic space appears to become vaster. The relativity of either celestial bodies becoming smaller or the space appearing to become vaster can be viewed online in a computer simulation provided by the Wolfram Demonstrations Project (Michelson, date unavailable).

My main argument in favor of the stated position is the effect of the red shift. Within the conception of the motion along the depth dimension, the red shift effect acquires a radically different interpretation and, being thus interpreted, becomes able to factually support the conception itself.

It is observed that the star light waves from the most distant parts of the Universe stretch in their wave length as compared to their respective counterparts from the nearer vicinity—this is known as the red shift effect. With the conception of contracting bodies, the effect might be explained differently than in the commonly accepted way. The red shift takes place not because the Universe periphery moves away from us; the further it is, the faster it moves, according to the Hubble law. Rather, the waves that we receive as representatives of the previous states of the Universe are in reality longer because they were emitted by the electrons or other material particles of actually larger size, those that existed at earlier times.

The second issue to be raised is as follows. In the standard three dimensions, metric lines of the coordinate net are parallel to the axes of length, width, and height. It is different for the depth dimension. Downward, the metric lines converge, and upward, they diverge. The following question arises: is the converging, conic shape of the depth dimension immanent to its nature, or is this shape only a matter of perspective, in which we, as observers, are able to view the placement of objects along the depth dimension? Therefore, taken on its own, perhaps the depth dimension would not show convergence to one coordinate axis vector and divergence to the opposite vector; thus, the inherent, not subjectively observable, depth dimension metric is likewise parallel, as it is with the three standard dimensions.

Suppose there is an observer whose biological body is protracted along the nearly entire depth dimension, embracing, say, an approximate 10^{-10} to 10^{10} m span at once. It should be noted that we as biological entities, the living creatures on Earth, embrace an incomparably narrower scale range. The fact that our biological tissue is, in the physical sense, ultimately reducible to quarks does not mean that ‘quarks are us’. This point is at the heart of the very conception of the scale dimension that I explicated at the beginning of the article. ‘We’ are only a small island floating amidst the whole pile of alien to our essence scale levels mounting under and over the one on which our biological organization nests. Our perception range is as narrow as the range of our biological existence. For a hypothetical creature with a much vaster bodily existence range up and down the scales, its habitual x, y, z space would embrace the portions of what for us are inaccessible regions up and down the depth dimension axis. For that creature, ‘atoms are him’ as well as ‘stars are him’. The habitual chunk of a three-dimensional space that seems pretty volumetric for us would be presented as an indiscernibly thin two-dimensional slice of space by this creature. Time scales determining the grain of temporal discernibility and the concrete duration of ‘now’ would also vary for different creatures. There is an approach in science called endophysics that stresses the inherent role of an observer in defining the perspectives of levels in space and time. On this approach, see (Vrobel et al. 2008; Alyushin 2010).

There is another aspect of the question of whether the world by itself is structured along the depth dimension in the parallel or in the converging metric lines. Suppose that a conic figure protracted along the depth dimension is transformed into a right cylinder by stretching a cone’s body up to a state in which the vertex spot becomes of the same square as the base of the cone. How would the view of the world be transformed for the cone that becomes a cylinder, were it able to perceive? The world would rearrange its shape in the opposite direction. The outer things that appeared extremely large as observed from the position of a vertex spot, with this vertex spot growing up to the square of the cone base, would squeeze to the sizes equal to those observed from the position of the original and unchanged base of that cone. If one becomes parallel, the counterpart converges relative to it, and vice versa. There seems to be no way to simultaneously render the d dimension and the x, y, z dimension metric lines parallel. The idea is visualized in Fig. 12.

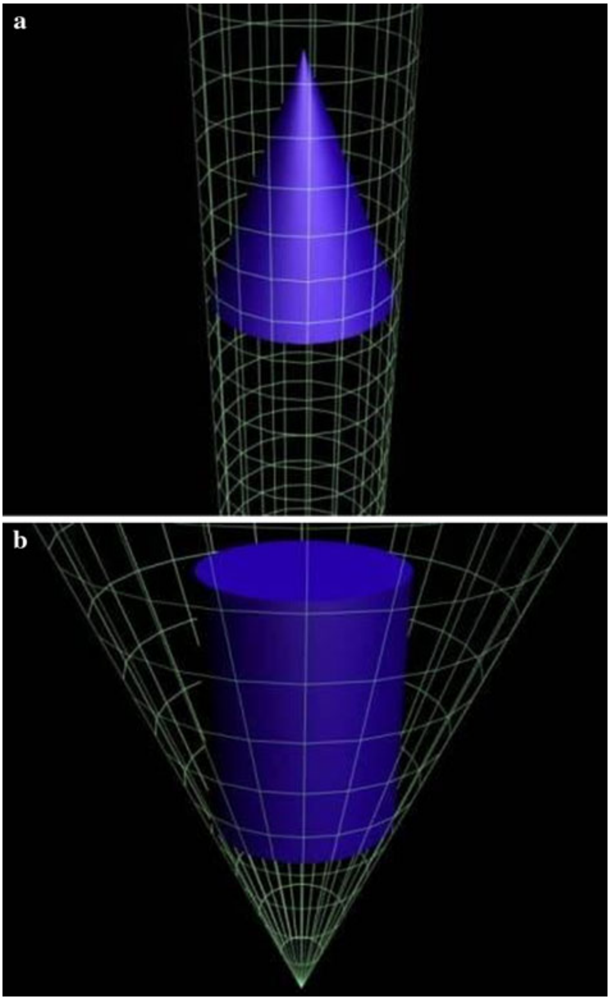

Fig. 12 Suppose that a conic figure protracted along the depth dimension is transformed into a right cylinder by stretching the cone's body to a state in which the vertex spot becomes the same square as the base of the cone. The world would rearrange its shape in the opposite direction. External objects that appeared extremely large as observed from the position of a vertex spot would compress to sizes equal to those observed from the position of the original and unchanged base of that cone were this vertex spot to enlarge to the square of the cone base. If one set of coordinate net lines becomes parallel, the counterpart converges relative to it, and vice versa. That in the perspective of the depth dimension matter is arranged not as a closed ball with a dead end inside, but rather as a tube that is open on opposite ends and provides a range for matter to move within is shown in Online Resource 6 (being original video, not replicating Fig. 12)

Imagine we are congruent to the depth dimension; we are in our element in it. In the common three-dimensional perspective in which we are used to perceiving matter, the direction inward a material body appears occluded. It is the blind end; there is no sink or free space opening beyond the body's center. This is not the case if we perceive matter in the depth dimension perspective. There, we see that matter is outbound in both directions along the depth dimension, not only to that of the larger-sizes end, as it appears in a common perspective. The world would look open to us at both sides. In our common three-axial x, y, z world, when we look to the left and to the right, up and down, or forward and back, we see equal hemispheres on the opposite sides, all three pairs of hands geometrically equal and unlimitedly open. By the same token, when we say that all matter moves along the depth dimension, we imply that the other end is open to enable the prospective motion. In the perspective of the depth dimension, matter is arranged not as a closed ball with a dead end inside, but rather as a tube that is open on opposite ends and provides a range for matter to move within.

