MOLECULES CAN EXPLAIN THE EXPANSION OF THE UNIVERSE

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ABSTRACT

The Hubble diagram continues to remain one of the most important graphical representations in the realm of astronomy and cosmology right from its genesis that depicts the velocity-distance relation for the receding large-scale structures within the Universe; it is the diagram that helps us to understand the Universe's expansion. In this paper I introduce the molecular expansion model in order to explain the expansion of the Universe. The molecular expansion model considers the large-scale structures as gas molecules undergoing free expansion into the vacuum. Large-scale structures being ensemble of atoms must behave like molecules possessing finite amount of energy. Since metric expansion of space cannot be tested practically and can only be observed indirectly due to the presence of observable entities, therefore, instead of considering the metaphysics of expanding space, the paper emphasizes upon the actual recession of large-scale structures as the most natural reason to explain the observed expansion. I show in this paper that the linear velocity-distance relation or the Hubble diagram is actually a natural and a characteristic feature of different gas molecules undergoing free expansion into the vacuum at the same time. Different gas molecules naturally have different velocities, and, molecules being natural entities provide a natural and a scientifically-viable explanation better than metaphysics. The study conducted in this paper finds the recessional behaviour of large-scale structures to be consistent with the recessional behaviour of molecules. The free expansion of different gas molecules into the vacuum of the Universe is found to be homogeneous, isotropic and in agreement with the Copernican principle. Redshift-distance relationship has been plotted for 580 type Ia supernovae from the Supernova Cosmology Project, 7 additional high redshift type Ia supernovae discovered through the Advanced Camera for Surveys on the Hubble Space Telescope from the Great Observatories Origins Deep Survey Treasury program, and 1 additional very high redshift type Ia supernova discovered with Wide Field and Planetary Camera 2 on the Hubble Space Telescope. Redshift-distance relationship for these 588 type Ia supernovae has been analysed and the reason for the deviation of the Hubble diagram from linearity at high redshifts has been explained without acceleration by introducing the concept of differential molecular expansion.

Key words: cosmology: theory – dark energy – Hubble's law – molecular data – molecular expansion.

1 INTRODUCTION

The revolutionizing discovery by Edwin Hubble in 1929 from his observations of distant galaxies through the 100-inch Hooker telescope atop Mount Wilson in California not only proved that the Universe was expanding, but it also paved a new way for modern astronomy and cosmology. The light from all the galaxies that were being observed was found to be redshifted, indicating that the galaxies were moving away; the Universe was expanding; it was not at all "static" as was previously being considered (Einstein 1917).

Hubble obtained a linear diagram by plotting the velocity-distance relationship for the receding galaxies. It was the diagram that changed our perspective of the Universe forever – the Hubble diagram. The linear relationship obtained while plotting the Hubble diagram depicts the Hubble's law according to which the recessional velocity of a galaxy is proportional to its distance – the further away a galaxy is, the faster it is receding away from us. The slope of the straight line yields the Hubble constant which was originally denoted by Hubble by the letter *K*. The Hubble constant gives the rate of expansion of the Universe while its inverse gives the Hubble time or the age of the Universe.

The aim of this paper is to explain the expansion of the Universe on the basis of the molecular expansion model which has been introduced in Section 2. It is shown through this model that the expansion pattern of structures expanding into the Universe is similar to the pattern of different gas molecules undergoing free expansion into the vacuum. Section 3 looks into the energy that causes the recession of large-scale structures. Section 4 shows that large-scale structures recede by the virtue of the energy possessed by them. The recessional behaviour of large-scale structures is found to be in agreement with the recessional behaviour of molecules, thereby suggesting the actual recession of large-scale structures. In Section 5, I discuss that the observed redshifts exhibited by the large-scale structures are due to their actual recession rather than expansion of space between them. Section 6 brings actual gas molecules into consideration to further study the recessional behaviour of large-scale structures with expanding gas molecules; calculations show that different gas molecules undergoing free expansion into the vacuum at the same time exhibit a linear velocity-distance relation or the Hubble diagram (velocities increasing with distance). Section 7 explains the reason for the observed homogeneous distribution of large-scale structures within the Universe. Section 8 studies the deviation of Hubble diagram from linearity at high redshifts and explains the deviation without acceleration, while Section 9 introduces the concept of differential molecular expansion to prove the reason for the deviation of the Hubble diagram from linearity at high redshifts without acceleration.

2 EXPANSION OF THE UNIVERSE AND THE EXPANSION OF GAS MOLECULES: THE MOLECULAR EXPANSION MODEL

Certain questions that should undoubtedly arise while looking at the Hubble diagram are – why is the Hubble diagram linear? Or more importantly, why do velocities increase with distance? There has to be a practical mechanism behind the working of the Hubble diagram. The Hubble diagram and therefore the expansion of the Universe can be explained practically if we consider the large-scale structures as different gas molecules undergoing free expansion into the vacuum. Since gas molecules expand into the vacuum by the virtue of the energy possessed by them instead of energy being possessed by empty space, therefore, we can expect the same from the large-scale structures expanding into the Universe as well (large-scale structures being constituted by atoms and molecular matter have utmost probability of possessing energy instead of energy being possessed by empty space). Also, gas molecules undergo actual expansion instead of space undergoing expansion between them. It is because we understand the exact mechanism of molecular expansion that we refrain from saying that space between the molecules is expanding.

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Being unable to explain the expansion of different gas molecules into the vacuum of the Universe (an expansion where velocities happen to increase with distance) one would readily put forward the concept of expanding space and the analogy of raisin bread to explain such expansion, however, in this case, saying that molecules are stationary while the distance between them is increasing due to expansion of space would not at all be accepted by the scientific community. So why is the vague concept of expanding space being used to explain the expansion of structures into the Universe?

3 ENERGY THAT CAUSES A LARGE-SCALE STRUCTURE TO RECEDE

The energy possessed by an object moving with velocity v is given as,

$$E = \frac{1}{2}mv^2 \tag{1}$$

Equation (1) can be expressed in terms of velocity as,

$$v = \sqrt{\frac{2E}{m}} \tag{2}$$

Equation (2) suggests that an object possessing sufficient amount of energy will recede with certain velocity. This is exactly what we practically observe for a molecule. Equation (2) is in agreement with the actual velocity equations for gas molecules as given by equation (4) and equation (5). If a large-scale structure possesses sufficient amount of energy (Section 4), then such structure will recede with certain velocity according to equation (2).

In an environment where gravitational force is stronger, the energy possessed by an object will not cause the object to recede as gravitational force takes over; a molecule, however, is an exception. Since the mass of a molecule is minuscule, therefore, a molecule is not influenced "significantly" by gravitational force; the energy possessed by a molecule turns out to be greater than the gravitational force acting upon it, and therefore the molecule recedes solely by the virtue of the energy possessed by it at a particular temperature.

In the absence of any other mass located nearby, the only source of gravitational force acting amongst different gas molecules during their expansion into the vacuum of the Universe would be due to the mass of those molecules. However, this gravitational force acting amongst the molecules is feeble as compared to the energy possessed by the molecules by the virtue of which they expand away from each other into the vacuum.

Similarly, since large-scale structures (those separated by large distances) are observed to be receding away from every other structure, therefore, the gravitational influence amongst them has to be weaker than the energy possessed by those structures by the virtue of which they expand away from each other into the Universe.

4 THE ENERGY POSSESSED BY A LARGE-SCALE STRUCTURE

Large-scale structures behaving like expanding gas molecules would be receding by the virtue of the energy possessed by them instead of energy being possessed by empty space. For an approximation, a "baryonic" galaxy cluster with mass of 2 x 10^{15} $M_\odot$ (4 x 10^{45} kg) can ideally be considered. From this mass we obtain the total number of protons making the cluster to be 2.3914 x 10^{72}.

The temperature of massive galaxy clusters is dominated by the extremely hot intracluster medium (ICM) at 10^8 K. The energy per molecule is given as,

$$E = \frac{3}{2}kT \tag{3}$$

where k is the Boltzmann constant and T is the temperature. Using this equation, the energy per proton corresponding to a temperature of 10^8 K turns out to be 2.0709 x 10^{-15} J, therefore, the total energy possessed by this galaxy cluster equates to 4.9523 x 10^{57} J.

With this much amount of energy being possessed by the cluster, its recessional velocity according to equation (2) will be 1.5736 x 10^6 m s^{-1}. This is just an approximation. For comparison, the recessional velocity of Norma Cluster is 4.707 x 10^6 m s^{-1} (NED 2006 results). Higher recessional velocities are also possible if the energy possessed by the large-scale structure is sufficiently large and the mass is less. For instance, for a 2 x 10^{15} $M_\odot$ (4 x 10^{45} kg) galaxy cluster to exhibit recessional velocity of 7 x 10^6 m s^{-1}, the energy possessed by it must be 9.8 x 10^{58} J. On the other hand, for a 10^{10} $M_\odot$ (2 x 10^{40} kg) galaxy or a quasar to exhibit an equal recessional velocity of 7 x 10^6 m s^{-1}, the energy possessed by them must be 4.9 x 10^{53} J (2 x 10^5 times less energy than the energy possessed by the massive galaxy cluster).

It is always observed that the highest recessional velocities are exhibited by the most distant galaxies and quasars and not by galaxy clusters as evident from their redshifts. Galaxy clusters being extremely massive are unable to efficiently utilize the energy possessed by them to exhibit such high recessional velocities as those exhibited by such distant galaxies and quasars which comparatively are very much less massive than galaxy clusters (a massive structure will recede faster than a lighter structure only if the energy possessed by it is high enough). This is in perfect agreement with the recessional behaviour of molecules according to the kinetic theory of gases – a lighter molecule recedes faster as compared to a massive molecule even when they both possess an equal amount of energy (see Table 2; Figure 2 and Table 3; Figure 3). A lighter molecule will therefore cover a larger distance with time as compared to the massive molecule; a lighter molecule will therefore become the most distant molecule as compared to the massive molecule (see Figures 2 to 6). Galaxies and quasars being less massive than galaxy clusters exhibit higher recessional velocities and therefore they manage to become the most distant structures within the observable Universe. This recessional behaviour of large-scale structures being consistent with the recessional behaviour of molecules suggests the actual recession of large-scale structures and confirms the molecular expansion model to some extent.

5 REDSHIFT: COSMOLOGICAL OR DOPPLER?

Large-scale structures are believed to be embedded into the ever-expanding fabric of space. Expansion of space causes the distance between the structures to increase (metric expansion of space) and the wavelength of light emitted by them to get "stretched" (cosmological redshift). Such belief involving the concept of metric expansion of space arises undoubtedly due to special relativity that restricts superluminal (faster-than-light) recessional velocities. However, according to Davis and Lineweaver (2004), "it is well accepted that general relativity, not special relativity, is necessary to describe cosmological observations". Furthermore, according to Chodorowski (2007), "we know that, as he was constructing GR, Einstein was greatly influenced by the thoughts of German physicist and philosopher Ernst Mach. In the words of Rindler (1977), for Mach 'space is not a 'thing' in its own right; it is merely an abstraction from the totality of distance-relations between matter'. Therefore, the idea of expanding space 'in its own right' is very much contrary to the spirit of GR".

All large-scale structures exhibiting redshift suggest that they all are receding away from us, and, since we are not located in any special or preferred place (center of expansion), every large-scale structure has to be receding away from every other structure as well. This provides very compelling evidence in favour of metric expansion of space between them. Furthermore, an expansion that is homogeneous (looks same at every location), isotropic (looks same in every direction) and in agreement with the Copernican principle (no preferred center) also confirms metric expansion of space. Recessional velocity of large-scale structures being proportional to their distance (Hubble's law) is also a characteristic feature of metric expansion of space. However, it is shown in this paper that free expansion of different gas molecules into the vacuum of the Universe also exhibits such remarkable features without considering metric expansion of space.

If the large-scale structures are actually receding away from each other, just like expanding gas molecules, then the light emitted by them would still undergo redshifting due to the involvement of actual recession rather than expansion of space between them (Doppler redshift). In fact, Bunn and Hogg (2009) have found that the redshifts are kinematic (Doppler redshifts) and not cosmological; according to them, the most natural interpretation of the redshift is kinematic. Regarding the concept of "expanding space", in the words of Milne (1934), "This concept, though mathematically significant, has by itself no physical content; it is merely the choice of a particular mathematical apparatus for describing and analysing phenomena".

The concept of expanding space is explained by considering certain analogies. Some of the very popular and dominant analogies that try to explain the expansion of the Universe include, expanding loaf of raisin bread, stretching rubber sheet, inflating balloon, and so on. Although these analogies provide a theoretical insight or an overview to explain the observed expansion of the Universe, these analogies are not scientifically-appealing in any way. The phrase, "metric expansion of space" is extensively used in the cosmic literature, however, the exact mechanism behind such expansion remains unexplained. According to Francis et al. (2007), "the very meaning of the phrase expanding space is not rigorously defined despite its widespread use in teaching and textbooks. Hence, it is prudent to be wary of predictions based on such a poorly defined intuitive frameworks".

My observation that questions the concept of metric expansion of space comes from the low redshifts of remote supernovae given their larger-than-expected distances from us (Figure 9). According to the well-accepted concept of metric expansion of space, the more the space between the distant object and the observer, the higher will be the observed redshift as light has to travel through more "stretched" space. "Light is stretched as the Universe expands, The Further an object is away, the more the Universe has expanded, so the more the light is stretched to the Red", Schmidt (2011 Nobel Prize Lecture in Physics). Larger-than-expected distances to the remote supernovae in Figure 9 clearly indicate more-than-expected "stretched" space between them and the local observer due to acceleration (according to accelerating expansion, the Universe has expanded more in the last half of its life, the distances to the remote supernovae are therefore larger than expected and they appear 10% to 25% dimmer as compared to the nearby local supernovae). Since the distances between the local and the remote supernovae are larger than expected due to acceleration and not the distances amongst the local supernovae, therefore, why is the observed redshift of remote supernovae not adequately high enough at such large distances if more-than-expected space has stretched between them and the local observer in the last half of Universe's life due to acceleration?

