Einstein, Friedmann, Lemaitre: Discovery of the Big Bang

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Discovery of the expanding Universe and of the origination of our world as the result of the Big Bang is one of the main achievements of the outgoing XX century.Now, after the satellite "COBE" fixed the anisotropy of primordeal radiation, there are no doubts in correctness of the theory and observations on which modern astrophysics and cosmology are based.Who were they, the first people, armed only with "pen" and their genious intuition, who discovered completely new image of the Universe?

Theory of expanding Universe is based on general relativity (GR) of Einstein.The first man who applied this theory to the Universe was the founder of GR- A.Einstein.In his paper "Problems of cosmology and general theory of relativity" in 1917 (1) he described the Universe as spatially closed (with finite space volume) world with uniform matter distribution.The space of the Universe was considered by him, following long-aged tradition as static.In order to have static Universe Einstein had to put into his equations the so called "cosmological term".Without this term which was put there "ad hoc" Einstein could find the expanding space and then could be "the father" of the "Big Bang theory".Why didn't he do this, a discovery of Big Bang was made by A.A.Friedmann? One can say that Einstein had the idea of possibility of nonstatic solutions which is seen from his words:"The curvature of space, dependent on matter distribution, depends on space and time"(1) and then about the cosmological term: "the laws are needed

to have the possibility of quasistatic matter distribution, corresponding to factual star velocities"(ibid).

Einstein followed here the observational astronomy of his time and observations up to the year 1917 gave constructed from Aristotle the picture of eternal and static "heaven".But, however, in the very 1917 the Dutch astrophysicist De Sitter found the static solution of Einstein's equations without physical matter but with Einstein's cosmological constant -the so called De Sitter Universe.And De Sitter discovered that in "his" Universe gravitating particles repel one another.

Expanding Universe was discovered in 1922 by the Russian mathematician, mechanicist and meteorologist Alexandr Alexandrovich Friedmann. His role in modern cosmology is so important,that one must know some basic facts of his biography (exhaustive description of his life and discovery a reader can find in (3)).

Friedmann was born in St.Petersburg(Russia) in 1888 in the family of the ballet dancer of the Emperor's Mariinsky Theatre Alexandr Alexandrovich Friedmann and of the beginning pianist L.I.Voyachek. In 1910 Friedmann graduated from the physical - mathematical faculty of St.Petersburg University, in 1914-1916 he participated in the 1 World War, flying on the military aeroplanes of the Russian army. He was master of exact bombing and made also work for compiling corresponding tables. In 1918 - 1920 he was professor of Perm University and in 1920- 1924 -professor of Petrograd University as well as of some other institutes in Petrograd.From the year 1925 he is director of the main geophysical observatory in Leningrad - this was the name of St.Petersburg from the end of 1924. In summer 1925 he together with the aviator P.F.Fedoseenko made a record flight on the stratospherical balloon(the maximal height was 7400m).

Friedmann died at 16.09.1925 from the typhus in Leningrad and was buried on the Smolenskoe graveyard of his native city.

His "Epochenmachen work" on the curvature of space he published in the magazin "Zeitschrift fur Physik"(2).There he made the work which Einstein was not ready to do: Friedmann showed "the possibility of obtaining of the special world, the space curvature of which, being constant for three space coordinates, is changing with time,depending on the fourth coordinate which is time".Here he wrote the metric, later being called Friedmann's metric. This solution discovered by Friedmann,describes homogeneous isotropic world with constant in space matter density. The Einstein's cosmological term can be absent. In his first cosmological paper A.A. Friedmann discussed what we now call "closed Friedmann Universe".Here he came to the important conclusion that time itself could have the beginning:he calculated the "time from the creation of the world" as some number "of the order of ten billions years". This value corresponds to our modern views and its calculation (without rational explanation how it was made) is the example of the great intuitions of the scientist. In the beginning of the twenties there was no evidence neither for expansion of the Universe or for its "creation".

In his popular book "The world as space and time"(4) A.A.Friedmann definitely speaks about the beginning as well as about the end of the Universe:"The Universe contracts into a point (into nothing),then from the point it increases its radius up to some value, then again decreases its radius becoming again a point etc. One can remember here Indian mythology about life periods, there is also the possibility of "creation of the world from nothing", but one must look now on all this as on some curious facts which can't be confirmed by nonsufficient astronomical data " (4). Nowadays we have this sufficient astronomical data.