The third issue is speculation regarding whether the converging metric lines after their x-crossing at the very bottom should, due to the suggested immanent geometry of the d dimension, be prolonged further beyond as already diverging. If so, we will have an image of two fascicles grasped in the middle by a waist and fanning to the opposite sides; or of two cones joined by their vertexes and symmetrically widening to the opposite directions; or of two globes symmetrically attached to their single common point at the x-crossing. My considerations with respect to the suggested prolongation of the depth dimension metric lines after their crossing at a focal dot into diverging lines beyond the dot are the following.

From the point of view of consistency, the symmetrical construction appears feasible. A cosmological scheme of the two fascicles, cones, or globes, converging to the mutual isthmus and diverging at the opposite sides, with the isthmus periodically shifting back and forth amidst the two worlds, or the two sides of the world (as shown in Fig. 13), has substantial explanatory potential. The Planck level may correspond to that periodically back-and-forth shuttling boarder or isthmus between the two

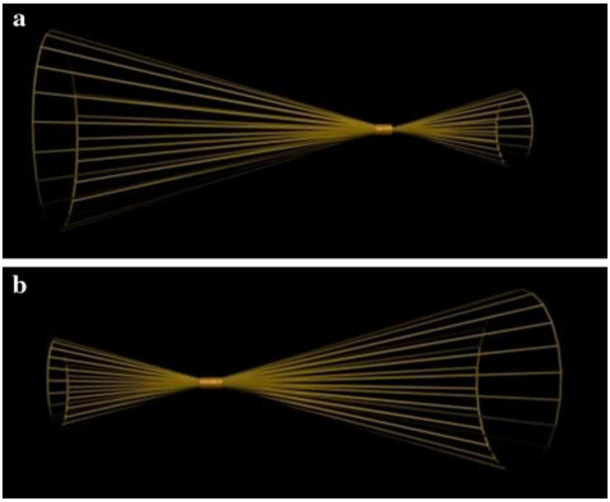

Fig. 13 Visualization of a cosmological scheme of the two fascicles (in their two- and three-dimensional representations being, these are cones and globes), that converge to their mutual isthmus and diverge again beyond the isthmus, with the isthmus probably shifting back and forth in a periodic way amidst between the two worlds, or the two sides of the world. Online Resource 7 presents the animated version of this figure

complimentary parts of the world. The current direction of the isthmus shift might be the ultimate cause for the described above downward motion of matter.

The shift, presumably, may periodically change to the opposite direction, somewhat resembling a piston double-acting pump. Due to the tentative shift that is opposite to the present direction, matter should jointly start moving upward, making all bodies expand. The whole cosmological picture of the Universe should radically change under these new conditions. How it would change in particular, and what happens then to gravity, may be an interesting point for separate hypothesizing. At least one detail might be pointed out as a signature mark of the direction change to the upward and of the commenced matter expansion. Astronomers will observe the blue shift instead of the red shift of light coming from the very distant galaxies. This will happen because the light from the very distant galaxies reach us with the great delay, and so this light will represent the older galaxies' state. In that older state, the stars and the elementary particles they consisted of and the light waves that the particles have emitted were smaller and shorter compared to what we should observe with respect to our Sun and nearby stars were they to start expanding instead of the former contraction.

The symmetrical construction seems to provide an intelligible explanation of antimatter as well as of the conservation of energy and of the entropy-negentropy balance. The explanation for the later point might consist in the idea that energy and entropy reflow between the worlds and their hierarchical levels. The symmetrical construction also appears to be able to illuminate the nature of life as a sequence of that reflow, supposedly accompanied by a local sharply nonlinear pumping-in of energy and by rising negentropy necessary to originate life. The construction can help treat the metaphysical question of why something does exist at all. It might be suggested that when the two sides of the scheme are superimposed they cancel each other out. Therefore, taken in its total summation, the world equals to zero. The world in its entirety is void. Something becomes to exist only as a tiny remainder aperture produced by a contingent deflection from a perfect self-cancelling symmetry, in which the twin folded worlds persistently abide.

7 The Origination of Gravity

To understand the physical nature of gravity, we have to explain at least four things: (1) Why do bodies in each other's presence change their straight trajectories and approach? (2) Why do bodies in doing so act coherently, as if 'feeling' the mate's presence at a distance, evidently without a link or a mediator between them? (3) What is the energy source of gravity? (4) Why does a force, supposedly responsible for changing the straight trajectories and an approach, rise as the bodies come closer to each other? The conception of the depth dimension and the matter's motion downward is able to explain the mentioned effects in their consistency.

I invite the reader to picture a single atom in the absence of any other atom in the vicinity, the inner complexity of atom omitted. Imagine the atom to be on the flight straight from us, or, likely straight toward us. The complementarity of the 'from us' and the 'to us' representations is desirable in order to exclude the bias of a plainly subjective visual perspective, when the retiring object would seem to be getting smaller or closer to another object by the very token of its retirement. An atom would be presented as a cone with its vertex either from us or to us in the most comprehensive one depth plus three standard dimensional space frame; as a ball in the three-dimensional projection, with the dimension of depth omitted; or as a circle in the two-dimensional projection.

If an atom flies straight away from us in the standard three-dimensional space and we watch it from the rear, we see an atom as a right circle. The dot in the center represents both the center of mass of an atom and the butt crosscut of a vector line along which an atom flies. The center of mass and the vector of flight in this case coincide.