The value of slope and hence the expansion rate for remote supernovae being much lower than the value of slope and hence the expansion rate for local supernovae would make one rightfully say that remote Universe is expanding slowly as compared to the local Universe. However, Section 8 and Section 9 unravel why remote supernovae, as compared to local supernovae, are further away than expected and yield a lower value of slope suggesting a slower rate of expansion, or deceleration.

6 PLOTTING THE GAS MOLECULES

A spherical enclosure enclosing different gas molecules is placed at some location within the emptiness of the Universe (different gas molecules ensure that every molecule will have a unique and essentially non-overlapping velocity profile). To ensure that gas molecules expand freely in every direction, imagine that the enclosure disappears or becomes perfectly permeable to the gas molecules at time t = 0. As soon as this happens, in an instant, the gas molecules will expand freely in every direction into the vacuum of the Universe (Figure 10). Since different gas molecules naturally exhibit different velocities, therefore, every gas molecule will cover a unique distance by the virtue of its unique and essentially non-overlapping velocity profile once the molecular expansion process is initiated – this will completely eliminate the collision probability between the gas molecules; the collision probability will be exactly zero once the distance between the molecules becomes significantly large over time as molecular expansion process proceeds (Figure 10 C).

With such arrangement available, eleven gas molecules, right from Hydrogen to Radon have been considered to prove the molecular expansion model. The mass of gas molecules has been obtained in Table 1. The mass of molecules increases from Hydrogen onwards; Hydrogen being the least massive molecule, whereas Radon being the most massive molecule. Hydrogen molecule can therefore be considered analogous to a galaxy or a quasar, whereas Radon molecule can be considered analogous to a massive galaxy cluster. All these gas molecules are initially contained before they are allowed to expand freely into the vacuum of the Universe. The gas molecules will expand freely and recede into the vacuum by the virtue of the energy possessed by them at particular temperature as given by equation (3), while their recessional velocity due to the energy possessed by them is given by equation (2). Equation (2) is in agreement with the actual velocity equations for gas molecules given as,

$$v = \sqrt{\frac{3RT}{M}} \tag{4}$$

and,

$$v = \sqrt{\frac{3kT}{m}} \tag{5}$$

where R is the gas constant, T is the temperature, M is the molecular mass (kg mol^{-1}) of the gas, that is, M/1000 (see M from Table 1), k is the Boltzmann constant and m is the mass of the molecule in kg.

In Table 2, all gas molecules are at same temperature of 303 K, the energy possessed by every molecule will therefore be equal. The recessional velocity of the molecules is obtained from equation (2) and the distance covered by them in 1 second (observation/expansion time) has been calculated. In Table 3, all molecules are still at the same temperature of 303 K, however, the observation time has been increased to 60 seconds. In Table 4, the observation time is 1 second, and every molecule is at a different temperature, therefore, the energy possessed by every molecule will also be different, although not by a significant amount since the temperature difference between the molecules is not large enough. In Table 5, every molecule is still at a different temperature, however, the observation time has been increased to 60 seconds. In Table 6, the observation time is 60 seconds, and every gas molecule is subjected to a very high temperature. It is also ensured in this case that the temperature difference between the molecules is large enough so that the energy possessed by every molecule is different by a significant amount as compared to the previous settings.

Based upon calculations (Table 2 to Table 6), the velocity-distance relationship for different gas molecules undergoing free expansion has been plotted (Figure 2 to Figure 6). The linear velocity-distance relation obtained for different gas molecules undergoing free expansion is similar to the linear velocity-distance relation obtained for large-scale structures according to the Hubble diagram (depiction of Hubble's law, Figure 1). According to the Hubble's law, the recessional velocity of a large-scale structure is proportional to its distance – the further away a large-scale structure is, the faster it is receding away from us. Therefore, according to the Hubble's law,

$$v = H \text{ x } D \tag{6}$$

and,

$$D = \frac{v}{H} \tag{7}$$

where v is the recessional velocity of the large-scale structure, D is its distance from us and H is the Hubble constant. The inverse of the Hubble constant ($1/H$) gives us the Hubble time which is the age of the Universe.

All of this is found to be obeyed by the expanding gas molecules under consideration. From the tables (Table 2 to Table 5) and figures (Figure 2 to Figure 5), it can be seen that the highest recessional velocity is exhibited by the Hydrogen molecule, followed by the Helium molecule, whereas the lowest recessional velocity is found to be exhibited by the Radon molecule. Hydrogen molecule being less massive exhibits higher recessional velocity as compared to the massive Radon molecule (according to scientific logic and reasoning that also happens to be consistent with the kinetic theory of gases, the fastest molecule will be the furthest molecule, the second fastest molecule will be the second furthest molecule – velocities will therefore be increasing with distance. It is practically impossible for the slowest molecule to be the furthest molecule during free expansion; this is extremely simple to comprehend even without calculations. Velocity increasing with distance is therefore a characteristic and a natural feature of different gas molecules undergoing free expansion into the vacuum).

In Table 6; Figure 6, the highest recessional velocity is still being exhibited by the Hydrogen molecule. Helium which previously remained the second fastest receding molecule behind Hydrogen has been replaced by Nitrogen. Similarly, Radon which previously remained the slowest receding molecule has been replaced by Xenon. Such change has occurred due to the involvement of large temperature differences. Such large differences in temperature influence the energy possessed by the molecules, thereby affecting their recessional velocities too. But no matter how the data changes for the gas molecules, the molecular plots continue to remain linear. Therefore, just like the Hubble's law, the recessional velocity of different gas molecules undergoing expansion into the vacuum is proportional to their distance – the further away a molecule is, the faster it is receding away from us. The Slope of this straight line is also similar to the Hubble constant (H) (the slope of Hubble diagram) since its inverse gives us the observation time in seconds, just like the Hubble time obtained from the inverse of H. Furthermore, the following equations that are obeyed by the large-scale structures,

$$v = Slope \text{ x } D \tag{8}$$

and,

$$D = \frac{v}{Slope} \tag{9}$$

are also found to be obeyed by the expanding gas molecules. In the above equations, v is the recessional velocity of the molecules and D is the distance covered by them within the given time frame. Since the velocity-distance relationship for structures expanding into the Universe is similar to the velocity-distance relationship for different gas molecules undergoing free expansion into the vacuum of the Universe, therefore, the molecular expansion model appears to be a valid model to explain practically the expansion of structures into the Universe.

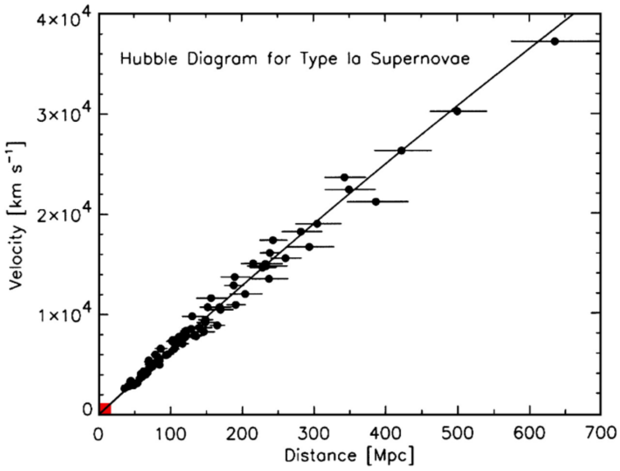


Figure 1. The Hubble diagram or the velocity-distance relationship for type Ia supernovae (compilation of type Ia supernovae by Jha (2002)). (Illustrated from Kirshner (2004) with permission from P.N.A.S. (© 2004 National Academy of Sciences, U.S.A.)). The slope of the straight line yields the Hubble constant (H). The inverse of the Hubble constant ($1/H$) gives us the age of the Universe (Hubble time). The Hubble diagram depicts the Hubble's law according to which the recessional velocity of a large-scale structure is proportional to its distance. The velocity-distance relation plots for different gas molecules undergoing expansion into the vacuum (Figure 2 to Figure 6) are exactly like the velocity-distance relationship for the large-scale structures according to the Hubble diagram; molecules receding slowly are closer, whereas the molecules receding faster are further away.

Plotting the velocity-distance relation for different gas molecules undergoing expansion is same as plotting the velocity-distance relation for the structures expanding into the Universe. If we plot the velocity-distance relation for the expanding gas molecules while being situated upon any one of the molecule that is part of the overall expansion, then we will get the Hubble diagram. It can be seen from the molecular plots that velocity of molecules is increasing with distance, therefore, no matter which molecule we would be situated upon, all other molecules will exhibit redshift – expansion in every direction.

The interpretation of the observed redshifts as Doppler shifts would not confer upon us any special place or centre of expansion, for instance, in Figure 6, since velocities are increasing with distance, therefore, being situated upon any receding molecule, say, Argon molecule, molecules such as Neon, Helium, Oxygen, Nitrogen and Hydrogen will exhibit redshift since they are receding away from the Argon molecule with recessional velocities that are higher than the recessional velocity of the Argon molecule. Similarly, molecules such as Krypton, Radon, Fluorine, Chlorine and Xenon will exhibit redshift since the Argon molecule is receding away from them with comparatively higher recessional velocity, therefore, every molecule will be exhibiting redshift, there is expansion in every direction, there is no preferred centre. This is in agreement with the Copernican principle, as well as with homogeneous and isotropic expansion.

The similar linear relationship obtained while plotting the velocity-distance relation for different gas molecules undergoing expansion is neither any coincidence nor any adjustment, it is only because the large-scale structures behave like expanding gas molecules receding by the virtue of the energy possessed by them that the velocity-distance relation plots turn out to be remarkably same.

7 HOMOGENEOUS DISTRIBUTION OF LARGE-SCALE STRUCTURES AND GAS MOLECULES DURING EXPANSION

The mass of every large-scale structure that we observe expanding into the Universe is different, however, if the energy possessed by them was equal, then their velocity-distance relation would have been in such a way, that the most distant structure would be the lightest and the fastest, whereas the structure nearest to us would be the most massive and the slowest. This can be seen in the molecular plots (Figure 2; Table 2 and Figure 3; Table 3), the mass of every molecule is different, but the energy possessed by them is equal, therefore, the mass of the molecules is decreasing with distance, while their recessional velocities are increasing with distance.

Now this is obviously not the actual case when we look at the Universe – velocities do increase with distance, but the structures are distributed homogeneously throughout the Universe irrespective of their mass. Therefore, to address why the distribution of structures within the Universe is homogeneous, we will consider the results obtained in Figure 6; Table 6. According to those results, the energy possessed by every molecule is different by a significant amount and so is their mass, therefore, during their expansion into the vacuum, the molecules get distributed homogeneously irrespective of their mass; this is consistent with actual observations. Since the energy possessed by every receding structure is different and so is their mass, therefore, we observe a homogeneous distribution of structures within the Universe.

Table 1. Mass of different gas molecules.

Gaseous Elements	Atomic Mass (A) a.m.u. or g mol^{-1}	Molecular Mass (M) a.m.u. or g mol^{-1}	Mass of Molecule (M/NA)/1000 kg
H	1.0079	2.0158	3.3473 x 10^{-27}
He*	4.0026	8.0052	1.3292 x 10^{-26}
N	14.0067	28.0134	4.6517 x 10^{-26}
O	15.9994	31.9988	5.3135 x 10^{-26}
F	18.9984	37.9968	6.3095 x 10^{-26}
Ne*	20.1797	40.3594	6.7018 x 10^{-26}
Cl	35.4530	70.9060	1.1774 x 10^{-25}
Ar*	39.9480	79.8960	1.3267 x 10^{-25}
Kr*	83.7980	167.5960	2.7829 x 10^{-25}
Xe*	131.2930	262.5860	4.3603 x 10^{-25}
Rn*	222.0000	444.0000	7.3727 x 10^{-25}

NA = 6.02214199 x 10^{23} (Avogadro constant)

Note: * marked are the non-reactive noble gases, they do not form molecules and remain in monoatomic state, however, since molecular expansion model is the emphasis of this paper, therefore, they have been considered as molecules too.

Table 2. Energy possessed by the gas molecules at same temperature of 303 K, their recessional velocities and the distance covered by them in 1 second **(Figure 2)**.

Gaseous Elements	Temperature (T) K	Energy possessed by molecule (E) J	Recessional Velocity (v) m s^{-1}	Distance covered in 1 second (D) m
H	303	6.2750 x 10^{-21}	1936.30	1936.30
He*	303	6.2750 x 10^{-21}	971.68	971.68
N	303	6.2750 x 10^{-21}	519.41	519.41
O	303	6.2750 x 10^{-21}	485.99	485.99
F	303	6.2750 x 10^{-21}	445.98	445.98
Ne*	303	6.2750 x 10^{-21}	432.73	432.73
Cl	303	6.2750 x 10^{-21}	326.48	326.48
Ar*	303	6.2750 x 10^{-21}	307.56	307.56
Kr*	303	6.2750 x 10^{-21}	212.36	212.36
Xe*	303	6.2750 x 10^{-21}	169.65	169.65
Rn*	303	6.2750 x 10^{-21}	130.46	130.46

Table 3. Energy possessed by the gas molecules at same temperature of 303 K, their recessional velocity and the distance covered by them in 60 seconds **(Figure 3)**.

Gaseous Elements	Temperature (T) K	Energy possessed by molecule (E) J	Recessional Velocity (v) m s^{-1}	Distance covered in 60 seconds (D) m
H	303	6.2750 x 10^{-21}	1936.30	116178.0
He*	303	6.2750 x 10^{-21}	971.68	58300.8
N	303	6.2750 x 10^{-21}	519.41	31164.6
O	303	6.2750 x 10^{-21}	485.99	29159.4
F	303	6.2750 x 10^{-21}	445.98	26758.8
Ne*	303	6.2750 x 10^{-21}	432.73	25963.8
Cl	303	6.2750 x 10^{-21}	326.48	19588.8
Ar*	303	6.2750 x 10^{-21}	307.56	18453.6
Kr*	303	6.2750 x 10^{-21}	212.36	12741.6
Xe*	303	6.2750 x 10^{-21}	169.65	10179.0
Rn*	303	6.2750 x 10^{-21}	130.46	7827.6

Table 4. Energy possessed by the gas molecules at different temperature, their recessional velocity and the distance covered by them in 1 second **(Figure 4)**.

