Observed Galaxy Distribution Transition with Increasing Redshift a Property of the Fractal

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Abstract

Is the universe a fractal? This is one of the great – though not often talked about – questions in cosmology. In my earlier publication where I inverted (Koch snowflake) fractal I showed the fractal demonstrated: Hubble's Law, accelerating expansion, and a singularity beginning. Surveys of the universe – the most recent and largest, the 2012 WiggleZ Dark Energy Survey – show, galaxy distribution on small scales to be fractal, while on large-scales, homogeneity holds. There appears to be new anomaly to explain: a galaxy distribution transition from rough to smooth with cosmic distance. From my model I derived a Fractal-Hubble diagram. On this diagram, measurement points along the curve are clustered near the origin. This clustering was not addressed in discussions or part of the conclusion of my earlier experiment. Can this clustering of points account for the observed galaxy distribution transition? Could this transition be another property of fractals, and therefore could the universe – itself – be fractal? It was found, yes they do. Clustering of measurement points (and of galaxies) is as a result of observation position in the fractal. On small scales – relative to large scales – the cosmic surveys are what one would expect to see if one were viewing from within an iterating – growing – fractal. If trees – natural fractals that have also been found to grow at accelerating rates – are used to demonstrate this fractal: the large-scale smoothness maybe akin to a tree's trunk; and the rough (fractal) on small-scales, to its branches. This discovery unifies the anomalies associated with the standard cosmological model. Together they are – through the mechanics of the fractal – inextricably linked.

Keywords: Fractal Cosmology, WiggleZ, Hubble's Law, General Relativity, Galaxy Distribution, Cosmological Principle

1 INTRODUCTION

The universe has been observed to be fractal on small-scales, and homogenous of large-scales. In this publication I would like to provide an explanation to this observed galaxy distribution transition, and show – based on my earlier findings – the observed homogeneity at large scales is a property of the fractal. My explanation will unify the galaxy distribution transitions with other observed anomalies of the ΛCDM model.

In my recent publication, 'Fractal Geometry a Possible Explanation to the Accelerating Expansion of the Universe and Other Standard ΛCDM Model Anomalies' [1] – I ran a simple experiment on a fundamental (Koch Snowflake) fractal to model its expansion – as it would be viewed from within it, and from a fixed position . I showed the iterating fractal explains and demonstrates many of the observational anomalies associated with the standard ΛCDM model of cosmology – a singularity beginning, increasing recessional velocity, and accelerating expansion of the observed universe with respect to distance. I concluded the universe is a fractal. From my 'fractspansion' (fractal-expansion) model I developed – what I termed – a Fractal-Hubble diagram (figure 1 below), and concluded the clustering of measurement points (crosses) near the origin of the diagram – followed by the increasing widening of them – demonstrated why universe is homogeneous on large scales. The widening of the spacing between the measurement points (with distance) was consistent with the cosmological principle. The more the fractal iterates, the smoother it becomes at large scales. What I neglected to analysis or discuss in the discussions was: why there was clustering of measurement points close to the origin in the first place?

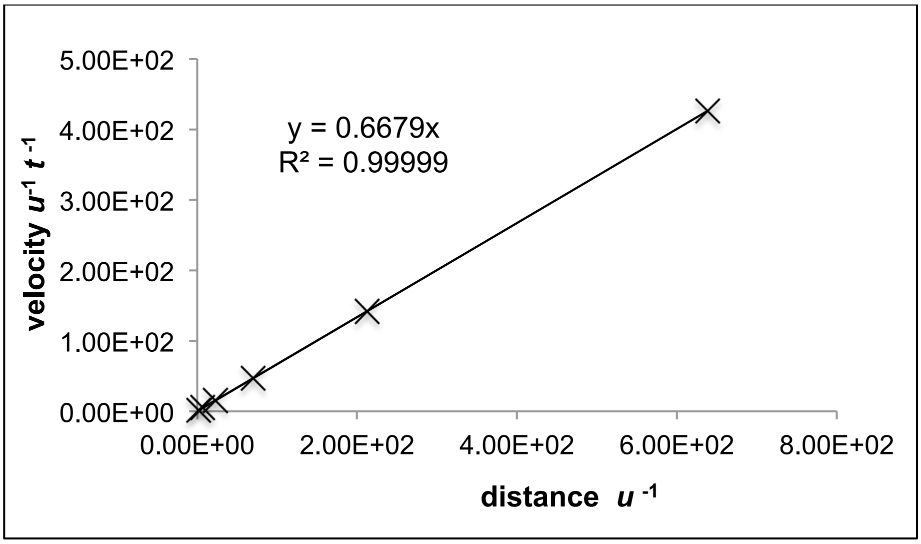

Figure 1. Measurement point clustering on the Fractal-Hubble diagram. Measurement points (crosses) are clustered near the origin, and spread out as distance between triangles geometric centres increases. *u* = arbitrary length unit.

