I.V. Without using Doppler's Shift Data and without knowing about Cosmological Redshift, Friedmann had already reached to the concept of Expanding Universe. How?

I have explained earlier that GR equations themselves could not provide lead towards expanding model of Universe. GR equations are field equations whose actual function was only to describe path (or curvature) of test particle under the given strength of mass-energy density. But Einstein pioneered the attempt to develop model of whole Universe solely on the basis of field equations by finding solution to equations by specifying certain assumptions and values for certain parameters. One of his main assumptions was that (i.e. assumption is not derived from equations) Universe has a finite radius. In his famous 1917 paper[1], Einstein has ₌assumedø finite radius of universe in following words:

> "From what has now been said it will be seen that I have not succeeded in formulating boundary conditions for spatial infinity. Nevertheless, there is still a possible way out without resigning as suggested under (b). For if it were possible to regard the universe as a continuum which is finite (closed) with respect to its spatial dimensions, we should have no need at all of any such boundary conditions. We shall proceed to show that both the general postulate of relativity and the fact of the small stellar velocities are compatible with the hypothesis of a spatially finite universe; though certainly, in order to carry through this idea, we need a generalizing modification of the field equations of gravitation."

"For if it were possible to regard" – that means the suggestion of 'finite' (closed) universe has not come from GR equations. It was like a commonsense judgment that idea of finite universe will fit into the rest of relativistic postulates and other 'facts' that include "small stellar velocities" etc.

Here we are noticing that in 1917, Einstein is trying to develop a model of universe and although he technically discussed (in first pages) the implications of infinite universe but then he "just assumes" finite universe as a proper case to be proceeded upon. He even announces to bring modifications in field equations only to carry through this idea.

> "In order to carry through this idea, we need a generalizing modification of the field equations of gravitation."

With this "modification", he was going to introduce his famous "Cosmological Constant". But what was the need to introduce "Cosmological Constant"? Well, it was needed because, as Einstein himself shows, original GR equations did not support the "assumption" of finite universe. In paragraph following the equation No.13, he writes following:

> "We should probably have to conclude that the theory of relativity does not admit the hypothesis of a spatially finite universe."

But Einstein had "intuitively" made up mind to move on with "hypotheses" of finite universe and he was ready to modify his equations which he did by introducing Cosmological Constant.

With this assumption of finite universe, Einstein actually realized that gravity shall cause matter to condense. The scenario of contracting universe was the natural and commonsense consequence of the assumption of finite radius. Relativity supporters often boast that GR equations themselves initially "predicted" expanding or contracting universe that tempted Einstein to introduce cosmological constant in year 1917 to confirm to the accepted point of view of that time. But why relativity supporters not boast these things when they get same disinformation right from NASA's website? Following is a quote from NASA website[2]:

> "The Big Bang model was a natural outcome of Einstein's General Relativity as applied to a homogeneous universe. However, in 1917, the idea that the universe was expanding was thought to be absurd. So Einstein invented the cosmological constant as a

term in his General Relativity theory that allowed for a static universe.ö

Actually GR equations themselves had no ÷predictionø at all. It happen that intuitively Einstein thought that let universe be finite. But his own equations did not accompany him. Original equations were neither giving him ÷contractingø nor ÷expandingø universe ó original equations when coupled with intuitive idea of finite universe were giving him ÷collapsingø or ÷contractingø universe. Therefore either it is plain misunderstanding or utter lie that original GR equations had the ÷predictionø of contracting or expanding universe.

He evaluated the idea of infinite universe but infinite universe had complications with regards to various postulates of relativity. Therefore he preferred the intuitive idea of finite universe and even modified his equations to pursue that otherwise incompatible idea. To carry through this intuitive idea, Einstein introduced a clear fudge factor in equations in the form of cosmological constant. We are told that this cosmological constant physically represents energy density of the vacuum of space[3] which exerts anti-gravity type repulsive force which does not let universe to contract. Here, my objection on physical meaning of cosmological constant is that energy-density (even if it is of ÷vacuum of spaceø) should add to more gravity rather than giving any sort of anti-gravity. But anyhow, accepted meaning of cosmological constant was anti-gravity whose parametric value could cause expansion, static stability or contraction. In short, possibility of ÷expansionø was provoked solely out of a commonsense assumption of a finite radius of universe such that the assumption was not derived from equations.

