On the variation of the energy scale 20

Miscellaneous topics

by

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Summary

The hypothesis has been put forward that the energy scale can vary from location to location. This hypothesis enables all astronomical situations where dark matter is invoked to be explained without any dark matter. This paper looks at miscellaneous topics not covered by other papers in this series.

Entropy

The Solar System

Some corrections and errata to earlier papers are also presented.

1 Introduction

1.1 JoKe1 (2015) puts forward the hypothesis that the energy scale can vary from location to location. It shows that the flat rotation curves of spiral galaxies can be explained by variations in the energy scale, without the need for any dark matter.

1.2 Other papers in this series (JoKe2 to JoKe20) explain other astronomical situations where dark matter is usually invoked, including: clusters of galaxies; cluster collisions; cosmic microwave background; Friedmann equation; galaxy interactions; gravitational lensing; gravitational potential; inflation; Lagrangian mechanics; physical cosmology; primordial density perturbations; radial acceleration relation; ring and shell galaxies; structure formation.

1.3 This paper lists the small number of errors in previous papers in this series, and a small number of corrections.

1.4 The main focus of this paper is to cover those topics that do not warrant a full paper in their own right. Also, unlike previous papers in this series, all of which are "frozen", this paper will be updated as we come across new topics that should be addressed.

2 Errata and corrections

The following lists errors and corrections that should be applied to previous papers in this series. The errors are listed by paper number.

JoKe1: The masses in Table 1 are too small by a factor of 10. So NGC 2403 has a mass around 2.1×10^{11} solar masses (and not around 2.1×10^{10} solar masses).

JoKe1. Paragraph 14.12 suggested that gravitational waves might not exist. This is clearly wrong following the detection of gravitational waves in 2016 by LIGO (Laser Interferometer Gravitational-Wave Observatory).

JoKe2. The masses in Table 1 are too small by a factor of 10. So NGC 2403 has a mass around 1.8×10^{11} solar masses (and not around 1.8×10^{10} solar masses).

3 Entropy

3.1 There is some confusion in physical cosmology surrounding entropy.

3.2 It can be argued that the Universe as a whole is a closed system with no input of energy from outside. Hence it must be adiabatic and the overall entropy cannot change.

3.3 The relation for a change in energy is

$$dQ = dE + p\,dV \tag{1}$$

where dQ is the change in energy; dE the change in internal energy; p the pressure; dV the change in volume.

3.4 The change in entropy is defined by

$$dS = \frac{dQ}{T} \tag{2}$$

where dS is the change in entropy; T is the temperature.

3.5 If there is no change in the energy then equation (1) becomes

$$dQ = 0 \tag{3}$$

and consequently equation (2) becomes

$$dS = 0 \tag{4}$$

which means the entropy is constant and does no change.

3.6 However, Roger Penrose argues that the Universe began in a very contrived state. The uniform temperature of the cosmic microwave background indicates a state of maximal entropy. At the same time the concentration of matter into a tiny volume indicates a state of minimal entropy.

3.7 Penrose argues that entropy increases throughout the evolution of the Universe and that the entropy is dominated by the vast amount of entropy contained within black holes.

3.8 We do not have anything to add to these conflicting views.

3.9 Entropy is also defined by Boltzmann's relation

$$\boldsymbol{S = k.ln(W)} \tag{5}$$

where $\boldsymbol{S}$ is the entropy; $\boldsymbol{k}$ is Boltzmann's constant; $\boldsymbol{W}$ is the number of possible states of the system.

3.10 Boltzmann's constant $\boldsymbol{k}$ is 1.381×10^{-23} J K^{-1}.

3.11 The units of entropy are those of Boltzmann's constant namely energy divided by temperature.

3.12 Our hypothesis is that the energy scale can vary from location to location. The fact that the energy scale can vary means that the entropy can also vary from location to location. This may have some bearing on how entropy is handled within the realm of physical cosmology.

4 The Solar System

4.1 We consider whether the (conjectured) energy scale variation that covers our entire Milky Way galaxy might have effects that are detectable within the Solar System.