Independent of my work, the question of whether or not the universe is a fractal has indeed been debated – and studied on cosmic scales [2] [3],[4] – though this debate is not often mentioned in mainstream or even popular science.

The proponents of fractal cosmology (Lucian Pietronero, Francesco Sylos Labini and others) have been arguing the observed hierarchies of clustering and super clustering – based on surveys similar to the 2003 2df Redshift Survey map (figure 2 below) – are direct evidence of a universe that is fractal [5],[6],[7],[8],[9],[10],[11]. The current consensus, however, is – after even deeper cosmic surveys – the universe on large scales smoothens out to become homogenous – and is overall not (a) fractal[12],[13],[14].

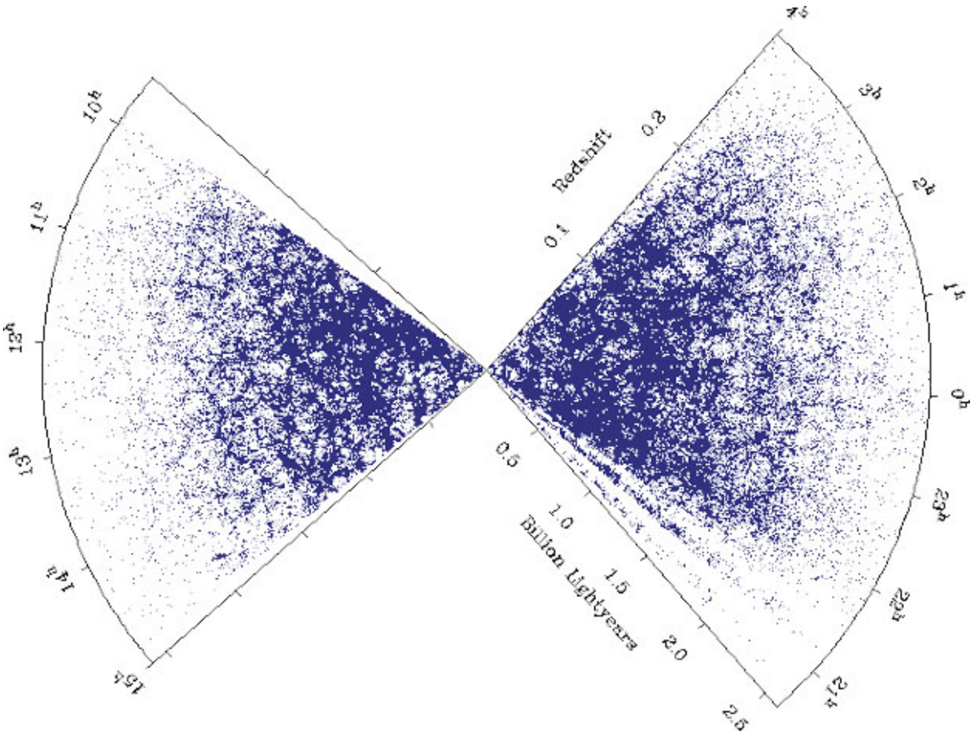

Figure 2. 2dF Galaxy Redshift Survey [15]

It was the 2012 WiggleZ Dark Energy Survey[16] – the largest survey to date – that settled the fractal question, and also caught my attention. They concluded – with increased, but similar confidence as previous teams (namely, the 2004 Sloan Digital Sky Survey [17],[18]) – the universe shows evidence of fractal galaxy distribution – with clustering and super-clustering – only on small scales (less than 70 to 100 Mega parsecs away) –beyond this distance, the pattern goes through transition to homogenous galaxy distribution.

On viewing the WiggleZ Dark Energy Survey results – particularly its figure 13 (figure 3 below) of changing galaxy distribution (from fractal at small cosmic scales to smooth at large cosmic scales) I questioned whether the inverted Fractal-Hubble measurement point clustering near the origin may offer explanation and insight to the decreasing 'Scaled N (r)' transitions (and increasing smoothness) with distance.