In 1922, Friedmann showed that zero parametric value of cosmological constant will give the result of a stable oscillating universe with oscillating period of 10 billion years if mass contained in the universe is 5×10 solar masses. Therefore by using cosmological constant in his equations, Friedmann made a commonsense assumption as part of his mathematical analysis. Furthermore, he added his own assumptions also. The Universe of Einstein had definite radius and the length of radius was dependent on quantity of (finite) matter contained in the Universe. Perhaps at the time general estimate of total mass content of Universe was the same figure of 5×10 solar masses. The radius of Einstein's static Universe had no relation with time as radius had relation only with total mass content of Universe. Here Friedmann added another assumption from outside the realm of equations. He added the ‑assumption' that radius of Universe was dependent on time (radius was function of time). In the translation of his famous 1922 paper, Friedmann describes mathematical model of Einstein's Universe in following words:

> õEinstein obtains the so called cylindrical world, in which space possesses a constant curvature independent of time and in which the radius of curvature is connected with the total mass of matter existing in space.ö

It is clear from above quote that relationship of radius with time could not be derived from mathematical model as proposed by Einstein. Afterwards, Friedmann tells us the goal of his own work which includes following:

> ōSecond (goal is), the proof of the possibility of a world whose spatial curvature is constant with respect to three coordinates that are permissible spatial coordinates and that depend on time, e.g. on the fourth (time) coordinate. This new type is, as far as its remaining properties are concerned, an analogue of the Einsteinian cylindrical universe.ö

Here we see that actually Friedmann is going to develop a new type (of model) which would be outside the framework provided by Einstein's model. Within the framework provided by Einstein's model, spatial curvature does not depend on time. But Friedmann wants to prove possibility of a separate kind of world where spatial curvature would depend on time. This is very important point to consider because modern Big Bang Cosmologists always tell us about the supremacy of GR equations that they already secretly contained, without being in notice of Einstein, the super powerful concept of ÷singularityø from which our whole universe has been originated. But when radius of Universe had no relation with time under GR equations then backward in time projection of radius of Universe at time 0 as ÷singularityø was also simply nowhere in GR equations.

Anyhow, Friedmann proceeds to describe two classes of assumptions for his own model. The first class of assumptions coincided with the assumptions of Einstein and de-Sitter (de-Sitter also had developed solution of GR equations for a model of Universe). The second class of assumptions was new comer and had no relation with previously developed models. The crucial assumption under second class as narrated by Friedmann was ōR (radius) depends only on x_4 (time coordinate) and it is proportional to the radius of curvature of

space, which may therefore change with time". Here important thing to be noticed is that though Friedmann assumed radius of curvature proportional to time but he has totally skipped first class of assumption according to which radius of curvature should also be proportional to total mass content of Universe. But since he has already mentioned first class of assumptions hence we should conclude that first class of assumptions shall remain valid part of further proceedings. This aspect gets clear under equation No.5 where Friedmann makes it clear that "R (radius of Universe) is a function of x_4 (time coordinate) and M (Total mass content of universe) depends, in the general case (i.e. Friedmann is calling his own model as general case), on all four world coordinates (i.e. three spatial and one time coordinate)".

Now we have reached to very important point. Above analysis is actually making it clear that Friedmann's model of expanding universe is consistent with the Steady State Model of Universe but categorically does not support Big Bang Cosmology. If, with the passage of time, Universe is expanding then total mass content of Universe is also increasing. This position of Friedmann is not in harmony with the Big Bang Model. However, this position is in line with the Steady State Model. On the contrary, Wikipedia article on Alexander Friedmann states that the dynamic cosmological model of 'general relativity' developed by him became standard for both the Big Bang and the Steady State theories. According to this Wikipedia article[4], Friedmann's work equally supported both theories and that Steady State theory was abandoned only after detection of CMBR.

