Did Edwin Hubble plagiarize?

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Abstract

Recently Block published an astro-ph[1] insinuating that Hubble censored a prior publication of his famous and seminal discovery of the expansion of the universe. This issue was investigated by us in detail as part of the book: *The Quest for Chemical Element Genesis and What the Chemical Elements Tell about the Universe*[2]. Since the book is due in few months, we extract here the relevant parts.

Our summary: We exonerate Hubble from the charge that he censored or ignored or plagiarized Lemaitre's earlier theoretical discovery.

1 The Expanding Universe and the Origin of Elements

As soon as Einstein published in 1915, in a series of papers, his General Theory of Relativity, attempts to apply the new theory to the entire universe were made by Einstein[3] himself and by de Sitter (1872-1934m)[4]. Both assumed an empty universe without mass, more accurately, they ignored the pressure inside the universe. Einstein searched for a static solution to the behavior of the universe while de Sitter allowed for a dynamic one. It would be found later that technically, de Sitter's solutions are also static, but this was due to the assumption that his models assumed an empty universe, namely in his approximation the mass did not affect the results. One of the important predictions by de Sitter was that distant objects would show a shift in their emitted spectral lines - an effect which became known as the 'de Sitter effect'. de Sitter's solution was found before the great debate on the nature of the nebulae was resolved, and de Sitter did not know at the time of the writing that extragalactic objects exist. Consequently, de Sitter[5] could only speak on distant stars. De Sitter estimated that the shift observed in faint and hence distant stars, would be equivalent to less than 1/3 km/sec. Happy with this result, de Sitter wrote that: *It is well known that stars of all*

[1] http://arxiv.org/abs/1106.3928 (2011).

[2] Accepted for publication, Springer Pub. Heidelberg, 2011. Please note, an 'm' after the death year of a person means that a lunar crater was named after him.

[3] Einstein, A., Berl. Ber., 1917, p 142., Ann. d. Phys. **55**, 241, (1918)

[4] de Sitter, W., Proc. Akad. Wetesch. Amsterdam, **19**, 1217, (1917), Ibid. **20**, 229, (1917)

[5] de Sitter, W., MNRAS, **77**, 155, (1916)

spectra actually show a small systematic displacement towards the red, but he did not tell who knew it. Einstein did not like the solution de Sitter found and criticized it[6].

It was Lanczos (1893-1974) who demonstrated[7], by a simple change of the coordinates, that the de Sitter static solution can be interpreted as an expansion of the universe. However, the direct solutions for the expanding universe (without manipulations with the coordinates) were found by Alexander Friedman (1888-1925m)[8] in 1924. Friedman's solutions are known today as the 'Friedman world models'. Einstein believed in 1923 that he found an error in the 1922 Friedman's paper because it did not agree with his expectations, but Friedman demonstrated that this was not the case. Consequently, Einstein withdrew his objection to the result[9]. It was difficult to shake Einstein's belief in the static universe. Friedman has essentially shown that Einstein's and de Sitter's solutions[10] were the only static solutions and all other solutions are either expanding or contracting. This dramatic result was confirmed in 1929 by Tolman (1881-1948)[11] and Robertson (1903-1961m)[12]. A summary of the static versus the non-static solutions to Einstein's equations was published by Robertson in 1933[13], when it was already clear that static solutions do not agree with the observations.

Returning to our story, in 1927 the Catholic Jesuit priest Abbé Lemaitre (1894-1966m) discovered[14] independently from Friedmann, solutions to Einstein's equation which included mass and pressure and discovered that Einstein's solution for the universe is unstable, namely, they behave like a giant explosion. It is in this paper that Lemaitre derived the *apparent Doppler effect* which implied that *the receding velocities of extragalactic nebulae are a cosmical effect of the expansion of the universe* with velocity proportional to the distance. This result was also found by Robertson in 1928[15] who, so it seems, did not know about the result of Lemaitre a year earlier. Robertson noted in his second paper that he discovered Lemaitre's 1925 paper[16] only after the completion of his paper, but apparently he was unaware of Lemaitre's important paper of 1927.