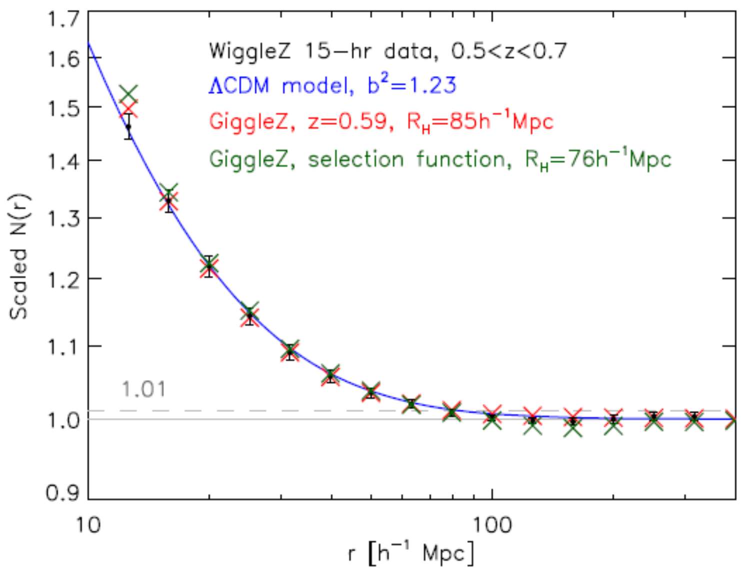

Figure 3. WiggleZ Dark Energy Survey figure 13, page 16. Revealing changing galaxy distributions from small-scale to large-scale.

In this publication I shall investigate whether the results from the WiggleZ Dark Energy Survey (and its contemporises) match a view of what one would expect to see if they viewed, not at a fractal – as is implied in their studies – but from within a (growing) fractal. To test this I shall return to the fractspansion model and analyse the occurrence of the said clustering of measurement points. For the clustering in the fractspansion model to have any significance to cosmology, it would have to demonstrate how the distribution of triangles (in the inverted Koch snowflake) changes over distance from the observer (section 4.1 and 4.2).

2 METHODS

To analysis and explain the point clustering on the fractal-Hubble diagram, relevant tables in fractspansion spreadsheet model [19] were analysed – particularly the table from where the fractal-Hubble diagram was derived. Calculations were made and diagrams created – these may also be viewed in the spreadsheet model:

1. The quantity of triangle sizes per total distance increment on the fractal-Hubble diagram was calculated by: counting the quantity of triangle sizes (in distance

column in table 2) and dividing this by the distance increments measured in the sample. See Table 2a of spreadsheet model.

2. The quantity of triangles at each increment was calculated by totalling the quantity of triangles (from table 4) for each respective iteration-distance.
3. An amended Fractal-Hubble diagram – combining (recessional) velocity with the quantity of triangles at every distance – was created. See table 7 of spreadsheet model.

3 RESULTS

The results are as follows:

1. 8 of the 10 measurement points are located inside the first (1.20E+4 $\boldsymbol{u}^{-1}$) increment distance. The remaining 2 measurement points are outside this range.
2. Figure 3 below shows the quantity of triangles by distance – between geometric centres from the observer. The quantity of triangles decreased exponentially from 7.86E+05, at iteration-distance 0, to a quantity of 1 at distance 51800 $\boldsymbol{u}^{-1}$ (iteration-10).