Gaseous Elements	Random Temperature (T) K	Energy possessed by molecule (E) J	Recessional Velocity (v) m s^{-1}	Distance covered in 1 second (D) m
H	306	6.3371 x 10^{-21}	1945.86	1945.86
He*	310	6.4200 x 10^{-21}	982.85	982.85
N	313	6.4821 x 10^{-21}	527.91	527.91
O	305	6.3164 x 10^{-21}	487.59	487.59
F	311	6.4407 x 10^{-21}	451.83	451.83
Ne*	303	6.2750 x 10^{-21}	432.73	432.73
Cl	308	6.3786 x 10^{-21}	329.16	329.16
Ar*	312	6.4614 x 10^{-21}	312.09	312.09
Kr*	304	6.2957 x 10^{-21}	212.71	212.71
Xe*	307	6.3578 x 10^{-21}	170.76	170.76
Rn*	309	6.3993 x 10^{-21}	131.75	131.75

Table 5. Energy possessed by the gas molecules at different temperature, their recessional velocity and the distance covered by them in 60 seconds **(Figure 5)**.

Gaseous Elements	Random Temperature (T) K	Energy possessed by molecule (E) J	Recessional Velocity (v) m s^{-1}	Distance covered in 60 seconds (D) m
H	306	6.3371 x 10^{-21}	1945.86	116751.6
He*	310	6.4200 x 10^{-21}	982.85	58971.0
N	313	6.4821 x 10^{-21}	527.91	31674.6
O	305	6.3164 x 10^{-21}	487.59	29255.4
F	311	6.4407 x 10^{-21}	451.83	27109.8
Ne*	303	6.2750 x 10^{-21}	432.73	25963.8
Cl	308	6.3786 x 10^{-21}	329.16	19749.6
Ar*	312	6.4614 x 10^{-21}	312.09	18725.4
Kr*	304	6.2957 x 10^{-21}	212.71	12762.6
Xe*	307	6.3578 x 10^{-21}	170.76	10245.6
Rn*	309	6.3993 x 10^{-21}	131.75	7905.0

Table 6. Energy possessed by the gas molecules at high temperature with large differences in temperature, their recessional velocity and the distance covered by them in 60 seconds **(Figure 6)**.

Gaseous Elements	Random Temperature (*T*) K	Energy possessed by molecule (*E*) J	Recessional Velocity (*v*) m s^{-1}	Distance covered in 60 seconds (*D*) m
H	1000	2.0709 x 10^{-20}	3517.60	211056.0
He*	2000	4.1419 x 10^{-20}	2496.43	149785.8
N	10000	2.0709 x 10^{-19}	2983.93	179035.8
O	9000	1.8638 x 10^{-19}	2648.64	158918.4
F	900	1.8638 x 10^{-20}	768.62	46117.2
Ne*	8000	1.6567 x 10^{-19}	2223.52	133411.2
Cl	800	1.6567 x 10^{-20}	530.48	31828.8
Ar*	9000	1.8638 x 10^{-19}	1676.20	100572.0
Kr*	10000	2.0709 x 10^{-19}	1219.96	73197.6
Xe*	700	1.4496 x 10^{-20}	257.85	15471.0
Rn*	15000	3.1064 x 10^{-19}	917.97	55078.2

Table 7. Energy possessed by the gas molecules at high temperature with large differences in temperature, their recessional velocity and the distance covered by them during differential molecular expansion **(Figure 7)**.

Gaseous Elements	Random Temperature (*T*) K	Energy possessed by molecule (*E*) J	Recessional Velocity (*v*) m s^{-1}	Observation time (*t*) Seconds	Distance covered in (*t*) seconds (*D*) m
H	1000	2.0709 x 10^{-20}	3517.60	1.9	6683.44
N	10000	2.0709 x 10^{-19}	2983.93	1.8	5371.074
O	9000	1.8638 x 10^{-19}	2648.64	1.7	4502.688
He*	2000	4.1419 x 10^{-20}	2496.43	1.6	3994.288
Ne*	8000	1.6567 x 10^{-19}	2223.52	1.5	3335.28
Ar*	9000	1.8638 x 10^{-19}	1676.20	1.4	2346.68
Kr*	10000	2.0709 x 10^{-19}	1219.96	1.3	1585.948
Rn*	15000	3.1064 x 10^{-19}	917.97	1.2	1101.564
F	900	1.8638 x 10^{-20}	768.62	1.1	845.482
Cl	800	1.6567 x 10^{-20}	530.48	1.0	530.48
Xe*	700	1.4496 x 10^{-20}	257.85	1.0	257.85

Table 8. Energy possessed by the gas molecules at high temperature with large differences in temperature, their recessional velocity and the distance covered by them during differential molecular expansion **(Figure 8)**.

Gaseous Elements	Random Temperature (*T*) K	Energy possessed by molecule (*E*) J	Recessional Velocity (*v*) m s^{-1}	Observation time (*t*) Seconds	Distance covered in (*t*) seconds (*D*) m
H	1000	2.0709 x 10^{-20}	3517.60	1.9	6683.44
He*	2000	4.1419 x 10^{-20}	2496.43	1.8	4493.574
N	10000	2.0709 x 10^{-19}	2983.93	1.7	5072.681
O	9000	1.8638 x 10^{-19}	2648.64	1.6	4237.824
F	900	1.8638 x 10^{-20}	768.62	1.5	1152.93
Ne*	8000	1.6567 x 10^{-19}	2223.52	1.4	3112.928
Cl	800	1.6567 x 10^{-20}	530.48	1.3	689.624
Ar*	9000	1.8638 x 10^{-19}	1676.20	1.2	2011.44
Kr*	10000	2.0709 x 10^{-19}	1219.96	1.1	1341.956
Xe*	700	1.4496 x 10^{-20}	257.85	1.0	257.85
Rn*	15000	3.1064 x 10^{-19}	917.97	1.0	917.97

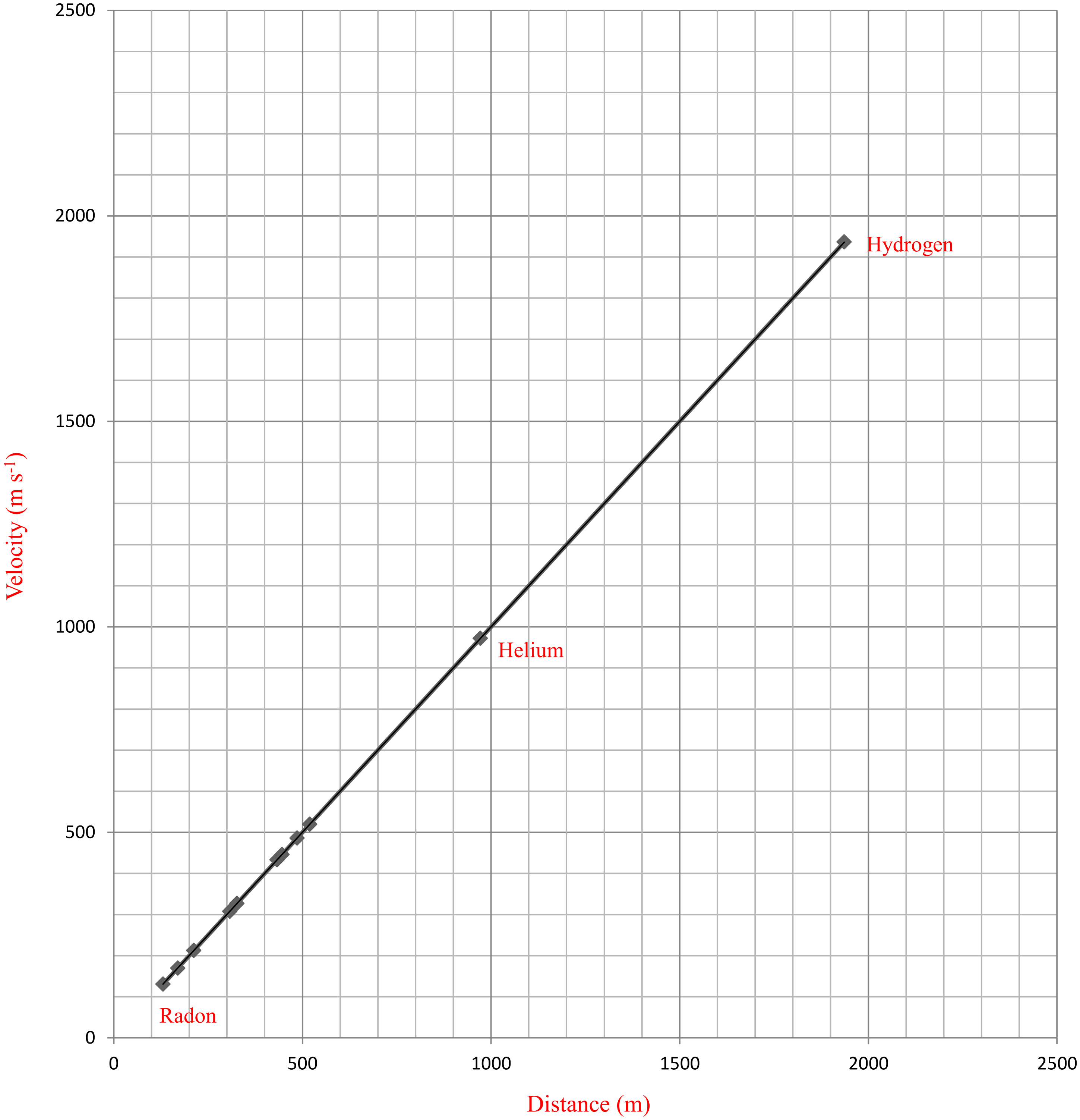


Figure 2. Velocity-distance relationship for molecules expanding at same temperature (303 K). Observation time = 1 second **(Table 2)**

(Calculated Slope = 1 m s^{-1} m^{-1} or 1 s^{-1})

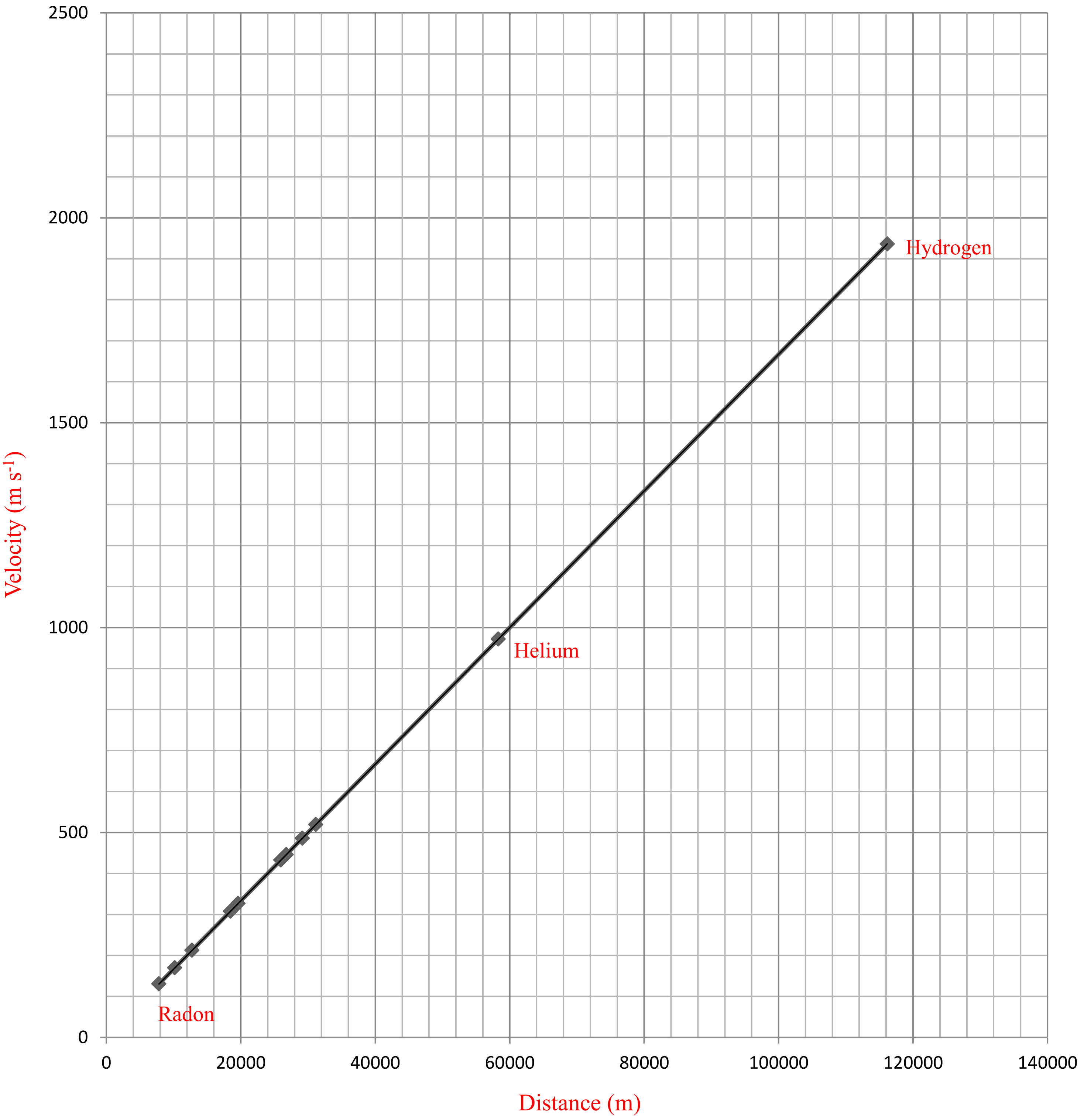


Figure 3. Velocity-distance relationship for gas molecules expanding at same temperature (303 K). Observation time = 60 seconds **(Table 3)**

(Calculated Slope = 0.016666666 m s^{-1} m^{-1} or 0.016666666 s^{-1})

In Figure 2, after 1 second of free expansion, the distance between the two molecules, Hydrogen and Helium is 964.62 m, whereas in Figure 3, after 60 seconds, the distance between them is 57,877.2 m. It appears that as time progressed, the space between these two molecules, in fact, the space between all other molecules as well, underwent an expansion; there is more space between the molecules after 60 seconds than was previously after 1 second. However, from a practical perspective, it is the freely expanding gas molecules that begin to occupy more space and therefore more volume as time progresses due to their own expansion into the prevailing emptiness – a characteristic feature of molecules undergoing free expansion. This is exactly similar to what we observe for the large-scale structures expanding into the Universe as well; the distance between them is increasing over time. The Slope of the molecular plots decreases as time progresses, but no matter how the Slope changes, its inverse gives back the original observation time in seconds.