Here first of all I should register my objection on the notion that Friedmann's cosmological model belonged to general relativity (GR). I have explained it earlier that cosmological constant was not derived from GR equations but was simply assumed as a commonsense based

consequence of non-mathematical assumption that Universe has finite radius. GR equations themselves could not give result of either expansion or contraction. Only with an extra assumption of ‑finite radius of universe‑, the need for a fudged solution evoked. Expansion was mathematical consequence of this type of fudge factor. This fudge factor cannot be fully traced back to GR equations. This fudge factor can be traced only up to a commonsense assumption and resultant commonsense solution. To register this objection was crucial because such instances highlight how relativists unduly trace every aspect of the Big Bang theory to GR equations and try to demonstrate superiority of (mathematical) equations in general and GR equations in particular. The only proof of Big Bang is actually like this ó Hubble found expanding Universe >>> Expansion was already derived from GR equations by Friedmann (1922) and Lemaître (1927). We people now keep on saying that what Hubble had found was not ‑expansion‑ as Cosmological Redshift which he had found is not the proof of expansion of space or physical receding of anything. While we may keep on saying this, relativists keep on saying that since Hubble‑s findings already had been derived from (GR) equations, therefore there is no need to physically demonstrate that meaning of Cosmological Redshift is anything other than ‑expansion of space‑ as depicted in Friedmann- Lemaître type equations.

After having registered the above objection, now we come back to the main discussion. We have seen so far that Friedmann‑s model is actually not consistent with the Big Bang Theory however there is supportive material for the Steady State Theory. The Big Bang Theory and the Steady State Theory are the only two accepted theories under standard model because both theories accept and adhere to basic framework of ‑expanding universe‑. Both theories accept that

Cosmological Redshift, even before having been discovered, was already mathematically described in terms of Expanding Universe by Friedmann and Lemaître. Wikipedia article[5] defines Steady State Theory in following words:

> õIn cosmology, the Steady State theory is an alternative to the Big Bang model of the evolution of our universe. In the steady-state theory, the density of matter in the expanding universe remains unchanged due to a continuous creation of matter, thus adhering to the perfect cosmological principle, a principle that asserts that the observable universe is basically the same at any time as well as at any place.ö

Thus Friedmann's model is actually supporting the Steady State theory because (i) radius of universe expands with time and; (ii) Total mass content of Universe also increases with increase in radius and in this way total mass density of the Universe remains the same. But standard model has the claim that Friedmann's model actually supports both (i) the Steady State and; (ii) the Big Bang theories equally. But ó the standard Big Bang theory does not permit continuous creation of more mass with the ongoing expansion.

Now we come back to original 1922 paper of Friedmann where he starts part-II (B) of the paper with sentence, õWe now want to consider the non-stationary world. M (total mass content of universe) is now function of x_4 (time coordinate)ö. We see here that for Friedmann, dynamic universe is not just contracting or expanding in terms of radius, it is also losing or gaining mass. But more relevant to Big Bang points are yet to come in Friedmann's 1922 paper. For the derivation of equation No.20, he writes:

> "Since the radius of curvature may not be smaller than zero, it must decrease with decreasing time, t, from R0 to the value zero at time t. We shall call the growth time of R from 0 to R0 the time since the creation of the world".

With above in the celebrated 1922 paper of Friedmann, we have actually reached to the basic idea of Big Bang. Friedmann calls the world at time zero as "monotonic world of the first time". Story does not end here. Under footnote No.11, Friedmann writes following:

> "11. The time Since the creation of the Universe is the time that has elapsed from the moment when space was a point (R=0) to the present state (R= R0): this term may also be infinite."

What we have found here are the plain original ideas of "singularity" as well as "expansion of space". Now we shall analyze these two aspects right here. First of all let us emphasize here that Lemaître also had learned his basic idea of "Primeval Atom" or "Cosmic Egg" from these points which are contained in famous 1922 paper of Friedmann. A pro-Friedmann paper confirms this point in following words:

> "In 1931, Lemaître first gave Friedmann's singularity a physical meaning, that of a "primeval atom" blowing up" what Fred Hoyle later dismissively called "the Big Bang."6

Story emerged so far is that while in year 1927 Lemaître had proposed expansion of universe but by that time he was unaware of

Friedmann's work. Einstein, while rejecting 1927 work of Lemaître, had told him that similar expanding universe solution was already presented by Friedmann. After publication of manipulated translation of 1927 article in 1931 by Lemaître, Einstein publically abandoned his concept of cosmological constant. In fact he had not abandoned this concept altogether but had conceded to the value assigned to it by Friedmann. These developments compelled Lemaître to review his own work in the light of Friedmann's ideas. Thus, in 1931, he picked the idea of 'monotonic world' from Friedmann, assigned physical meanings to it and called it 'Primeval Atom' or 'Cosmic Egg'.

