On the variation of the energy scale 10

Observed Properties

by

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Summary

The idea has been put forward that the energy scale varies from location to location and this idea has been used to explain the rotation curves of spiral galaxies without the need to invoke any dark matter. This paper examines at the data for spiral galaxies to see if there are any trends or suggestions as to how the energy scale variations might behave. There are indications that their heights decrease and their widths broaden as the galaxy mass increases, and that this may be an evolutionary effect.

1 Introduction

1.1 In Sep 2015 the idea was put forward that the energy scale could vary from location to location (JoKe1, 2015). This idea enabled the rotation curves of spiral galaxies to be explained without the need for any dark matter. JoKe2 (2015) improved the model of JoKe1 to include a Gaussian density distribution for the galaxy and a Gaussian distribution for the energy scale variation.

1.2 JoKe3 (2015) applied the model of JoKe2 to a set of 74 spiral galaxies. Parameters were obtained that defined the energy scale variations, as well as values for the galaxy mass and rotational velocity.

1.3 This paper examines the parameters given in JoKe3 to see if there are any trends that might give hints as to the nature and properties of energy scale variations.

2 Introduction to energy scale variations

2.1 Newtonian dynamics and Newtonian gravity show that the rotational velocity of a mass, m, around a central mass, M, is given by:

$$\frac{m\,v^2}{r} = \frac{G\,M\,m}{r^2} \tag{1}$$

where v is the rotational speed; r is the radial distance.

2.2 JoKe1 showed that, in the presence of an energy scale variation, this equation becomes

$$\frac{m\,v^2}{r} = \frac{G\,M\,m}{r^2}\frac{\xi(0)}{\xi(r)} \tag{2}$$

where $\xi(x)$ is the value of the energy scale variation at location x.

2.3 For a Gaussian energy scale variation the $\xi(x)$ function is given by

$$\xi(x) = A + B\ \ exp(-\,x^2/\alpha^2\ ) \tag{3}$$

where A, B are constants for a given energy scale variation.

2.4 As the $\xi(x)$ function occurs in both numerator and denominator of (2), equation (3) can be taken to be

$$\xi(x) = 1 + \gamma\ \ exp(-\,x^2/\alpha^2\ ) \tag{4}$$

where

$$\gamma\ =\ \ 1 + B/A \tag{5}$$

2.5 This is illustrated in Figure 1, below. Paper JoKe3 followed this and modelled a spiral galaxy as a narrow Gaussian density distribution embedded inside a broader Gaussian energy scale variation. This simple model was sufficient to explain the rotation curves of 74 spiral galaxies.

2.6 Equation (4) shows that Gaussian energy scale variations are characterised by just two values: the 1/e-width α (a distance, typically of the order of 10kpc); and the pure number γ (typically between 2 and 10). α, γ are fixed for a given energy scale variation (galaxy), but vary from galaxy to galaxy.

