

The Universe: Inflationary Expansion, or Accelerating Contraction?

Goran Krstić, Senior Environmental Toxicologist, Trow Associates Inc., BC, Canada, goran.krstic@trow.com;
Adjunct faculty, Interpreting Statistics and Data, City University, Vancouver, BC; and Instructor, Environmental
Toxicology, Simon Fraser University, Burnaby, British Columbia, Canada, Goran_Krstic@sfu.ca.

Abstract

According to generally accepted cosmological model, the universe is in a state of inflationary and accelerating expansion. Almost all visible galaxies appear not only to be moving away from us, as observed by Hubble at the beginning of the last century, but they are accelerating. This is described as an accelerating expansion of the space-time continuum where galaxies are left as some sort of gravitational islands immune to this universal effect. There is overwhelming observational evidence, which appears to support this concept. However, is it possible to explain an accelerating expansion as a contraction of the universe? Could it be possible that our universe is in a state of free fall with gravitational acceleration? Galactic clusters appear to dominate the Northern Galactic hemisphere and the results of regression analyses performed in this study indicate statistically significant positive correlation between the maximum Log₁₀ galactic rotation velocities and the Galactic latitudes ($r=0.06$, $p=0.001$). The difference between the means of maximum Log₁₀ rotation velocities for distant galaxies in the Northern vs. the Southern Galactic hemisphere is also statistically significant ($t=2.58$, $p=0.0049$). This indicates that the universe does not appear to be perfectly homogenous and isotropic in all directions. Based on the observed complex galactic structure distribution and considering currently available galactic rotation velocity and cosmic microwave background (CMB) data, it is not impossible for the universe to be contracting. Although our universe could still be expanding, rotating, or even contracting, we have no sufficient scientific evidence to accept a particular model as valid at this time. Limitations and uncertainties associated with our study of the universe should be duly acknowledged.

Keywords: cosmological models, large-scale structure of the universe, galactic rotation velocity

Introduction

Based on astronomical observations and theoretical considerations, it is now generally accepted that the universe is in a state of inflationary expansion [1, 2, 3]. In the 1920s, the astronomers observed that light spectra of most stars in other galaxies of the universe are shifted towards lower frequencies (i.e., red-shift (z)) [4]. It was established that almost all of the observable galaxies move away from our own, Milky Way galaxy, and that such an effect could not be expected to occur in a stationary universe. Furthermore, in 1929, Hubble published his finding that the size of a galaxy's red-shift is directly proportional to its distance from the observer: the farther a galaxy is, the faster it appears to be moving away from the observer [5].

Although variations of the Standard cosmological model are currently developing, it is assumed by consensus that the universe is expanding due to inflation of the space-time continuum. The observed red-shifts are considered as cosmological red-shifts and are believed not to be true Doppler red-shifts. In other words, the universe is assumed to have been "bubbling", resulting in inflation (accelerating expansion) of photons and matter, and a continuous and increasing separation of galaxies over time, as they appear to be moving away from each other.

However, is it possible to see an inflationary expansion as a contraction of the universe? Is our universe in a state of "free fall" with gravitational acceleration, rather than in a "bubbling" accelerating expansion? Based on available cosmological data, including large-scale structure of the universe and maximum rotation velocities of distant galaxies, attempts were made in this study to explain the appearance of an inflationary expansion as a hypothetical accelerating contraction.

Methodology

Maximum galactic rotation velocities

The maximum rotation velocities for distant galaxies considered in this study were obtained from HyperLeda information system for astronomy (Observatoire de Lyon (France)) and include available values of logarithm (\log_{10}) of maximum velocity rotation (VM in km/s) from optical observations (H-alpha).

Statistical analyses were performed using linear regression and a t-test of statistical significance for the coefficient of correlation (r) on the entire data set covering both the Northern and the Southern Galactic latitudes. In addition, a t-test for two independent groups was used to test the hypothetical equality between the means of maximum galactic rotation velocities for the Northern vs. the Southern Galactic latitudes. Statistical tests were performed using MegaStat® add-in for Microsoft Excel.

Complex galactic formations

A part of this study is based on the available data for complex galactic formations, covering the entire Galactic latitude (b) range from the Galactic plane. The data were obtained from National Aeronautics and Space Administration (NASA)/Infrared Processing & Analysis Center (IPAC) Extragalactic Database (NED) using the advanced all-sky search.