It is now clear that concept of 'initial singularity' has come in the standard Big Bang Cosmology from Friedmann. First thing is that since Friedmann's expansion or oscillating model was based on 'cosmological constant' which was not the part of original GR equations, therefore the idea of initial singularity also has nothing to do with GR equations. Second thing is that concept of 'initial singularity' has come from an incorrect understanding of actual model of Friedmann. The actual model of Friedmann is based on two classes of assumptions. First class of assumptions includes the assumption that radius of universe is function of total mass content of universe. Second class of assumptions includes the assumption that radius of universe is a function of time. While specifying second class of assumptions, Friedmann has used word 'only' with the word x_4 (i.e. time). The usage of word 'only' has deceived Big Bang Cosmologists into believing that radius of universe is function of time only. Here they completely forget that Fiedmann also has specified another class of assumptions where he has assumed that radius of universe is function of total mass contents of universe as well. Now the standard concept of 'initial singularity' of standard Big Bang Model is based on exactly

this mistake. This view is further strengthens on account of the fact that in the translation note of the translation of 1922 paper, the translator also has committed the same mistake. In the translation note[7], the translator has written following:

> õIf R (radius of universe) is independent of time, then the stationary world models of Einstein and Wilhelm de-Sitter follow. If R(t) depends only on the time variable, then a variety of monotonically expanding or periodically oscillating models result, depending on the value chosen for cosmological constant.ö

What we need to understand here is that Friedmann has not actually presented any expanding model of universe. What he has presented is a broader and general scheme of all the mathematical possibilities of stationary as well as non-stationary models. Expanding or oscillating models are only particular cases of this general scheme. Even stationary models are also particular cases of this general scheme. More precisely, two particular stationary models of Einstein and de-Sitter[8] were available by his time. Stationary model of Einstein was cylindrical universe model where radius depended on mass content only. Wilhelm de Sitterøs spherical universe model was more geometrical where even mass content was also not discussed. After identifying the nature and type of available stationary models, then Friedmann proceeds to formulate a general scheme. The general scheme shall cover both stationary as well as non-stationary models. But the whole general scheme would be based on two classes of assumptions. In the new general scheme, stationary models will follow both classes of assumptions and non-stationary models also would

follow both sets of assumptions. In this way, Friedmann, at first, was going to amend already available two stationary models. In equations No.6 to 10, Friedmann thus derived Einstein's model and de-Sitter's model separately such that now these two models were based on both classes of assumptions and in this way Friedmann made it clear that both the stationary models of Einstein and de-Sitter were basically special cases of his own general scheme which was based on two classes of assumptions. After equation No.10, Friedmann proceeds to consider the non-stationary worlds and clearly writes "M (total mass content of universe) is now a function of x_4 (time coordinate)". With this sentence, every doubt should be cleared. His non-stationary models were dependent on both classes of assumptions and not on time coordinate only (i.e. only second class of assumptions).

I.VI. Concept of 'Initial Singularity' of Modern Big Bang Cosmology has been derived from Incorrect Understanding of Friedmann's Model

Friedmann has presented a general scheme of stationary as well as non-stationary models of universe. Both types of models are based on two classes of assumptions. First class of assumptions included that radius of universe is function of total mass contents of universe. Second class of assumptions included that radius of universe is function of time. Then Friedmann started discussing possibility of 'monotonic world' i.e. world at time zero and radius zero. Here Big Bang Cosmologists committed a crucial mistake and made whole

universe into a mythological fiction of zero radius with infinite density of mass. They simply ignored first class of assumption that radius was dependent on total mass content as well. If Friedmann is discussing possibility of a monotonic world where radius of universe is zero at time zero, then total mass content of universe was also zero at that zero time. Its meaning is that in mathematics, there is no valid concept of infinitely dense mass within infinitely small point and thus ÷initial singularityø concept of modern Big Bang Cosmology is nothing more than an incorrect fiction. Friedmann was presenting only abstract mathematics where he ruled out possibility of certain scenarios only due to one reason that square root under that option was imaginary number. Zero was not a reason, within mathematical analysis, to rule out possibility of a scenario. Zero space with zero mass was thus a valid option within abstract mathematics. But Big Bang cosmologists mistakenly took it as zero space with infinite mass or density, assigned it literal physical meanings and started calling it initial singularity that started to ÷expandø with the start of time. Those Big Bang Cosmologists failed to see error messages notified to them by their own commonsense because they were devotees of ÷counter-intuitiveø physics which was based on ultra-superior ÷relativisticø equations. Now, within the right meanings of ÷monotonic worldø of Friedmann, these (Big Bang) cosmologists are under obligation to tell us about the valid physical processes that can keep on producing new mass after passage of time from initial zero values of both mass and time.