What is the center of mass, in terms of the depth dimension? This is a point or, with the finer discernibility, a spherical object at the bottom level of the matter structure that is moving along the depth dimension further downward and is applying herewith the pulling force to the higher level matter constituents. The center of mass indicates a vector, along which a pulling force is acting and to which's direction a body is contracting. What is visible to us as a center of mass is the butt crosscut of the arrow that always points at the bottom level, that is, inside. The other arrow's end denotes the outside of the matter. That a center of mass is not solely a point but rather an axis line along which objects are dragged downward in the depth dimension can be clearly visualized with the help of an online computer simulation available at the Wolfram Demonstrations Project (Ribeiro 2011).

In the one plus three-dimensional representation, where atoms are viewed as cones, the vertexes of all the cones-atoms in the Universe are oriented uniformly. They all converge to and are conjoint in their common focus at the very inside or at the very bottom of matter. In the one plus three-dimensional representation, the inner and outer directions are always unambiguously distinguishable by a straight axis line, analogical to a compass needle pointing to the South and to the North. However, similar to the exception of being on the North or on the South Pole itself, where the opposite direction becomes everywhere, while one's own nowhere, in the standard three-dimensional representation only the total set of arrows fanning 360 degrees rightly indicate the outer direction. The opposite ends of all those arrows, focusing into a dot with, so to say, minus 360 degrees embracement, rightly indicate the inside direction. Wherever you poke your finger into the three-dimensional space, this direction will be a correct indication of the outside direction, and the same is true for the inside direction.

Let us now picture a group of three triangularly placed uniform atoms instead of a former single atom. In Fig. 14a, we obtain a flat triangle with the centers of the three atoms in the equal angle vertexes. In Fig. 14b, we obtain a volumetric angle vertex located at the point at which the converging lines from three upper vertexes focus. This angle vertex represents the bottom pulling point on the depth dimension axis. The center of mass of the system of three atoms is located beyond any of the three circles, in an empty square in the geometrical center of the triangle. If atoms are represented as balls, the system's center of mass is in an empty space between the balls; if atoms are viewed as cones, the center of mass is a one-dimensional line piercing an empty space in between and equidistant from each cone's volume.

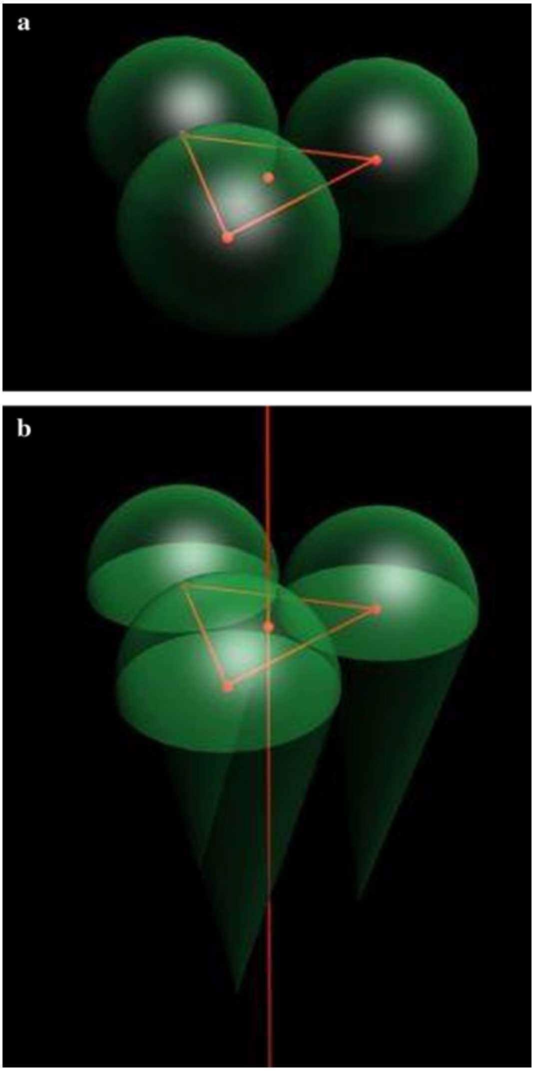

Fig. 14 If atoms are represented as balls, the system's center of mass of three atoms is a point in an empty space between the balls (**a**); if atoms are viewed as cones, the system's center of mass is a one-dimensional line piercing an empty space in between and equidistant from each cone's volume (**b**)

If there are no atoms in the near vicinity, the downward force would drag the single atom to its own geometrical center such that the surface of a system of a single atom contracts symmetrically. The system of the three atoms is also dragged and contracts symmetrically as an entire system, though already asymmetrically with respect to each of the atoms constituting the system. The atoms are dragged not to their own centers, as it would be if they stay alone or extremely remote from each other, but to a system's center that is placed beyond each atom and in between them. In the one plus three-dimensional space the three objects are directed toward their common central dragging point at the bottom level placed in the intermediate span, not to each object's own central point. The outcome of this is that in the projection onto our common three-dimensional space, the three objects appear to be directed to each other, that is, to mutually approach, as shown in Fig. 15. This phenomenon is the basis of the gravity effect.

Objects do approach each other by virtue of a mediating pulling force that uniformly acts upon them in the downward direction, and not because of the existence of a special dragging force that links and attracts the bodies together directly on the horizontal level. Actually, there is no such real physical force as 'gravity'. What we observe as 'gravity' is only a byproduct and a manifestation of the joint downward motion of all matter. In fact, what material objects are physically attracted to, is the bottom level of the matter structure represented by the center of mass. As an accompanying effect, an approaching of objects to each other on the horizontal level also takes place; the approach proceeds in such a fashion as if (and only 'as if') objects were immediately attracted by and to each other.

We are not able to directly perceive the downward motion of matter, because our bodies alike to all material objects in the world are totally and uniformly swept by this very motion. What we are entitled to by the way we as biological creatures are built in the physical world is to observe the approaching motion of objects, ascribing it to the