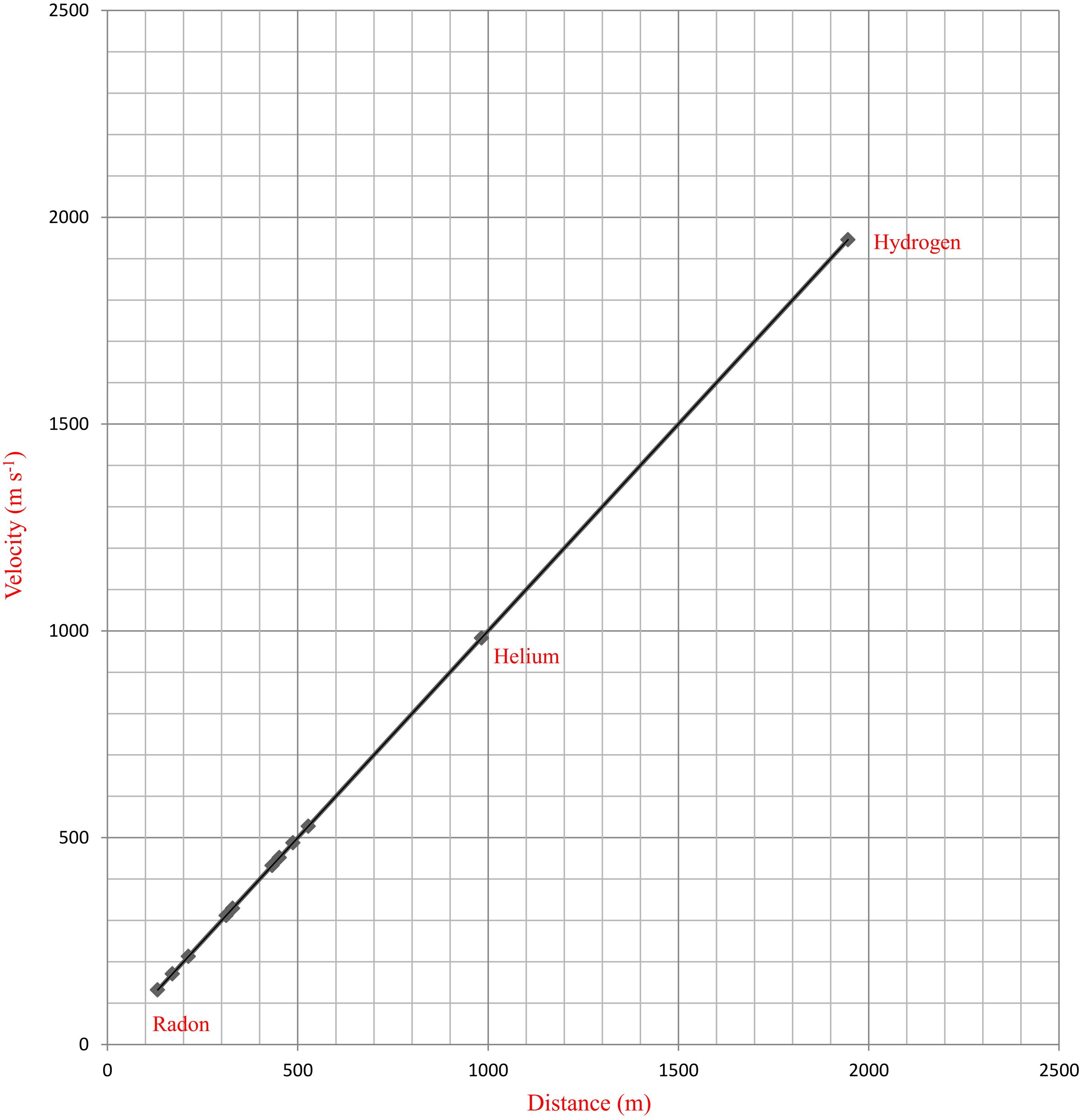


Figure 4. Velocity-distance relationship for gas molecules expanding at different temperature. Observation time = 1 second **(Table 4)**

(Calculated Slope = 1 m s^{-1} m^{-1} or 1 s^{-1})

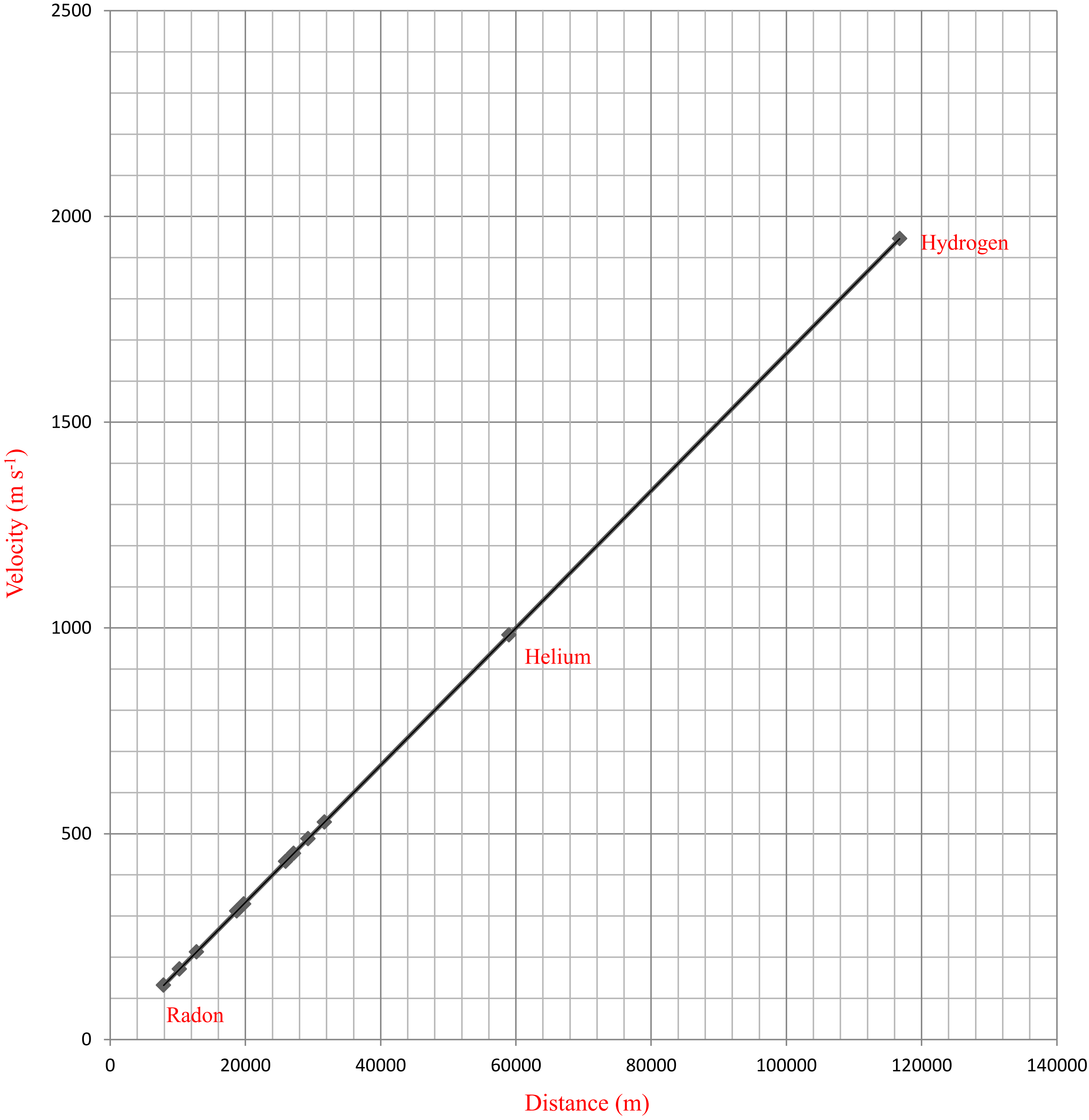


Figure 5. Velocity-distance relationship for gas molecules expanding at different temperature. Observation time = 60 seconds **(Table 5)**

(Calculated Slope = 0.016666666 m s^{-1} m^{-1} or 0.016666666 s^{-1})

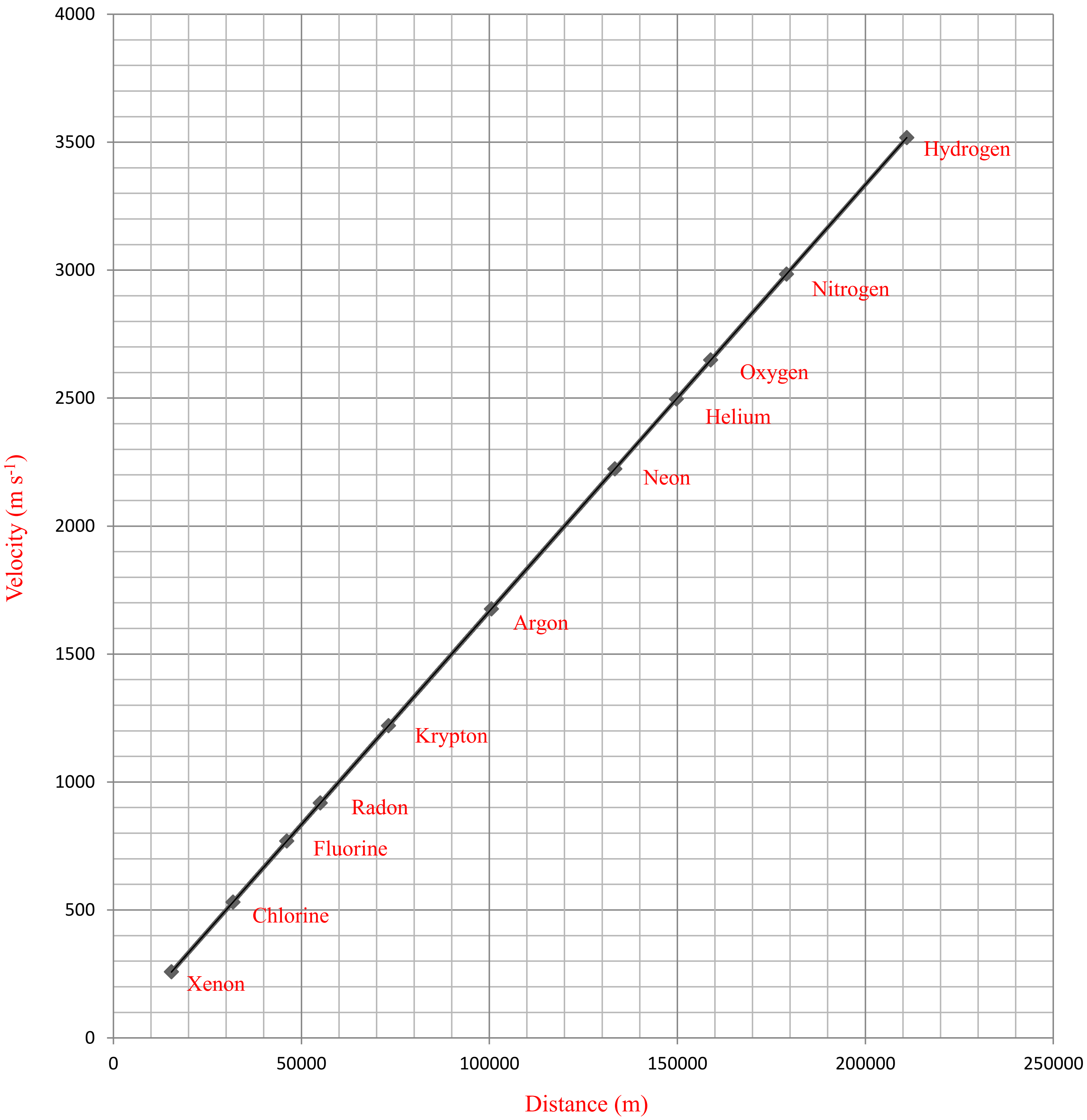


Figure 6. Velocity-distance relationship for molecules expanding at very high temperature with large differences in temperature. Observation time = 60 seconds **(Table 6)**

(Calculated Slope = 0.016666666 m s^{-1} m^{-1} or 0.016666666 s^{-1})

During free expansion, being situated upon any receding molecule that is part of the overall expansion, say, Argon molecule, molecules such as Neon, Helium, Oxygen, Nitrogen and Hydrogen will exhibit redshift since they are receding away from the Argon molecule with recessional velocities that are higher than the recessional velocity of the Argon molecule. Similarly, molecules such as Krypton, Radon, Fluorine, Chlorine and Xenon will exhibit redshift since the Argon molecule is receding away from them with comparatively higher recessional velocity, therefore, every molecule will be exhibiting redshift, there is expansion in every direction, there is no preferred centre. Therefore, the interpretation of the observed redshifts as Doppler shifts does not confer upon us any special place or centre of expansion. The expansion is homogeneous (looks same at every location), isotropic (looks same in every direction) and in agreement with the Copernican principle (no preferred center).