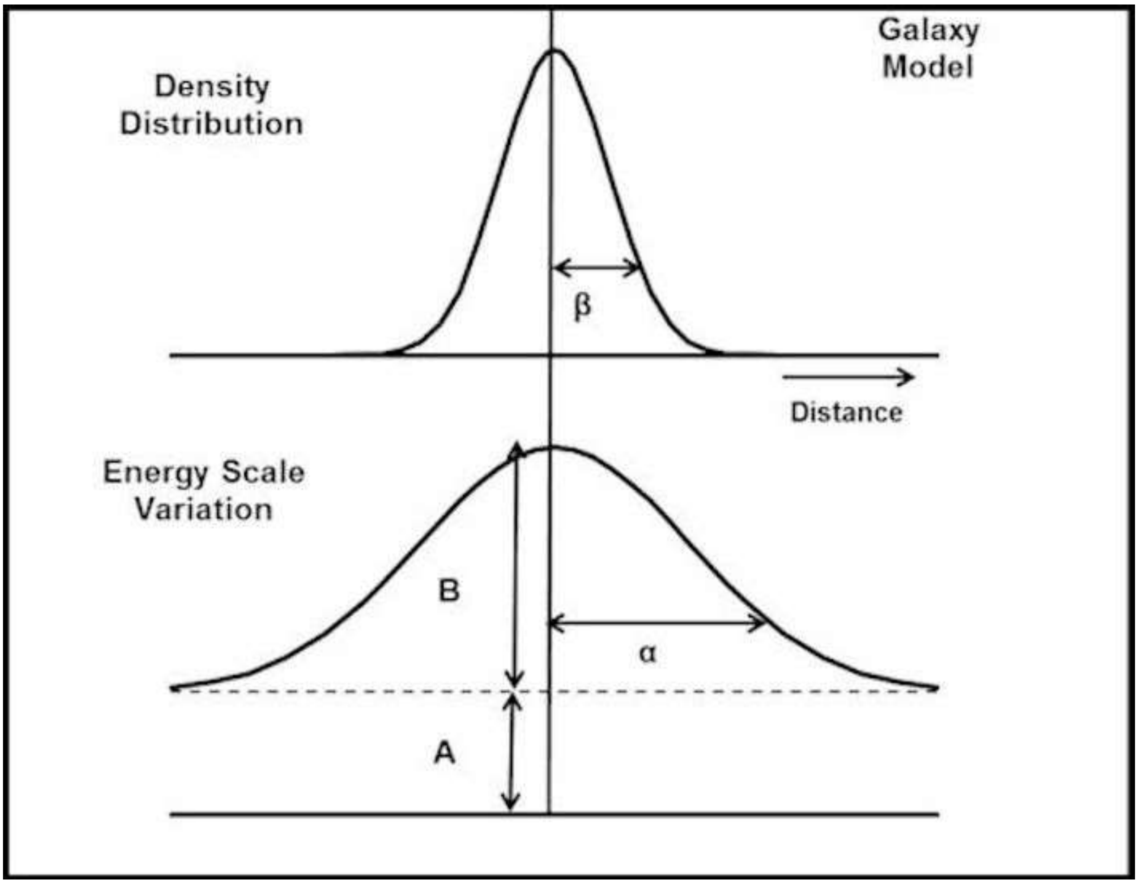

Figure 1. Model of a spiral galaxy as a narrow Gaussian density distribution embedded in a broad Gaussian energy scale variation.