I.VII. Expansion of Space

The case of the Big Bang Cosmology is that after the discovery of Hubbleøs law in 1929 that ÷more distant galaxies are moving away at

greater speedø, scientists realized that this law was already derived from GR equations by Friedmann (1922) and Lemaître (1927). We have seen already that Lemaître had actually found this law in 1927 out of observational data and he did not derive it from any equation. For the case of Friedmann, let us now analyze whether he actually derived this law in 1922 or not. But before analyzing this aspect, let us first confirm the case of Big Bang Cosmology as mentioned above. The following is written in Wikipedia article on Hubbleøs Law[9]:

> õAlthough widely attributed to Edwin Hubble, the law was first derived from the general relativity equations, in 1922, by Alexander Friedmann who published a set of equations, now known as the Friedmann equations, showing that the universe might expand, and presenting the expansion speed if this was the case. Then Georges Lemaître, in a 1927 article, proposed the expansion of the universe and suggested an estimated value of the rate of expansion, which when corrected by Hubble became known as the Hubble constant.ö

Before attempting to find this law in Friedmannøs 1922 paper, it is necessary to understand that modern concept of ÷expansion of spaceø is deeply linked with Hubbleøs law. Although I have objection on usage of term ÷velocitiesø in Hubbleøs law as Hubble has only noted relation of ÷redshiftø with distance and not ÷velocityø with distance and he had clarified that he had used term ÷(apparent) velocitiesø but let us move on with the term ÷velocitiesø because the same is the accepted meaning under standard model. So within the standard meaning of Hubbleøs law, the first problem aroused then ÷why do we appear to be at center?ø

This problem was resolved easily by using expanding balloon surface analogy as every point on balloon surface would experience that every other point is moving away from it and every point could take itself at center. The second problem was that Cosmological Redshift (redshift-distance relationship) was not the physical proof of receding of anything. Third problem was that if more distant galaxies are receding away with greater speed then the galaxies located at far off astronomical distances must be receding away at speed greater than speed of light which is not permissible under the same standard model. The ÷solutionø for the second and third problem was this idea of ÷expansion of spaceø Cosmological Redshift is not the physical proof of receding of anything but idea of expanding universe is rescued through this idea of ÷expansion of spaceø Galaxies are not physically moving away from us. It is actually ÷spaceø which is expanding everywhere at constant rate which corresponds with Hubbleøs constant. And the proof of ÷expansion of spaceø is Friedmann-Lemaître equations. Since galaxies are not physically moving away as only space is expanding so there is also no actual problem of receding speed greater than speed of light.

Now we come to the 1922 paper of Friedmann to see extent to which it is true that Hubbleøs law was already derived by him through equations or was he really talking about ÷expansion of spaceø within the modern standard meanings of this notion.

The expanding universe model of Friedmann is that radius of universe expands with passage of time and creation of new mass. Zero radius at zero time may reach to maximum radius in 10 billion years with total mass of 5×10 solar masses. If more mass is not created then total mass will start diminishing and in next 10 billion years, the radius and mass quantum both will again reach to zero. Now readers

are invited to judge by themselves regarding where is Hubble's law in this type of expansion model? In this expansion model, continuous induction of new mass is required. It is not Hubble's Law of experimental physics. This is Friedmann's law of Abstract Mathematical Physics. Now suppose that time is passing and mass is being created at uniform rate, then speed of expansion of radius will also be uniform. When radius is 1, expansion speed is 100. When radius is 13 billion light years, expansion speed is again 100. This is not speed-distance relationship of Hubble's law. It is not even speed-mass relationship. Hubble type expansion is possible only if every second, greater than the previously added mass is created. If at first second 1 Kg mass is created and the same increment of 1 Kg is being created every next second, then it is not the case of Hubble type expansion. But if at first second 1 Kg mass was created, at second increment was 1.1 Kg and at third second increment was 1.2 Kg, then it would be a proper case of Hubble type expansion. But Friedmann had not made equations for these things. When he has calculated time period of 10 billion years for mass of 5×10 solar masses he has not even told the value of radius after 10 billion years or that what was mass and radius after let's say 5 billion years. In no way could Friedmann found Hubble's law in 1922 on the basis of mathematics alone and neither did he found. Claim of Big Bang Cosmologists that he already had derived Hubble's law from GR equations is not hereby accepted. His equations only could give similar to Hubble's Law type graphs but only depending on increasing incremental values of newly created mass with passage of time. And continuous increase in total mass is not a valid or even remote part of standard Big Bang Cosmology. This thing might be relevant to the Steady State Cosmology but Steady State is already defeated theory and therefore is

