Ockham, Olbers and dark matter

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Abstract.

It is the task of the theoretician to explain observations with a theory that has no unnecessary complexity. This letter explores the possibility that the observed Hubble red-shift effect and the microwave background radiation are consistent with the hypothesis that the universe is infinite, eternal and not expanding.

Introduction

Astronomers and cosmologists have shown a reluctance to accept that the Hubble effect might arise from any other cause than a receding velocity. Indeed measurements of the effect are cited as a velocity gradient rather than as a multiplying coefficient of wavelength or frequency.

Theories based on expansion have been compounded with the addition of inflation, a theory that requires early rates of many times the speed of light, of dark energy and even of multiple universes. Having attended lectures on electromagnetic theory by Professor Fred Hoyle at a time when the term 'Big Bang' was coined as one of derision, I feel that there is a need to test a simpler paradigm.

I am a mathematics scholar turned engineer and in my Cambridge research days was a personal friend of Stephen Hawking. As an engineer I am unfettered by the preconceptions of the astronomers and cosmologists, but follow these matters with great interest. As the examiner of a course on research methodology, I am somewhat concerned with the way that researchers have sought to embellish the received theory, rather than to examine the observational evidence *ab initio*.

The well-known paradox stated by Heinrich Wilhelm Matthias Olbers observes that in any infinite universe, every line of sight must terminate on the surface of an object such as star. Of this I have no doubt, but his conclusion that the sky would appear uniformly bright did not take into account the Hubble red-shift. The conjectures and calculations that follow explore alternatives that are consistent with the observations, particularly those of the cosmic background radiation.

An early conjecture was the possibility that the background radiation was the result of immensely red-shifted radiation from very distant stars. A simple simulation refuted that, but laid the foundation for a more likely conjecture.

Stellar density.

Let us assume that a mean stellar density, which I term here alpha, is defined not by the number or mass of stars, but as a proportion of the 4π solid angle occupied by the disks of stars in a spherical shell of unit thickness and radial distance r.

Not only will this area be a multiplier for the radiation from stars within that shell of unit thickness, stars at a greater distance will be occluded. The contribution from a star at a distance r will thus be attenuated by an occlusion factor of $e^{-\alpha r}$.

Some effort can be put into estimating a rough value for alpha. If it is assumed that there are 10^{24} stars within a distance of 14 billion lightyears, their density can be taken as 10^{-7} stars per cubic lightyear. But this must then be multiplied by the area of a typical solar disk which can be approximated to $1.5*10^{-14}$ square lightyears. The rough rule of thumb for alpha is thus $1.5*10^{-21}$ per lightyear of distance.

The spectrum

We can represent the radiated spectrum as the Planck function P(λ), taking some mean temperature for the ensemble of stars. The Hubble effect will cause received wavelength to be H(r)λ, where H(r) represents a function of distance. Thus if we instead wish to calculate the received power density for a given received wavelength λ, we have to consider the integral over emitted wavelengths λ/H(r).

Since the emission has been defined for an area, not a point, there will be no inverse square term in the integral to be performed:

$$Density(\lambda) = \int_0^\infty e^{-\alpha r} P(\lambda / H(r)) \alpha dr$$

The function H(r) is already the subject of some debate. Astronomers would wish that H(r) should approach infinity at the 'Hubble radius' c/H_0, but acceptance of such a hyperbola would preclude any alternative hypothesis. Other options can include a linear or an exponential relationship.

Some attempt can be made to relate the function to the more recent observations concerning the relationship between distance and 1+z. If we were to try to attribute the background 'CMR' radiation to intensely red-shifted starlight, it would involve relating emitted light at a wavelength around 0.5 microns to the perceived background radiation at 2 mm. A z value of 4000 could be involved, well beyond any confidence range of observations. This conjecture has been ruled out.

An exponential function for H(r) has the appeal that its incremental influence is the same at any distance. It would cause the wavelength to be increased by a factor of e at the 'Hubble Radius' c/H_0 if it is to be matched to the gradient observed for 'local space'.