In these early stages of the developments of the ideas, it was not clear what exactly

[6]Einstein's criticism had a bad impact on de Sitter who abstained from cosmology for almost a decade and resumed his interest in cosmology only after Hubble's discovery of the expanding universe.

[7]Lanczos, C., Phys. Zeit., **23**, 539, (1922)

[8]Friedman, A.A., Zeit. fur Phys. **10**, 377, (1922), Ibid., **21**, 326, (1924)

[9]This story is an example that even eminent scientists can be captive of their feelings and have problems liberating themselves from personal biases by means of scientific logic.

[10]When de Sitter came with his solution, Einstein did not like it and criticized it, giving rise to bad mutual feelings. This should not be the result of a scientific criticism if properly expressed.... After close to a decade they reconciled and agreed upon the solution called the Einstein-de Sitter model. Eddington tells that when Einstein visited hims and they discussed the model, Einstein remarked that he 'did not think the paper was important but de Sitter was keen on it'. Sometime later, de Sitter wrote to Eddington about a visit to Cambridge and added 'You will have seen the paper by Einstein and myself. I do not myself consider the result of much importance, but Einstein seemed to think it was.' Kerszberg, P., *The Invented Universe: The Einstein - de Sitter Controversy*, Clarendon Press, p 403, 1989.

[11]Tolman, R. C., PNAS, **15**, 297, (1929)

[12]Robertson, H.P., PNAS, **15**, 822, (1929). It is in this publication that Robertson rectified the earlier deductions by Friedmann, which were not entirely satisfactory.

[13]Robertson, H.P., Rev. Mod. Phys.,**5**, 62, (1933)

[14]Lemaitre, G., Annales de la Societe Scientifique de Bruxelles, **47**, 49, (1927). After writing the paper, Lemaitre met Einstein in Brussels and they discussed its content. Einstein verdict to Lemaitre was: *The calculations are right but your understanding of physics is abominable*, Midbon, M. *A day without yesterday: George Lemaitre & the Big Bang*, Commonweal, March 24th, 2000.

[15]Robertson, H.P., Phil. Mag., **5**, 835, (1928). Ibid., Phil. Mag., Supple., **5**, 385, (1928)

[16]Lemaitre, G., J. Math. and Phys.,**4**, 188, (1925)

happened ′at the beginning′ of the universe. Was there a singularity, namely, the density and temperature tend to infinity, or the universe started expanding from a static state and if so what was the static state? The question of the elements was not considered. A lá Lemaitre, the universe started ′from some primeval matter′, the properties of which were ill defined.

2 First attempts to verify the de Sitter model

In 1918, the couple Shapley and Shapley[17] analyzed the differences in properties between globular clusters and spiral nebulae. The couple found that the radial velocities of globular clusters are predominately negative, a fact which led the Shapleys to the hypothesis that globular clusters are extra-galactic objects and are falling onto the general galactic system.

As for the spiral nebulae, *the brighter spiral nebula as a class, apparently regardless of the gravitational attraction of the galactic system, are receding from the sun and from the galactic plane - a remarkable condition that has been little emphasized heretofore.* The reason for this remarkable conclusion at this point in time was that though the number of velocities of spiral nebula was limited, out of 25 spirals all but 3 had positive velocities (meaning that they are moving away from us) and the velocities were 150 km/sec and above. These velocities are much higher than the (negative) velocities of the globular clusters.

The Shapleys stressed several times in the paper that *Globular clusters as a class appear to be rapidly approaching the galactic system; spiral nebula as a class are receding with high velocities.* They explained the fact that the spirals have receding velocities due to repulsive forces which act between the spirals and the Milky Way.

Another conclusion of the Shapleys was that: *The speed of spiral nebula is dependent to some extent upon apparent brightness, indicating a relation of speed to distance or, possibly to mass.* This of course, fitted the Shapley's idea of a repulsive force acting on the spirals, as they stated that: *The hypothesis demands that gravitation be the ruling power of stars and star clusters, and that a repulsive force, radiation pressure or an equivalent, predominate in the resultant behavior of spiral nebula.*

It is interesting to note that the 1917 de Sitter's paper was published just a year before the Shapleys completed their work but in a quite obscure location[18], not frequently accessed by astronomers. Neither were the year earlier papers in the Monthly Notices mentioned by Shapley (though his papers contained other references from this journal published roughly at the same time). On the other hand, the *Annalen der k.k Universitäts-Sternwarte in Wien* was consulted. The Shapleys had the first indication that the system of spiral nebula expands. They did not know what the recession velocity depended on, but the overall expansion was obvious[19].