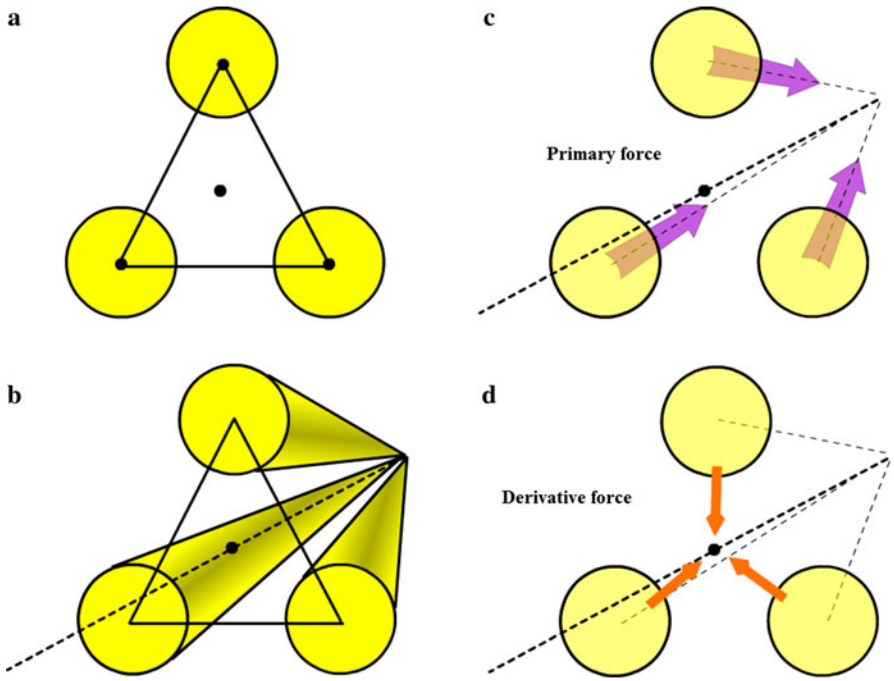

Fig. 15 The system of three triangularly placed matter units (suppose them to be atoms), is dragged downward and contracts symmetrically as an entire system, though asymmetrically with respect to each of the atoms constituting the system. Atoms are dragged to the system's center, which is located beyond each atom's borders and between them. In the one-plus-three-dimensional space, the three objects are directed toward their common central bottom dragging point placed in the intermediate span between all three of them, not to each object's own central point. The outcome is that, in the projection onto our common three-dimensional space, the three objects appear to be directed to each other, that is, to mutually approach. This phenomenon is the basis of the gravity effect. Online Resource 8 presents the animated version of this figure

non-existing gravity force. The so called gravity is derivative of that primary but unobservable motion; it is only its by-product and indirect manifestation.

The idea stated in the above passages lies at the core of the conception of gravity developed in this article. The analogy visualized in Fig. 16 helps better understand this core idea. Imagine a motorboat that starts towing two or several barges behind it on separate towropes of equal lengths, in a fan-like manner. After some initial period, when the barges are at a distance between each other and go parallel, they will bunch up because each wants to follow an economic, thus straight, trajectory. The straightest trajectory means the closest path to the motorboat's own trajectory and no side acceleration. While competing for the straightest trajectory and bunching up, the barges would put pressure on each other's boards. There might be an impression that there is some special force making the barges approach and press into each other. In reality, however, there is no attracting force that would connect one object directly to another; rather, objects are drawn together because they are tied to a common dragging point beyond them all. There is no rope that would tie the barges directly between each other in the absence of the motorboat; barges are tied with towropes to a boat that drag them all, and only because of that forceful motion do the barges move toward each other as well.

The conception of the depth dimension helps us spot the missing mediator of the gravitational interaction. The mediator is the lowest, or deepest, level of the matter structure, upon which level all matter is in cohesion and from which the uniform pulling force to all matter is applied. The conception also sheds light on the question of an energy source for gravity. The source is a downward-directed pulling force. However, the cause and the energy source for bringing matter into motion downward along the depth dimension, is unclear. Two other important issues remain unclear as well. First, is there a single universal force or are the several forces acting on different hierarchical levels that provide for the translation of the pulling momentum from below upward, and support herewith the uniting down-up tension of the whole construction? Second, what is the speed with which a pulling

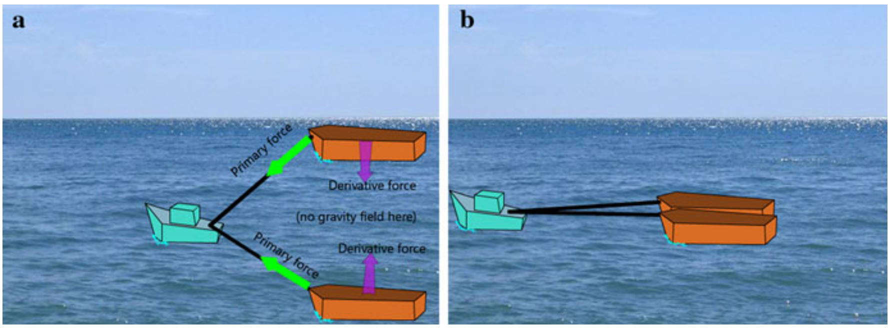

Fig. 16 The purpose of this visualization is to demonstrate by means of analogy that there is no attracting force that connects one object directly to another; rather, objects are drawn together because they are tied to a common dragging point in front or beyond of them all. There is no rope that would tie the barges directly between each other in the absence of the motorboat; barges are tied with towropes to a boat that drag them all, and only because of that forceful motion do the barges move toward each other as well. Online Resource 9 presents the animated version of this figure

momentum is translated upward the levels chain; is there a time delay or some analog of inertia hindering the translation from level to level?

8 Representing Gravity as a Redirection to a Common Center of Mass

A spherical cloud of pulverized non-contacting drops of matter devoid of any physical and chemical bonds would experience, because of their having a common center of mass, the same convergence as compared to the equal amount of mass tightened together in a solid matter body of equal volume. A lump of matter in both dispersed and dense forms would constitute a body with respect to acting of the pulling force on that lump of matter.

We have to explain more generally what the body is as a unit from the point of view of the depth dimension. When I spoke of an atom in its very schematized representation, I assumed it be a single unit without constituent parts. In reality, however, an atom does have constituent parts that are themselves material bodies. There is a massive nucleus, having still deeper inside the particles that constitute it, and a light electronic shell closer to the outside. Similar to considering a system of several atoms, we can peer into any single atom as an already complex system of units with their own masses and common centers of mass. The same is true for celestial bodies. In different representations, depending on the accepted grain of discernibility and on the rate of idealization of a model, we see a celestial body either as a point center of mass or as a complex multitude of massive units.

In the overall perspective, all matter in the Universe is a single body. The detachment of bodies is only relative and having a quantitative rate, whereas unity is an all-encompassing qualitative state. Although two or several celestial bodies are presented to us as evidently detached, for the pulling force that acts upon them from below, or within, they are all a single unit. For any arbitrarily selected pair of bodies, be they non-linked in any stellar system and detached by huge cosmic distances, as well as for a group of bodies or unshaped clusters of matter, the set of their common centers of mass can be singled out; the sets of mass centers do really exist as a manifold of potential cut-out profiles do be done across the integrated whole. No body is ever on its own; any unit does have a common center of mass with any other unit arbitrarily selected out of the universal matter tissue. The idea that there is a common center of mass of any piece with any piece of matter in the Universe means that the trajectories of any two bodies and of all bodies altogether are bent toward each other, although, in most cases, to an undistinguishable degree. It follows that any piece of matter is inclined to approach, that is, is gravitating toward any other piece of matter.