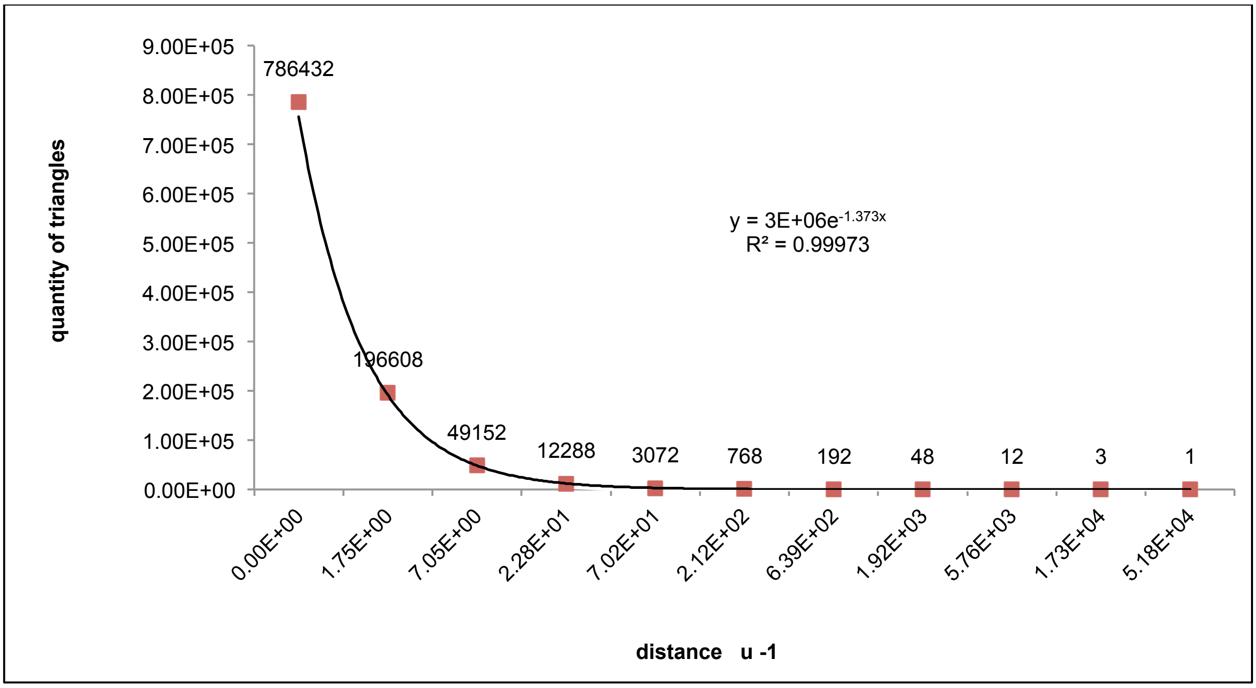

Figure 3. Quantity of triangles at each distance (point) from the observer on the inverted Koch Snowflake fractal. As the distance between triangle geometric centres increases (exponentially) with iteration, and so

increasing the distance from the observer, the quantity of triangles per iteration decreases exponentially to a quantity of one – at time 0. *u* = arbitrary length unit.

4 DISCUSSIONS

4.1 Clustering of Measurement Points

At the point of observation (the origin on the Fractal-Hubble diagram) there is a quantity of 786,432 triangles, all of which are the same size as the observers triangle viewing position. The clustering of the measurement points near the origin of the diagram is due to the location the observer within the (inverted) fractal, and the relative size of these triangles near the observer. The observer will, in principle, be surrounded by these sized triangles. The observer will not see all these triangles, how many they will see is beyond of the scope of this investigation, but it will be many. As we view further out, the quantity of triangles decrease – while the area of the respective triangles increase. This property of clustering near the origin is scale invariant: no matter the distance, this pattern of clustering near the origin will remain.

4.2 Clustering and the Fractal-Hubble Law

Figure 4 (below) combines – on the original (Koch snowflake) fractal-Hubble diagram – the quantity of triangles at each distance point with the (recessional) velocity at the same distance point. The diagram reveals the relationship between the clustering of measurement points close to the (low recessional velocity) origin, and the smooth distribution (high recessional velocity) at large distances.

