Hubble Motion without Dark Energy giving an Alternative Model of the Universe

Written by: Michael John Olley

mikeolley3@gmail.com

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Abstract: The explanation of Hubble Motion is fundamental to the Standard Model of Cosmology(SMC), in which the expansion of the universe from a singularity is powered by the anti-gravity property of dark energy. In this paper we show that the Hubble Motion of galaxies could be driven by gravity alone in a new model of the origin of the universe, which could provide the basis of alternatives to the SMC.

Background

The Standard Model of Cosmology (SMC) is founded on observations made by Hubble and Humason in 1929, which confirmed theoretical proposals that the universe was expanding. They concluded that galaxies move away from each other at a rate which is proportional to the distance between galaxies, in a dynamic process known as Hubble Motion. Although their initial measurements were inaccurate the expansion of the universe is now generally accepted and the rate at which galaxies move away from each other is measured by the Hubble Constant, H_0.

Redshift is the basic tool for cosmological measurement and is used to calculate H_0. Light emitted from a stationary source has the particular wavelength associated with white light. If the source is moving towards the observer the wavelength of the incoming light is shortened moving it towards the blue end of the spectrum, and if the source is moving away from the observer the wavelength is increased towards the red end of the spectrum. The light is said to be blue-shifted or redshifted. This is known as the Doppler effect, commonly associated with sound but also applicable to light. The wavelength of light from galaxies which are not gravitationally attached to the Milky Way is redshifted to a degree which is proportional to the distance to the galaxy. This was first observed by Hubble and Humason and the interpretation of this fact underpins the SMC.

Under the SMC, redshift is assumed to be wholly due to the Doppler effect which means that the increase in wavelength is assumed to be caused by the galaxy moving away from the observer. This means that the further away the galaxy is from the observer the greater the recessional velocity, which for the measured value of H_0, implies that the more distant galaxies are moving away from the Milky Way at faster than the speed of light. This apparent contradiction of Einstein's principle is explained as being due to the expansion of space, which is not theoretically limited to the speed of light. It is the anti-gravity property of dark energy which drives this expansion.

Thus, the interpretation of redshift as wholly due to the Doppler effect (known as cosmological redshift), and the anti-gravity property of dark energy are both basic and necessary assumptions of the SMC, despite the fact that there is no physical proof that either assumption is correct.

The interpretation of redshift has been contentious since the second half of the last century. Edwin Hubble himself never accepted that redshift was purely a Doppler effect, but the SMC has been developed on that assumption, so that any interpretation of redshift other than a purely Doppler effect could be fatal for the SMC. In this paper we will develop a model of the universe which requires that redshift is not a purely Doppler effect and is mainly due to the distance light travels to the observer.

Hubble Motion

Under the SMC there is the concept of the observable universe which depends on the location from where the observation of the universe is made. There is no single centre of the universe, every location is the centre of its own observable universe. The universe is said to have evolved from a tiny seed, mathematically known as a singularity, which is treated as the beginning of space and time. Hence under the SMC there is no concept of anything outside the universe.

Early models of the universe placed the Earth or Sun at the centre, but it was later recognised that the Milky Way has no special place in the universe, and it is assumed that the motion of galaxies when observed from anywhere in the universe will be the same as observed from Earth. The Big Bang is said to have occurred everywhere rather than at a single location, and all galaxies move away from each other with Hubble Motion.

The basic assumption of the SMC is that the universe is both homogeneous and isotropic and the concept of a centre would seem to break this condition. This assumption is made to simplify the solution of Einstein's relativity equations which provides the theoretical justification of the SMC. However, if the primary objective is to develop a model which explains Hubble Motion, then it is not necessary to restrict the choice to isotropic models. If a universe with a centre is able to explain Hubble Motion from all locations in the universe including the centre itself, then it achieves this objective and is a valid model for consideration.