After de Sitter's paper became known various attempts to verify de Sitter's model were carried out. One of the first attempts to discover the spectral shift (=velocity) versus distance relation was carried out by Ludwig Silberstein (1872-1948)[20] who applied de Sitter's result

[17]Shapley, H., & Shapley, M.B., ApJ., **50**, 107, (1919)

[18]de Sitter, W., Koninklijke Nederlandsche Akademie van Wetenschappen Proceedings, **19**, 367, 527, 1217, (1917)

[19]These fantastic observations did not prevent Shapley from arguing during the Great Debate, that the spirals are within the Milky Way. He had the expansion of the universe in his findings. Personal bias?

[20]Silberstein, L., MNRAS, **4**, 363, (1924). Silberstein considered himself an expert in relativity, and approached Eddington at the Royal Society's 1919 meeting where Eddington reported his successful trip to see the solar eclipse in Brazil and confirm the theory of General Relativity, with some degree of skepticism and charged Eddington as one who claimed to be one of only three men who actually understood the theory (Silberstein, as can be imagined, hoped to hear from Eddington that he belongs to group of Eddington and Einstein). When Eddington refrained from

	cD. kil./sec.	r. (Astron. units.)	R. (Astron. units.)
N.G.C. 5024	−170	$3{\cdot}8 \times 10^9$	$6{\cdot}7 \times 10^{12}$
5272	−125	2·8	6·7
6205	−300	2·2	2·2
6333	+225	5·0	6·7
6341	−160	2·5	4·7
6934	−350	6·7	5·7
7078	− 95	2·9	9·1
Lesser Magellanic Cloud	+150	4·1	8·2
Greater Magellanic Cloud	+260	3·8	4·4

Figure 1: *The original data of Silberstein 1924.*

to derive a formula for the shift of the spectral lines emitted by stars. For distant stars Silberstein found that (the Doppler shift) is:

$$\frac{\Delta\lambda}{\lambda} = \pm\frac{r}{R}, \tag{1}$$

where R is the radius of curvature of the universe and $\Delta\lambda$ the shift in wavelength λ of the line. Note that the sign can be positive or negative. Silberstein applied the formula to a list of stellar clusters for which he found mostly negative velocities but one positive one, as well as to the small and large Magellan Clouds which presented positive velocities. At that time it was not known that the Magellan clouds are outside the Milky Way or that there are any objects outside the Milky Way. The application of this law to this mix of objects gave a value for the radius of curvature of the universe of $R = 6.0 \times 10^{12}$ astronomical units or about 10^8 *lyrs*. In table 1 we give the data Silberstein used to derive $'$the radius of the universe$'$. As can be seen for example, the implied distance to the globular cluster NGC 6934, is 6.7×10^9 *astronomical units* or $100,100$ *lyrs* significantly more than the size of the Milky Way. It also implied that the small and large Magellan Clouds are outside the Milky Way. Silberstein sent his paper for publication on January 18th, 1924. The time was before Hubble's discovery that the nebulae are extra-galactic. But, it appears that Silberstein was unaware of the astronomical debate because his results, though very inaccurate, would have implied the same result Hubble got shortly after, namely that the spiral nebulae are extra-galactic. On the other hand, the possibility that the globular clusters were as far away as he claimed, would have implied unacceptable high intrinsic luminosities for the stars in the cluster. In short, lack of astronomical facts gave rise to unacceptable results.

Silberstein's results were criticized by Lundmark(1889-1958m)[21]. The criticism reflects how much people were locked up in dogmas. First, Lundmark claimed that the data on the Doppler shifts which were taken from Slipher, were suspiciously large and he questioned whether the shifts in spectral lines were not caused by another reason which had nothing to do with velocity[22]. Lundmark could not believe that such high velocities can be real. Next, Lundmark pointed out that the theory of Weyl and Eddington did not allow for a negative velocity, in contrast to Silberstein's result[23]. As for the globular clusters used by Silberstein, Lundmark claimed that: *These objects are probably among the most distant celestial objects*

replying, Silberstein pressed Eddington not be "so shy", whereupon Eddington retorted, "Oh, no! I was wondering who the third one might be!" As told by Chandrasekhar to Isaacson (*Einstein: His Life and Universe*,Simon & Schuster, 2008, p262.)