Results

Maximum galactic rotation velocities

As presented in **Table 1** and **Figure 1**, the regression analysis results indicate relatively weak but statistically significant correlation between the observed \log_{10} values for maximum velocity rotation (VM in km/s) from optical observations (H-alpha) and all Galactic latitudes from -90° to $+90^\circ$ across the Galactic axis ($r=0.06$, $p=0.001$). The statistical residual plots revealed no evidence of non-linear relationship between the two variables, allowing the implementation of linear regression.

The difference between the means of maximum \log_{10} rotation velocities for distant galaxies in the Northern vs. the Southern Galactic hemisphere is also statistically significant ($t=2.58$, $p=0.0049$), with the overall greater rotation velocity of distant galaxies in the Northern Galactic latitudes. In addition, both the maximum and the median \log_{10} values were found to be greater in the Northern Galactic hemisphere (**Table 2**).

Table 1: Regression statistics for logarithm (\log_{10}) of maximum velocity rotation (VM in km/s) from optical observations (H-alpha) vs. Galactic latitude

Number of observations (n):	Coefficients	Standard Error	t-Stat	p-value	Lower 95% CI	Upper 95% CI
3035						
Slope (a)	0.0002291	0.0000697	3.289	0.0010	0.0000925	0.0003657
Correlation (r)	0.060					
Determination (r ²)	0.0036					

Figure 1: Correlation between the Log10 of maximum rotation velocity for distant galaxies vs. Galactic latitude