The multiplier that relates emitted wavelength to received wavelength is then $\exp(-rH_0/c)$, so for the integral we would have

$$density(\lambda) = \int_0^\infty e^{-\alpha r} P(\lambda e^{-r/r_h}) \alpha dr$$

where r_h is the 'Hubble radius.

Simple software was written to assess the result of the integration for several possible functions and for various values of alpha. It was easily seen that for stellar objects the Planck function would be excessively 'blurred' for any value of alpha.

Dark matter

Of the existence of dark matter there is no possible doubt. It makes up our own substance and the Earth we inhabit. The presence in space of non-luminous objects and 'cosmic dust' will contribute to the occlusion factor alpha, and must be considered as a potential source of the microwave background radiation.

A star or any spherical object has a surface area that is proportional to the square of its radius and a mass that is proportional to the cube. If the sun were therefore to be broken up into fragments one kilometre in diameter, those fragments would present an occluding area over a million times greater than that of the unbroken sun.

For a mix of masses in which stars and dark matter contribute in equal parts, the value of alpha could now be estimated to be in the region of $2*10^{-15}$ per lightyear for particles one kilometre in size, or as great as $2*10^{-10}$ if fragments as small as one centimetre are assumed to be the mean. The observation of meteor showers suggests that this is not unreasonable.

It has troubled me that the background has been attributed to being the 'echo of the Big Bang'. It is counterintuitive that a burst of radiation outwards from a point source should now be returning from all directions, albeit not uniformly. My conjecture is therefore that the background radiation could be that of dark matter, stabilised nearly uniformly at a temperature in the region of 2.7K.

Once again the red shift must be considered, since much of the radiation will be from distant matter unless alpha is relatively large. But now the numerical integration code displays a much reduced distortion of the Planck function. Empirical experimentation allows a variety of values of alpha and temperature to be tried, adjusting them to fit the measured spectrum.

Figures 1 (a), (b) and (c) show comparisons of the estimated spectrum against that of a black body at 2.726 K. The dark-matter temperature and alpha have been mutually adjusted to give a peak at the same wavelength. Since a higher temperature has been assumed for the radiating matter, the peak power is higher than that of the reference, so further curves for multiples of 1.1, 1.2 and so on are also shown to enable the quality of fit to be assessed.

