CAN ACCELERATION PHASE ACCOUNT FOR THE OBSERVED ACCELERATING EXPANSION OF THE UNIVERSE ?

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ABSTRACT

A new cosmological era began with the discovery of accelerating expansion of the Universe. The deviation of the Hubble diagram from exhibiting a linear distance-redshift relation at high redshifts provides the very crucial clue to support this discovery. In this paper I present a theory to account for the observed accelerating expansion of the Universe. I discuss that the Universe should attain a constant rate of expansion in future, given the linear distance-redshift relation being obeyed by the receding large-scale structures within the local Universe, suggesting constant recessional velocities. I compare the local Universe within which the receding large-scale structures exhibit the linear distance-redshift relation in accordance with the Hubble diagram, and the remote Universe within which the receding large-scale structures deviate from exhibiting the expected linearity. There may be a simple terminology termed by me as “acceleration phase” that would probably account for the observed acceleration, particularly for the receding large-scale structures belonging to the remote Universe that exhibit high redshifts.

Key words: acceleration phase - cosmology: theory - dark energy - Hubble diagram: Hubble’s law.

1 INTRODUCTION

The independent research conducted by the High-Z Supernova Search Team in the 1998 (Riess et al.) and by Supernova Cosmology Project team in the 1999 (Perlmutter et al.) by using Type Ia supernovae as standard candles (magnitude-redshift relation) resulted into a very surprising discovery that sent shockwaves among the astronomical community. A surprising feat was found to be displayed by the Universe, a feat that was so extraordinary that the remarkable results obtained were not even expected. It was the remarkable discovery of Universe expanding at an accelerating rate. A research that was actually aimed at observing the expected deceleration of the Universe was welcomed by something completely unexpected. This is what perfectly defines a discovery; instead of getting the expected result something unexpected comes knocking at the door.

A mysterious energy that rightfully got coined as dark energy is considered responsible for causing the Universe to expand at an accelerating rate. Acceleration began with the introduction of dark energy 5 billion years ago (Frieman, Turner and Huterer 2008) and since then the Universe has continued to expand at an accelerating rate. Unfortunately, what type of energy dark energy exactly is remains an unsolved mystery.

The aim of this paper is to provide a credible reason for the observed accelerating expansion of the Universe on the basis of “acceleration phase” terminology which has been discussed in Section 3.

2 A BRIEF RECALL

The Hubble diagram is the velocity-distance relation plot for the receding large-scale structures within the observable Universe that depicts the Hubble’s law according to which the recessional velocity of a large-scale structure is proportional to its distance, that is, the further away a large-scale structure is, the faster it will be receding. Now the Hubble diagram exhibits a linear distance-redshift relation (standard rulers) for the local Universe, that is, for the large-scale structures that exhibit lower redshifts and are comparatively closer to us than the structures that exhibit higher redshifts or the most distant ones that belong to the remote Universe. It is for these structures belonging to the remote Universe that the Hubble diagram deviates from exhibiting a linear distance-redshift relation; a direct proof of accelerating expansion.

The explanation to the real meaning of the Hubble diagram has been provided in the paper (The real meaning of the Hubble diagram) on the basis of the molecular diffusion model that considers the large-scale structures as molecules. The recessional behaviour of large-scale structures was found to be in perfect agreement with the recessional behaviour of molecules. The paper therefore proved the actual recession of large-scale structures rather than expansion of space between them as is believed, thereby suggesting that the redshifts exhibited by the large-scale structures are caused due to their actual recession and are therefore Doppler redshifts and not cosmological redshifts caused due to the expansion of space.

3 THE ACCELERATION PHASE

If we gaze into the very local Universe, few million light years away, we find the Andromeda Galaxy racing towards our home galaxy. Gazing further away, some millions of light years away, within the extent of the local Universe, we observe the receding large-scale structures exhibiting the linear distance-redshift relation and obeying the Hubble's law very well. Further away begins the remote Universe within which the receding large-scale structures exhibit high redshifts (high recessional velocities). These structures deviate from exhibiting the linear distance-redshift relation, suggesting acceleration.

Now, the most distant large-scale structures, those belonging to the very remote Universe reveal themselves to us as they were billions of years ago when the Universe was comparatively younger than it is today. Such structures exhibit high redshifts, and basically, the higher the redshift, the greater is the distance and the larger is the look-back time; with higher and higher redshifts we are literally looking back into an earlier epoch. We do not know the present day recessional velocity of such distant celestial objects since we are observing them how those structures were billions of years ago when the Universe was much younger, and younger were those structures too. Therefore, at present the most distant large-scale structures that are not falling within the linear regime of the Hubble diagram are not revealing their present day picture to us, but how they were billions of years ago. Such structures most probably by now would already be exhibiting a linear distance-redshift relation, this would however remain unknown to us probably for a considerable amount of time, since at present we just know the linear distance-redshift relation being exhibited by the large-scale structures that are millions of light years distant (structures within the local Universe; structures that appear much older and quite evolved). We do not know when such local structures began exhibiting the linear distance-redshift relation, but before attaining such constant recessional velocities they would have surely been accelerating since constant recessional velocities are not achieved directly in an instant. Gradually and gradually a body accelerates before attaining a constant recessional velocity (this confirms the actual recession of large-scale structures rather than expansion of space between them).