not on the hit list of this book. When we consider the actual fact that Hubble's law does not even talk about speed, then along with Big Bang, Steady State also becomes irrelevant. In addition, if Friedmann really had reached to Hubble law type expansion then he should not have described oscillation model in simple terms. He should have told us that with maximum radius achieved, contraction would be more difficult because expansion had to be at higher speed at maximum radius. In short, in simple terms of Hubble's Law, greater radius means greater recessional velocity then how contraction phase could initiate at all and why Friedmann has described possibility of oscillation model without first removing this difficulty? Fact is only that in 1922, he had not reached to Hubble Type expansion model neither he could reach to this concept solely on the basis of mathematical analysis of GR equations.

Now we move to the issue of 'expansion of space' and find it true that plain (but shallow) reading of Friedmann's 1922 paper does suggest as if he was talking about 'expansion of space' Following two portions of his 1922 paper, particularly the second one are capable to give idea of 'expansion of space':

> "From that, it follows that R is an increasing function of t. The positive initial value R0 is free of any restriction. Since the radius of curvature may not be smaller than zero, it must decrease with decreasing time, t, from R0 to the value zero at time t' We shall call the growth time of R from 0 to R0 the time since the creation of the world".
>
> "11. The time Since the creation of the Universe is the time that has elapsed from the moment when space

> was a point (R=0) to the present state (R= R0): this term may also be infinite.ö

Both these portions if read in isolation can mislead us into thinking that radius of universe is function of only time and not the function of mass contents of universe. But we have already seen that both first and second classes of assumptions are valid feature of the overall general scheme of possible models presented by Friedmann. Therefore R is function of t and R is also function of M. But here Friedmann is discussing only two variables R and t. A valid assumption ‑Mø is not being assumed at all. When a valid thing ‑massø is not even being considered then we have to accept that yes he is actually talking about ‑expansion of spaceø We must consider another aspect also that Friedmann is discussing things within the framework of Abstract Mathematics only. Mathematics is study of space (dimensions, area, volume, shape etc.) and numbers (real, unreal, constants, variables etc.). Within a mathematical model, Friedmann is discussing about space. We must not conclude that he has made ‑spaceø into a real thing having a solid object like capabilities of expansion or contraction.

At this point, we must try to understand Friedmannøs actual concept of space. The English Translated title of his 1922 paper is õOn the Curvature of Spaceö. By the term ‑radius of universeø his meaning is that mass contents of universe would cause gravitational boundary of universe that a straight line universal journey of a physical object would be a complete circle and would reach back to the original point. ‑Radius of universeø is radius of this universal ‑straightø line which is actually circular. Within this meaning of ‑spaceø it is physically valid to say that space may expand or contract. Within mathematical model of Friedmann, space is really expanding or contracting according to

this meaning. Following are some examples in Friedmann's paper of usage of term Radius R as curvature of space:

> "Here R depends only on x4 and it is proportional to the radius of curvature of space, which may therefore change with time."
>
> While deriving constant universe model of Einstein within his own general scheme, Friedmann writes: "whereby R signifies the constant (independent of x4) radius of curvature of space."
>
> "If we restrict our consideration to positive radii of curvature".
>
> "Let the radius of curvature equal R0 for t = t0."
>
> "Positive or negative depending on whether the radius of curvature is increasing or decreasing for t = t0."
>
> "by choice of the time it can always be arranged such that the radius of curvature increases with increasing time at t = t0."