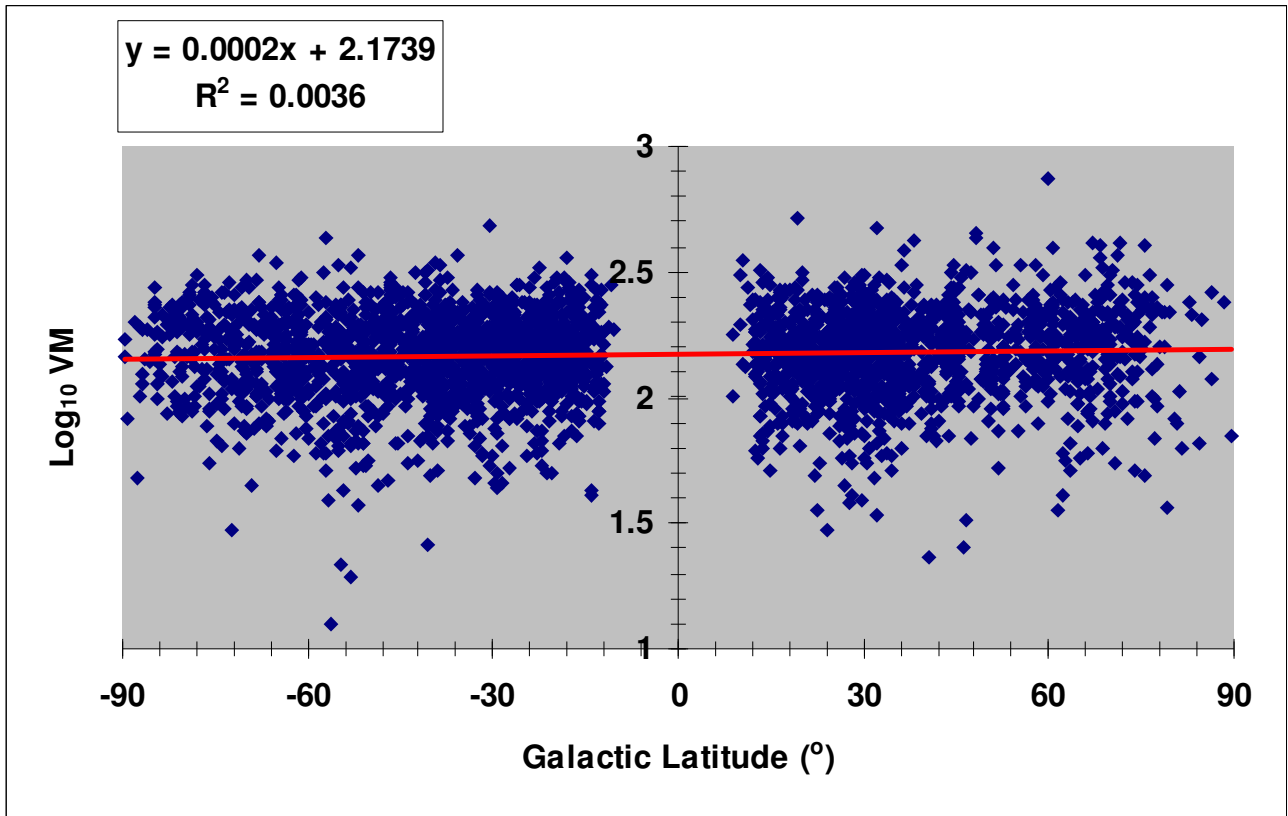


Table 2: t-Test for the difference between the mean logarithm (log₁₀) of maximum velocity rotation (VM in km/s) values from optical observations (H-alpha) for distant galaxies in the Northern vs. the Southern Galactic latitudes

	No. of galaxies (n)	Mean Log ₁₀ rotation velocity	Median Log ₁₀ rotation velocity	Maximum Log ₁₀ rotation velocity	Standard deviation	Galactic Latitudes (b)
Northern latitudes	1390	2.182	2.198	2.872	0.17630	0° to 90°
Southern latitudes	1645	2.165	2.184	2.685	0.17183	0° to -90°
t-Test Statistics						
df	Difference between the means	Pooled variance	Pooled std. dev.	Standard error of difference	Hypothesized difference	t-Test value
3033	0.016367	0.030237	0.173887	0.006335	0	2.58
p-value (one-tailed, upper)	Lower 95% CI	Upper 95% CI	Half-width			
0.0049	0.003945	0.028789	0.012422			

Complex galactic formations

NED database was searched for galactic clusters, groups, triplets and pairs. This search indicated that the Northern Galactic hemisphere contains approximately 22720 identified visible galactic clusters and 3620 groups, compared to only approximately 9130 galactic clusters and 3070 groups in the Southern Galactic hemisphere. The number of galactic triplets observed in the Northern hemisphere is marginally smaller than in the South, approximately 970 vs. 1040 respectively. However, the number of galactic pairs (approximately 5290) observed in the South is greater than in the Northern Galactic hemisphere, where approximately 3990 galactic pairs have been observed (**Table 3**).

Table 3: Distribution of complex galactic structures in the Northern vs. the Southern Galactic hemisphere

	Number of Clusters	Number of Groups	Number of Triplets	Number of Pairs
Northern Galactic hemisphere (N)	22720	3620	970	3990
Southern Galactic hemisphere (S)	9130	3070	1040	5290

Based on the observed distribution of complex galactic formations, the Southern hemisphere appears to be younger than the Northern hemisphere. The dominant type of structure in the Northern Galactic hemisphere are galactic clusters, while in the South we observe mainly simpler structures, such as galactic pairs and triplets. Considering these large scale structures, the universe as a whole does not appear to be perfectly homogenous and isotropic when the two hemispheres are compared.

Discussion

Can we really tell if our universe is expanding using only the apparent red-shifts of distant galaxies? According to Einstein's principle of equivalence we cannot tell the difference between gravitation and uniform acceleration. Therefore, we could explain at least a part of the observed apparent red-shift of distant galaxies in the universe as a gravitational red-shift. There is no doubt that light from distant galaxies, billions of light years away from us, undergoes gravitational impact, not only from its own source, but also from numerous other gravitational fields on its way to the observer.

If the principle of equivalence is true, and if a significant part of the observed red-shift of distant galaxies could be attributed to gravitational effects, then we cannot tell if the universe is expanding, contracting, or stationary by observing only the red-shift information from distant stars. Perhaps, similarly to our own and many other galaxies, the universe could also be in a perfect balance of rotation on the grand scale, without a danger of collapsing on itself, hence no need for a cosmological constant, dark energy, or anti-gravity. After all, rotation is observed in both micro-and macro-cosmos, and it would be logical to assume that it is an inherent characteristic of the universe.