In 1924 A.A.Friedmann in the paper "On the possibility of the world with constant negative curvature"(5) showed the possibility of the existence of what is called now "open Friedmann Universe"-expanding Universe with the beginning, but without end. Scientific community in the twenties was not ready to these Friedmann's "curious facts". The reason for this was connected not only with the absence of observations but in the ideological climate of that time not only in Russia but also in the world too. This was the time of atheistic, antichristian invasion. Surely, such people as Einstein, were independent enough to be outside of any ideology. Nevertheless one must still be surprised by the referee's report of Einstein on the first paper by Friedmann, published in the same "Zeitschrift fur Physik" on September 18 in 1922 :"The results concerning the nonstationary world contained in (Friedmann's) work appear to me suspicious. In reality it turns out the solution does not satisfy the field equations". And this was written by Einstein, from whose paper (published in 1917) one could see, as we mentioned earlier, that he was not against the assumption of nonstationary solutions! This nonadequate reaction was conditioned by

some irritation of nonscientific source.

The external story of contacts of A.A.Friedmann and A.Einstein was the following. After the first Einstein's referee letter in Z.Physik Friedmann sends him a letter: he explains there undoubtful correctness of his calculations (this letter and comments to it are published in the book (3)). The journal Z.Physik with the Einstein's reply there, came to Russia in October, and it was of course read by Friedmann and his colleagues. However Friedmann learned its contents before. Here are some sentences from Friedmann's letter to Einstein: "Dear professor! From the letter of a friend of mine who is now abroad I had the honour to learn, that you had submitted a short note to be printed in the 11th volume of the "Zeitschrift fur Physik",where it is stated that if one accepts the assumptions made in my article "On the curvature of space", it will follow from the world equations derived by you, that the radius of curvature of the world is a quantity independent of time". Let us stop the quotation. There is no doubt that "a friend of mine" is Yu.A.Krutkov. There is a note in one of Krutkov's diaries: in 1922-1923 he spent "a year and a day" in Germany. The date of his departure for Russia from Germany is exactly known: September 28,1922. So Krutkov arrived to Berlin at September 27,1922, soon after the journal had received Einstein's comment. In his letter to Einstein, Friedmann further shows by direct calculations that from zero divergence of energy-momentum tensor one can not come to the conclusion of constant in time radius of the curvature. "Considering that the possible existence of a nonstationary world has a certain interest,-writes Friedmann,-will allow myself to present you here the calculations I have made (...) for verification and critical assesment". After presenting his calculations Friedmann notes that he has recently studied "the case of the world with a constant and changing (in time) negative curvature(...). The results of the calculations shown that(...) both the world with a constant but negative curvature and the world with changing (in time) curvature may exist.The possibility to obtain from your world equations a world with a constant negative curvature,-Friedmann continues-is of exceptional interest to me, and I therefore ask you to reply to my letter, although I well know, that you are very busy". And he concluded:"Should you find the calculations presented in my letter correct, please, be so kind as to inform the editors of the "Zeitschrift fur Physik", about it; perhaps in this case

you will publish a correction to your statement or provide an opportunity of this letter to be printed".

Friedmann had undoubtedly discussed his calculations with his colleagues, especially V.K.Frederiks and was, as a matter of fact, convinced in their correctness. Let us note,however, that he did not send the letter to the editorial office of the journal, thus displaying great tact toward his opponent. Friedmann was right in suggesting that Einstein was "very busy",though he probably hoped to receive his reply.However weeks passed and there was no answer on this letter. The explanation was very simple: Einstein was away from Berlin in December. Back in late September, about two weeks after he had sent his comment on Friedmann's article, he together with his wife left Berlin - first for Switzerland, and from there to France, and on October 11th he sailed to Japan. Einstein, is known, to have learnt with delay that in his absence he had been awarded the Nobel prize for physics. He could not be presented in Stockholm at the presentation ceremony of getting the prize. Only in March 1923 having visited on his way back home Palestine, France and Spain did Einstein return to Berlin. It obviously took him some time to sort out the mail accumulated during his almost half-year absence. April passed, and in May Einstein was invited to Leiden (he was a honorary professor of that university) to attend the farewell public lecture of Lorentz. At the same time Krutkov was in Leiden too. Einstein met with him at Ehrenfest's place, where he always stayed when in the Netherlands. As it is clear from Einstein's letters to Born, at this time he knew about Krutkov.