3 Properties

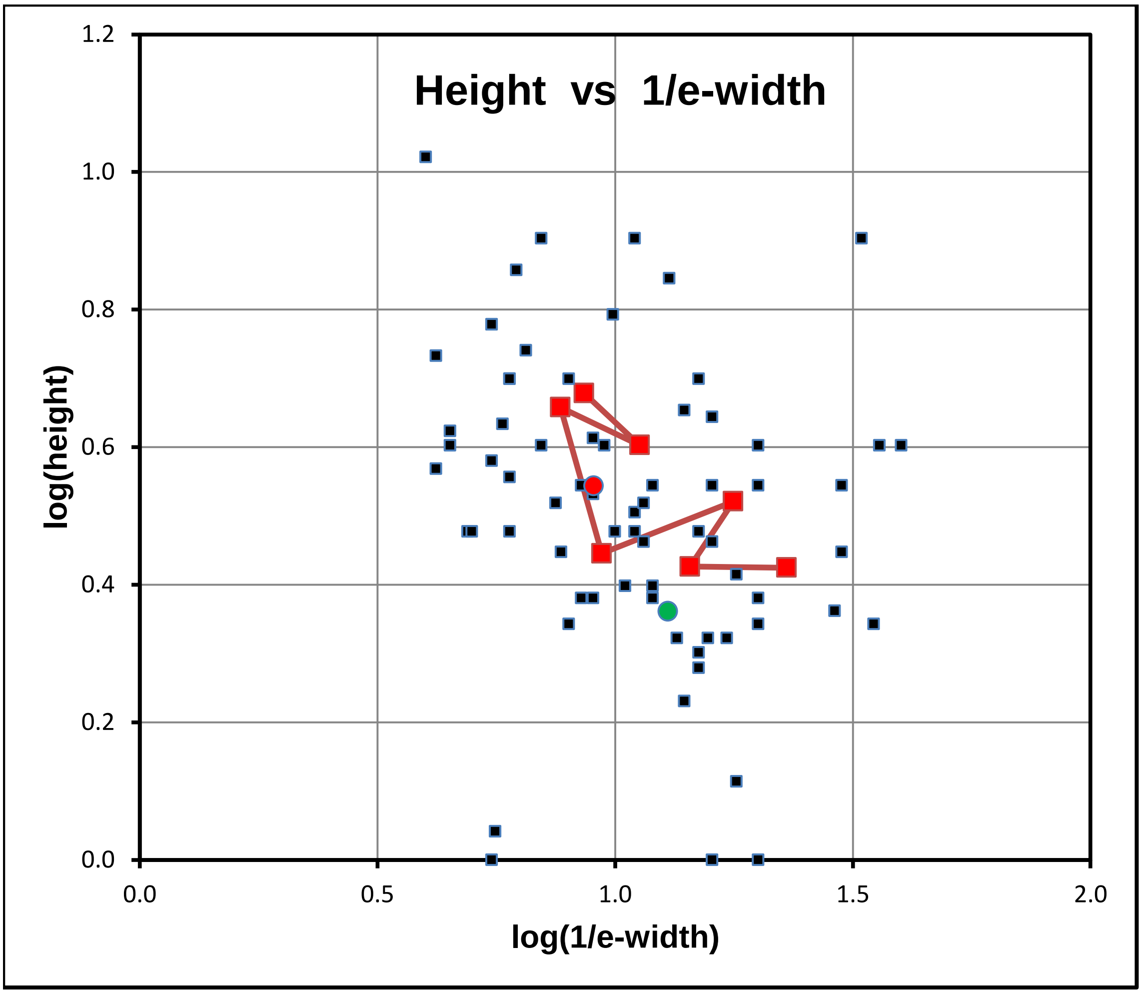

Figure 2. The observed variation of the energy scale parameters: 1/e-width α and height γ, for the 74 spiral galaxies examined in JoKe3 (2015). The red line is the 10-point average from low mass to high mass. The red dot is the Milky Way; the green dot is the Andromeda galaxy.

3.1 Figure 2 shows the data for the 74 spiral galaxies covered in JoKe3 (2015). α is the 1/e-width, and γ the height of the energy scale variation.

3.2 It is clear from the scatter of Figure 2 that there is no obvious relationship between α and γ.

3.3 The red line in Figure 2 is the 10-point average of the data going from lowest mass (top left) to heaviest mass (bottom right). There is a hint that, as galaxies get more massive, the energy scale height decreases and the energy scale width broadens.

3.4 It is generally taken that massive galaxies have evolved by the merger of lower mass galaxies. Hence there is a hint that, when energy scale variations merge or evolve, they tend to reduce in height and broaden in width.