[21]Lundmark,K., MNRAS, **84**, 747, (1924)

[22]Years later when the large redshift of the quasar 2C273 was discovered by Maarten Schmidt astronomers were equally skeptic about the reality of the Doppler interpretation.

[23]It was difficult to believe that such high peculiar velocities exists.

we know at present, but how do we know that they are so far away that the effect of the curvature on space-time outweighs the effect of the real motions of the clusters themselves? Lundmark repeated Silberstein's analysis for various groups of celestial objects. We show in fig. 2 and 3 the data Lundmark compiled for the globular clusters and the spiral nebulae. From the globular clusters data, Lundmark found a much greater radius of curvature for the universe. As for the spiral nebula result (fig. 3) Lundmark states that *we find that there may be a relation between the two quantities, albeit not a very definite one.*

Shortly after Lundmark's criticism appeared in press, a similar criticism, this time by Strömberg, was published[24]. Strömberg concluded that *we have found no sufficient reason to believe that there exists any dependence of radial motion upon distance.*

What neither Silberstein, Lundmark or Strömberg noticed was that while the de Sitter solution to Einstein's equations yields a positive or negative sign in eq. 1, it means that either the universe expands and the sign is positive for all distant objects, or the universe contracts and the sign is negative for all distant objects. Silberstein assumed that some objects may have a positive sign while others a negative sign and Lundmark and Strömberg did not touch this point.

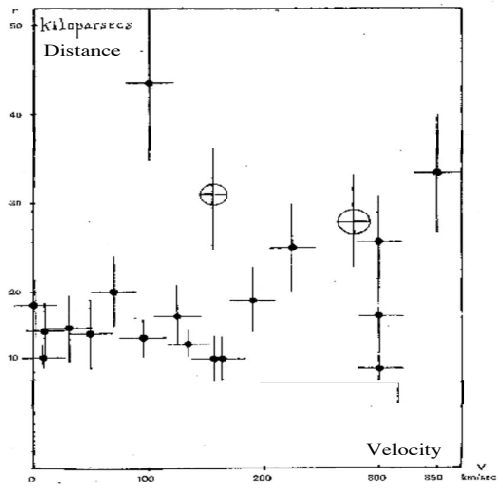

Figure 2: *The relation between velocities and distances of globular clusters. The circles are the values for the two Magellan clouds. Lundmark, 1924. The signs of a linear correlations are seen?*

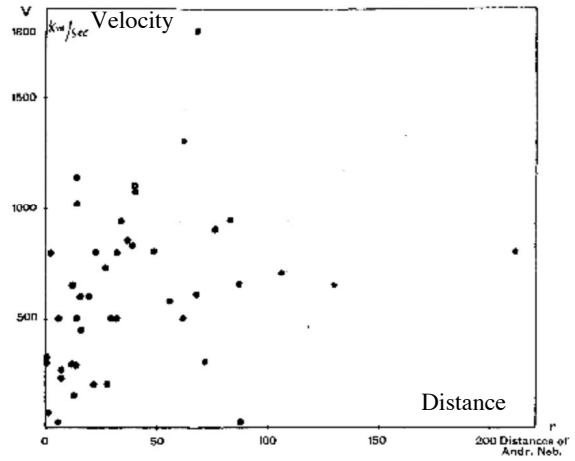

Figure 3: *The velocity distance relation for spiral nebula as discovered by Lundmark (1924) in his criticism of Silberstein's (1924) paper. On the lower right side the distance to the Great Andromeda nebula is marked.*

Further attempts were carried out in 1922-1924 when Wirtz (1875-1939)[25] examined the statistics of the radial motions of spiral nebula. Out of 29 nebulae he had the data for, he found 25 with positive velocities so that the average speed of the spiral nebulae was +840 km/sec. In 1924, Wirtz[26] tried to relate the velocities to the distance. To this goal, Wirtz searched for a reliable distance indicator, for example, the apparent diameter, or luminosity of the spiral nebulae, assuming of course that they are all identical and can serve as ′standard candles′.