In 1923 Krutkov was one of the most educated and gifted physicists of our country. He studied special relativity being the participant of Ehrenfest's seminar in St.Petersburg in 1907-1912, and he knew general relativity participating the seminar of Petrograd University. There, in 1920, Friedmann, Frederiks, he himself, young V.A.Fock and other physicists read lectures and essays on GR.

About the personal acquaintance of Krutkov with Einstein, his conversations with the great physicist, one must learn from Krutkov's surviving notes and his letters to his sister, Tatyana Krutkova from Berlin and Leiden to Petrograd. Diary notes of May 1923 are covered with formulae from Friedmann's article and relevant calculations connected with it. In one of these letters Krutkov writes to his sister: "On Monday, May 7, 1923, I was

reading, together with Einstein, Friedmann's article in the "Zeitschrift fur Physik"". In the other letter of May 18:"At 5 o'clock Einstein reported to Ehrenfest, Droite and one Belgian on his latest paper... I defeated Einstein in the argument about Friedmann. Petrograd's honour is saved!".

It is well known about existence of the second note of Einstien concerning the first Friedmann's cosmological article. This second letter was received by the journal in May 21 of 1923. There is no doubt that this coincidence in time is not accidental and that the note is outcome of discussions with Krutkov.

Let us now quote the text of the second Einstein's note:"In my previous note I criticized the above-mentioned work (Einstein included the title of Friedmann's paper in the title of his note-Auth.). However, my criticism, as I became convinced by Friedmann's letter, communicated to me by Mr.Krutkov, was based on an error in calculations. I consider Mr.Friedmann's results are correct and shed new light. It has turned out that field equations allow not only static but also dynamic i.e. variable with respect (to time) centrosymmetrical solutions for the space structure".

The implication of the phrase :"by Friedmann's letter communicated to me by Mr.Krutkov" was obvious: amidst the hurly-burly of arrival from the long journey failed Einstein to read Friedmann's letter; only after his meeting with Krutkov was he aware of its contents - probably because they were conveyed to Krutkov by Friedmann (or may be Krutkov had the copy of this letter). It is important that on May, 7 Einstein and Krutkov were reading Friedmann's article - Krutkov did not say a word about the letter from Petrograd to Berlin. Yu.B.Tatarinov, a Soviet historian of science, being interested in Friedmann - Einstein's polemics and in Krutkov's notes, published in 1970 and 1974, decided to check the accuracy of the Einstein's notes (translated from German into Russian) from which he came to conclusion that Einstein read Friedmann's letter. This was based on more exact translation of words:"...as I became convinced by Friedmann's letter communicated to me by Mr.Krutkov". May be he is right in his conclusion. Krutkov was acting at Friedmann's request, as V.A.Fock remembered, met with Einstein, but in Leiden, not Berlin; they analysed Friedmann's article and Krutkov supplemented it with Friedmann's arguments which he knew. On May 16, 1923 Einstein left Leiden for Berlin. On his arrival

he presumably began sorting out all his correspondence and found Friedmann's letter , alternatively he could have found it earlier and taken it to Leiden with him prompted by Krutkov, and on May 21, as appears from the second note, submitted it to the "Zeitschrift fur Physik". A recently published article by Dr.J.Stachel, dealing with the principles of selecting materials from Einstein's archive to be published in a multy-volume collection of the all his works, scientific papers, official and private letters, interviews and etc. In this Stachel's paper Stachel included another, quite remarkable first (unpublished) version of his final (second one) note to "Zeitschrift fur Physik". It coincides with the published text, but with one however very important exception. In the first version after stating the correctness of Friedmann's mathematical calculations and conclusions connected with non-stationary world, there was a sentence :"However, the solution, given by A.A.Friedmann - unlikely has the physical sense". This sentence was - in good time! - put away by Einstein. It seems that the letter to the journal was written by Einstein after first conversations with Krutkov either in Leiden, or just after his return to Berlin. And there was some other meeting with Krutkov (it is possible, that they took one and the same train Leiden-Berlin), who proved Einstein that Friedmann's conclusions had fundamental sense. It is interesting that this omited sentence is similar to the sentence, said later, in 1927, to Lemaitre (see below).