For the pulling sphere at the bottom level, from which a unified force is applied to a pair of bodies, such as the Earth and the Moon, they are represented as one body with two constituent parts. More precisely, the force is applied to the elementary units that all matter consists of. Via these immediate links and in those minimal exertions only, the force is summarily applied to 'bodies'. The force deals rather with the layout of elementary units than with 'bodies' proper. All overtly detached bodies and their systems are presented at the bottom level as only a layout of elementary units. The layout is flat because all units are placed at the same scale level, and only up to the higher scale levels they constellate into the volumetric figures. Our common sense lets perceive the celestial bodies as definitely separated; thus, their interaction in the absence of a mediator appears enigmatic. The conception of a depth dimension offers a different view. An atom, a single body, a system of bodies, or all the matter in the Universe, are to be viewed as an uneven, almost partly hollow, although not torn-apart layout of elementary units, each experiencing the exertion of the force acting along the depth dimension.

The described state of things is depicted in Fig. 17. It is a coincidence, although telling, that the graph in Fig. 17 is plotted in the form of a layout of the multitude of elementary two-dimensional polygons. Different colors represent areas with different rate of mass and so gravity force. The overall curvature of space makes each of the involved two-dimensional units acquire voluminosity, thus, turning them into three-dimensional objects, in the correspondence with the said when discussing Fig. 8.

The vector and the density pattern of the overall layout of units, each contributing its elementary aid to the total amount of force, may well be represented in terms of a gravity force field. This field exists in reality in the sense that any object of a known mass potentially to be placed in the known space location would exert and experience a known amount of pulling force. What this field is devoid of and what distinguishes it from a field commonly accepted in physical theories is that there are neither real elementary particles to mediate the suggested gravitational interaction nor real gravitational waves. The conception of the motion along the depth dimension dismisses gravitons and gravitational waves as not existing in reality.

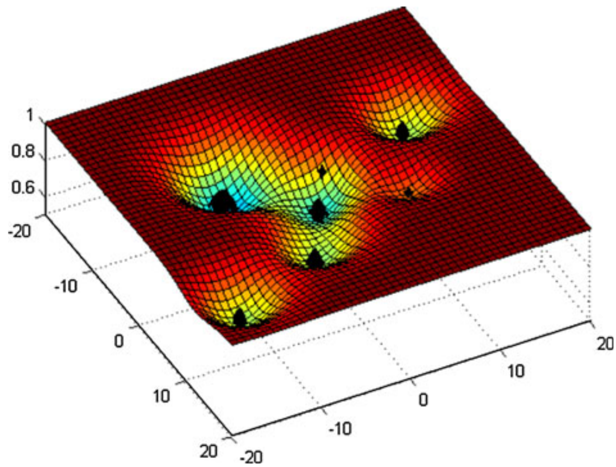

Fig. 17 All material bodies and their systems are presented at the bottom level as only a layout of elementary units. The layout is flat because all units are placed at the same scale level, and only up to the higher scale levels they constellate into the volumetric figures of solid bodies. The common sense lets perceive celestial bodies as definitely separated, and thus, their interaction in the absence of a mediator appears enigmatic. The conception of a depth dimension offers a different view. An atom, a single body, a system of bodies, or all the matter in the Universe, are to be viewed as an uneven, almost partly hollow, although not torn-apart layout of elementary units, each experiencing the exertion of the force acting along the depth dimension

Earlier, we considered the very simplified case of mutual approach to a common center of mass of the two equal material particles, taken to be atoms. Let us see how the outlined approach works with respect to a massive celestial body such as a planet, on one hand, and a smaller body moving on its own trajectory in the vicinity of a planet, on the other hand. It should be noted that in the reflections below, I operate with a highly idealized case, taking only the dragging force acting along the depth dimension into account, whereas bodies in reality move with their velocities in the common three-dimensional space as well, which should make the picture of the approach much more complex.

My further explication is visualized in detail in Fig. 18. On the initial stage, let us place a satellite at a substantial distance from the planet. Still, they have their shared center of mass already, as all bodies have in any case. Let us look at the satellite and draw the two vectors for it. The first vector would indicate the direction of a satellite being dragged to its own inner center of mass, the vector shown as a straight line pointing strictly downward. The second vector would indicate the direction of an already-incepted shared center of mass with the planet, this vector shown as a line turned at a small angle to the planet's side from the first straight line. The planet

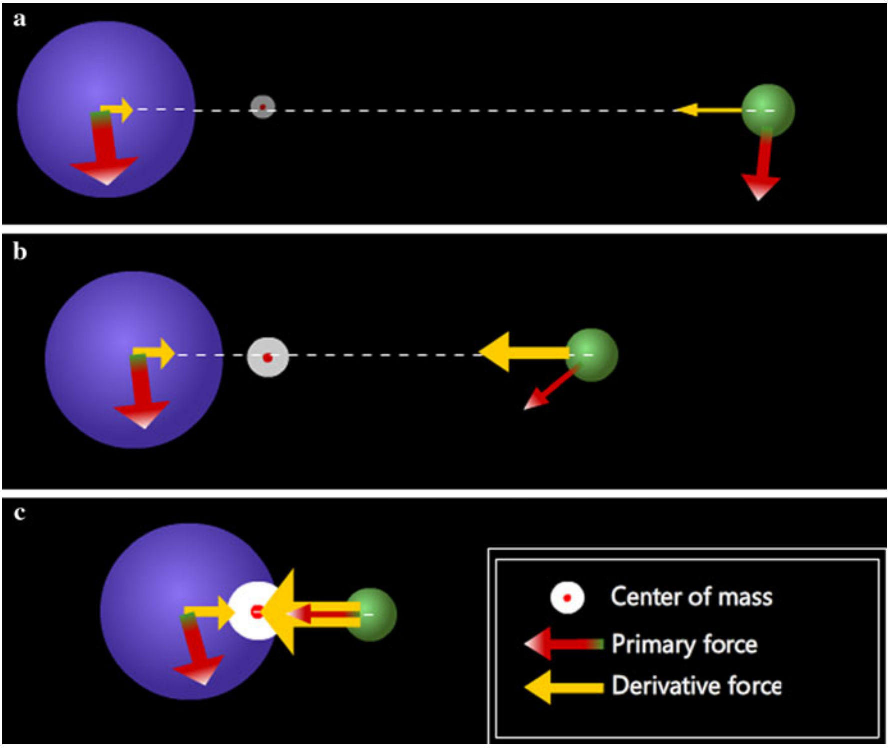

Fig. 18 The closer the two bodies come to each other, the greater the component of the force that drags them in a single direction as a single body as compared to a diminishing component of the same force that drags them to their centers as sole bodies, as if the other was not present. As the mutual approach continues, the biased vectors converge more and more, and the components of force continuously redistribute, the directions and the lengths of the vector arrows changing respectively