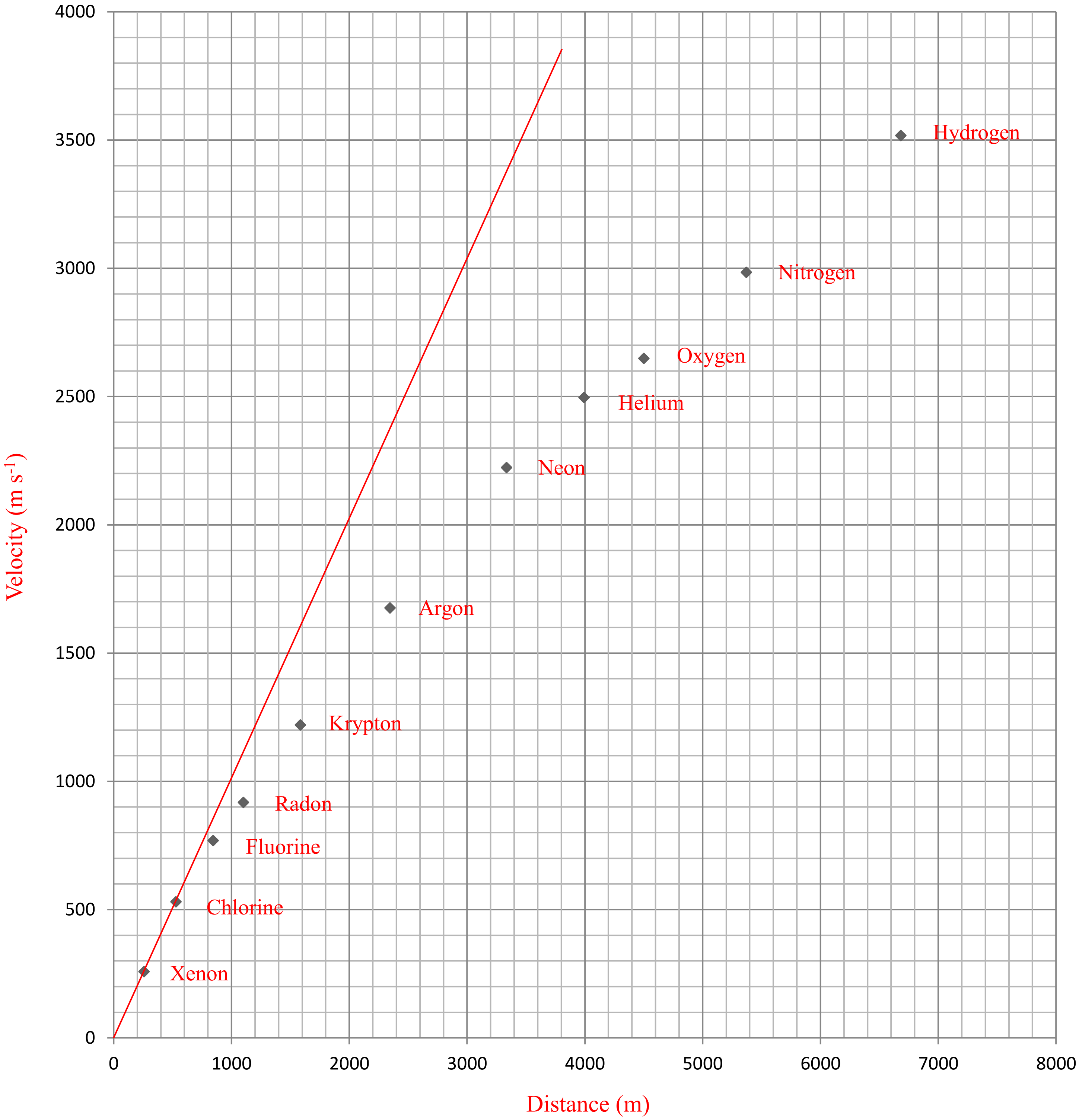


Figure 7. Velocity-distance relationship for gas molecules expanding differentially from the perspective of a local molecule (differential molecular expansion) **(Table 7)**. Local molecules, Xenon and Chlorine are allowed to expand at the same time and therefore they exhibit a linear velocity-distance relation. The remote molecules are allowed to expand differentially and therefore they deviate from exhibiting a linear velocity-distance relation. Such differential expansion causes distances to the remote molecules to be larger than expected with respect to the local molecules without acceleration. In other words, expansion initiated for the remote molecules before it did for the local molecules.

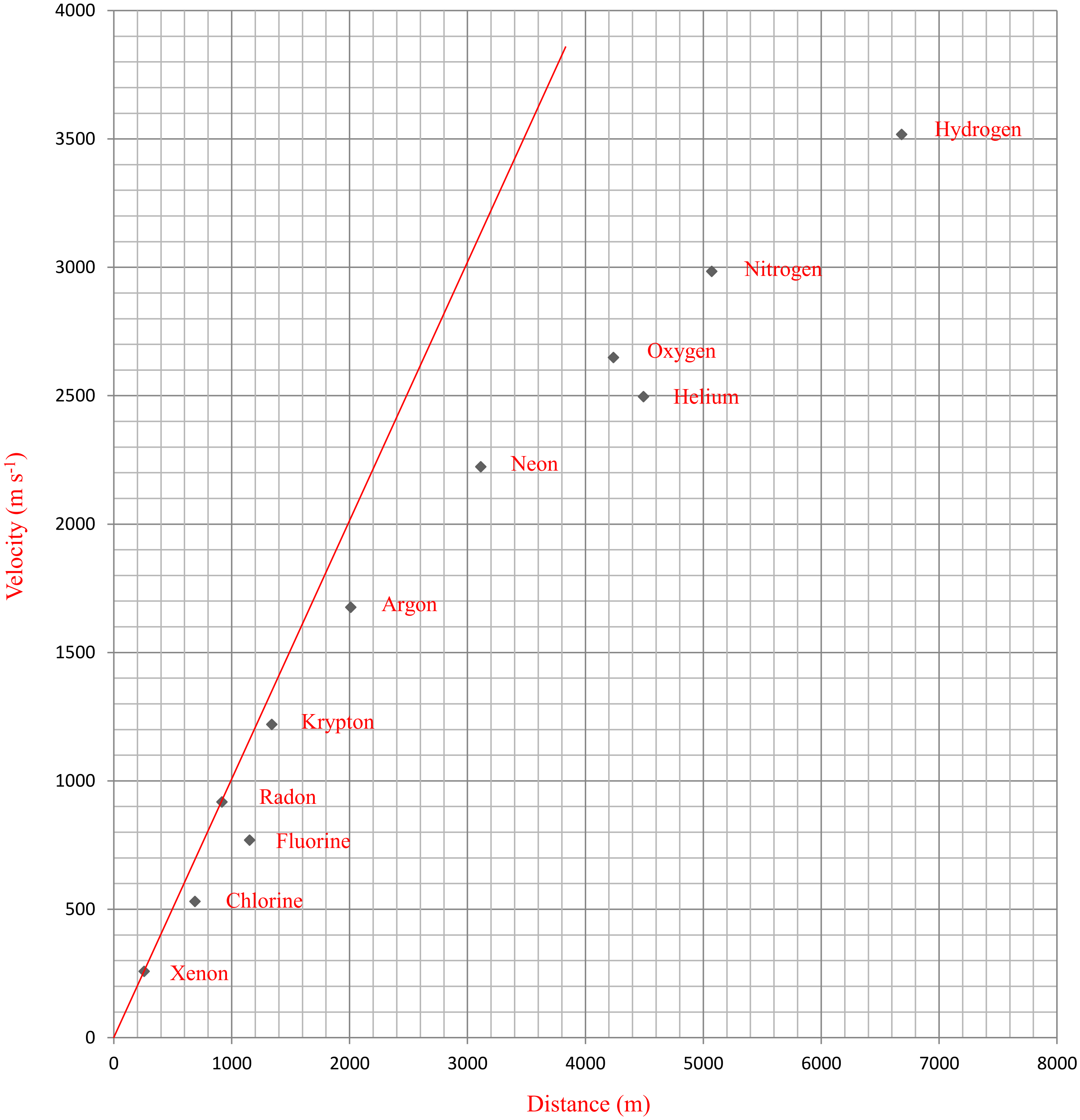


Figure 8. Velocity-distance relationship for gas molecules expanding differentially from the perspective of a local molecule (differential molecular expansion) **(Table 8)**. Local molecules, Xenon and Radon are allowed to expand at the same time and therefore they exhibit a linear velocity-distance relation. The remote molecules are allowed to expand differentially and therefore they deviate from exhibiting a linear velocity-distance relation. Such differential expansion causes distances to the remote molecules to be larger than expected with respect to the local molecules without acceleration. In other words, expansion initiated for the remote molecules before it did for the local molecules.

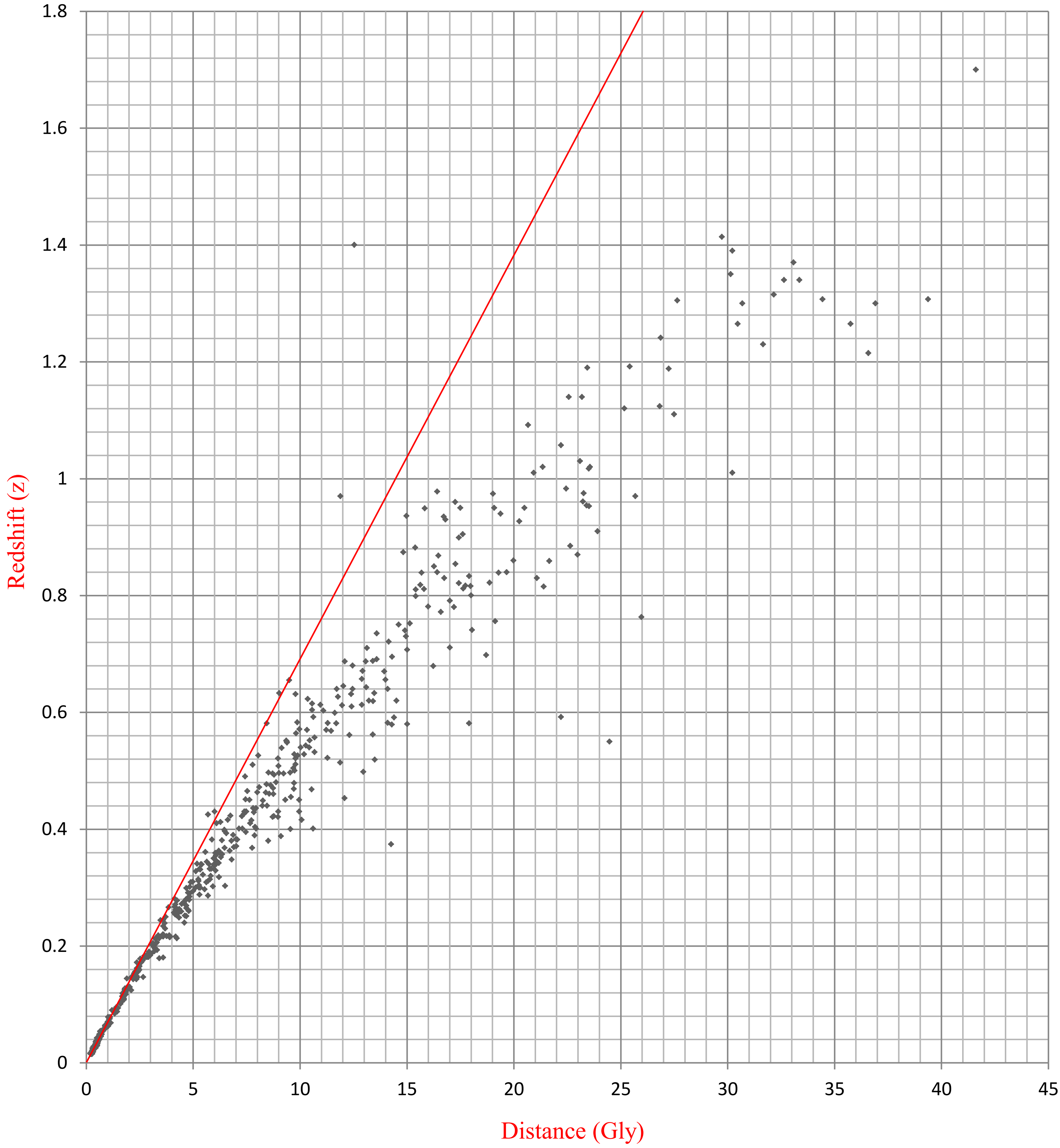


Figure 9. The redshift-distance relationship for 580 type Ia supernovae plotted by using the data (Union 2 and Union 2.1) from the Supernova Cosmology Project, 7 additional high redshift type Ia supernovae discovered through the ACS (Advanced Camera for Surveys) on the Hubble Space Telescope from the GOODS (Great Observatories Origins Deep Survey) Treasury program, and 1 additional very high redshift type Ia supernova discovered with WFPC2 (Wide Field and Planetary Camera 2) on the Hubble Space Telescope. The straight red line indicates the linear redshift-distance relationship exhibited by the structures within the local Universe. The deviation from linearity at high redshifts indicates an accelerating expansion of the Universe since the distances to the remote supernovae are larger than expected with respect to the nearby supernovae belonging to the local Universe. The slope is steeper for the local structures suggesting a faster rate of expansion (acceleration) and shallower for the remote structures, suggesting a slower rate of expansion (deceleration).

8 THE DEVIATION OF THE HUBBLE DIAGRAM FROM LINEARITY AT HIGH REDSHIFTS AND THE ACCELERATING EXPANSION OF THE UNIVERSE

The independent research conducted by the High-Z Supernova Search Team in the 1998 (Riess et al.) and by the Supernova Cosmology Project team in the 1999 (Perlmutter et al.) by using type Ia supernovae as standard candles resulted into a very surprising discovery that made the team members win the 2011 Nobel Prize in Physics. By comparing the brightness of the very distant supernovae with the brightness of the nearby ones, distant supernovae were found to be 10% to 25% dimmer than the nearby supernovae, suggesting that the distances to them were larger than expected. A surprising feat was found being 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.

A mysterious energy of unknown origin that rightfully got coined as dark energy is considered responsible for causing the Universe to expand at an accelerating rate. Acceleration of the Universe began with the introduction of dark energy 5 billion years ago (Frieman, Turner and Huterer 2008). According to Durrer (2011), “our single indication for the existence of dark energy comes from distance measurements and their relation to redshift. Supernovae, cosmic microwave background anisotropies and observations of baryon acoustic oscillations simply tell us that the observed distance to a given redshift is larger than the one expected from a locally measured Hubble parameter”.