4.2 Figure 2 shows the rotation curve for our Milky Way galaxy (taken from JoKe3, 2015). The curve does not fit the inner few kpc, which we know because this region is very sensitive to the mass distribution and the Gaussian density distribution is too simplistic. The fit is reasonable for the outer part of the galaxy, considering the simple Gaussian model.

4.3 Figure 1 shows the Gaussian density distribution and the Gaussian energy scale variation that were used to generate the rotation curve shown as the red curve in Figure 2.

4.4 The Solar System is situated around 8 kpc from the galactic centre. This means it lies on the steepest part of the energy scale variation curve. The rate of change is about 3 units per 10 kpc, or 1 unit per 10^{20} m.

4.5 The diameter of the Solar System is about 60 AU, or approx 10^{13} m.

4.6 So the change in the strength of gravity across the entire Solar System is expected to be about 1 part in 10 million. The change should be aligned with the direction of the galactic centre. Gravity would be weaker on the side nearest the galactic centre and stronger on the side away from the galactic centre.

4.7 Of course, should such as small change be detectable the ambiguity problem still remains as to whether it is an energy scale variation or dark matter.

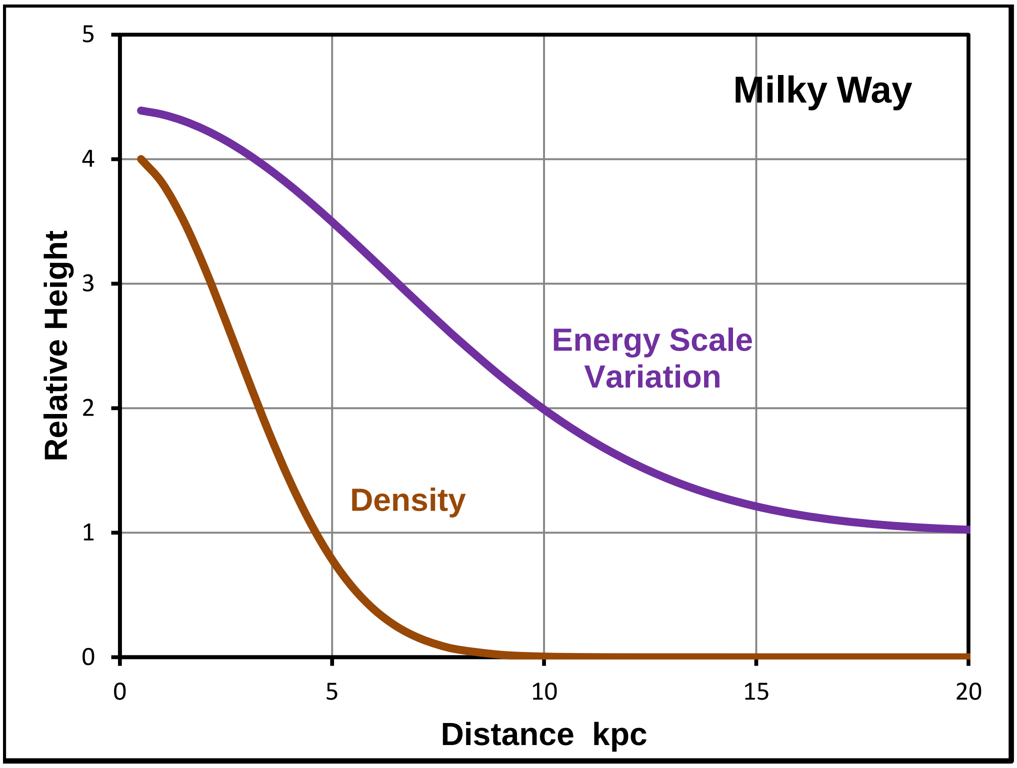

Figure 1. Energy Scale Variation and Density distributions for our Milky Way galaxy