As far as the laws of Physics go, and knowing that the Hubble's law is a valid law since it applies quite precisely to the local Universe, then most likely it should be equally applicable to the very remote Universe as well, that is, there should not be any deviation from a linear distance-redshift relation and all receding large-scale structures should lie on the straight Hubble line, unless we are looking into an earlier epoch within which the receding structures are rightfully expected to be accelerating since they appear younger and recession has begun for them; such structures are therefore still within their "acceleration phase".

When we look at the most distant structures, we are actually gazing back in time, we are looking into the past of those structures, therefore, there is an utmost probability that we will observe such remote structures to be accelerating in order to achieve a constant recessional velocity. Now since the most distant or the remote structures are already exhibiting recessional velocities that are higher than the recessional velocities of the local structures (Hubble's law) therefore, any further increase in their already-high recessional velocities would simply suggest an accelerating Universe. So as long as the accelerating structures remain in their "acceleration phase" their recessional velocities would keep on increasing before becoming constant in future.

By looking at the deviation from the expected linearity in the Hubble diagram it appears that the structures that are exhibiting the linear distance-redshift relation within the local Universe, structures that are receding with constant recessional velocity will begin to accelerate in distant future, however, this may probably not be the case at all, in fact there is more probability that the distant structures belonging to the remote Universe that are accelerating as observed today will attain a constant recessional velocity in the distant future probably by the time they get as old and evolved as the structures that are within the local Universe. The rule is, if the older and therefore the more evolved structures are following the linear trend on the Hubble diagram since they have already gone through the billion-year evolutionary phase, then we should most probably expect the younger structures to exhibit the same trend by the time they get equivalently old and evolved. (It is not necessary that the accelerating structures belonging to the remote Universe have to appear equivalently old and evolved as the local structures to exhibit constant recessional velocities. Remote structures that appear to be accelerating may attain constant recessional velocities at any time in future. This would help us to know when local structures attained constant recessional velocities or when their acceleration phase terminated).

The structures within the local Universe appear much older and evolved since they are closer to us. We observe such local structures having gone through the billion-year evolutionary phase quite efficiently, therefore, they are the ones that should appear to be accelerating due to the fact that acceleration began or dark energy got introduced during the formation, evolution and development of structures billions of years ago, and since we are observing the local structures in much evolved state as they were millions of years ago, therefore, the billion-year accelerating effect of dark energy upon the local structures should already be visible to us the way we are observing them now.

The most distant structures or the accelerating ones are billions of light years away and therefore they appear comparatively younger and therefore newer than the structures within the local Universe. Since these younger and newer structures belong to an early era of the Universe, therefore, as seen today they are still found to be within their "acceleration phase", that is, they are still undergoing the process of attaining a constant recessional velocity, and as a result they are found to be accelerating, just like an object that keeps accelerating before attaining a constant recessional velocity; the velocity keeps increasing every second as long as the permissible constant recessional velocity is not attained. It will probably take significant amount of time for the remote structures to achieve a constant recessional velocity, constant recessional velocity as achieved by the large-scale structures within the local Universe; structures that exhibit the linear distance-redshift relation. In fact, the very distant large-scale structures belonging to the remote Universe that do not exhibit the linear distance-redshift relation or the linear Hubble diagram, still obey the Hubble's law in the sense that, the further away they are, the faster they are receding.

It is all about time that their actual recessional behaviour would get revealed in the distant future, behaviour that would either be consistent with the Hubble diagram and hence the Hubble's law suggesting constant recessional velocity and hence distance-redshift linearity, or behaviour that would suggest acceleration that is real and inevitable.

CONCLUSION

Based upon the terminology of "acceleration phase" the reason for the observed accelerating expansion of the Universe has been explained. The accelerating recession of large-scale structures that we are observing at present is their recessional velocities billions of years ago, when they were still within their "acceleration phase". The present day velocity of such accelerating structures would probably remain unknown to us for a significant amount of time. Therefore whether they are still accelerating or not cannot be correctly inferred. There is more probability that the accelerating structures will attain a constant recessional velocity in future by the time they get as old and evolved as the structures within the local Universe for which the distance-redshift relation according to the Hubble diagram is linear, suggesting constant recessional velocity.

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