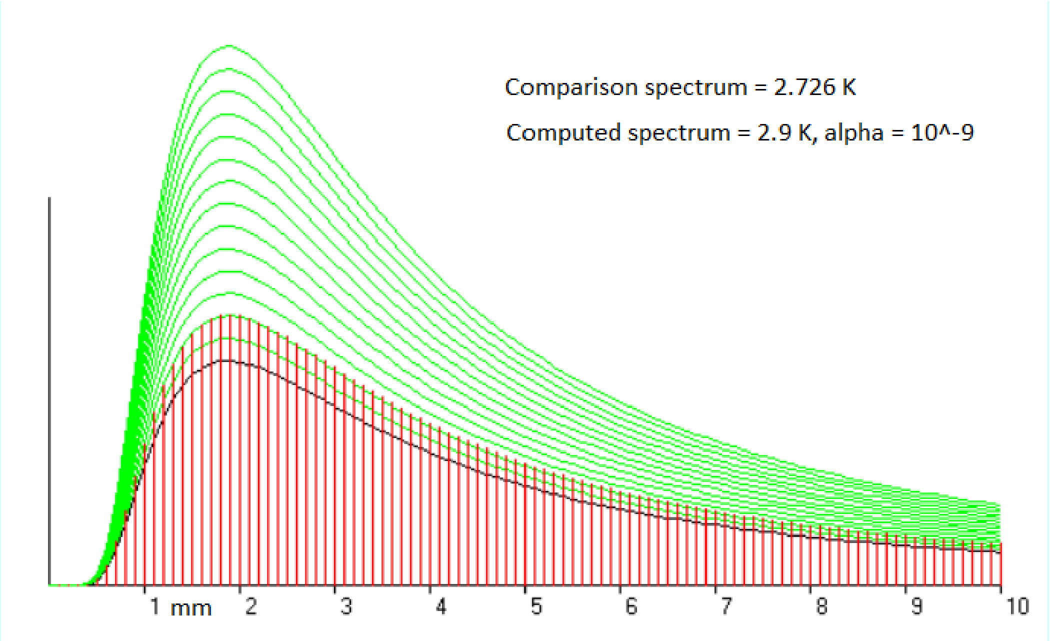

Figure 1 (a). Alpha = 10^{-9}

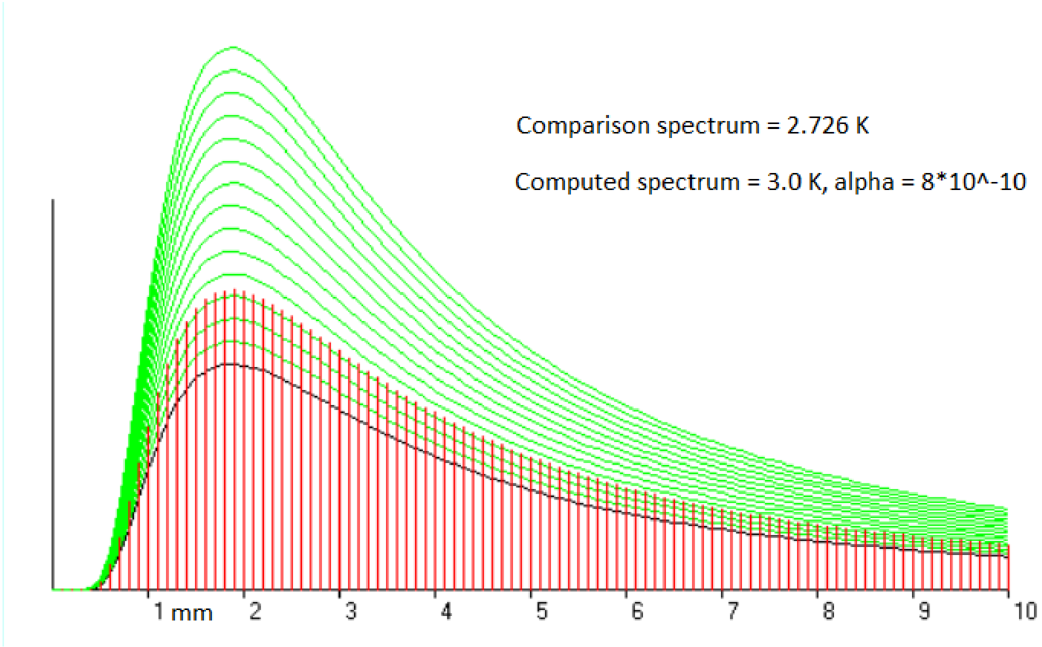

Figure 1 (b). Alpha = 8 * 10^{-10}

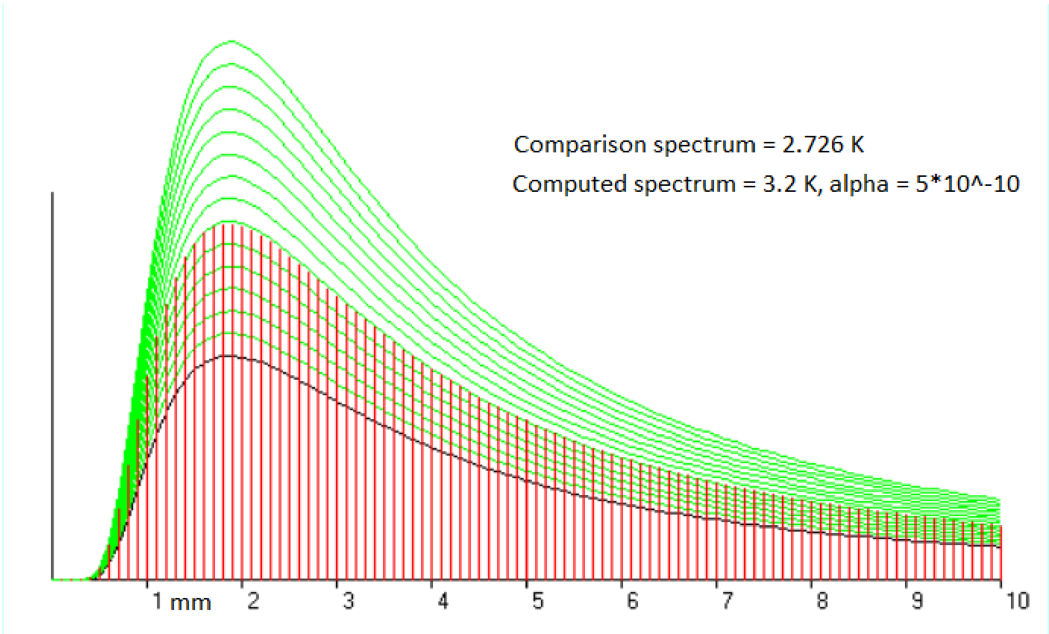

Figure 1 (c). Alpha = 5 * 10^{-10}

The spectrum shape appears to fit the reported measured background spectrum within a fine tolerance. The first test of the viability of the conjecture can thus be a comparison between the power of the measured spectrum and that computed for a surrounding shell at temperature 2.726 K. This will then yield a corresponding estimate for alpha, provided the ratio is greater than one.

The next test must be close inspection of the relationship between apparent magnitude and z value. To the displeasure of astronomers, values of alpha in the range being considered will affect the 'yardstick' used to estimate stellar distances, due to the introduction of the exponential attenuating term. Conventionally the apparent change in magnitude is -5 * log(r^2), but it will now have an added term –5(α r). This will only be significant at great distances.

The next conjecture that can be tested is that the frequency of light decays with distance exponentially, rather than linearly. Values of z up to 1.2 have been measured. Do these observations align with the modified measure of distance to give the suggested exponential relationship? At present they are being accepted as evidence of accelerating expansion, requiring further great embellishment of the current theories. Occlusion by dark matter could give a simpler explanation of the unexpected faintness of the distant stars, whether the exponential decay of frequency is upheld or not.

Gravitational waves

It has been claimed that a gravitational wave has been detected, confirming Einstein's prediction of cylindrically emitted waves. My first concern is that a wave requires a 'co-field' as with the combination of electrical and magnetic fields to support light waves. No such co-field has been detected for gravity. In its absence the quadrupole field would have to change instantaneously at any distance, albeit with a magnitude that would decay with the fifth power or distance.

My next concern is that when the d'Alembertian

$$\frac{1}{c^2}\frac{\partial^2}{\partial t^2} - \nabla^2$$