should have its own biased vector to the satellite's side, but it remains vanishingly small along the whole process. More exactly, the greater is the portion of mass of a body in the shared mass of two bodies, the less is its bias to a mate's side.

The direction of the second, biased vector would indicate the direction of a satellite's approach to the planet, whereas the length of a vector arrow would mark the rate of a component of force that starts dragging the satellite to a common center with the planet, as compared to the continuing dragging of the satellite to its own center. The closer the two bodies come to each other, the greater the component of the force that drags them in a single direction as a single body as compared to a diminishing component of the same force that drags them to their centers as sole bodies, as if the other was not present. As the mutual approach continues, the biased vectors converge more and more, and the components of force continuously redistribute, the directions and the lengths of the vector arrows changing respectively.

When the common center of mass passes into the inner spatial volume of the larger body, the satellite's projected trajectory crosses the body's surface, that is, a satellite starts falling on the planet. Pressing into the planet surface is not the final stage, however. The fallen satellite's own center of mass and its common center of mass with the planet still stay spatially detached, such that the satellite residing on the planet's surface is still dragged to the common center, which is, with the slightest deviation, the planet's center. The final 'quieting' stage would come if the matter out of which a satellite is constituted penetrates the planet's matter and merges with the very planet's center, completely losing its own center as detached, hence generating the vectors' bias. The gravitational interaction of several celestial bodies of variable masses can be simulated online using a computer model available through the Wolfram Demonstration Project (Vikram, date unavailable).

Why does the force component that drags bodies in the mutually biased direction rise as the bodies come closer, such that the gravity force increases quadratically as the distance shortens, and the approach proceeds with acceleration? The explanation follows rather clearly from geometrical considerations. Two or several bodies, even very distant ones, due to the ultimate sphericality of the universal arrangement of matter, would always have the mutually converging bias in their downward movement's trajectories. The bodies may come closer because of their forced displacement in the standard three-dimensional space, but they are to come closer anyway because of the ever-present converging bias due to the downward motion to the center of the overall sphere. The propensity to approach is immanent to the one plus three dimensional geometry proper, thus, the approach is permanently there. In the new, closer position, whatever the cause for displacement, the bias itself becomes larger, and so exponentially.

9 Representing Gravity as a Shrinking Space

In the former sections on the mass substance matter bodies, I left without explication the question of whether and how space and electromagnetic radiation are involved. Electromagnetic radiation is often provisionally suggested to be the special kind of matter, although in its massless, non-substance, and non-inertial form. Radiation does not fall under either the empty space or the pure energy categories; so, logically, matter is the closest category to define the physical nature of radiation. It was generally stated in the discussion on whether the Universe actually expands or contracts that the pulling force is only applied to the hypothetical elementary units as the constituents of the mass substance matter. Space and radiation do not manifest having mass themselves; that takes place because space and radiation do not deal directly with the pulling force; the pulling force is inapplicable to them since there are no ‘hooks’ in space and radiation for the pulling force to grip on and get attached to. Hence, space and radiation do not experience the downward motion on their own; rather, only the mass substance matter does. In this section, I will dwell upon this issue more explicitly.

Let us leave radiation aside for the time being and consider only space. In my model, space does experience metric alterations. The space alterations, however, are not performed independently of matter; they are only derivatives of and the collaterals to the motion of matter. Space has no physical essence, shape, or motion of its own. Space is nothing more than a given span and mould of matter. Moreover, space is matter; space is an overall pattern of dispersal and allocation of the sites of matter.

With this notion of space in mind, let us consider what happens to space in the two distinct areas: where matter is densely concentrated, like in a star or a galaxy, and where there is no noticeable fragment of the mass substance in the vast vicinity, that is, where space is empty, only radiation from the distant material objects are traversing it and occasional mass-having particles meet.

In an empty space, where there is no matter, there is nothing for the pulling force to be applied to, there is no move downward, and there is nothing to be contracted. The areas with matter do experience the action of the downward pulling force. The greater is the mass, the greater the force, so the greater the contraction. The space profile of the two areas mentioned is represented in their match as regions of humps, or undisturbed flat areas, and regions of pits. The shape, in which all matter in the Universe is arranged, looks like a relatively even surface pitted with funnels produced by the clods of mass (illustrated in Fig. 19). The mass substance matter subsides itself and thereby, so to say, ‘eats out’, or consumes, space as well. In the regions of matter allocation and subsidence, space subsides too; space shrinks as far as matter shrinks. The matter-free areas are left to the largest extent non-subsided.

If a material body were separated from space with an absolute delimiter and were immersed into space as in some self-existing container, the body would have been passing through space as a knife through water, leaving it non-involved and unmodified by one’s own motion and transformation. However, this supposition does not hold true. Space not only depends on matter and is formed by matter; space is matter, namely, space is the matter’s dispersal arrangement pattern. Space may be likened in metaphorical way to fat in marble meat: space appears to be everywhere between the matter filaments up to the tiniest inner levels. On none of the levels is matter absolutely dense; it is always interlaid with space hollows, as is, for example, in the inner atomic volume. Matter shrinks, and consequently so does any streak of space, as non-existing apart from matter.