It is now clear that yes space is contracting or expanding in Friedmann's model but it is contracting or expanding within above physically valid meanings of contraction or expansion of space. But Big Bang Cosmologists tell us a whole different and misleading thing and they attribute their own faulty model to Friedmann. They call their own misleading model of 'expansion of space' as 'metric expansion of space' and wrongfully attribute this faulty physical model to Friedmann. Following are the accepted meanings of metric expansion of space according to Wikipedia article[10]:

õThe metric expansion of space is the increase of the distance between two distant parts of the universe with time. It is an intrinsic expansion whereby the scale of space itself changes. It means that the early universe did not expand "into" anything and does not require space to exist "outside" the universe - instead space itself changed, carrying the early universe with it as it grew. This is a completely different kind of expansion than the expansions and explosions seen in daily life. It also seems to be a property of the entire universe as a whole rather than a phenomenon that applies just to one part of the universe or can be observed from "outside" it. Metric expansion is a key feature of Big Bang cosmology, is modeled mathematically with the Friedmann-Lemaître-Robertson-Walker metric and is a generic property of the universe we inhabit. However, the model is valid only on large scales (roughly the scale of galaxy clusters and above), because gravitational attraction binds matter together strongly enough that metric expansion cannot be observed at this time, on a smaller scale.ö

So the article is proudly saying that this model is valid (or physically detectable) only on large scale astronomical distances. Whereas as per Friedmannøs actual model if universe consists of only 1 solar mass, then it will have a radius of curvature which will be set by the gravitational boundary of only one solar mass and in physical terms it may be equal to only few thousand astronomical units. In simple terms, it should be equal to largest possible orbit around sun. If universe contains 5×10 solar masses, then radius is beyond of our reach. But standard model is saying that only after local galaxy cluster

they are able to see expansion of this radius. Off course they are not able to see expansion of radius as the only thing which they see is 'receding' of galaxies. But Friedmann is talking about increase in radius due to increase in mass and he is not talking about physical receding of galaxies in terms of misinterpreted Hubble's Law. FLRW metric where 'F' stands for 'Friedmann' is only a deliberate modification or at worst, the plain misunderstanding of Friedmann's actual model. Only thing is that science community learned an amazing thing in 1929 that there is a linear relationship between distance and redshift of light coming from far off galaxies. They misread the actual fact in the modified form that there is linear relationship between distance and receding velocities of galaxies. They also wrongfully realized that in year 1922, Friedmann had derived exact this fact from equations of General Relativity. Then two new mathematicians 'R' (Robertson) and 'W' (Walker) might have modified equations of 'F' (Friedmann) and 'L' (Lemaître) and the resultant new metric equations are now known as FLRW metric. This FLRW metric is considered, under standard model, as the only possible explanation of Cosmological Redshifts discovered by Hubble in 1929. There is no physical proof that cosmological redshift has anything to do with physical receding of anything. It is only account of authority of (dubious) mathematics (FLRW metric) that Big Bang Cosmologists do not feel the need to have physical proof that cosmological redshift really means receding of galaxies from us. They do not need any proof and they do not offer any proof. Yet they say that Big Bang is a scientific theory and they promote this clearly false theory as such. Science has been wrongfully disconnected from real observations or experiments and is now based on mathematics. Mathematicians now float their equations in market (official papers)

and wait for the time when any real observation would be found remotely consistent with their equations. Then they would jump in with claims that such and such observed fact was already 'predicted' by their equations and sadly, this is the only permissible way of proposal and acceptance of new scientific ideas under the established system of scientific methodology.

Anyhow, we have seen that Friedmann has only presented abstract mathematics. The physics behind expanding model of Friedmann is set out by 'cosmological constant' which is not the genuine part of General Relativity equations. Einstein himself writes following in his 1917 paper where he presented his stationary model of universe by introducing 'cosmological constant':

> "In order to arrive at this consistent view, we admittedly had to introduce an extension of the field equations of gravitation which is not justified by our actual knowledge of gravitation. It is to be emphasized, however, that a positive curvature of space is given by our results, even if supplementary term is not introduced. That term is necessary only for the purpose of making possible a quassi-static distribution of matter, as required by the fact of small velocities of the stars."