On June, 1 Krutkov wrote to his sister (from Berlin): "Einstein is very nice... I am going to visit Einstein one of these days".Finally on June, 8 :"How is Friedmann getting along? I have written him about his business with Einstein and keep wondering: what he is thinking about? At any rate he should have written me". Alas, we could not find any correspondence between Krutkov and Friedmann, but other letters from Krutkov to his sister and, particularly, from Friedmann to N.Malinina - his future wife - can provide information evidence about Friedmann's stay in Berlin in August-September of that year (1923) and his attempts to meet Einstein.

On August, 9 Krutkov writes:"Friedmann is here; today in a few hours time he is going to Hamburg. Einstein's note, in which he is rehabilitated, with my encouragement, has already come out". On August, 19 Friedmann writes:"My trip is not going well - Einstein, for instance, has left Berlin on vacation, and I will not be able to see him". On September, 2 :"I have only the following things to be done: 1)to visit Gottingen; 2)to see

Pahlen (an astronomer, my former collaborator); 3)to see Mises (editor of the "Zeitschrift fur Ang.Math.") and Einstein, and to make necessary purchases".

On September,13 :"Today I visited the astronomer Pahlen, an old friend of mine.I met there the astronomer Freundlich, a very interesting person, we talked with him about the structure of the Universe.." (now we interrupt citation for some information about persons mentioned).

A.A.Friedmann knew E.A.von Pahlen well from time before 1 World War in St.Petersburg, and during the war he worked with him in the aviation staff in Kiev (1916). After the revolution Pahlen seems to have returned to Germany and begun working there at the Potsdam Observatory.He is known for his works in the star statistics. The other astronomer, mentioned in Friedmann's letter - E.Freundlich - the founder and the first director of the Einstein's Institute in Potsdam. In 1916 Freundlich published in Berlin a popular-science book "The foundation of Einstein's theory of gravitation", to which Einstein wrote a preface.

It is interesting to mention that craters on the Moon are named for A.A.Friedmann, E.von Pahlen and E.Freundlich.

It is time now to continue the citation from Friedmann's letter: "...Everybody was much impressed by my struggle with Einstein and my eventual victory, it is pleasant for me, because of my papers, I shall be able to get them published more easily".

Friedmann did not meet Einstein in 1923 as well as in the next 1924, when he was in Germany going to the International Congress on Technical Mechanics in Delft, Holland (April, 22-28, 1924).

Now let us return to Einstein's words:"I consider that Mr. Friedmann's results are correct and shed new light. It has turned out that the field equations allow not only static but also dynamic (i.e.variable with respect to time) centrosymmetrical solutions for the space structure". (7)

Can one see from these words, that Einstein admits Friedmann's discovery of the new image of the Universe? It is now that we acknowledge Friedmann's work as beginning of the new theory of the Universe. However Einstein in 1923 was not interested in what he considered as to be phantasy and noted only that his (Einstein's) field equations have also nonstationary solutions! Surely there was no Einstein's comment on "the time from creation of the World"! Here one must say some words about

religious beliefs of A.A. Friedmann.

It is known that he was an Orthodox Christian. One can give some arguments for his nonformal attitude to his Christianity. The most early in time argument is that the only discipline at the St.Petersburg gymnasium on which the young pupil Alexandr Friedmann had mainly excellent marks (five) was catechism. At the same time his marks in mathematics were only threes (i.e."satisfactory"). Alexandr Alexandrovich Friedmann married his first wife - E.N.Dorofeeva in the church. V.V.Doynikova remembered many of his words about his religious mindedness. It is interesting that some of them were of mystical kind - Friedmann "was fond of "the occult" in general" thought that he can cure toothache by words and etc. Deep religious were people closed to Friedmann - for example Vladimir Ivanovich Smirnov, famous Russian mathematician.

On the grave of Alexandr Alexandrovich on the Smolenskoe graveyard in St.Petersburg there is an Orthodox cross. May be this was done according to his last will, or made by his relatives, who knew about his attitude to faith. In 1925, just before his death, being the Director of the Main Geophysical Observatory in the time of antireligious and antichurch persecutions of Communist power, he married according to Orthodox Christian rule his second wife - N.E.Malinina in the church in Simferopol (Crimea). So the phrase:"creation of the World" was not only a word for him. One can say that in his work Friedmann realized the idea of F.M.Dostoevsky in "Karamazovs brothers" that a non-euclidian mind may be will solve the contradiction between science and the religious revelation! V.V.Doynikova remembered that Dostoevsky was one of the favourite writers for Friedmann. Here one can remember also the well known words of Einstein:"Dostoevsky gave me more than Gauss!".