In relatively small regions of the universe, such as our local group of galaxies, we can see peculiar blue-shifted galaxies due to an intense close range gravitational effect and not necessarily due to the motion of these galaxies towards us. For example, the apparent blue-shift of Andromeda could be explained by the gravitational pull of our Milky Way galaxy, which is larger and has stronger gravitation than Andromeda, effectively overriding the apparent gravitational effect of Andromeda on its own light. Andromeda would be expected to appear red-shifted for most other observers in distant galaxies, which is in agreement with our own observation of other parts of the universe.

Even in the absence of any motion, all distant galaxies would invariably appear as red-shifted for all observers due to galactic gravitational impact on their own light. The gravitational impact could be expected to weaken with distance, leading to gradual elongation of light spectra. The observed cosmic microwave background (CMB) radiation could be a stretched visible light, representing a gravitational signature of galaxies and larger cosmological structures beyond the observable visible light universe. CMB is apparently an inherent characteristic of our universe and is probably defined by the overall gravitational field of the largest cosmological structures, spreading their influence through the entire universe.

Perhaps, visible light cannot travel long distance without a change, and is gradually converted into longer wavelength radiation. In addition, the distance of visible light universe could be shorter than the event horizon. Under these conditions,

Olbers' paradox would not be expected to present an obstacle for a rotating or even contracting universe. Penzias and Wilson may have discovered the Olber's paradoxical bright sky when they detected the CMB radiation in the 1960s. Although we do not see visible light everywhere in the night sky, we can detect relatively homogeneous radiation outside visible spectrum, in the form of CMB, in all directions day and night. Therefore, it could be that the Olber's principle not only fails to make a contracting or a rotating universe impossible, but it actually appears to be confirming the possibility of their very existence.

It would be logical to assume that the first principle of thermodynamics (i.e., conservation of energy) applies to the universe as a whole. In other words, the universe must have its own "economy". In a system dominated by gravity, such as the universe on a large scale, there are likely three main forms of energy: kinetic, potential, and "convertible mass-nuclear" energy. These three forms of energy are likely in historical "competition" for prevalence, and each one would be expected to have its own relatively brief time of absolute "reign". At the time of assumed "singularity", the entire energy of the universe may have existed as "convertible mass-nuclear" energy. However, the universe that we observe today is likely "powered" by neither sole kinetic, sole potential, nor sole "convertible mass-nuclear" energy, but rather exists in balance of these three energy forms. It is only a question of which way the balance is shifted in a particular time frame.

In an expanding universe, which would likely be only a phase in its life-cycle, characterised by deceleration of particles, the kinetic energy of particles/photons moving from the centre of origin would gradually decrease over time, giving way to the increasing potential energy until the point of equilibrium. At equilibrium, expansion would be terminated and converted into an accelerating contraction, which would initiate a new phase in the cycle.

Most matter in the expansion phase of the universe life-cycle was likely in the form of primordial elementary particles, which could have travelled at speeds exceeding the speed of light. It would be anyone's guess how long it took the universe to complete its expansion phase. However, it is unlikely that any large-scale structures of the universe could have been formed during the expansion phase. Stars, galaxies, and galactic clusters, as we observe them today are more likely to be formed during the contraction phase of the universe life-cycle.

In a closed system, expanding universe could exist only in deceleration, as acceleration would require an energy source from outside. On the other hand, a universe in accelerating expansion would not constitute a true universe, but rather only a part of a larger open system structure, which would then remain to be defined. If it is the vacuum energy that drives the generally accepted accelerating expansion (inflation), then where did the energy come from to force the universe to collapse in the first place, resulting in the development of an enormous vacuum potential? Was it "antigravity" that had to be overcome, or are the basic principles of gravitation sufficient to explain what we see today, as a simple loss of accumulated potential energy and collapse due to gravitational pull from the centre of origin?

With relatively rare exceptions, where distant galaxies have blue-shift and appear to be moving towards us (i.e., z-values less than 0), red-shift of light spectra is a characteristic of almost all visible galaxies. The presence of rare blue-shifted galaxies in the visible sky, outside the Galactic plane, could be attributed to intra-cluster or intra-group motion of galaxies, or intra-galactic motion of stars and galactic rotation. According to NED database, blue-shifts have been observed only in galaxies with relatively small absolute z-values, ranging from approximately -1×10^{-6} to -0.01 .