The expansion of the Universe is best-depicted by the Hubble diagram that exhibits a linear velocity-distance relation for the local Universe; the Universe within which the large-scale structures 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 redshift-distance relation as shown in Figure 9 (plotted by using the Supernova Cosmology Project data for 580 type Ia supernovae from Union 2 (Amanullah et al. 2010) and Union 2.1 (Suzuki et al. 2012), 7 additional high redshift type Ia supernovae discovered through the ACS (Advanced Camera for Surveys) on the Hubble Space Telescope from the GOODS (Great Observatories Origins Deep Survey) Treasury program (joint work conducted by Giavalisco et al. 2004 and Riess et al. 2004), and 1 additional very high redshift type Ia supernova discovered with WFPC2 (Wide Field and Planetary Camera 2) on the Hubble Space Telescope (Gilliland et al. 1999)).

The observed deviation from redshift-distance linearity in Figure 9 at high redshifts, or at large distances indicates an accelerating expansion of the Universe since the distances to the remote supernovae are larger than expected with respect to the nearby ones. The value of slope is higher (steeper slope) for the local structures and lower (shallower slope) for the remote structures, suggesting that the Universe is accelerating now (locally) and was decelerating in the past (remotely). “A purely kinematic interpretation of the SN Ia sample provides evidence at the greater than 99% confidence level for a transition from deceleration to acceleration or, similarly, strong evidence for a cosmic jerk” (Riess et al. 2004).

Why does it appear that the Universe was expanding slowly in the past, that is, remotely even with high velocities and is expanding faster now, that is, locally even with low velocities? Why are the distances to the remote supernovae larger than expected, thereby making them appear 10% to 25% dimmer than the nearby local supernovae? Could the distant supernovae appear dim due to intervening dust? Or could it be that those distant supernovae have different properties as compared to the nearby supernovae? These possibilities have already been taken into account. Dust is not a factor. Similarly, the brightness of local and remote supernovae differing due to property mismatch brought about by evolution is also not a factor. However, there still remains another reason that has not yet been taken into account that would satisfactorily explain the larger-than-expected distances to these remote supernovae without acceleration.

If remote structures began expanding into the Universe before the expansion of local structures initiated, then the distances to the remote structures would obviously be larger than expected without acceleration.

Since 1/slope yields the expansion time, therefore, the value of slope would naturally be lower (shallower slope) for the remote structures as they began expanding before, and higher (steeper slope) for the local structures as they began expanding later.

It remains unknown to the scientific community that an object with high recessional velocity that begins expanding before will not only be further away than expected, but it will also yield a lower value of slope (shallower slope) as compared to an object with low recessional velocity that begins expanding later (steeper slope). Had this been known, remote supernovae being further away than expected and yielding a lower value of slope even with high velocities as compared to the low-velocity local supernovae would have not taken them by surprise.

In Figure 7, Figure 8, and Figure 9, the velocities are clearly much higher for the remote objects as compared to the velocities of the local objects, however, remote objects still yield a lower value of slope (a shallower slope) as compared to the value of slope obtained for the local objects (a steeper slope). High velocities do not indicate a slower expansion rate or deceleration! Then why would an object with high velocity yield a lower value of slope (suggesting a slower expansion rate or deceleration) and then be further away than expected?

For instance, in Figure 9, the redshift of the most distant remote supernova at 41.6119 Gly is 1.7, this yields a slope of 1.2949×10^{-18} m s^{-1} m^{-1} (39.9567 km s^{-1} $Mpc^{-1} \approx 40$ km s^{-1} Mpc^{-1} – a lower value of slope, or a shallower slope even with high recessional velocity – does this imply deceleration?), whereas the redshift of a very nearby local supernova at 0.2148 Gly is 0.015166, this yields a slope of 2.2379×10^{-18} m s^{-1} m^{-1} (69.0548 km s^{-1} $Mpc^{-1} \approx 70$ km s^{-1} Mpc^{-1} – a higher value of slope, or a steeper slope even with low recessional velocity – does this imply acceleration?) The redshift of the remote supernova is 112.10 times higher than the redshift of the very local supernova (by rule, high redshifts indicate high velocities – the more shifted a spectral line is towards the red end of the spectrum (redshift), the higher is the object’s velocity). Expansion rate would literally have no significance if redshifts are not interpreted as velocities. It is the velocity-interpretation of the observed redshifts that helps us to determine and compare the expansion rate of local and remote structures. In fact, according to Riess et al. (2004), “It is valuable to consider the distance-redshift relation of SNe Ia as a purely *kinematic* record of the expansion history of the universe”.

Such high redshift of the remote supernova does not indicate in any way a low recessional velocity, or a slower rate of expansion, or deceleration! Then why does this remote supernova exhibiting such high redshift (high velocity) yield a lower value of slope as compared to the value of slope for the local supernova exhibiting low redshift (low velocity) and then be further away than expected?

By comparing the slope and hence the expansion rate of the remote supernovae with the slope and hence the expansion rate of the local supernovae, cosmologists have come to a conclusion that the very local Universe is accelerating, whereas the remote Universe is decelerating. "Observations of Type Ia supernovae (SNe Ia) at redshift $z < 1$ provide startling and puzzling evidence that the expansion of the universe at the present time appears to be *accelerating*" (Riess et al. 2004). It is believed that the Universe was decelerating in the past due to the gravitational attraction of matter (Riess et al. 2001, Riess 2012). "A single SN Ia at $z \approx 1.7$, SN 1997ff, discovered with WFPC2 on the *Hubble Space Telescope* (*HST*) (Gilliland et al. 1999), provided a hint of past deceleration" (Riess et al. 2004). It becomes evidently clear from this that the value of slope and hence the expansion rate for the remote supernovae is being compared with the value of slope and hence the expansion rate for the local supernovae.

Obviously, the value of slope and hence the expansion rate (1.2949×10^{-18} m s^{-1} m^{-1} $\approx$ 40 km s^{-1} Mpc^{-1}) for a remote supernova with a redshift z of 1.7 being much lower than the value of slope and hence the expansion rate (2.2379×10^{-18} m s^{-1} m^{-1} $\approx$ 70 km s^{-1} Mpc^{-1}) for a local supernova with a redshift z of 0.015166 would make one believe that the Universe was decelerating in the past and is accelerating now. However, judging from the redshifts of the very remote supernovae in Figure 9, redshifts that are 85 to 112 times higher than the redshifts of the very local supernovae, it can confidently be concluded that those velocities, corresponding to those redshifts, are significantly higher, again, by rule, high redshifts indicate high velocities, high velocities do not indicate deceleration or a slower rate of expansion in any way. Why would then an object with high recessional velocity yield a lower value of slope, thereby suggesting a slower rate of expansion or deceleration and then be further away than expected?

There is absolutely no other reason for an object with high velocity to yield a lower value of slope and then be further away than expected, unless it began expanding before. It is practically impossible that all the structures would have expanded at the same time into the Universe. Plotting together the high-velocity remote structures that began expanding before and the low-velocity local structures that began expanding later into the Universe causes the Hubble diagram to deviate from linearity. Comparing the slope and hence the expansion rate of high-velocity remote structures that began expanding before into the Universe with the slope and hence the expansion rate of low-velocity local structures that began expanding later into the Universe makes us believe that the Universe was decelerating in the past even with high velocities and is accelerating now even with low velocities.

It is imperative to note that even with high velocity, an object that begins expanding before will never yield a value of slope that is as high as, or even higher than the value of slope for an object with low velocity that begins expanding later. Therefore, we should never compare and then expect the slope and hence the expansion rate of such objects to be the same, doing so, without any doubt, will result (as already has) into the apparent transition of Universe's expansion from deceleration to acceleration – an object with high velocity that began expanding before will be further away than expected and will appear to be decelerating, whereas an object with low velocity that began expanding comparatively later will appear to be accelerating.

Comparing the slope and hence the expansion rate of high-velocity remote structures that began expanding before into the Universe with the slope and hence the expansion rate of low-velocity local structures that began expanding later into the Universe causes the high-velocity remote structures to appear as if they are receding slower than expected as compared to the low-velocity local structures. Based upon such comparison, it appears that the Universe is accelerating now (locally) and was decelerating in the past (remotely).

9 DIFFERENTIAL MOLECULAR EXPANSION

Different gas molecules expanding into the vacuum at the same time exhibit a linear velocity-distance relation consistent with the Hubble diagram for the local structures belonging to the local Universe. Since freely expanding gas molecules recede by the virtue of the energy possessed by them to exhibit a linear velocity-distance relation or the Hubble diagram, therefore, the large-scale structures that are known to exhibit the same linear diagram have to be receding by the virtue of the energy possessed by them. Therefore, it is very unlikely that an unknown and a mysterious form of energy would be responsible for the overall expansion. After all, the free expansion of gas molecules into the vacuum by the virtue of dark energy has never been heard off, such claim if considered to be true would only suggest that gas molecules do not possess any energy; the velocity of gas molecules, as evident from equation (2), equation (4), and equation (5) depends upon their mass and the energy possessed by them. In fact, an experiment conducted by Sabulsky et al. (2019) by using atom interferometry to detect dark energy acting on a single atom inside an ultra-high vacuum chamber showed no trace of any mysterious energy. Dark energy believed to be stronger in high vacuum environments should have easily been detected acting on a minuscule mass – a single atom.

Having considered the velocity-distance relation for different gas molecules undergoing free expansion at the same time into the vacuum of the Universe, it is now imperative to consider their velocity-distance relation during a differential expansion. If different gas molecules are released and allowed to expand consecutively into the vacuum of the Universe, one molecule after another, then the gas molecules will be undergoing a differential molecular expansion.

Based upon calculations, the data for gas molecules undergoing differential molecular expansion has been tabulated in Table 7. The same apparatus has been considered that was introduced in Section 6 – a spherical enclosure enclosing different gas molecules. This enclosure placed at some location within the emptiness of the Universe would allow different gas molecules to expand differentially in any random direction.

Initially, Hydrogen molecule (3517.60 m s^{-1}) is released and allowed to expand freely into the vacuum of the Universe, 0.1 second later, Nitrogen molecule (2983.93 m s^{-1}) is allowed to expand freely, the release of Nitrogen molecule is followed by the release of Oxygen molecule (2648.64 m s^{-1}) after another 0.1 second. Differential release and expansion of gas molecules is continued in the same way for Helium (2496.43 m s^{-1}), Neon (2223.52 m s^{-1}), Argon (1676.20 m s^{-1}), Krypton (1219.96 m s^{-1}), Radon (917.97 m s^{-1}) and Fluorine (768.62 m s^{-1}). Chlorine (530.48 m s^{-1}) and Xenon (257.85 m s^{-1}) are the last molecules to be released, and they are released at the same time into the prevailing emptiness of the Universe and observed for 1 second. By the time these last two molecules are released and observed for 1 second, Hydrogen molecule has already been receding for 1.9 second and the Nitrogen molecule for 1.8 second, this becomes their respective observation time.

The velocity-distance relationship for different gas molecules expanding differentially has been plotted in Figure 7 and Figure 8 from the perspective of a low-velocity local molecule which is also taking part in the overall expansion process (this is consistent with our observations of the remote Universe (high redshift/high velocity) from the perspective of the local Universe (low redshift/low velocity)). We observe the remote supernovae belonging to the remote Universe in every direction beyond the local Universe and not just along one particular direction extending beyond the local Universe. So when cosmologists say that remote supernovae are further away than expected as compared to the local supernovae, then those remote supernovae are further away than expected along every direction we observe beyond the local Universe and not just along a particular direction. Since we happen to observe the remote supernovae belonging to the remote Universe in every direction extending beyond the local Universe and not just along one particular direction, therefore, the results obtained in this paper are consistent with our observations of the remote Universe from the perspective of the local Universe, after all, it is through the original observations of the remote Universe from the perspective of the local Universe that has made cosmologists conclude that the distances to the remote supernovae are larger than expected as compared to the nearby local supernovae.

Furthermore, it is the distance between the local supernovae (believed to be accelerating) and the remote supernovae (believed to be decelerating) that is larger than expected and not the distance amongst the local supernovae that are believed to be accelerating, moreover, as already discussed, remote supernovae are observed to be further away than expected along every direction we observe extending beyond the local Universe and not just along one particular direction, therefore, with such observational scenario that led to the discovery of Universe expanding at an accelerating rate, the only reason why the remote structures are further away than expected and yield a lower value of slope or a shallower slope, thereby suggesting deceleration even with high recessional velocities as compared to the low-velocity local structures is due to the initiation of their expansion into the Universe before the expansion initiated for the local structures.

All molecules that expand differentially deviate from exhibiting the expected velocity-distance linearity. Only Xenon and Chlorine molecules in Figure 7 follow a linear velocity-distance relation since they were allowed to expand at the same time. Similarly, in Figure 8, Xenon and Radon molecules follow the linear velocity-distance relation.

The molecules that deviate from exhibiting velocity-distance linearity are analogous to the distant remote structures belonging to the remote Universe, these molecules can therefore be termed as remote molecules, whereas the molecules that follow a linear velocity-distance relation and are therefore analogous to the local structures can be termed as local molecules. Based upon calculations, the velocity-distance relation plots for different gas molecules undergoing differential expansion (Figure 7 and Figure 8) are found to be similar to the redshift-distance or the velocity-distance relationship for 588 type Ia supernovae as shown in Figure 9. If there was any ambiguity, then the plots would have not been identical at all. The observed deviation from linearity is a characteristic feature of molecules undergoing differential expansion. The distances to the remote molecules are larger than expected with respect to the local molecules, and this has occurred not because of acceleration, but because of differential expansion of those molecules.

The value of Slope obtained for the local molecules, Xenon and Chlorine (Figure 7) and Xenon and Radon (Figure 8) is 1 m s^{-1} m^{-1} or 1 s^{-1}. The inverse of this gives us the original observation time of 1 second for these local molecules. The deviation from linearity in Figure 7 and Figure 8 clearly indicates that the distances to the remote molecules, from the perspective of the local molecules, are larger than expected. Had expansion initiated for all the molecules into the vacuum of the Universe at the same time, then there would have been no deviation from linearity – the Slope would have been the same.