The Earth and the Moon in their togetherness (or the Sun and the Earth, or our entire Galaxy etc.), are a single body, being in the other respect the two or several

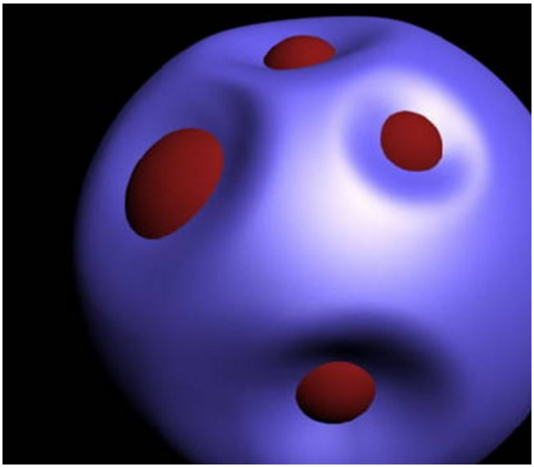

Fig. 19 In an empty space, where there is no matter, there is nothing for the pulling force to be applied to, there is no move downward, and there is nothing to be contracted. The areas with matter do experience the action of the downward pulling force. The shape, in which all matter in the Universe is arranged, looks like a relatively even surface pitted with funnels produced by the clods of mass

bodies, or the numberless set of molecules each. Hence, there is space subsidence and shrinkage not only inside the Earth proper but also in the interval between the Earth and the Moon, in the interval between the Galaxy's stars, and, likewise, in between every two molecules and atoms of all these larger bodies. Each overtly separate celestial body in the solar system shrinks by itself, but at the same time, they all constitute a single body, and therefore, there is an additional component of their shrinkage together as a single body, with intermediate space in between the bodies affected to a particular degree (Fig. 20).

A volumetric image of curved three-dimensional space (which becomes curved due to the presence of mass) would reflect the actual scheme of things much more realistically and adequately than a mere image of a curved surface. To produce such a volumetric image, let us return to Fig. 17 and induce in our imagination an exact copy of the colorful plotted graph of the curved surface pictured therein. Let us turn this copy of the plot upside down and place it symmetrically beneath the first plot on the grid with the (20–20–20) marks. In this way, we produce something resembling a shepherd's pie construction. As a result of turning the second imaginary plot upside down, the pits (painted black) of the original upper plot become hills on the copied plot so that now each pit and hill match up and look right into their inverted counterparts. The scheme very much resembles cave stalactites and stalagmites that face their counterparts with some clearance remaining between them. The in-between space produced by the symmetrical overlay of the two unevenly inward bent surfaces in our image is a realistic visual analogy of the notion of three-dimensional curved space as developed in general relativity theory.

The three-dimensional inward space curvature presented in Fig. 20 provides a much more adequate representation of the nature of the space curvature causing the gravity effect than the notorious trampoline visualization that nestles in many school physics textbooks. In Fig. 21 I present another way of visualizing the three-dimensional inward space curvature produced by the presence of mass. An online video that I recently came across in the Internet (Kakitsev 2010) depicts the three-dimensional inward warp of space in the very similar way to that visualized in Fig. 21.

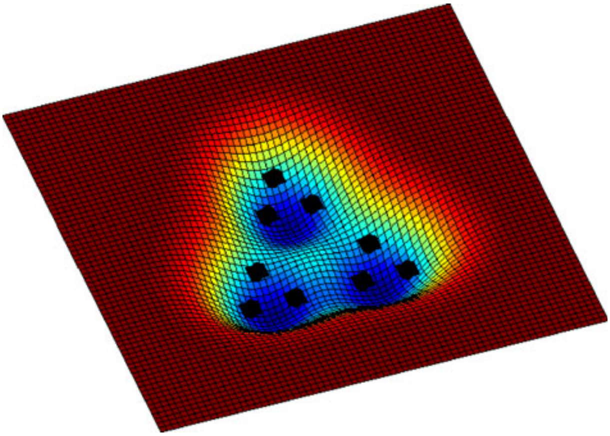

Fig. 20 The plotted graph demonstrates not only that the evidently single and detached celestial body (corresponding to a tiny black square on the graph) is a body but that a system of visibly detached bodies (a group of three black squares), as well as a system of systems of bodies (a triangle composed of nine squares altogether), are all single bodies on their respective levels of approximation. Space curvatures are pertinent to each of the single 'single bodies'; at the same time, these basic curvatures form and integrate into the overall complex curvature profile pertinent to a 'single body' of the (actually) nine bodies that nest within and compose it. The plot is rendered as symmetrical only for the purpose of simplicity; the real integrated profile would normally be quite nonsymmetrical. It would also be dynamically changeable with the time and with the ongoing dislocations of the celestial bodies

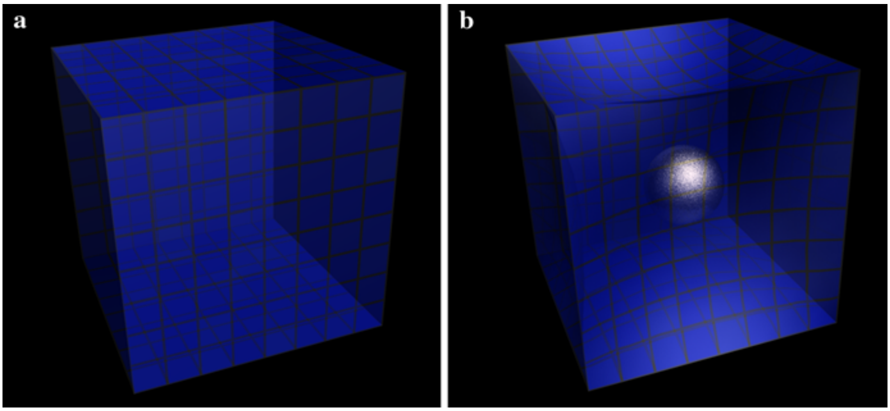

Fig. 21 A flat space in the absence of mass followed by the three-dimensional inward warp of space in the presence of mass. Online Resource 10 presents the animated version of this figure

The shrinkage of matter and the accompanying shrinkage of space can be illustrated by another (the third in the list) and even more tangible analogy. Let us take a transparent silicon cube and, using a syringe, insert some drops of glue in the inner space of the cube. When the glue dries, it causes the silicon texture in the vicinities of the inserted drops to shrink and curve. In this example, the glue is analogous to mass. The glued texture remains transparent and begins to bow the light rays. The further the cube's regions are from the glue's application, the less there is shrinkage and curve, up to that some regions remain completely non-affected and non-warped.

With the introduction of the pulling force acting along the depth dimension, the revolving motion typically observed with the multi-body celestial formations like solar systems, spiral galaxies, etc. as well as the rotational motion of single bodies composing these systems acquires its new and quite consistent explanation. When you open a sink in a bath, the water vortex appears due to that water is pulled down by the Earth's gravity, the sink being restricted in size and so bringing about the non-linear effect of the water structured swirl. The universal downward pulling force engenders the rotational motion of celestial systems in the way much similar to that in which the Earth's gravity engenders sinking of water with the accompanying water swirling around the sink's center.