However, the fact that Andromeda Galaxy (M31) and some members of the "local group" exhibit a small blue-shift, and that Sagittarius Dwarf is slowly being ripped apart by our own galaxy, cannot be clearly explained using the assumptions of the Standard model. For example, how the generally accepted "bubbling" process, which is expected to cause the distance between individual galaxies to increase, as more space is continually being added between them, selectively chose to ignore some of the members of our "local group"? How galaxies continue to form groups, clusters and super-clusters? This would be impossible if the space between all distant galaxies is continually increasing.

The true laws of physics must be universal, and logically must apply equally to all parts of the universe. Why would we chose to believe what we can barely see in deep space, rather than what we can clearly see on Earth, within the Solar system, within the Milky Way, and in our own galactic "back yard"? Although often tempted, we may not need to invent new laws/principles of physics, to be able to solve some general cosmological problems. Some of our currently accepted theories, however, may need to be changed in light of new observational evidence. However, theoretical physicists should take into consideration not only observable celestial objects, but also the objects that cannot be observed. In other words, it is not only what we can, but also what we cannot see that matters.

It should be noted that high density of stars and interstellar dust within the latitude bands of approximately 10 to 20 degrees along the equatorial plane of the Milky Way, the *zone of avoidance*, obscures our view of distant stars and other galaxies [2, 6, 7]. Although some progress was made with advanced technologies in cosmic observation, it is not possible

to clearly observe many galaxies surrounding the Milky Way, and particularly those within the Galactic plane, to establish their red-shift/blue-shift values.

According to the generally accepted inflationary expansion theory, at some initial stages after the “big bang”, expansion of the universe had to slow down to allow aggregation of cosmic matter and dust into larger entities and later into stars and galaxies. To adjust the theory for experimental evidence, it was suggested that the universe must have switched at some point from a simple expansion to an inflationary (accelerating) expansion [1, 2, 3]. However, even if we decided to accept the current cosmological concept of an accelerating expansion, there would still be a possibility for an alternative interpretation of the available observational evidence. Described below is an alternative concept of a contracting universe.

An alternative cosmological model

The universe could be originating from the “Big Bang”, as an initial expansion phase of the universe life-cycle. As gravity gradually prevailed, the universe terminated its expansion and began its contraction phase, allowing primordial particle interaction, and formation of cosmic dust, galaxies, galactic groups, clusters, and larger cosmological structures. Spontaneous particle interactions and accretion could be considered as natural and statistically more likely to occur in a contracting, rather than in an expanding universe.

Considering available observational evidence and assuming, for the purpose of this model, that the red-shifts of distant galaxies are almost entirely attributable to acceleration, the universe could be explained using the following hypothetical model:

1 The universe is currently in its contraction phase, with all matter heading with acceleration towards the gravitational center of origin.

2 The Milky Way galaxy and other galaxies of the universe are moving towards the gravitational centre of origin in the direction approximately perpendicular to their rotation planes.

3 As a result of gravitational acceleration, galaxies that have started their motion towards the center of origin earlier in time would have gained greater speed relative to younger galaxies. Therefore, from any referent system in the universe, all visible galaxies of different age would appear to be moving away from the observer and from each other.

4 Galaxies of the same age would be found within the same plane of universal contraction, perpendicular to the gravitational center of origin, and having negative red-shift values (i.e., blue-shifts) would appear to be moving towards the observer. Although there is no observational evidence of such formations in the visible universe, a very fine line/circle of blue-shifted galaxies millions of light years away from us would be quite hard to detect among billions of galaxies with clear red-shifts. The probability of looking in the right direction would be very small. Finding this fine line of “blue” galaxies would be necessary to support the proposed model of contraction. However, due to the *zone of avoidance*, we are currently unable to clearly observe many distant galaxies within the Galactic plane, where blue-shifted galaxies would be expected to occur in a very fine “blue-line” formation on the horizon.

5 Galaxies observed outside the “blue line” would be of different age, would appear to move away from the observer, and would have positive red-shift values, exactly as it is observed today for almost all visible galaxies.

6 It may not be possible to observe galaxies beyond the hypothetical center of contraction. The universe could be so large, thus preventing us from observing the galaxies even remotely close to the center of contraction.

7 The overall density of distant galaxies and their rotation velocities would appear to increase towards the gravitational centre of origin, and to decrease in the opposite direction. The increase of density would also be expected to lead to an increased number of galactic groups and clusters as galaxies become closer to each other, allowing the formation of more complex structures.