The value of Slope obtained for the most distant remote molecule in Figure 7, that is, Hydrogen molecule, is 0.5263 m s^{-1} m^{-1} (lower value of Slope, or a shallower Slope even with high velocity of 3517.60 m s^{-1} – does this imply deceleration?), the inverse of this gives us the original observation/expansion time of 1.9 second.

The Slope for an intermediately-distant remote molecule, that is, Argon molecule, turns out to be 0.7142 m s^{-1} m^{-1} (value of Slope is increasing; Slope is becoming steeper as we move from the remote molecules towards the local molecules – the slope of a curve changes at every point), the inverse of this gives us the original observation/expansion time of 1.4 second.

For local molecules, Xenon and Chlorine, the Slope (slope of the red line) turns out to be 1 m s^{-1} m^{-1} (higher value of Slope, or a steeper Slope even with low velocities of 257.85 m s^{-1} and 530.48 m s^{-1} respectively – does this imply acceleration?) the inverse of this gives the original observation/expansion time of 1 second.

The value of Slope for the remote molecules being lower than the value of Slope for the local molecules yields a larger observation/expansion time for the remote molecules. This strongly indicates that remote molecules had their expansion initiated into the vacuum of the Universe before local molecules began expanding – there is absolutely no other reason for an object with high velocity to yield a lower value of slope and then be further away than expected, unless it began expanding before.

If we happen to compare the expansion rate of high-velocity Hydrogen molecule that began expanding before into the vacuum of the Universe with the expansion rate of low-velocity Xenon and Chlorine molecules that began expanding comparatively later, then even high-velocity Hydrogen molecule appears to be expanding at a slower rate (decelerating) as compared to the low-velocity Xenon and Chlorine molecules. Does this imply that Hydrogen molecule is decelerating, whereas Xenon and Chlorine molecules are accelerating?

The velocity of Hydrogen molecule is 6.6309 times higher than the velocity of Chlorine molecule, and 13.6420 times higher than the velocity of Xenon molecule, Hydrogen molecule still happens to yield a lower value of Slope, thereby suggesting a slower rate of expansion or deceleration as compared to these two molecules (not to mention again that Hydrogen molecule is further away than expected as compared to these two molecules). Even though the differences between the velocities of these molecules (remote and local molecules) are not significantly high enough if compared to the differences between the velocities of remote and local supernovae, we still have Hydrogen molecule yielding a lower value of slope even with high velocity.

Now for local and remote supernovae, the differences between their velocities are significantly much higher as compared to the differences between the velocities of the discussed molecules – velocities of remote supernovae are 85 to 112 times higher than the velocity of a local supernova. Even with such significantly high velocities, remote supernovae still happen to yield a lower value of slope, thereby suggesting a slower rate of expansion or deceleration as compared to a local supernova (not to mention again that remote supernovae are further away than expected as compared to the local supernovae). Could there be any other reason now why an object with significantly high velocity would be yielding a lower value of slope, thereby suggesting a slower rate of expansion or deceleration and then be further away than expected as compared to an object with low velocity? There seems absolutely no other reason for such a trend, unless the high-velocity object began expanding into the Universe before the expansion initiated for the low-velocity object.

With reference to Figure 7, Figure 8, and Figure 9, the velocities are evidently much higher for the remote objects as compared to the velocities of the local objects, however, remote objects still yield a lower value of slope (a shallower slope) as compared to the value of slope obtained for the local objects (a steeper slope). High velocities do not indicate a slower expansion rate or deceleration! Then why would an object with high velocity yield a lower value of slope (suggesting a slower expansion rate or deceleration) and be further away than expected? This is only possible if remote objects began expanding before, and local objects later. High velocities of remote objects yielding a lower value of slope do not indicate their deceleration. Similarly, low velocities of local objects yielding a higher value of slope do not indicate their acceleration. Requiring mysterious dark energy of unknown origin to explain this transition has only complicated things further to an unimaginable extent. Not to mention the pivotal role played by the 120 orders of magnitude (10^{120}) discrepancy suggesting that something is grievously wrong and unnecessarily introduced to account for the observations.

Since expansion began for the remote molecules before it did for the local molecules, therefore, from the perspective of local molecules, remote molecules are not only further away than expected, but they also yield a lower value of Slope even with high velocities as compared to the higher value of Slope for the local molecules even with low velocities (a higher value of Slope (steeper Slope) gives a lower expansion time as compared to a lower value of Slope (shallower Slope) that gives a higher expansion time). It therefore appears that local molecules are expanding at a faster rate as compared to the remote molecules. One would therefore believe that local molecules, as compared to the remote molecules, are accelerating due to a higher value of their Slope; it appears that remote molecules are decelerating while local molecules are accelerating.

In Figure 7 and Figure 8, the remote molecules began expanding before the expansion of local molecules initiated, therefore, the distances to the remote molecules are larger than expected with respect to the local molecules without acceleration. Since the local molecules began expanding at the same time, therefore, they follow a linear velocity-distance relation. If all molecules had expanded freely at the same time, then their velocity-distance relation would have been linear.

This can also be verified for the large-scale structures expanding into the Universe. The deviation from linearity in Figure 9 clearly indicates that the distances to the remote structures, from the perspective of the local structures, are larger than expected.

The value of slope (H) for the most distant remote structure in Figure 9 is 1.2949 x 10^{-18} m s^{-1} m^{-1}, this gives us a Hubble constant of 39.9567 km s^{-1} Mpc^{-1} and an expansion time of 24.4882 x 10^9 years.

The value of slope for an intermediately-distant remote structure in Figure 9 is 1.5475 x 10^{-18} m s^{-1} m^{-1} which yields a Hubble constant of 47.7512 km s^{-1} Mpc^{-1} and an expansion time of 20.4908 x 10^9 years (value of slope is increasing; slope is becoming steeper as we move from the remote structures towards the local structures – the slope of a curve changes at every point).

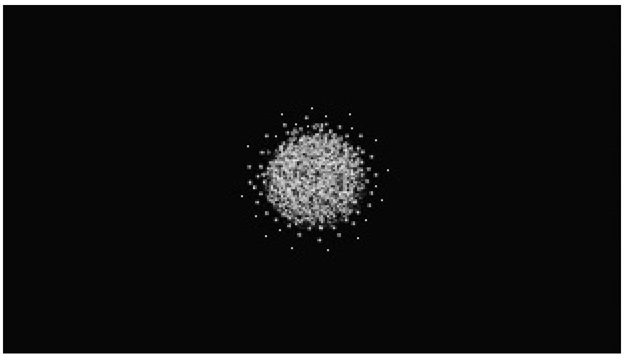
The value of slope (slope of the red line) for a local structure in Figure 9, is 2.2379 x 10^{-18} m s^{-1} m^{-1}, this yields a Hubble constant of 69.0548 km s^{-1} Mpc^{-1}. This gives us an observation time, or an expansion time of 14.1694 x 10^9 years.

The value of slope for the remote structures being lower than the value of slope for the local structures yields a larger observation time for the remote structures. This strongly indicates that remote structures began expanding into the Universe before local structures began expanding.

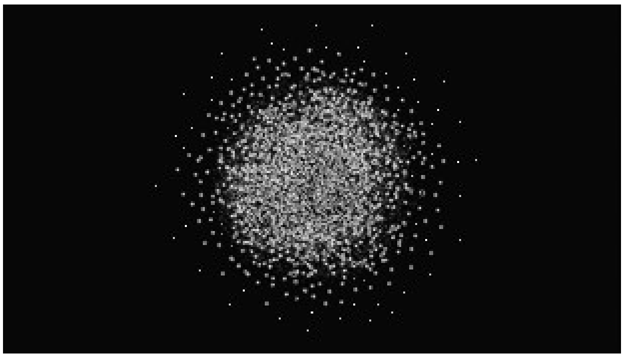
Since remote structures began expanding into the Universe before the expansion initiated for the local structures, therefore, the remote structures are not only further away than expected, but they also yield a lower value of Hubble constant as compared to the local structures that began expanding later (a higher value of Hubble constant gives a lower expansion time as compared to a lower value of Hubble constant that gives a higher expansion time).

Since the inverse of Hubble constant gives us the expansion time of structures into the Universe, therefore, the structures that began expanding before (remote structures) should naturally yield a lower value of Hubble constant and therefore a higher expansion time. Since the expansion time is less for the local structures, therefore, local structures naturally yield a higher value of Hubble constant and it appears that the local Universe is expanding at a faster rate as compared to the remote Universe. One would therefore believe that Universe is accelerating now, and had a slower expansion in the past.

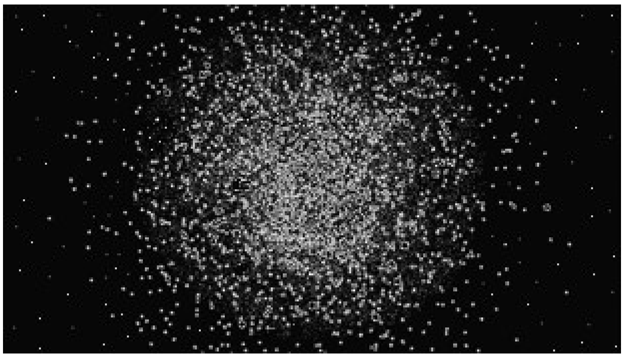
Remote structures began expanding into the Universe before local structures began expanding; the distances to the remote structures are therefore larger than expected with respect to the local structures without acceleration. The structures that follow the linear velocity-distance relation started expanding at the same time. Had expansion initiated for all the structures into the Universe at the same time, then the Hubble diagram would have been linear.



A



B



C

Figure 10. Free expansion of different gas molecules into the vacuum of the Universe (A to C). Free expansion of different gas molecules initiates into the vacuum of the Universe as soon as the enclosure vanishes or becomes perfectly permeable to the gas molecules. The distance between gas molecules keeps on increasing over time during free expansion. The collision probability between the molecules becomes exactly zero over time as the process of molecular expansion proceeds. It can also be seen that some of the molecules begin to expand before other molecules begin expanding (differential molecular expansion), these molecules that begin expanding before cover larger-than-expected distances (remote molecules) with respect to the molecules that have not expanded yet, or will begin expanding comparatively later (local molecules); remote molecules are therefore further away than expected with respect to the local molecules. As compared to the remote molecules, local molecules began expanding at the same time, therefore, they exhibit a linear velocity-distance relationship (the velocity-distance relationship obtained for expanding gas molecules (Figure 7 and Figure 8) being identical to the redshift-distance/velocity-distance relationship for 588 type Ia supernovae (Figure 9) confirms this). Since remote molecules began expanding before, therefore, the expansion time for the remote molecules is more as compared to the expansion time for the local molecules, remote molecules for this reason naturally yield a lower value of Slope (a shallower Slope) even with high velocities as compared to the value of Slope obtained from the local molecules for which the expansion time being less, a higher value of Slope (a steeper Slope) is obtained even with low velocities. Based upon this differential molecular expansion scenario, one would be forced into believing that the local molecules, as compared to the remote molecules, are accelerating. Once the molecular expansion process begins, no matter which molecule we would be situated upon, it would be impossible to determine the centre of expansion – every molecule will be moving away (expanding away) from every other molecule, and, every molecule will exhibit redshift as velocities are increasing with distance. However, if we happen to reverse the molecular expansion process (C to A), then all molecules would get closer and closer, and after a certain period of time, we would have reached the initial stage when free expansion of molecules was just about to happen. This is exactly what the best cosmologists say when referring to reversing the expansion of the Universe, "If the expansion of the Universe is reversed then everything within the Universe would get closer and closer, and at some point, everything in the Universe would be on top of everything else – the Big Bang".

10 CONCLUSIONS

(1) Cosmology is dominated by certain analogies that are readily used in order to explain the expansion of the Universe. These analogies include, expanding loaf of raisin bread, stretching rubber sheet, inflating balloon, and so on. Although these analogies provide a theoretical insight or an overview to explain the expansion of the Universe, these analogies are not scientifically-appealing in any way. Moreover, these analogies cannot explain why the distances to the remote supernovae are larger than expected, or why does the Hubble diagram deviate from linearity at high redshifts, or at large distances. Being reliant on such analogies clearly suggests that we lack a scientific and a practically-feasible model that can explain the expansion of the Universe, an expansion that is found to be homogeneous, isotropic, and in agreement with the Copernican principle.

(2) The concept of metric expansion of space is extensively used in the literature of cosmology by empowering space with exotic abilities – the space between the structures is somehow created, the space somehow expands, the space somehow stretches, and the space somehow grows. How exactly do these exotic concepts work remain unexplained.

(3) Metric expansion of space can only be observed indirectly due the presence of observable entities, therefore, of what significance is the concept of metric expansion of space without the presence of any observable entity? Can metric expansion of space be tested or observed practically without the presence of an observable entity, or is it merely a concept of a metaphysical domain just required to explain the observations in the simplest manner due to the unavailability of a practically-feasible scientific model?

(4) It is literally the redshift of a distant object that is considered in an intrinsic manner just like its distance in order to plot the velocity-distance relationship and not the redshift of empty space or the distance to empty space. Can the distance to empty space or the redshift of empty space even be determined without the presence of an observable entity? Does distance to empty space or redshift of empty space even have any significance without the presence of an observable entity?

(5) Being unable to explain the expansion of different gas molecules into the vacuum of the Universe one would readily put forward the concept of expanding space as the most possible reason to explain the observed expansion of those molecules; an expansion where velocities happen to increase with distance, however, in this case, saying that molecules are stationary while the distance between them is increasing due to expansion of space would not at all be welcomed by the scientific community; such concept would straight away be dismissed as being vague, practically improbable and baseless – then, ironically, why is such vague concept of expanding space being used to explain the expansion of structures into the Universe?

(6) Expansion of the Universe has been explained in this paper by conducting a detailed study based upon the molecular expansion model that considers the large-scale structures as different gas molecules undergoing free expansion into the vacuum. The molecular expansion model shows that the linear velocity-distance relation or the Hubble diagram (velocities increasing with distance) is a natural and a characteristic feature of different gas molecules undergoing free expansion into the vacuum of the Universe at the same time.