[24]Strömberg, G., ApJ., **61**, 353, (1925)
[25]Wirtz, C., AN, **215**, 349, (1922)
[26]Wirtz, C., AN, **222**, 21, (1924)

Wirtz took the data of the apparent diameter of spiral nebulae from Curtis[27] and Pease,[28] to find out that the velocity of the spiral nebula v relates to the diameter Dm as:

$$v(\ km/sec) = 914 - 479 \cdot log(Dm).$$

Here the diameter is given in arc minutes. Wirtz was careful and added to this result also an evaluation of the reliability of the correlation just found. Various attempts to verify the velocity-distance relation which emerged from the de Sitter models were carried out at that time. In 1923 Eddington derived $v \sim R^2$, a year later Weyl obtained that $v \sim tanR$ and we mentioned before the Silberstein result. Hence, the logarithm was not a surprise. We can say that Wirtz almost confirmed de Sitter's model (we say almost because the expansion law in the de Sitter model does not contain the logarithm).

Wirtz's contribution is hardly cited and when cited, it is by few historians of science. In 1936, a short time before his death, Wirtz wrote a half a page long note[29] reminding the reader about his discoveries back in 1921 and 1924, and before Hubble in 1929, but in no avail.

3 The expansion of the universe

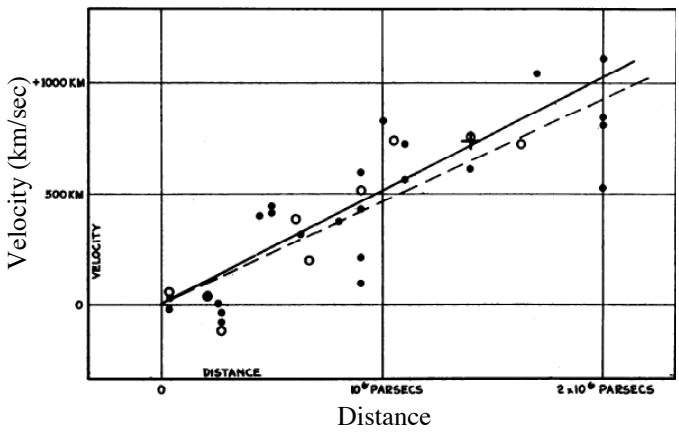

Figure 4: *The original velocity-distance relation discovered by Hubble in 1929.*

The expansion of the entire universe was discovered on the other side of the Atlantic Ocean when Hubble (1898-1953m)[30] plotted the shift in the spectral lines of galaxies (which he interpreted as a velocity) as a function of their distance measured by means of the standard candle assumption but with one fundamental difference. Hubble used the standard candle assumption for stars (Cepheids, novae and blue stars) observed inside the spiral nebula while his predecessors assumed the standard candle assumption to the entire spiral nebulae. This difference was pivotal. Indeed, if one took Hubble's distances and plotted the intrinsic luminosity of the spiral nebulae as derived from the distance and apparent luminosity, he would find a scatter diagram meaning that the distance and apparent luminosity are not correlated.

[27]Curtis, H.D., Lick Public. #13, (1918). This is the fellow who argued with Shapley in the 'Great Debate' that the spiral nebulae are extra-galactic objects.

[28]Pease, F.G., Mt. Wilson Cont. , **132**, (1917), **186**, 1920.

[29]Wirtz, C. Zeit. f. Astrophys., **11**, 261, (1936). *Ein literarischer Hinweis Zur Radialbewegung der Spiral Nebel.*

[30]Hubble, E., PNAS, **15**, 168, (1929)