8 The currently observed phenomenon of generally accepted accelerating expansion could be regarded as equivalent to a simple gravitational accelerating contraction (i.e., free fall).

Although the observed galactic planes of galaxies in deep space appear to be randomly distributed, and not necessarily parallel to the plane of our Milky Way, it is quite possible that visual appearance of distant galaxies billions of light-years away from the observer may depend on the angle of observation within the three- or four-dimensional space. In addition,

this alternative cosmological model does not exclude possibility that galaxies, including our Milky Way, undergo rotational fluctuations and deviations from the currently observed planes of rotation. In fact, similar rotational plane/axis fluctuations have been observed for the Earth and were measured accurately by Milutin Milanković in his study of the insolation and the ice ages, also known as Milanković's cycles [8]. Therefore, our Milky Way could currently be in a phase of rotational plane fluctuation with an insufficient axis tilt from the assumed theoretical plane of universal contraction, effectively preventing us from observing other galaxies (i.e., hypothetical "blue" galaxies) within the same theoretical plane, due to the thickness of its vast number of stars and interstellar dust, the *zone of avoidance*.

Cosmic Microwave Background Radiation

The available cosmic microwave background (CMB) radiation data indicate the presence of both dipole and multi-pole anisotropies [9, 10]. The map of CMB values shows a polar nature of this radiation, with a "hot-region" in the Northern and a "cold-region" in the Southern Galactic hemisphere [11, 12]. This dipole has been attributed to the motion of the solar system relative to the cosmological reference frame [13]. However, the Doppler effect resulting from the solar system motion through the space creates such a strong dipole that it simply swamps out any underlying small cosmological dipole. If a true cosmological dipole exists, could it be due to primordial early universe fluctuations in the dark matter-baryon-photon fluid, as it has been suggested [9], or could it be related to the universal contraction? It is interesting that the observed CMB "hot-region" coincides with the direction of contraction, as proposed in this study.

Conclusions

Statistical analyses of astronomical data considered in this study indicate that there are greater numbers of identified galactic groups and clusters in the Northern than in the Southern Galactic hemisphere. The maximum rotation velocities (Log10 of maximum velocities expressed in km/s) of distant galaxies are in positive correlation with Galactic latitude across the Galactic axis ($p=0.001$). In addition, the mean of maximum log10 rotation velocities for distant galaxies in the Northern is statistically greater than in the Southern Galactic hemisphere ($p=0.0049$), and both the maximum and the median log10 values are greater in the Northern Galactic hemisphere. This indicates that the universe does not appear to be perfectly homogenous and isotropic in all directions.

The overall results of regression and correlation analyses provide evidence in support of the hypothetical accelerating contraction model. The Milky Way appears to be moving Northerly towards the gravitational centre of origin. The galaxies in the Northern hemisphere appear to be older and larger, resulting in greater rotation velocities when compared to the galaxies in the Southern hemisphere.

Apparently, we have no other means of knowing whether distant galaxies are moving away from us, but to measure their red-shifts. Theoretically, we could be observing just a gravitational red-shift or a combination of gravitational and acceleration related red-shift effects. If a galaxy is not moving relative to the observer, then we would probably be able to measure only the red-shift resulting from its gravitational field. However, it is not certain if the red-shift would not increase with increased distance to the observer, as the gravitational field gradually weakens. Our historical cosmological experiments with spectral characteristics of light are constrained to relatively short distances of several light-minutes within our solar system, where we are hoping to maintain better control of our experimental techniques. However, having in mind Einstein's principle of equivalence, even with accurately measured red-shifts of distant galaxies, it would be difficult to establish how significant or negligible gravitational red-shifts would be relative to the red-shifts resulting from their assumed motion, especially when they are not light-minutes but rather up to billions of light-years away from us.

The results of this study are limited by the quality of currently available astrophysical/cosmological data. Many low luminosity galaxies are not possible to clearly observe and, therefore, measured physical parameters from such galaxies may not be sufficiently accurate to allow us to make general conclusions.

Although our universe could still be expanding, rotating, or even contracting, we have no sufficient scientific evidence to accept a particular model as valid at this time. Limitations and uncertainties associated with our study of the universe should be duly acknowledged.

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