4 Mass vs Velocity relationship

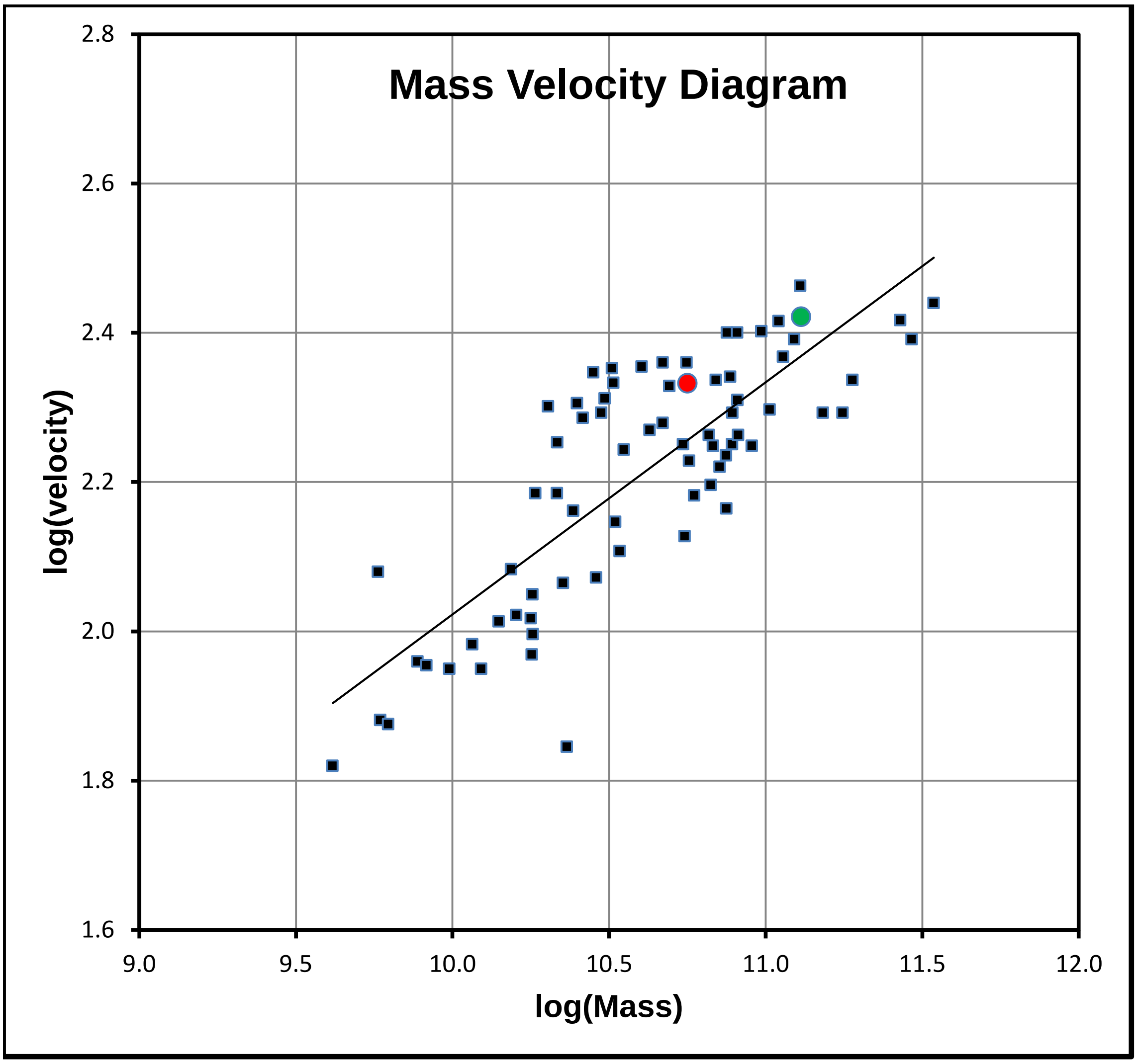

Figure 3. The mass vs velocity diagram for the 74 spiral galaxies covered in JoKe3 (2015). The line has a slope of 0.3. The red dot is the Milky Way; the green dot is the Andromeda galaxy.

4.1 Figure 3 shows the mass and velocity data for the 74 galaxies examined in JoKe3 (2013). The velocity is that given by equation (2) for distance α from the galaxy centre, i.e. at the 1/e-width point. The mass is that derived from equation (2) after fitting the observations.

4.2 The line in Figure 3 has a slope of 0.3 indicating that the mass is roughly proportional to the velocity to the power 3.3. The well-known Tully-Fisher relation has a power between 3.5 and 4.0.