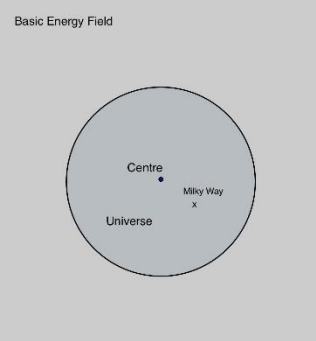
The motion of galaxies in the universe is compared to the expansion of currants in a currant cake when the cake is heated up from a ball of dough. Currants, randomly distributed in the dough, all move away from each other as the dough expands. The motion of the currants is caused by the expansion of the dough and is not the motion of currants through the dough. This illustrates the interpretation of Hubble Motion under the SMC, in which the relative motion of galaxies is caused by the expansion of space.

Under the SMC there is no centre to the universe. Even though the cake would have a centre and all currants would move away from the centre with Hubble Motion, this is not part of the analogy. Similarly, the cake is finite with an outer shell and is surrounded by something, which again is not a property of the SMC.

The motion of the currants is an illustration of Hubble Motion. All currants move away from each other with velocity proportional to the distance between them. If there is a currant at the centre, all the other currants move away radially from the central currant with velocity proportional to distance to the centre. In this example the motion is caused by the expansion of the dough, but if the currents had real velocity through the dough, it would still be Hubble Motion. Of course, the currants do not move through the dough, but galaxies can move through space with a real velocity.

Hence a model of the universe as a sphere with galaxies moving away from the centre with a velocity proportional to the distance from the centre would exhibit Hubble Motion. The model would require a force which causes galaxies to move in this way, which could be the gravitational effect which would arise if the universe were to be surrounded by something of a greater density than the universe. This would create a gravity differential acting on galaxies to move them along the radial away from the centre.

Simple Model of a Universe with a Centre



Consider a spherical universe surrounded by something which we will call a Basic Energy Field. The universe has a centre, and the Milky Way is a galaxy which exists on a radial from the centre to the surface of the sphere. This simple model could provide gravitational attraction along the radial away from the centre if the density of the Basic Energy Field outside the universe was greater than the mean mass/energy density within the universe.

This demonstrates how the gravitational force on a galaxy would cause galaxies to move along the radial. For a galaxy at the centre the net gravitational force and hence real velocity would be zero, just like the currant at the centre of the cake. The net gravitational force on galaxies close to the centre would be small but would increase for galaxies positioned further along the radial towards the surrounding greater density. If the gravitational differential increased linearly from the centre to the boundary of the universe, the velocity of a galaxy would be proportional to distance from the centre, which in the cake analogy is the basis for Hubble Motion of all galaxies.

In summary, if galaxies move along the radial from the centre, under a gravitational attraction surrounding the universe, the observed motion of unconnected galaxies in the universe is consistent with Hubble Motion. While the simplified model presented would explain the observed motion of galaxies, it is not a plausible model because the evolution of the universe would not have just stopped in a fixed position. Also, galaxies formed at the edge of the universe would have to have somewhere to go. Under any plausible model the universe continues to evolve.

Developing an Alternative Model

"It is more logical to assume all space was full of something that converted to the matter (and energy) in the universe than to assume that everything came from a single point" -James C Baker.

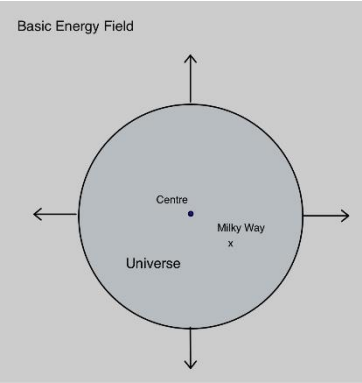
Hubble Motion was the starting point for the Big Bang model. If galaxies are moving apart now, they must have been closer together in the past. This has led to the conclusion that all the energy of the universe was initially contained within a single point, mathematically termed a singularity, which is the basis of the SMC. Despite the fact that it seems incomprehensible, the universe from a singularity is a logical explanation to explain Hubble Motion if redshift is a purely Doppler effect.

According to James C. Baker, if we are to develop an alternative model, we must explain Hubble Motion from the assumption that the matter in the universe converted from something. If something converted to the hydrogen and helium which makes up the matter in the universe it is inconceivable that the conversion into the whole universe happened in an instant. The conversion would have happened over time and would still be ongoing. As a band of conversion passed through a region of space, the something would have been converted to hydrogen and helium from which galaxies would have formed over time.