This fact explains why Hubble succeeded where his predecessors failed[31]. Hubble assumed that the building blocks of the nebulae are standard candles and this is a more fundamental premise than that the entire galaxy is a standard candle. Hubble had only 24 pieces of data at his disposal, cf. fig.4. Consequently, the conclusions of the prudent Hubble were (a) more data must be accumulated to verify the discovery and (b) if confirmed, then: *The outstanding feature, however, is the possibility that the velocity distance relation may represent the de Sitter effect, and hence that numerical data may be introduced into discussions of the general curvature of space.* Hubble also realized that the simple (linear) relation between the velocity of recession and the distance is only the first approximation to the real full law. The simple law is:

$$v = Hr$$

where r is the distance of the nebula and v its recession velocity. H is a constant known today as the Hubble constant. The value Hubble found (the slope in his figure) was

$$H = 536 \pm 50 \;\; km/sec\; per\; million\; parsec = 156 \pm 15\, km/sec\; per\; million\; lightyears,$$

namely, a galaxy about a million light years away recedes with a velocity of $156\, km/sec$. More accurate measurements yielded today a value of $22.2\, km/sec$.

Naturally, the colossal discovery of the expansion stirred discussions about the initial state out of which the expansion started. The questions were: (a) what causes the expansion and (b) what is the initial state which started the expansion. The fact that the nebulae show a shift to the red of the spectral lines was known already to Campbell[32] as early as 1911 and to Vesto Slipher (1875-1969m)[33] in 1915, long before the location of the nebulae (inside or outside our Milky Way) was known. Campbell hypothesized that the radial velocities are associated with the evolutionary stages of the nebulae. Slipher measured 14 spiral nebulae and out of these, two showed negative velocities and three showed no velocity at all. All the rest showed positive velocity, namely, they recede from us. Slipher explained the results by noticing that the velocities of the nebulae were about 25 times greater than the average stellar velocity[34]. Campbell and Kapteyn discovered that stars with 'advanced' stellar spectra move faster, as discussed in the previous chapter of this book, than the average stars. Hence, Slipher suggested that the nebulae are even more advanced[35]. It was Hubble who found the connection between the shift in the spectral lines and the distance and who introduced the dramatic hypothesis that the phenomenon is nothing but the expansion of the universe. For

[31] In 1935 Hubble was awarded the Barnard medal which is granted once every five years. Distinguished scientists who got the medal before Hubble were Roentgen, Rutherford, Einstein, Bohr and Heisenberg, who won the Nobel prize. With this award he became the first american and astronomer to win the Barnard medal. In those days astronomy was treated by the Nobel committee as a separate discipline from physics. So a clandestine move to include astronomy within physics so as to include Hubble among the potential nominees for the Nobel prize, was supported by Hoyle, Fermi and Chandrasekhar. Alas, Hubble passed away in 1953, at the age of 61, long before any such move was brought to fruition. Soares, D.S.L., JRASC, **95**, 10, (2001)

[32] Campbell, W.W., *Note on Radial Velocities of nebulae*, AN, **188**, 346, (1911)

[33] Slipher, V.M., *Spectrographic Observations of Nebulae*, Popular Astronomy, **23**, 21, (1915)

[34] Reynolds (Obs. **40**, 131, (1917)) questioned Slipher's results and Slipher replied (Obs., **40**, 304, (1917)) about the accuracy of the measurements and on the fact that the mean velocity of the spirals was found to be 570km/sec while the mean velocity of stars is about 20km/sec. As for the measurements of the speed of the Great Andromeda nebula Slipher got -300km/sec and he cited Wright who got -304km/sec, Wolf who got -300 - -400km/sec and Pease who got -329km/sec. It is surprising that the question how can our galaxy hold such fast moving nebula was not raised.

[35] The maximum velocity of stars was significantly less than the velocities found in the spiral nebulae.

this reason probably, no earlier works or data were mentioned by Hubble[36].

Lemaitre's 1927 paper was published in an obscure and mostly inaccessible journal. Consequently, it did not attract much attention, even the careful Hubble did not mention it and went back to de Sitter's paper, published 10 years earlier, while Lemaitre's paper was much more relevant and recent. Only when Eddington[37] became aware of Lemaitre's paper, was its importance recognized. Eddington's paper is actually a review paper on Lemaitre's article because *my original hope of contributing some definitely new results has been forestalled by Lemaitre's brilliant solution.* Different people select different researchers as the predictors of the expansion of the universe. However, de Sitter, Friedman, Lemaitre, Robertson and Tolman found dynamic expanding solutions and hence all qualify as predictors of the expansion of the universe. Einstein, on the other hand, did not believe during the first years just after the publication of the General Theory of Relativity, in a dynamic universe and added to his equation an ad hoc constant, known as the cosmological constant, whose role was to stabilize the solution and allow for a static solution. Einstein did not know much astronomy or astrophysics and presumably did not hear about Olbers' paradox[38] which is inconsistent with the static solution. However, as soon as he learnt about Hubble's discovery, he changed his view. It is Gamow[39] who recounted that Einstein had told him that the attempt to obtain a static solution was his greatest blunder. It appears that there is no other confirmation that Einstein indeed thought so.