(7) Different gas molecules naturally have different velocities – velocities that are essentially unique and hence non-overlapping. Therefore, if different gas

molecules are allowed to expand into the vacuum of the Universe at the same time, then according to scientific logic and reasoning that happens to be consistent with the kinetic theory of gases, the molecule with the highest recessional velocity will naturally manage to become the most distant molecule. The molecule with the second highest recessional velocity will naturally become the second most distant molecule. Therefore, velocities increasing with distance will be observed naturally during free expansion of different gas molecules into the vacuum of the Universe (it is practically impossible for the slowest molecule to be the furthest molecule – this is extremely simple to comprehend). Once velocities are increasing with distance, all molecules and large-scale structures will be observed exhibiting redshift no matter from which molecule or large-scale structure we happen to observe them – expansion in every direction.

(8) The behaviour of large-scale structures expanding into the Universe is found to be consistent with the behaviour of different gas molecules undergoing expansion into the vacuum; the free expansion of different gas molecules into the vacuum is found to be homogeneous, isotropic and in agreement with the Copernican principle; there is expansion in every direction; there is no preferred centre of expansion.

(9) Gas molecules and large-scale structures being natural entities and exhibiting the natural tendency of undergoing expansion into the vacuum should behave similarly during an expansion process. Large-scale structures being constituted by atoms and molecules should behave like molecules. There should not be a problem considering the large-scale structures as expanding gas molecules since such consideration is more scientifically-appealing (as compared to the raisin bread and similar analogies that tend to explain the expansion of the Universe), practically-feasible (as compared to the metaphysics of expanding space whose mechanism remains unexplained) and provides a viable solution that is consistent with actual observations.

(10) Large-scale structures would resemble molecules if compared to the colossal size of the Universe. In fact, the large-scale structures that we observe today have evolved by colliding and merging with one another during the initial phase of the Universe when the distance between them was much smaller than what is today. The expansion of structures into the Universe has increased the distance between them and has decreased their collision probability, much like gas molecules that collide with one another before they begin expanding freely into the vacuum. Expansion of gas molecules into the vacuum of the Universe also increases the distance between them and decreases their collision probability as time progresses.

(11) According to the molecular expansion model, large-scale structures recede with velocity corresponding to the total amount of energy that they possess – just like a gas molecule that recedes solely by the virtue of the energy possessed by it at a particular temperature.

(12) The highest recessional velocities are always found to be exhibited by the most distant galaxies and quasars and not by galaxy clusters. This observation is consistent with the recessional behaviour of molecules according to the kinetic theory of gases, that is, a lighter molecule recedes faster than a massive molecule even when they both possess an equivalent amount of energy (a massive molecule will recede faster than a lighter molecule only if the energy possessed by it is high enough). Such consistent recessional behaviour suggests the actual recession of large-scale structures rather than metric expansion of space between them. Since galaxies and quasars are less massive than galaxy clusters, therefore, galaxies and quasars exhibit higher recessional velocities than galaxy clusters. For this reason, galaxies and quasars, as compared to massive galaxy clusters, manage to become the most distant structures within the observable Universe.

(13) It is evidently clear from the molecular plots that the behaviour of large-scale structures expanding into the Universe is similar to the behaviour of different gas molecules undergoing expansion into the vacuum of the Universe. The velocity-distance relationship for different gas molecules undergoing expansion into the vacuum is consistent with the velocity-distance relationship for the large-scale structures expanding into the Universe according to the Hubble diagram which depicts the Hubble's law. Such consistency also suggests the actual recession of large-scale structures rather than expansion of space between them; if space between the large-scale structures was expanding, then the velocity-distance relationship for the large-scale structures expanding into the Universe would have been completely different from the velocity-distance relationship for different gas molecules expanding into the Universe.

(14) According to the well-accepted concept of metric expansion of space, the more the space between the distant object and the observer, the higher will be the observed redshift as light has to travel through more "stretched" space – "Light is stretched as the Universe expands, The Further an object is away, the more the Universe has expanded, so the more the light is stretched to the Red". Distances to the remote supernovae in Figure 9 being larger than expected clearly indicate more-than-expected "stretched" space between them and the observer, furthermore, according to accelerating expansion of Universe, Universe has expanded more in the last half of its life, the distances to the remote supernovae are therefore larger than expected as compared to the distances to the local supernovae. Larger-than-expected distances to the remote supernovae indicate more-than-expected "stretched" space between them and the local supernovae in the last half of Universe's life due to acceleration, after all, it is acceleration that has placed the remote supernovae at distances that are larger than expected as compared to the distances to the nearby local supernovae, therefore, for larger-than-expected distances (implying more-than-expected "stretched" space) there should be more-than-expected "stretching" of light and higher should be the observed redshifts. If larger-than-expected distances to the remote supernovae due to acceleration can cause the remote supernovae to appear 10% to 25% dimmer as compared to the nearby local supernovae, then larger-than-expected stretched space due to larger-than-expected distances between the local and the remote supernovae in the last half of Universe's life due to acceleration should have also stretched the light emitted by those remote supernovae by a larger-than-expected amount and higher should have been their observed redshifts. This observation according to me questions the concept of expanding space and suggests kinematic origin of the observed redshifts as the most natural explanation for the observed expansion. This observation also rules out other theories, models and analogies that require redshift to increase proportionally with distance.

(15) The molecular plots are exactly like the Hubble diagram; velocities of molecules are increasing with distance – the further away a molecule is, the faster it is receding away. The distribution of molecules in Figure 6 is relatable to the homogeneous distribution of large-scale structures within the observable Universe since the

molecules are distributed homogeneously irrespective of their mass.

(16) The gas molecules under consideration have deliberately been subjected to random temperature differences to see if the molecules deviate from exhibiting a linear velocity-distance relationship while expanding at the same time into the vacuum of the Universe. No matter how randomly the data changes for the gas molecules, the velocity-distance relation plots continue to exhibit the linear behaviour just like the Hubble diagram.

(17) The value of Slope obtained from the velocity-distance relationship for different gas molecules undergoing expansion into the vacuum is similar to the Hubble constant (*H*) (the slope of Hubble diagram), since its inverse gives us the observation/expansion time in seconds, just like the Hubble time obtained from the inverse of (*H*).

(18) From the velocity-distance relationship for different gas molecules undergoing free expansion into the vacuum it is found that the further away a gas molecule is, the faster it is receding away – the recessional velocity of different gas molecules is proportional to their distance, therefore, the Hubble's law and all Hubble equations are obeyed by different gas molecules undergoing expansion, Hubble equations like, $v = H \times D$, $D = v/H$, $t_H = 1/H$; where v is the recessional velocity, H is the Hubble constant, D is the distance and t_H is the Hubble time. For expanding gas molecules the corresponding equations are, v = Slope x D, $D = v/$Slope, t = 1/Slope.

(19) Since velocities happen to increase with distance for different gas molecules undergoing free expansion into the vacuum of the Universe, therefore, no matter which molecule we would be situated upon, all other molecules will exhibit redshift, therefore, there is expansion in every direction; there is no preferred centre of expansion. This is consistent with observation since all large-scale structures exhibit redshift except for some exceptionally rare ones (nearby structures).

(20) By knowing the values of Slope and the distance covered by the receding gas molecules, their recessional velocity can be recalculated. Similarly, by knowing the values of Slope and the recessional velocity of gas molecules, the distance covered by them can be recalculated. This is again consistent with the Hubble's law and hence with the Hubble diagram.

(21) Since different gas molecules undergoing free expansion into the vacuum of the Universe exhibit Hubble diagram and obey all Hubble equations solely due to their recession by the virtue of the energy possessed by them, therefore, the large-scale structures that are known to exhibit Hubble diagram and obey all Hubble equations have to be receding solely by the virtue of the energy possessed by them instead of energy being possessed by empty space. After all, the expansion of gas molecules into the vacuum by the virtue of dark energy has never been heard off.

(22) Since the mass of every large-scale structure expanding into the Universe is different and so is the energy possessed by them, therefore, the large-scale structures get distributed homogeneously throughout the Universe irrespective of their mass. This is relatable to the homogeneous distribution of gas molecules during free expansion into the vacuum of the Universe as shown in Figure 6.

(23) The expansion pattern of large-scale structures expanding into the Universe is similar to the pattern of different gas molecules undergoing free expansion into the vacuum. Therefore, plotting the velocity-distance relation for the large-scale structures expanding into the Universe is same as plotting the velocity-distance relation for different gas molecules undergoing free expansion into the vacuum of the Universe.

(24) Different gas molecules undergoing free expansion into the vacuum of the Universe will always exhibit the Hubble diagram (velocities increasing with distance). Since large-scale structures expanding into the Universe behave like different gas molecules undergoing expansion into the vacuum – justified by identical velocity-distance relation plots, the Hubble diagram therefore simply is the velocity-distance relationship for different gas molecules undergoing free expansion into the vacuum of the Universe.

(25) Based upon the concept of differential molecular expansion, the observed deviation of the Hubble diagram from linearity at high redshifts, or at large distances has been explained without acceleration. Differential molecular expansion model suggests that the expansion of remote structures initiated into the Universe before the expansion of local structures initiated. Remote structures are therefore further away than expected with respect to the local structures; plotting together the high-velocity remote structures that began expanding before and the low-velocity local structures that began expanding later into the Universe is the actual reason for the deviation of the Hubble diagram from linearity at high redshifts, or at large distances without acceleration. Structures that began expanding into the Universe at the same time exhibit a linear velocity-distance relation. If all the structures had their expansion initiated into the Universe at the same time, then the Hubble diagram would have been linear – the value of slope would have been the same.

(26) The value of Slope obtained for the high-velocity remote molecules in Figure 7 and Figure 8 is found to be lower than the value of Slope obtained for the low-velocity local molecules. This gives us a larger observation or expansion time for the remote molecules as compared to the local molecules. This proves that remote molecules began expanding into the vacuum of the Universe before local molecules began expanding. Higher value of Slope (steeper Slope) for the local molecules even with low velocities as compared to the lower value of Slope (shallower Slope) for the remote molecules even with high velocities makes us believe that local molecules are expanding at a faster rate as compared to the remote molecules, that is, local molecules are accelerating, whereas the remote molecules are decelerating (there is absolutely no other reason for an object with high velocity to yield a lower value slope and then be further away than expected, unless it began expanding before; high velocities do not indicate a slower expansion rate or deceleration, similarly, low velocities do not indicate a faster expansion rate or acceleration).

(27) Plotting together the remote structures that began expanding before and the local structures that began expanding later into the Universe causes the Hubble diagram to deviate from linearity. The value of slope turns out to be lower for the remote structures (even with high velocities) as they began expanding before and higher for the local structures (even with low velocities) as they began expanding later. This makes it appear that an object with high velocity is decelerating, whereas an object with low velocity is accelerating. One would therefore be forced into believing that the Universe was expanding slowly in the past even with high velocities and is expanding faster now even with low velocities.

(28) This has been found to be consistent with the values of slope and Hubble constant for the local and remote structures in Figure 9. The value of the Hubble constant obtained for the local and remote structures is

69.0548 km s^{-1} Mpc^{-1} (slope: 2.2379 x 10^{-18} m s^{-1} m^{-1}) and 39.9567 km s^{-1} Mpc^{-1} (slope: 1.2949 x 10^{-18} m s^{-1} m^{-1}) respectively. The redshifts of remote supernovae are much higher (85 to 112 times higher) than the redshifts of the local supernovae! By rule, high redshifts indicate high recessional velocities (the more shifted a spectral line is towards the red end of the spectrum (redshift), the higher is the object's velocity), high recessional velocities do not indicate a slower expansion rate or deceleration! Then why would an object with high recessional velocity yield a lower value of slope (suggesting a slower expansion rate or deceleration) and then be further away than expected? Lower value of slope and Hubble constant for the remote structures even with high velocities strongly indicate that the remote structures had their expansion initiated into the Universe before the expansion got initiated for the local structures. Higher value of Hubble constant for the local Universe as compared to the lower value of the Hubble constant for the remote Universe makes us believe that the Universe is expanding faster now, that is, Universe is accelerating now, and had a slower expansion in the past.

(29) Even with high velocity, an object that begins expanding before will never yield a value of slope that is as high as, or even higher than the value of slope for an object with low velocity that begins expanding later. The slope and hence the expansion rate of such objects should therefore never be compared and then expected to be the same. It is the mere comparison of slope and hence the expansion rate of such objects that gives rise to the apparent transition of Universe's expansion from deceleration to acceleration. An object with high velocity that began expanding before will be further away than expected and will appear to be decelerating (shallower slope), whereas an object with low velocity that began expanding later will appear to be accelerating (steeper slope).

(30) Comparing the slope and hence the expansion rate of high-velocity remote structures that began expanding before into the Universe with the slope and hence the expansion rate of low-velocity local structures that began expanding later into the Universe causes the high-velocity remote structures to appear as if they are receding slower than expected as compared to the low-velocity local structures.

(31) Remote supernovae are observed to be further away than expected along every direction we observe extending beyond the local Universe and not just along one particular direction. Furthermore, it is the distance between the local supernovae (believed to be accelerating) and the remote supernovae (believed to be decelerating) that is larger than expected and not the distance amongst the local supernovae that are believed to be accelerating. Therefore, with such observational scenario that happens to be consistent with the original observations that led to the discovery of Universe expanding at an accelerating rate, the only reason why the remote structures are further away than expected and yield a lower value of slope or a shallower slope, thereby suggesting deceleration even with high recessional velocities as compared to the local structures is due to the initiation of their expansion into the Universe before the expansion initiated for the local structures.

(32) The deviation from velocity-distance linearity in Figure 7, Figure 8, and Figure 9 clearly indicates that the distances to the remote objects (molecules and structures) are larger than expected because they began expanding before the expansion of local structures initiated into the Universe – value of slope for the remote objects being lower (even with high velocities) than the value of slope for the local objects (even with low velocities) strongly confirms this. Had expansion initiated for all the objects into the vacuum of the Universe at the same time, then there would have been no deviation from linearity.

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