This would mean that the age of galaxies would depend on the time when the band of conversion passed through. Galaxies in the direction from which the band of conversion came would be older than galaxies in the opposite direction. This would be true for all galaxies. The most plausible explanation of this would be if galaxies of the same age were situated at the same distance from the centre of a sphere. Galaxies towards the centre would be older, galaxies further away from the centre would be younger. Hence a universe with a centre is the logical conclusion if we assume that all space was full of something that converted to the matter (and energy) which make up the universe.

Under the SMC it is assumed that redshift is a purely Doppler effect, in which case the reverse of Hubble Motion leads to a singularity as the origin of the universe. Under the proposed alternative model, reversing Hubble motion moves galaxies back towards the centre to the location in space where they first formed, and converts them into the hydrogen and helium they are formed from, and ultimately into the pre-conversion something. Galaxies would not return to a central location in space.

At this stage, although we have not developed a particular model, we can say that if the universe developed from something which converted to mass/energy, that conversion process would have resulted in an age distribution of galaxies which is direction dependent and hence anisotropic. Under the SMC all the hydrogen and helium from which galaxies formed came into being within a few hundred thousand years following the Big Bang, and so the age distribution of galaxies under this model is isotropic. It should therefore be possible to differentiate between the two models.

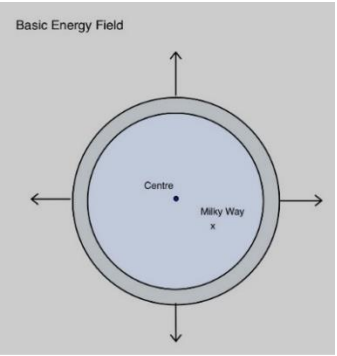


The diagram shows the universe as a sphere of conversion surrounded by the "something" which we have called the Basic Energy Field (BEF). The universe is shown expanding into the BEF as the shell of conversion moves outwards. The Milky Way is shown on a radial from the centre and under Hubble Motion it will have a velocity along the radial away from the centre.

The Milky Way has a real velocity relative to the Cosmic Microwave Background (CMB), which is not predicted under SMC. The explanation normally given is that it is due to the attraction of a large mass of galaxies, centred on the Great Attractor, which is obscured from our view from Earth by the stars within the Milky Way. Under the SMC the real motion of the Milky Way is explained as being due to the gravitational attraction of this mass of galaxies, independent of the effect of dark energy. Upcoming space telescopes will provide much greater knowledge of this mass of galaxies but in order to develop our alternative model of the universe we will assume that the motion of the Milky Way, is along the radial away from the centre, and is due to a gravitational attraction located at the extremities of the universe.

Alternative Model of the Evolution of the Universe

In a previous paper "The Effect of an Elementary Particle on the Standard Model of Cosmology" [i] we suggested how the universe could have developed if there is an elementary particle from which all other particles are made. In that paper we proposed that the universe developed at some location in space and spread outwards in an expanding sphere.



We discussed the possible nature of the "something" and how the proposed model would have developed into the universe we inhabit. In the conversion process the "something" converts into the electrons, protons, and neutrons and hence into the hydrogen and helium which makes up the stars. It is proposed that the neutrinos released in this nucleosynthesis process would not be evenly distributed within the universe and that there would be a greater density of neutrinos following the expanding shell than there would be around the centre, resulting in an uneven distribution of neutrinos with the greater density towards to perimeter.

In the diagram above the neutrinos are depicted as the darker ring at the outer edge of the universe following the outer shell of conversion. Within this ring is the inner universe.in which galaxies have had time to form

and mature. The movement of neutrinos to the outer edge increases the density there and reduces the density in the inner universe, creating the gravity differential which causes galaxies to move outwards away from the centre.