One of the first explanations as to why the universe expands was given by Tolman[40] who suggested that the expansion is due to the conversion of matter into radiation. As the radiation accumulates the radiation pressure increases and causes the expansion. In all these papers the physics of the initial state was not discussed and remained, therefore, an enigma. This explanation of the expansion was also suggested by Lemaitre[41].

Immediately after Hubble's discovery, Lemaitre[42] started to look for solutions to Einstein's equations which yield expansion. By 1931 Lemaitre succeeded to construct two possible models for the universe. In the first model[43], Lemaitre presents a universe with a constant total mass (meaning a closed universe), and with increasing in time radius. In this model the the radius of the universe increases without limit from an initial value R_0 at time $t \to -\infty$, namely, the universe always existed and it will expand forever.[44] This feature of the solution was later a fundamental property of Gamow's model for the universe, namely, the universe

[36]Of the 14 spirals on Slipher's list, only 2 appeared on Hubble's list. The first was NGC1023 for which Slipher measured a velocity of +200 km/sec while Hubble got -10 km/sec and NGC 3115 for which Slipher got +400 and Hubble 600 km/sec due to being able to apply the Mount Wilson 100 inch telescope.

[37]Eddington, A.S., MNRAS, **90**, 668, (1930)

[38]The Olbers' paradox, discovered by the physician and astronomy amateur Heinrich Olbers (1758-1840m) in 1823 (but not published until 1826 by Bode) is the following: If you assume that the universe is infinite and that the stars are distributed evenly in the universe, the total stellar light on the Earth is infinite and the night would not be dark.

[39] Gamow, G., *My World Line: An Informal Autobiography*, New York, Viking press, p 44, 1970.

[40]Tolman, R.C., PNAS, **16**, 320, (1930)

[41]Lemaitre, G., MNRAS, **91**, 483, (1931)

[42]Lemaitre, G., BAN, **5**, 273, (1930)

[43]Lemaitre, G., MNRAS, **91**, 483, (1931). This paper is the translation into english of the 1927 paper in the Brussels Scientific Society, a translation and publication under Eddington's recommendation. The paper is followed by a paper by Eddington in which he explains that the expansion results from *formation of condensation, which may be named the 'stagnation' of the universe. Later he withdrew this explanation.*

[44]The initial radius R_0 is given by: $R_0 = rc/(v\sqrt{3})$, where r and v are the distance and velocity of a galaxy and c the speed of light.

started from some state with finite properties[45]

Applying the data provided by Hubble, Lemaitre predicted that the light from galaxies at a distance of 0.087 of the present radius of the universe, will never be seen because their light is completely shifted towards the invisible infra red. Lemaitre could not imagine the space era with infra-red telescopes placed on board of satellites moving well outside the earth's atmosphere. Similarly, Lemaitre could not imagine that the light from distant powerful galaxies would be shifted from the ultra violet into the visible range.

Lemaitre provided a possible explanation for the expansion of the universe: *it seems to suggest that the expansion has been set up by the radiation itself,* (cf. Tolman's explanation). In a static universe, light emitted by matter travels around the space, comes back to its starting point, and accumulates indefinitely. This light gives rise to radiation pressure which causes the universe to expand. *seems that this may be the origin of the velocity of expansion which Einstein assumed to be zero, and which in our interpretation is observed as the radial velocity of extragalactic nebulae,* explained Lemaitre.

In the second model published together with the first one[46], Lemaitre proposed that the universe started from an initial $'$stagnation$'$ state which had extreme conditions. No further specification was given, in particular, neither the composition nor the temperature and density were specified.