5 Mass vs Energy Scale Variation relationships

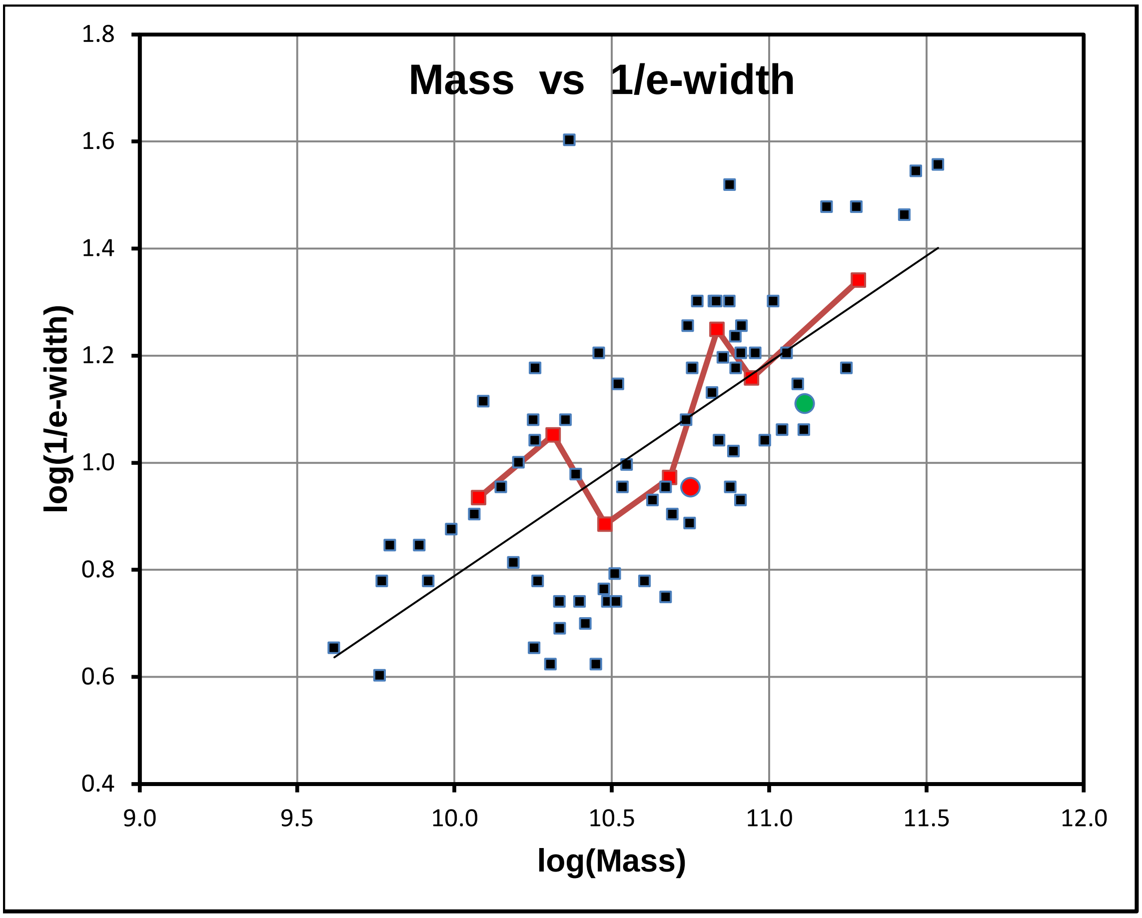

Figure 4. The mass vs 1/-e width of the energy scale variation for the 74 galaxies examined in JoKe3. The red line is the 10-point average. The red dot is the Milky Way, the green dot is the Andromeda galaxy.

5.1 Figure 4 shows the distribution of derived mass against α , the 1/e-width of the energy scale variation (as defined by equation 3) for the 74 galaxies examined in JoKe3.