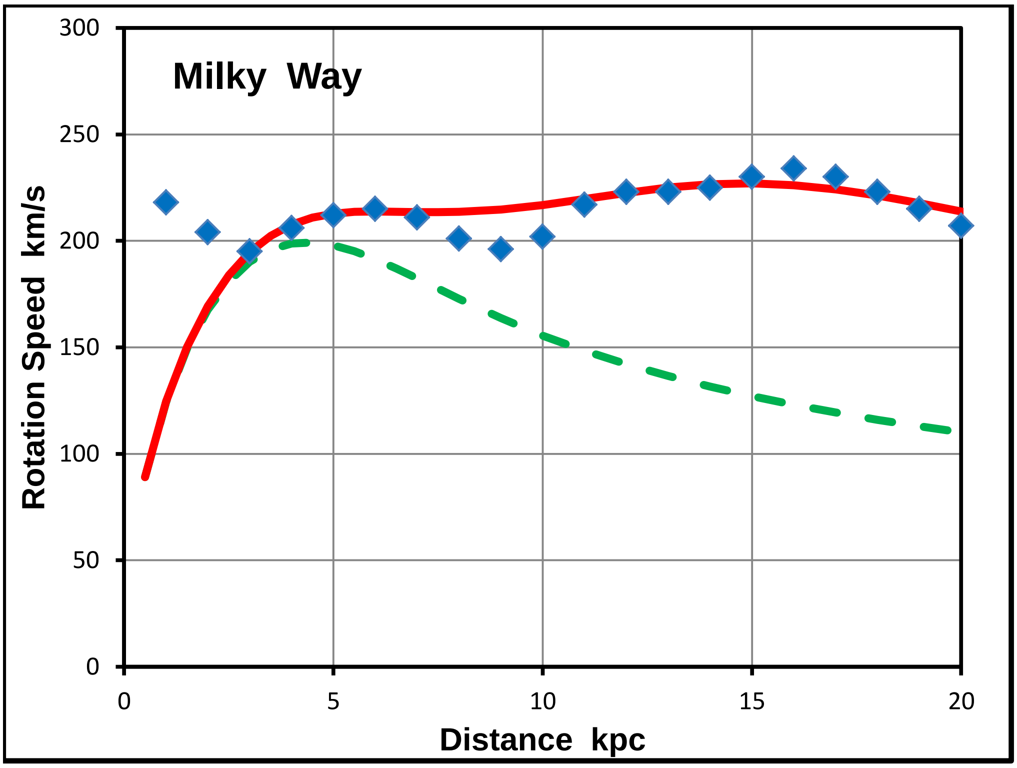

Figure 2. The rotation curve for our Milky Way galaxy. The blue diamonds are the observations; the green curve represents Newtonian gravity; the red curve is for an energy scale variation.

4 The Sun and the Earth

4.1 What limits can we put on there being a small energy scale variation inside the Sun or inside the Earth?

4.2 Table of Gaussian factors

r/α	**exp(-r²/α²)**
1.0	3.7×10^{-1}
2.0	1.8×10^{-2}
3.0	1.2×10^{-4}
4.0	1.1×10^{-7}
5.0	1.4×10^{-11}
6.0	2.3×10^{-16}

Table 1. Gaussian factors.

From Table 1 we can see that, for $\boldsymbol{r/\alpha = 5.0}$, the Gaussian factor is 1.4×10^{-11}. This means the effect at the surface of an object will be undetectable provided the 1/e-width of the energy scale variation is less than 1/5th of the radius.

4.3 If the Sun had an energy scale variation inside it with 1/e-width less than 140,000km, then there would be no effects at the surface and beyond that we could detect.

4.4 If the Earth had an energy scale variation inside it with 1/e-width less than 1,200km, then there would be no effects at the surface and beyond that we could detect.

3 References

JoKe1. (2015). "On the variation of the energy scale: An alternative to dark matter".

JoKe2. (2015). "On the variation of the energy scale 2: Galaxy rotation curves".

JoKe3. (2015). "On the variation of the energy scale 3: Parameters for galaxy rotation curves".

JoKe11. (2017). "On the variation of the energy scale 11: The gravitational potential".