What were the next steps to the "Big Bang"? As the authors of (8) say, in 1923 H.Weyl noted, that particles in De Sitter world repel each other with the velocity proportional to the distance between them. So Weyl predicted what later became known as Hubble's law.

And now we must speak about the other scientist who made an outstanding step in forming modern view on the Universe. It was the Belgian scientist, abbot George Lemaitre. In 1927 he wrote a paper:"Homogeneous Universe of constant mass and increasing radius, explaining radial velocities of extragalactical nebulae" (9). In this paper Lemaitre connects

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expansion of the Universe being the consequence according to Friedmann of general relativity with observational repelling from us of extragalactical nebulae. Lemaitre writes:"Velocities of repelling of extragalactical nebulae represent the cosmical effect of the expansion of the Universe".

It is due to Lemaitre that we have the notion of "expanding Universe". Contrary to Friedmann who came to astronomy only in 1921-1922, three years before his death, Lemaitre all his long life was closely connected with astronomy.

Arthur Eddington in his book "Mathematical theory of relativity" in 1922 wrote that "one of the mysterious problems in cosmology are large velocities of many nebulae. Their radial velocities have the order of 600km/sec, and the majority of nebulae go from the Solar system".(10)

It was Edwin Hubble who in 1923 made a major step towards understanding of this mystery.On the telescope of Mount Wilson he observed that spiral nebulae are other star systems - galaxies.Their movement from us (our galaxy) leads to Doppler effect (red shift of spectral lines of radiation of these galaxies).

So from the paper of Lemaitre one can see that it was he who gave the interpretation of movement from us of spiral galaxies as relativistic effect of the expansion of the Universe. One can be surprised why in the article of 1927 of Lemaitre there is no reference on the works of A.A.Friedmann. Lemaitre obtains the same as Friedmann nonstationary solution of Einstein's equations with nonzero cosmological constant. The difference is that Friedmann solved Einstein's equations with zero pressure (what is called now "dustlike" Friedmann's model). Lemaitre investigated more general case with nonzero pressure.

The reference on A.A.Friedmann appeared however in the English translation of Lemaitre's paper, published in March, 1931 in "Monthly Notices of the Royal Astronomical Society"(11). In references we read:"Equations of the Universe of variable radius and constant mass have been fully discussed without reference to the receding velocities of nebulae by A.Friedmann "Uber die Krummung der Raumes", Zs.fur Phys. 10,377,1922, A.Einstein - Zs.fur Phys.11,326,1922 and 16,225,1923. The Universe of variable radius has been independently studied by I.C. Tolman in P.N.A.S. 16,320 (1930)".

It is this absence of reference on A.A.Friedmann in the first paper of

Lemaitre which became the reason for C.Misner, K.Thorn and J. Wheeler in their "Gravitation"(8) to speak about "independent discovery by A.A.Friedmann in 1922 and Lemaitre in 1927 of the evolution of homogeneous and isotropic cosmological models". This statement surely is not exact: even if one looks on the years of publication given by these authors (8) one must speak about "independent from" Friedmann (1922) discovery by Lemaitre in 1927 of the expansion of the Universe. So one must be sorry about so popular in the West point of view of "independent" discovery by Friedmann and Lemaitre of the expansion of the Universe.

What was the reason for absence in Lemaitre's paper of 1927 of reference on Friedmann's paper published in "Zeitschrift fur Physik"- the most known physical journal of that time? This absence becomes more strange if one remembers about two letters of Einstein, one critical (6) and the other "self critical" (7),which were widely discussed in the scientific community.Appearance of reference on Friedmann in the English translation of Lemaitre's paper surely was stimulated by meeting A.Eddington, who surely knew everything published on general relativity.

The possible answer on this question, according to the opinion of one of the authors of this paper (A.A.Grib) can be given from the paper of Lemaitre's secretary Godar (12) from which it occurs, that, strange as it was, but Lemaitre, who struggled in the 1 World War... did not know the German language!