The Solar system as well as the typical spiral galaxies like Milky Way are rotating, evidently, in almost flat two-dimensional plane, alike to a sling or a wheel spinup. The evident flatness of the plane of rotation and the seeming absence of a third-dimension component makes researchers seek causes of the rotation also within only the two-dimensional framework. The apparent two-dimensionality of a process hinders from making a conjecture that the causational mechanism of the rotation may involve and can be comprehended only while taking into account the proceedings in the third standard dimension and, chiefly, in the overtly non-manifested fourth dimension of depth.

The atmospheric tornado cannot be explained only by exploring the behavior of the tornado whirl in a horizontal plane. Rather, the three-dimensional body of a tornado protracted along the vertical axis and the intensive up-down-up circulation of air because of a substantial temperature difference are rightly taken into account by researchers for presenting the process in its essential completeness and thus giving it a consistent explanation. The same is true for disclosing the mechanism of the rotation of celestial systems. Although non-manifested, there exists a sink at the bottom level of matter in the Universe in the overall as well as of any restricted system of material celestial bodies. Matter sinks along the depth dimension, which traverses all hierarchical levels of the matter structure. By a mechanism yet to be explored, the matter sinking, manifested in the material bodies converging to their mutual center of mass, would engender the rotational motion of the celestial systems. Although seeming to be performed only on a flat plane and having no overt signs of an additional dimension involved, the rotation is consistently explainable only with the proceedings along the depth dimension taken into account.

10 Conclusion

The conception of the depth dimension has brought us, although through somewhat different way of reasoning, right close to the idea of the space curvature being the origin or the very essence of gravity as it is developed in the general theory of relativity.

There is some difference between the presented conception and general relativity, though. The difference is manifested when we consider the cause-and-effect sequence. General relativity states that that the presence of mass bows geodesics and in this way curves space in the vicinity of mass; the space curve makes material bodies as well as light follow geodesics that are straight within the curved space but are bent for an observer in non-curved space.

In the conception of motion along the depth dimension, the causation chain is to some extent different. To explicate the difference, let me first remind, that I distinguish matter in a broader sense, that includes electromagnetic radiation, and matter substance in the narrow sense, which has mass and inertia, and which is an object of the direct exertion of the downward force. Throughout this article, I have dealt only with matter substance in the narrow meaning of the word. According to my conception, the primary factor in bringing about gravity is the pulling force that drags all matter substance downward. The direct exertion of that force to matter substance is manifested in that all matter substance bodies have some distinct mass. The downward shift and so subsidence of matter has, as its consequence, the shrinking of space in the vicinity of matter; shrinking of space makes space be curved.

In my conception, the space curve is itself neither the causation origin nor the essence of gravity, contrarily to what is suggested in general relativity. According to my conception, the 'gravitating' of mass substance objects to each other has a different cause, namely, the action of the primary downward directed pulling force upon each object and of the collateral force that brings all of the objects closer together, as shown at the most important graph presented in this article (Fig. 15).

It is only the mass substance matter that experiences the direct action of the pulling force, hence, subsidence and contraction. The pulling force is not exerted to light, what is confirmed by the very fact that light has neither mass nor inertia. Only as a result of the contraction of matter substance objects themselves, the space around, inside, and between the objects shrinks and curves as well. Because of this secondary effect of space curving, the trajectories of light rays in the vicinities of masses bend. So, there are two relatively different causes for the matter substance bodies to approach each other, on the one hand, and for light to bend toward each of the matter substance objects, on the other hand. The approach of the mass substance objects to each other is engendered by the action of the downward pulling force, whereas the light bending is not originated by the direct action of that force upon light; rather, the light bending effect is mediated by a few consequent steps in the same causation chain.

At the end, I will briefly reproduce the logic that led me through my discourse in this article. All material objects in the world are positioned along the scale of their magnitude, from the tiniest to the largest. The succession in which we shift from scale to scale can be described within a specific dimension. This dimension might be called a scale or a depth dimension. At a minimum, the depth dimension would have only a measurement application, describing the change of the grains of resolution and of the precision levels of observation, when we peer into the finer details of one and the same object. At a maximum, the depth dimension would correspond to the inherent arrangement of matter itself, with the distribution of scales along their hierarchy having not only observational but also ontological status.

I took the ‘maximum’ stance and suggested the depth dimension to be the essential feature of the ontological structuring of matter. There was substantial ground for following an ontological, not only observational, understanding of the depth dimension, as I believe. What makes an axis a dimension in the ontological sense, is this axis’ ability to provide an additional and specific degree of freedom of motion. Inward to outward and vice versa is as specific as is left to right and up to down. The scale axis provides for an additional and specific degree of freedom of motion that can be only authentically described with the help of a corresponding dimension. This understanding persuaded me that the depth dimension does exist and should be introduced as an ontological hierarchy of levels and not only as a set of observational tools of changeable resolution and precision.

The motion within the dimension of scale, logically, might proceed in the directions upward or downward the scale, that is, outward or inward an object itself. Upward denotes the expansion in size and space embrace, and downward denotes contraction. Basing on that understanding, I made a hypothetical suggestion that there is the universal joint physical motion of all matter along the depth dimension in the direction downward, that is, to contraction. The suggestion was not entirely arbitrary; there is some experimental evidence in its favor, particularly, the expansion of the Universe and the red shift, in the special and novel treatment of these effects that I developed in the article. By hypothetically implying the motion of the bottom level of the matter structure, a physical force has been introduced that pulls all matter on ever higher levels in the direction to contraction. An explanation pulls all matter on ever higher levels in the direction to contraction. An explanation of gravity as a consequent redistribution of this initial pulling force was thereby of gravity as a consequent redistribution of this initial pulling force was thereby.

What remained completely unexplained in the article, however, is the cause of the downward joint motion of matter itself, as well as the energy source of that motion. The enigma of gravity has been readdressed to and replaced with the enigma of the matter joint motion downward the depth dimension to contraction.

To finally conclude, I believe that with all its roughness and noticeable weaknesses, there is a considerable explanative potential in the presented conception. Even if the whole conception is not supported later by strict proof and more consistent argumentation, its heuristic elements might serve as hints for further reflection on the issues touched hereupon.

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