Second thing is that Firedmann did present expanding model but a variable curvature of space depending on time and mass was not out of sight of Einstein in 1917:

> "Curvature of space is variable in time and place, according to the distribution of matter, but we may

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However here Einstein might be talking about curvature of space at particular location of universe. Friedmann extended this idea to the curvature of whole universe. But neither Einstein (up to that time), nor Friedmann (ever) talked about ÷FLRWø metric type expansion of space which is causing far off galaxies to move away from solar system at speeds greater than speed of light. In fact, one of the fundamental assumptions of Einstein, in year 1917, was that speeds of stars are too low as compared with velocity of light. In 1917 paper, he wrote following:

> õWe shall proceed to show that both the general postulate of relativity and the fact of the small stellar velocities are compatible with the hypothesis of a spatially finite universe.ö
> õThe most important fact that we draw from experience as to the distribution of matter is that the relative velocities of the stars are very small as compared with the velocity of light.ö

Thus we see that, while not knowing Hubble type expansion in year 1917, Einstein could think of local variable curvature of space that depended on time and distribution of matter. In 1922, Friedmann was also equally unaware of Hubble type expansion and he could think of variable curvature of space for the whole universe. Friedmann never challenged the ÷fact drawn from experienceø that relative velocities of stars are very small as compared with the velocity of light. If he (Friedmann) knew anything about coming ÷FLRWø metric then he

should have explained in 1922 that though relative velocities of stars are very small as compared with the velocity of light but 'proper distance' between heavenly objects is increasing at speed greater than the speed of light due to 'FLRW type expansion of space' But actually he did not explain this crucial difference of his model with Einstein's model. He only stated that Einstein's model was a special case of his own general scheme. To derive case of Einstein's model within the framework of his general scheme, he never stated that heavenly bodies must move apart at enormous speeds. Within his general framework, he reached to the same model of Einstein with no modification of idea of Einstein that stars have very low relative velocities. In fact, if Friedmann had really reached to the fact of Hubble Type expansion, then his whatever 'general scheme' should not have accomodated the stationary models of Einstein and de-Sitter as special cases. Fact is only that 'FLRW' metric is not consistent with the actual Friedmann and 'FLRW' metric is only an after development when Hubble's Law had already been surfaced.

Now what we see in 1922 paper of Friedmann is that he also has assumed very low relative velocities of heavenly bodies. Under serial No.2 of the first class of assumptions, he writes following:

> "The matter is incoherent and relatively at rest. Stated less strongly, the relative velocities of matter are vanishingly small in comparison with the velocity of light."

We know that first class of assumptions, just like second class of assumptions, form the core framework within which whole general scheme of possible stationary as well as non-stationary models of universe operate. If, for Friedmann, relative velocities of heavenly

bodies are vanishingly small in comparison with the velocity of light, then 'expansion of space' for him is only expansion of overall curvature of space due to increase in quantity of total matter of universe. If all the matter is relatively at rest, then there is no 'FLRW' type expansion of space going on which is causing matter to relatively move apart at enormous speed that eventually, due to enormous increase in relative distance, crosses the light speed limit. It also means that Hubble type 'expansion of universe' was nowhere in the mind of Friedmann as he did not write another third class of assumptions where he could accommodate enormous relative velocities of heavenly bodies due to 'Hubble' or 'FLRW' type 'expansion of space'

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[1] http://einsteinpapers.press.princeton.edu/vol6-trans/433

[2] https://map.gsfc.nasa.gov/universe/bb_tests_exp.html

[3] https://en.wikipedia.org/wiki/Cosmological_constant

[4] https://en.wikipedia.org/wiki/Alexander_Friedmann (This dynamic cosmological model of general relativity would come to form the standard for both the Big Bang and Steady State theories. Friedmann's work supports both theories equally, so it was not until the detection of the cosmic microwave background radiation that the Steady State theory was abandoned in favor of the current favorite Big Bang paradigm.)

[5] https://en.wikipedia.org/wiki/Steady_State_theory

[6] (Alexander Friedmann and the origins of modern cosmology: Ari Belenkiy - Phys. Today 65(10), 38 (2012); doi: 10.1063/PT.3.1750, http://dx.doi.org/10.1063/PT.3.1750

[7] "On the Curvature of Space" Aleksandr Friedmann – Translation by Brian Doyle.

[8] De-Sitter's model is now-a-days projected as expanding universe model and even inflationary period is also derived from de-Sitter's present (modified) model. By the time of Friedmann, it was a stationary model of Universe. Edwin Hubble, after 1929 had requested de-Sitter to provide explanation of redshifts. Hubble himself remained skeptical to the idea of expansion but de-Sitter adopted expansion ideas after 1929.

[9] https://en.wikipedia.org/wiki/Hubble%27s_law

[10] https://en.wikipedia.org/wiki/Metric_expansion_of_space