Now let us say some words about biography of this scientist, the centenary of whose birthday is celebrated in 1994. George Lemaitre was born in Charleroi (Belgium) in July, 17 in 1894 and died in Louvain on June, 20 in 1966. He was educated in Jesuit college Sacre Couer, after graduating from it he went to the engineering faculty of the Catholic University of Louvain. After beginning of the 1 World War in 1914 Lemaitre went to the army, to artillery. He was honoured by the cross with palm leaves - there is some resemblance in it with the fate of the pilot, honoured by St.George order, A.A.Friedmann!

Returning in 1919 to the University, Lemaitre from technical sciences goes to physical-mathematical and makes in 1920 his Ph.D. on "Approximation of functions of many real variables". In the same 1920 Lemaitre enters the catholic seminary Malin, and in 1923 he was made a priest by the cardinal Desire Jose-von Mercier, the primas of Belgium. In the sa-

me 1923 he goes abroad. In Cambridge (England) he becomes acquainted with A.Eddington. From England Lemaitre goes to other Cambridge (Massachusets), where the astronomer Shepley, working in Garvard observatory, tells him about his works on nebulae. There he visited Massachusets Institute of Technology (MIT) where Hubble and Slyfer worked. These American astronomers measured at that time distances to nebulae (this was made by Hubble who observed cefeides) and their velocities (Slyfer).

On July, 8 of 1925 Lemaitre returns to Louvain. On November, 19 of 1925 he makes his other Ph.D. on general relativity.Its name is: "Gravitational field in liquid sphere of homogeneous invariant density according to theory of relativity". One must compare this with the Ph.D. of the pupil of Friedmann G.A.Greenberg in 1924 on the similar problem (12). In 1926-1927 Lemaitre goes to the USA to MIT, where stays for the third semester of the academic 1926-1927 year. In MIT he makes his third Ph.D. in June 1927 and becomes there doctor of philosophy.In the same 1927 Lemaitre published his famous paper which made him one of the fathers of the theory of expanding Universe (9), the English translation of which was made in 1931 (11).

Now let us turn our attention to the other participant of the discovery of the "expanding Universe" - Edwin Hubble. In 1929 Hubble finds that for distances larger than 300000000 light years the velocity of movement from us of any Galaxy "v" is proportional to the distance "r" to it, so he finds "the Hubble's law" according to which v=Hr, where H is the Hubble's constant. Its value is constant for any Galaxy and is independent from distance. Hubble also found that our Universe is homogeneous and isotropic for large space distances. But the value of H was found by him erroneously. This played a bad role in the history of the concept of "Big Bang". According to Hubble, H was equal to 540 km/cmps which is on the order larger than 50-75 km/cmps, which we take as its value now. The mistake of Hubble was due to erroneous measurement of distances to other galaxies. Values of these distances were reconsidered by Baade in 1952 and by Sandadge in 1958 which led to the new value of H. From Hubble's value of H it occured that the age of the Universe is less than the age of the Earth! Surely there was no much belief at that time in "expanding Universe".

Now return to Lemaitre. In 1927 there was his meeting with Einstein.

At the end of September of this year in Brussels there was the 5th Solvay Congress. The secretary of Lemaitre, Godart writes:"Professor Piccar invited young Lemaitre to the taxi, where he saw Einstein. They had a short conversation. Lemaitre was interested in opinion of Einstein on his note in Annales-(that which made him the "father of the theory of expanding Universe"). Einstein's answer was short:"Mathematics is correct, but physics...-how ugly!""(12). (Note the resemblance to the remark in second letter on Friedmann's paper, which Einstein as we saw, put away from final publication). "In his defence Lemaitre began to speak about Hubble's observations... but Einstein began to speak with Piccar in German. But Lemaitre did not understand German". So we have important information from Godart that in 1927 Lemaitre did not know German! (Strange here is the German speech of Einstein, who working once in Switzerland, spoke well in French and who knew that German was not native language for his colleagues in taxi). So this ignorance in German can be the explanation for "independence" of discovery by Lemaitre of the Big Bang. It made also difficult contacts with Einstein.

The 5th Solvay Congress was devoted to the new science - quantum mechanics, problems of which disturbed many physicists, Einstein among them. And Big Bang waited for its hour! So the situation with "non-meeting" of Einstein and Friedmann (1923 and 1925) was repeated in case of Lemaitre and Einstein.

