Emergent Gravity
from Discrete Geometry
[EG from DG]

° Author K.M.L.L.Van Spaendonck © 2017

° Publication date 2017 [Submitted January 16th]

° ISBN 9789402158601

° # text pages / # graphs 27 / 22

This work is published by K.M.L.L. Van Spaendonck

Website : www.vanspaendonck.info Email : koenraadmllvanspaendonck@gmail.com

www.generalquantumgravity.com

The problem seems to me how one can formulate statements

about a discontinuum without calling upon a continuum…

...but we still lack the mathematical structure unfortunately.

How much have I already plagued myself in this way !

Albert Einstein [6]

TABLE OF CONTENTS

MOTIVATION

° *On the physics*

An elaborate motivation for the Emergent Gravity Paradigm can be found in reference (1). Here we focus on the mathematical organization of processes which are proposed to exist at the origin of the negative curvature of spacetime in General Relativity. And we focus on the generalisation of General Relativity, arising from new insights found in that underlying organisation. Generalisation here means that the long-term goal is a theory with more explaining power (or alternatives) concerning concepts like dark matter, dark energy, inflation, a unifying building block for space and matter hypothesized necessity of a discreteness of space, for such a unification.

On the road to General Relativity, Einstein contemplated on several concepts towards his final version in 1915. An important decision concerned the Ehrenfest Paradox (2). Paul Ehrenfest proposed a problem with a rotating disk (3). “Ehrenfest had pointed out that a uniformly rotating rigid disk would be a paradoxical object in special relativity, since on setting it into motion its circumference would undergo a contraction whereas its radius would remain uncontracted (As prescribed by Special Relativity: contraction in the direction of motion only.) Einstein concluded that the possibility for a Euclidean geometry on a uniformly rotating disk was unacceptable, and that a system in a gravitational field had to have non-Euclidean geometry (4 – page 3). Further taking the form of a mathematical object ‘spacetime’, consisting of a continuous curved surface with negative curvature.

But in reality the apple does not fall to the earth along a curved line consisting of (x,y,z,t)-coordinates. The hyperbolic nature of spacetime arises from an exponential relationship between cause and effect. We argue that Einstein’s decision lead to ‘emergent gravity’ [EG] right here at this cross-roads. And that assigning time to the Newtonian radii, prevented an intrinsic expansion of the geometry in GR.

Consequently we argue for a new option which will avoid resorting to non-Euclidean geometry, by solving the issue of the rotating disk differently than Einstein did, with a discrete geometry which will maintain proportionality of radius and circumference under any change in the field. (Page 19 slides 11,12 : Doubling # quanta on circumference, doubles # quanta on the radius section).

We explain the intensity of the gravitational field along the straight path of the apple instead of the ‘emergent’ curved path : the option of a discrete geometry [DG] resembling a special kind of polar or spherical coordinate system, arising from a Carthesian background : Discrete Contracted Coordinates [DCC]. Elaborated in the Preface ‘On the mathematics’, and in reference 5.

From this discrete contracting geometry, arises an intrinsic expansion of distance units. Time along the direction of motion instead of perpendicular to the direction of motion, as a physical characteristic of the field itself, leads to the concept of an intrinsic contraction of the field towards the gravitational well. Giving rise to the illusion of an expanding universe. Thus leading to an all-in-one unification where the quantum (unit, discrete coordinate with intrinsic dimensions) of a unified field, holding 3x2 functions : space & time, energy & gravity, light & matter. And the latter follows from the former.

Einstein might have liked the idea of a quantisized, discrete geometry for space(time), since he already plagued himself in 1916 with the validity of the continuum and the lack of the appropriate mathematical structure (6). Furthermore Max Planck showed that energy comes in finite quanta. So we argue that the problem cannot be addressed with infinitesimal calculus, because it does not reflect the underlying processes leading to an emergent gravity adequately, and it does not solve the discrepancy between discrete matter and continuous spacetime. [Obviously we do not want to criticize those areas where this calculus proved to be fruitful. The question concerns the application in a theory of Emergent Gravity with the characteristic of unifying space and matter (7).]

° *On the mathematics*

" Bonaventura Cavalieri is considered a pioneer on Polar Coordinate systems. He published his '*Geometria invisibulus continuorum*' in 1635, with a second edition in 1653. The first writer to visualize polar coordinates as a means to locating any point in a plane appears to be Newton. The work appeared in 1736, but was undoubltedly composed in 1771. " (8)

We develope a coordinate system which uses its own coordinates to model 2D (or 3D) items in a circularly (or spherically) symmetric configuration. Hence the input = the output : It's not the landscape upon which we build something. Polar (or spherical) coordinate systems traditionally cannot handle this because they consist of dimensionless points, and so they are a priori incapable of being intrinsically 2D or 3D. This 'discreteness' is obtained when the circles are turned into either spheres, or pivoting circles. The coordinates now have dimensions of their own. We could call it '*Geometria visibulus discontinuorum*', but we'll just call it DCC : Discrete Contracting Geometry from which we can derive a finite amount of coordinates, and extrapolate these into curves and negative curvature.

It is important to mention the log-polar coordinate system, because it entails a kind of discontinuum. However, it differs significantly from our proposed coordinate system in the following ways :

°In DCC, radial distances (circles or 'quanta' with radius Rq upto RQ) evolve with a fixed expansion rate X (or contraction rate, leading to an very specific 'accelerated' increase of the size of the distance units (quanta featuring as circles) radially outward (or decrease inward) along : RQ = Rq [(1 + X)^n]. Whereas with log-polar coordinates the radial coordinate is transformed according to r = e^ρ. With ρ as the logarithm of the distance between a given point and the origin.

°In DCC, the radial distances evolve isotropically. This means that the radial size increase of the circles (quanta) is equal to the tangential size increase (x-y-z-axis symmetry of the quanta), leading to a model with circles instead of e.g. distorted squares. And this feature is precisely the cause of the above special case of 'isotropical increase of the increase'. Whereas with log-polar coordinates the segment angle (determining the tangential size) is set as a separate parameter, independent of the radial evolution. This isotropy also leads to a linear proportionality of radius to circumference.

°In DCC, the origin of the coordinate system is not the origin of the polar or spherical coordinate system. The origin is instead a circle or a spherical surface (2D or 3D case : the surface of the blue sphere in de slides) instead of a point in the centre of the origin-circle. Whereas with log-polar coordinates, this point-origin features an infinitesimal character of the evolution of the units radially inward, as they approach zero. So DCC avoids this infinitesimal characteristic inwards, because the distance units (quanta) on the origin-circle or origin-spherical surface, always have a non-zero size, and will not approach towards zero. Outwards, there is no approach of infinite quantum size either.

This 'discreteness' of DCC thus entails a finite amount of radial and tangential allowed points, each with 3 dimensions, symmetrically (isotropically) varying in size : a Euclidean finite malleable 'abacus' driving the non-Euclidean negative curvature. 'Abacus' because one can actually count the individual units of the unified field.