4 Few comments

We explained the fundamental difference between Hubble's work and his predecessors and why Hubble results were sufficiently accurate to draw the dramatic conclusion. The credit for the observational (in contrast to the theoretical) seems definitely justified and the answer to the title of this paper is NO!

Some historians of science expressed the view that reference to previous works was not a common practice in those days. I reject this claim. First, Hubble himself cited de Sitter. Second, the papers in those days contain many references. Third, there is no need to invent farfetched explanations.

The claim that Hubble overlooked the paper by Lemaitre while he cited de Sitter appears ludicrous. Lemaitre published his work in the Annals de la Société Scientifique de Bruxelles. How many astrophysical and astronomical libraries carry today this publication? Let alone in the past. How many astronomers check today for relevant papers in this and similar publications? What do you want from Hubble, who was in California, when Eddington, who was on the other side of the English channel, stated that he overlooked Lemaitre's paper[47].

In 1930, de Sitter published in America[48] a discussion about the expansion of the Universe. de Sitter was in Holland, the neighboring country to Belgium, where Lemaitre published, and

[45]Lemaitre was a physicist and a catholic priest. It is tantalizing to think that a catholic priest initiated the idea that the age of the universe is a few billion years, while the age of the Earth according to the Bible is about 5800 years. When asked, how he lives with this apparent contradiction, he replied, that God made the Earth indeed 5800years ago along with all the scientific evidence to the contrary, to test humankind belief in the Bible. (Gratzer, W. *Eurekas and euphorias: the Oxford book of scientific anecdotes*, 2004, p 187). On other occasions Lemaitre said in private that his theory was a way to reconcile science with St. Thomas Aquinas' theological dictum of 'creation out of nothing'. Quoted in Anthony L. Peratt, 'Dean of the Plasma Dissidents', Washington Times, supplement: The World and I (May 1988)

[46]Lemaitre, G., MNRAS, **91**, 490, (1931). The two models are published in the same journal issue, one after the other.

[47]Eddington, A.S., MNRAS, **90**, 668, (1930)

[48]de Sitter, W., PNAS,**16**, 474, (1930)

so wrote de Sitter: *A dynamical solution of the equations(4),with the line-element (5), (7) and the material energy tensor (6) is given by Dr. G. Lemaitre in a paper published in1927,which had unfortunately escaped my notice until my attention was called to it by Professor Eddington a few weeks ago.* If de Sitter who was in Leiden did not know about Lemaitre's paper, what do you want from Hubble who was in California? de Sitter does not mention any 'Lemaitre's determination of the Hubble constant'.

Few american scientists read then and today european journals. When Ritter published in 1878-1883 in German his seminal series of papers of the theory of stellar structure, Hale, the then editor of the Astrophysical Journal, complained in a special editorial introduction to Ritter's paper, that *These seems to have received hardly the attention they deserve, and at the suggestion of one of our associates we have translated one of the most important papers on the series.*[49] As a matter of fact, the paper was re-edited by the editorial board of the ApJ and the name of the translator is not given.

Eddington published his famous theory of the the structure of stars in the european journal[50] yet he found it appropriate to repeat the publication in the american journal[51].

The figure claimed by Block that is provided by Lemaitre does not appear in Lemaitre's paper in french. The paper can be today (but not in 1929) downloaded from the ADS. Did the ADS censor Lemaitre's paper and implied by Block? Lemaitre as a priest, did not have tenure problems and if he felt mistreated by Hubble, could have written so. No such complaint could be found.

The claims that Hubble plagiarized the 'Hubble classification' are discussed in detail by Sandage[52] who concluded that Hubble did not plagiarized Reynolds. In one word, Reynolds insisted on including many details in the classification of galaxies while Hubble did not think that the details should enter the classification and provided a simpler scheme. There was an ongoing controversy between Reynolds and Hubble about exactly this issue.

[49]Ritter, A. ApJ, 8, 293, (1898)
[50]Eddington, A.S., MNRAS, **77**, 16, 596, 1916-1917.
[51]Eddington, A.S., ApJ, **48**, 205, (1918)
[52]Sandage, A., Ann. Rev. Ast. & Astrophys., **43**, 581, (2005)