New quantum mechanics rather impressed Lemaitre. Due to this interest he agreed to take the invitation of the British Association for science and came to London on its meeting devoted to relation between physical Universe and the life of spirit. It is there that Lemaitre expressed the idea of singular creation of the expanding Universe - the Big Bang and the idea of Primeval Atom. As we said earlier singular creation of the Universe was discussed by Friedmann and was totally ignored by the scientific community!

Lemaitre following Eddington supposed that time and its direction are connected with growth of entropy so plurality itself appeared from something "one", called by him the Primeval Atom, coinciding with singularity. The Primeval Atom exploded and plurality appeared; entropy became nonzero, time and direction of time appeared also. This idea of Lemaitre corresponds to what is called now quantum cosmology. Eddington being in

his religious beliefs the quacker, neglecting any authority and recognizing only personal religious experience found this idea "disgusting". Einstein with his belief in eternal Universe found it "inspired by the Christian dogma of creation and unjustified by the physical point of view" (2). It is only five years later, in 1933, that Lemaitre could publish his ideas in the paper "Expansion of the Universe" (14).

More successful was meeting of Lemaitre with Einstein in 1932 in Pasadena (USA). Einstein at that time thought about emigration to USA from Germany. The Belgian king Albert and the queen Elisabeth, as it is known, sympathized Einstein, in conversations with the royal pair, as Godar says, sometimes Lemaitre's name and his idea of expanding Universe were mentioned... So in Pasadena Einstein met not some unknown young scientist, but the man, ideas of whom were known to many... Talk in Pasadena was devoted to the cosmological constant. The idea of Primeval Atom was not discussed. Einstein agreed with the "expanding Universe" and Hubble's law. The thing is that in 1931 Einstein in his paper "To the cosmological problem in general relativity" (15) definitely recognized due to Hubble's discovery importance of Friedmann's works for description of the Universe. In 1932 Einstein and De Sitter (16) found a new nonstationary solution - quasieuclidian Friedmann's model. So in 1932 "the expanding Universe" at last found its real place in the consciousness of leading scientists of Europe and USA.

Now let us say some words about beliefs of Lemaitre. Becoming the priest at the same time as going to work in general relativity and cosmology surely was not an ordinary act! The reason for this act is not well discussed in literature. It is difficult to see explanation in words said by Lemaitre to the American journalist (12):"Our family was always known by its deep religiousity. But among its representatives there was no scientist or the priest. So I decided to unite both". Lemaitre said that scientific knowledge and the religious faith are ways to the truth, but he did not mix them. So in 1958 (17) discussing his idea of Primeval Atom Lemaitre said:"As I see this theory is totally free of any metaphysical or religious solution. It leaves possible for the materialist to neglect any transcendental being. He can preserve for foundation of space-time the same relation of reason, that for events in nonsingular places of space-time: For the believer it rejects any familiarity with God: like the Laplace joke or Jeanse Finger.

It corresponds to Isahia words about the "Hidden God", hidden even in the beginning of creation".

In his book "Primeval Atom" published in 1950 in the chapter devoted to expansion of the Universe Lemaitre speaks about his religious feeling close to the "cosmical religion" of Einstein:"One can not finish this review without giving thanks to One, who said:"I am the truth", to One, who gave us reason for understanding Him and seeing reflection of His glory in our Universe, which He so goodly assimilated to the force of reason, which He gave to us".

From conversations with people who knew Lemaitre one of the authors of this paper (A.G.) being in Louvain in February, 1993 learned that becoming a priest was connected in Lemaitre with some personal feelings during the 1 World War. In any case science and religious revelation were united in these two creators of the theory of Big Bang - A.A.Friedmann and G.Lemaitre.

So: Einstein, Friedmann, Lemaitre - creators of the new theory of the Universe! Einstein created general theory of relativity and wrote his equations, describing properties of the Universe. A.A.Friedmann found nonstationary solutions, leading to expansion of the Universe and to beginning of the expansion - the singularity. G.Lemaitre connected expansion of space with movement of nebulae - the galaxies, observed due to Doppler's effect.

These ideas helped E.Hubble experimentally to find the law of expansion of the Universe and the value of Hubble's constant.

One of the authors (A.A.G.) is grateful to Prof.Cerulus of Louvain for help in getting information about Lemaitre.

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