5.2 The solid red line is the 10-point average and goes from less mass galaxies (bottom left) to more massive galaxies (top right).

5.3 Although there is considerable scatter the diagram shows a definite correlation with the more massive galaxies having a broader energy scale variation.

5.4 If galaxies grow through mergers then the diagram suggests that energy scale variations my also broaden as they evolve.

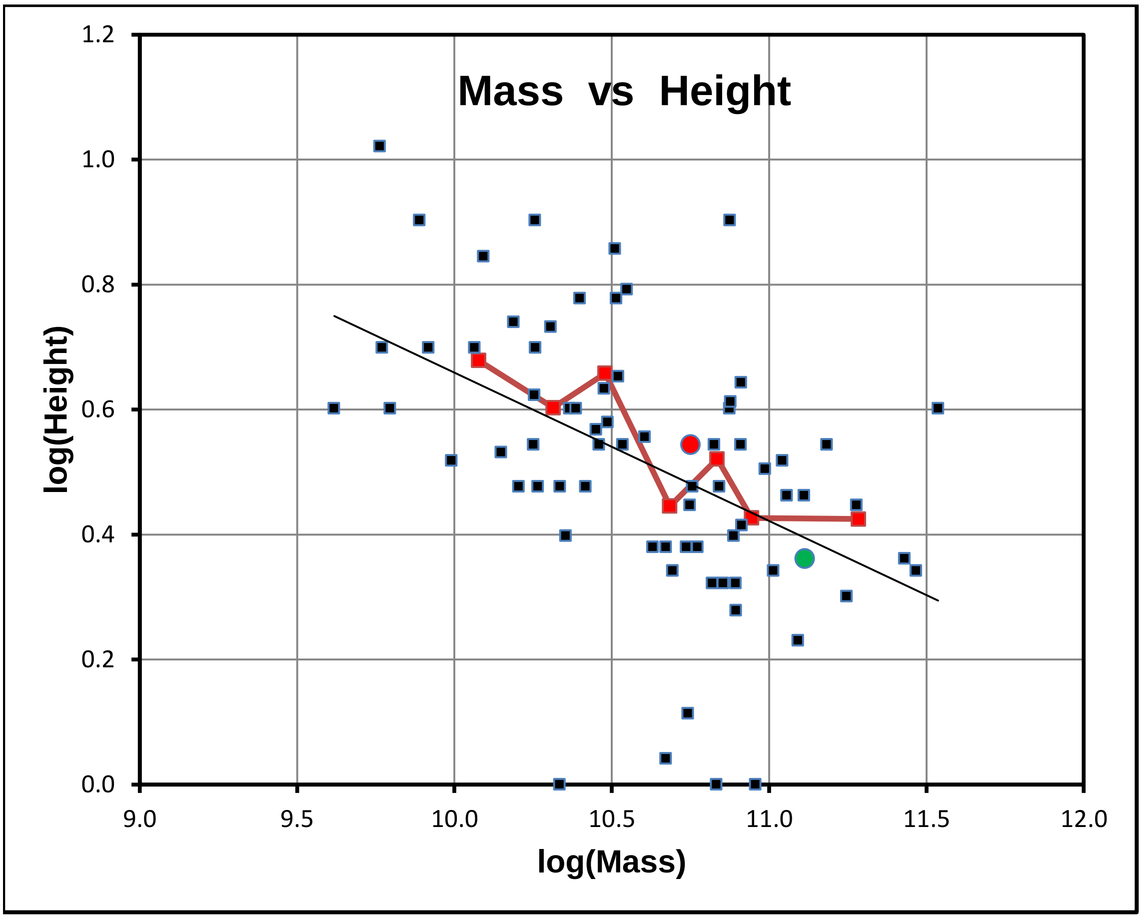

Figure 5. The mass vs the height of the energy scale variation for the 74 spiral galaxies examined in JoKe3. The red line is the 10-point average. The red dot is the Milky Way; the green dot is the Andromeda galaxy.