Interpretation of the Alternative Model

Neutrino mass is extremely small and so, even though under the model countless billions of neutrinos have been and continue to be produced in the nucleosynthesis of hydrogen and helium, the net effect on the gravity differential acting on galaxies is still small but has increased over time. However, the small gravity differential acting on a galaxy over its lifetime causes the galaxy to gather speed over billions of years which, in the case of the Milky Way, is now around 600 km/sec relative to the CMB. This velocity, which is about one fiftieth of the speed of light, will have been acquired over the lifetime of the Milky Way.

Under this model, galaxies have real velocity away from the centre due to the net gravitational attraction acting on them. This real motion is independent of the more local motion of the galaxy within a galaxy cluster. Other galaxies which are not gravitationally bound to the Milky Way will exhibit Hubble motion relative to it, but the real velocity of separation will be relatively small, a small fraction of that given by the current value of the Hubble Constant. The main contribution to the observed value of the Hubble Constant would be the redshift due to the distance the light travels from the observed galaxy.

Testing Models with Observations of the Universe

In deriving an alternative model, we have assumed that all space is filled with "something", which we have called the Basic Energy Field, that converted into the matter and energy in the universe. This model leads to a universe with a centre and an age distribution of galaxies in which galaxies in one direction (towards the centre) are older than galaxies in the other direction. This directional age distribution differs from the isotropic age distribution of galaxies under the SMC and so gives a method by which the models can be tested.

In order to investigate the age distribution of galaxies in the universe, it would be necessary to carry out a full sky survey into the shape and structure (morphology) of galaxies at all distances (redshift values) since morphology is indicative of age. Full sky surveys are not yet available but there are some indications that the distribution of galaxies is not isotropic as required by the SMC. A recent survey of galaxies by Javanmardi, B. and Kroupa, P. (2016) [ii] found anisotropy in the all-sky distribution of galaxy morphological types over a limited range of distances using observations from ground-based telescopes. If this result were repeated in a full all-sky survey using space telescopes, hence eliminating any possible effect due to the positioning of the telescope, it would indicate that the age distribution of galaxies is anisotropic, contrary to the underlying assumption of the SMC.

All observations of the universe are taken from within the Milky Way and so observations in directions in the plane of the Milky Way are obstructed by the stars within the galaxy. This obstructed region is known as the Zone of Avoidance. The efficiency of optical telescopes such as Hubble and most ground-based telescopes to look beyond this region is restricted by light pollution from stars within the Milky Way and so most galactic research is concentrated on galaxies outside the Zone of Avoidance.

The new generation replacement for the Hubble telescope, the James Webb Space Telescope (JWST), has infrared capability which will enable galaxies in all areas of the sky to be surveyed, including Zone of Avoidance. Other space missions such as Euclid and new ground-based telescopes will ultimately enable a full sky survey of galaxies to be carried out. A full survey of the most distant galaxies will undoubtedly answer many questions regarding the viability of the SMC or any alternative model.

Conclusion

The SMC is the accepted paradigm for the evolution of the universe and has been developed over time to fit and explain observations, but it started with the assumption of Hubble Motion and the interpretation of redshift as a purely Doppler effect. If this interpretation of redshift is wrong, then the foundation of the SMC is undermined.

In this paper we have shown that gravity acting on galaxies from the edge or outside a finite spherical universe would cause the galaxies to move along the radial away from the centre, and that the motion of unbound galaxies relative to each other would be Hubble motion. Forthcoming space missions designed to observe the whole universe will undoubtedly throw up challenges to the SMC, which raises the possibility that the model becomes unviable, and a new concept is needed.

The objective of this paper is to promote the development of alternative models to the SMC based on a there being a centre to the universe. We have proposed one such model, but the freedom to consider the evolution of the universe with a centre should inspire other alternative models of the universe which are not constrained by the assumption of isotropy.

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[i] Olley and Yee, Feb 2021, The Effect of a Fundamental Particle on the Standard Model of Cosmology, https://www.researchgate.net/publication/349348961

[ii] Javanmardi, B. and Kroupa, P., 2016. Anisotropy in the all-sky distribution of galaxy morphological types, Astronomy and Astrophysics, Online: https://arxiv.org/pdf/1609.06719.pdf