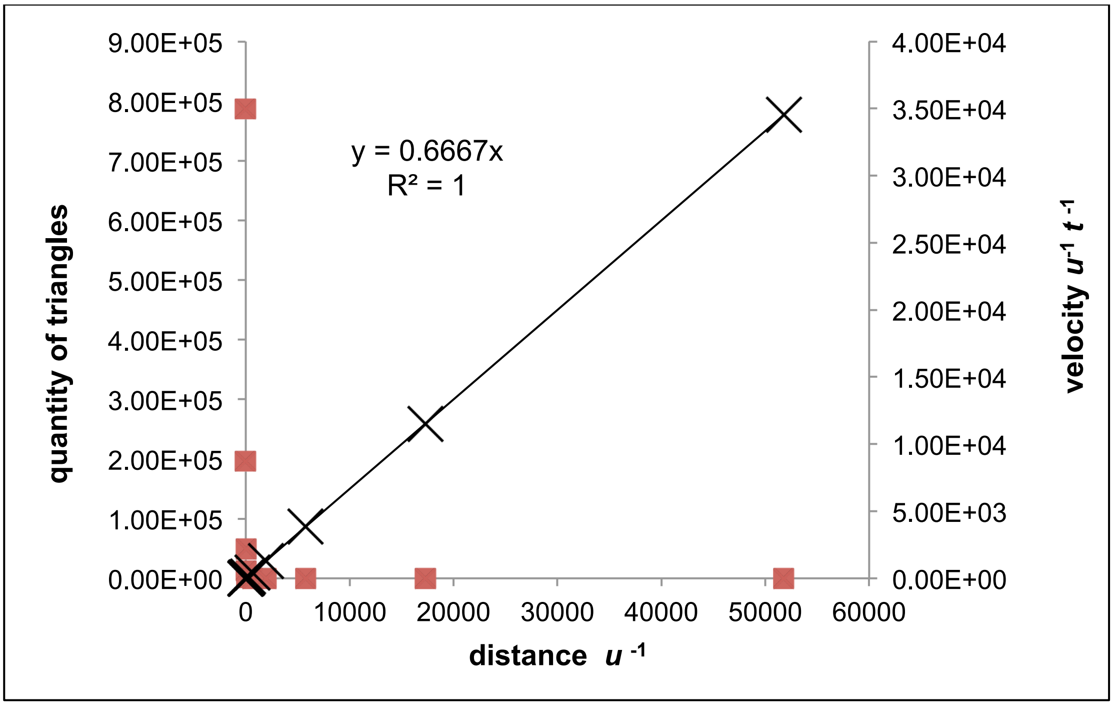

Figure 4. The inverted (Koch snowflake) fractal, Fractal-Hubble Diagram combined with the quantity of triangles at each distance from the observer . As distance increases with respect to iteration-time: the recession velocity of distance between geometric points increases; while the quantity of triangles at each distance decreases. *u* = arbitrary length unit.

4.3 Tree metaphor

If the observation from deep within a snowflake fractal is substituted with observation from high within a common branching tree (also a natural fractal): the clustering of points on the Fractal-Hubble diagram would equally correspond to the clustering of self-similar (sized) branches – in the tree – surrounding the observer. If the observer were to look down, inwards from the outer branches – towards the trunk of the tree – the branch (nodes) quantity would decrease, the volume of the single branches would increase, and the branch 'clustering' would smooth out.

4.4 The Universe

The distribution of measurement-point clustering along the Fractal-Hubble diagram matches the transitions from rough to smooth as revealed in (recent) galaxy surveys. The distribution of galaxies in the universe (shown above in figure 1) is of a nature expected if one was viewing from within a fractal universe: looking back through the universe – in terms of distance and time – to its – now expanded – origin. The smooth outer reaches of the universe – out near the CMB origin of the universe – is the trunk of the universe, and the rough fractal clusters are the branches of the tree. Using a tree as a metaphor of the universe is not to say the universe is a fractal tree structure: it is to say, just as a tree is a fractal structure, the universe is a fractal structure. It should be noted trees growth have recently been found to also increase at accelerating rates [20], [21].

4.5 Raised Questions

There are many questions and issues arising from this finding – all of which, at this point, are beyond the scope of this investigation, but not beyond the scope of reason.

4.5.1 Super Clusters

Proponents of fractal cosmology are expecting to see even larger galactic clusters further out into the large-scale homogeneous region. The fractspansion model would concur with this, only that the distance (in principle) to the next cluster (next larger branch or node) may be beyond the age of the universe – and or may not exist at all.

4.5.2 Emergent Structure

A fractal universe would imply an emergent structure – the whole made of many parts – just as the tree is made of many branches. It may force us to question the initial conditions of the big bang beginning. Namely, whether all mass (in the universe) was together in one place and at one time. It could now be argued – from the principles of fractal emergence – the universe developed/evolved mass from the bottom up, with the passing of time.

4.5.3 Growth Explanation

If the branches of the tree are akin to the small-scale galaxy clusters of the universe, we may find it profitable to search for growth explanations to the universe in the branches too. Given it is at the branches where trees grow form and the trunk and first branches are only infrastructure to the total emergent structure. This would suggest growth begins at the smallest of scales: at the sub-atomic level, the Planck scale.

The quantum nature of the fractal has been addressed in my original publication – and must be further investigated [22].

4.5.4 Dark Matter

Beyond the scope of the investigation is whether this fractal structure offers insight to the dark matter structure of the universe also? Given the current mapped structure of the dark matter, and the structure of the observed 'fractal' universe, I would suggest yes it does.

4.5.5 General Relativity

What a fractal universe means for the future of General Relativity theory is unclear and beyond the scope of the author – though it is conceivable it may have to be adapted to take account the geometry of the fractal. Work has already begun in this area: from noted theorist Laurent Nottale [23],[24] and others [25].

4.5.6 Fractal Dimension

Recent studies have shown fractal dimension decreases with increased *z* values [26]. This may also complement my study.

4.6 Conclusion

The model of fractspansion (fractal-expansion) demonstrates the universe's galaxy distribution transition from rough (fractal) on small-scales, to smooth (homogeneous) on large-scales. This demonstration can now be combined with the models original demonstrations: a single beginning; a CMB; Hubble's law; and is expansion at an accelerating rate – lambda. The results show strong agreement with the WMAP + ΛCDM models of the universe.

The properties listed are all properties of the fractal, and are inextricably linked with each other. From observations of the universe – at all scales – it can be concluded the universe is – by its nature – fractal. It looks like a fractal, and acts like a fractal – it is a fractal.

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