of a function is equated to zero it only has non-dispersive solutions for odd numbers of dimensions, so that plane and spherical waves are supported, but not cylindrical.

An exponential decay of frequency has the appeal that its description is independent of location, whereas a linear decay would imply that extinction would occur at the Hubble radius. For an exponential decay the wave function could be

$$\exp(j\omega e^{-t/T}(t \pm x/c))$$

where T = r_h /c. If we apply the d'Alembertian to this, we find there is a residue.

Might it be possible to 'tweak' Maxwell's equations to explain this with a gravitational term? This would ensure that any corresponding gravitational waves would propagate with the same velocity as that of light.

Black holes and entropy

If an eternal universe is to be considered, there has to be some process for disposing of the ever-increasing entropy. At the same time it is logical that large masses will tend to accrete until they reach a mass at which they can collapse into a Black Hole, either to the notional mathematical singularity or to a compact mass within an event horizon. This collapse can be a mechanism to eliminate entropy, but now we need a process to release the mass and recycle it. Maybe this is the function of supernovae.

In conclusion

These conjectures will not appeal to those astronomers who are steeped in the accepted theories. To a pragmatist, however, they are much more plausible than the complexity of theories that have sprung from a conviction that the red shift cannot have any other cause than receding velocity. As objections to those theories have been perceived, they have been compounded with elaborations.

The essential proposition is that there can be some other explanation for the red shift that does not involve expansion, although a conjecture is offered here as a mere suggestion, not as a founding principle. A further proposition is that there is sufficient dark matter in the form of dust and small particles, having reached an equilibrium temperature slightly above 2.726 K, both to provide the cosmic microwave background radiation and to attenuate the light from very distant stars.

At present this is a mere conjecture, even less substantial than a hypothesis. Considerable effort is still required to draw together the observations that will either support or refute it.

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