5.5 Figure 5 shows the distribution of derived mass against γ, the height of the energy scale variation (as defined by equation 3) for the 74 galaxies examined in JoKe3.

5.6 The solid red line is the 10-point average and goes from less mass galaxies (top left) to more massive galaxies (bottom right).

5.7 Although there is considerable scatter the diagram shows a definite correlation with the more massive galaxies having a lower energy scale variation.

5.8 If galaxies grow through mergers then the diagram suggests that energy scale variations my also decrease as they evolve.

6 Discussion

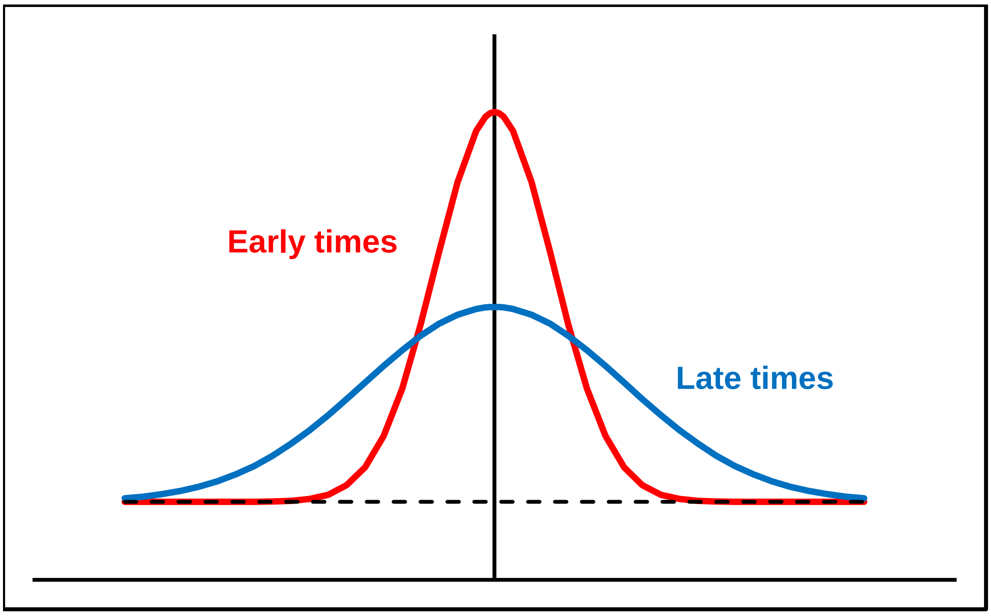

Figure 6. Illustration of possible evolution of energy scale variations from high & narrow to low & broad.

6.1 Of course, there is no proof that energy scale variations occur; it is a hypothesis. And if they do occur there is no particular reason that they should be Gaussian in shape.

6.2 If energy scale variations do occur then one might expect there to be a random variation of heights and widths. Indeed the data presented in the diagrams seems to support this idea.

6.3 If large galaxies grow through collisions and mergers of smaller galaxies then there should be some indications of how energy scale variations behave. Indeed all the diagrams point towards an evolution whereby the energy scale variations decrease in height and broaden in width. This is illustrated in Figure 6 above.

7 Conclusion

7.1 The study of 74 spiral galaxies in JoKe3 (2015) shows a large scatter in the height and width of the energy scale variations. There is no obvious correlation between the two parameters.

7.2 An examination of the behaviour of energy scale variations with galaxy mass suggests that as galaxies merge their masses increase, the energy scale variation height decreases and the energy scale variation width broadens.

6 References

JoKe1. "On the variation of the energy scale: an alternative to dark matter". (Sep 2015). www.varensca.com

JoKe2. "On the variation of the energy scale 2: galaxy rotation curves". (Nov 2015). www.varensca.com

JoKe3. "On the variation of the energy scale 3: parameters for galaxy rotation curves". (Nov 2015). www.varensca.com