The background and history of the possible discovery of the reasons for *cosmological redshift*

by W. Jim Jastrzebski

Ever since I read as a kid in a popular astronomy book about the expanding universe I've been curious why astronomers think that the universe is expanding.

Of course I learned from the same book that the universe looks as if it were expanding because the spectrum of light coming from distant galaxies is shifted towards red end of the spectrum in relation to the spectrum of light emitted by the same materials on the earth. Such thing happens when the sorce of the light is moving away from us (known as "Doppler effect") which suggests that those galaxies move awy from us. Also the light from galaxies that are at farther distance from us is shifted more, roughly proportionally to the distance to the galaxy. Therefore, if we assumed that this redshift (named "Hubble's redshift" after its discoverer Edvin Hubble, or sometimes called "cosmological redshift") is caused by movement of galaxies away from us, then the universe (accordig to this assumption) would be uniformly expanding.

The point though has been why the astronomers assume that this redshift is caused by the movement of galaxies or equivalently why they *assume* that the universe is expanding. This hasn't been explained anywhere except that apparently the astronomers don't have any better idea for the explanation of Hubble's redshift, and so it seemed that any better idea has been welcomed.

The further detailes of this assumed expansion have been that its speed is called by the astronomers Hubble's constant and abbreviated to letter H, or more often to H_0 where "0" means that it is measured at the place in the universe where we are, since it turned out that farther from us it is slightly different and so it is "constant" only in one place in the universe.

"H" is the ratio of the assumed speed with which galaxies seem to fly away from us to the distance to those galaxies. It is equal about 70 km/s per each megaparsec of distance (Mpc in short, a unit of distance used in astronomy, equal about 3,000,000 light-years). So if the galaxies at distance 1 Mpc fly away with velocities 70 km/s the galaxies that are twice as far from us, at 2 Mpc, seem to fly away with velocity about 140 km/s, at 3 Mpc with about 210 km/s and so on.

Their velocity increases supposedly until it becomes equal to the speed of light (300,000 km/s at about 4,000 Mpc), which cosmologists call "reaching the particle horizon" since no particle sent out from the earth can go beyond that limit since this particle would have to move with velocity greater than the speed of light which is impossible. Apparently, according to astronomers who believe that the universe is expanding, this impossibility makes no difference to galaxies since their velocity increases beyond the speed of light at farther distances.

This is one of problems with the assumption that the universe is really expanding and not just looks like it because of some other mechanism that produces Hubble's redshift.

The problem with galaxies moving faster than speed of light is rationalized away by saying that it is not really *velocities of galaxies* but only the *increase of the distance to them* (as it it were two different things) caused by the increasing *amount of space* between us and the galaxies (by some additional space appearing from "somewhere"). It is supposed to be for the rason that Friedmann's solutions of Einstein's field equation require it when g_{ik} tensor of in this equation is symmetric ("Is it?" one might ask). For curious minds: g_{ik} tensor is a mathematical creature, a table containing 16 numbers for each point in spacetime (such point being called "event"), which describes where and when the time runs slower than normal and where there is more space than it would be expected from the simple Euclidean geometry. This table (g_{ik} tensor) can be symmetric or non symmetric depending on the properties of the spacetime it describes. The cosmologists insist it has to be symmetric because then it is "elegant".

The above rationalization seems to work on a principle that if one names an old thing with a new name the majority of people tend to think that it is a different thing (e.g. politicians are not *stealing* money from taxpayers, but are just *spending* money on various projects, e.g. rebuilding some countries, which requires paying taxpayers money to companies the freinds of those politicians happen to own, by sheer coincidence of course).

Another problem with expanding universe is that to believe that the universe is expanding one has to abandon the principle of conservation of energy. To believe that the universe is expanding one has to believe that energy just like space is created from nothing on daily basis. Of course it is no problem for religious people, but after reading my first scientific book at the age of 12 I was not a religious person anymore so this part of explanation of expanding universe physics bothered me a lot.

The problem with conservation of energy in expanding universe is a more subtle problem than creating the whole universe from nothing as the "big bang" theory postulates. I skip the "big bang" though, since when a gross violation of something happens, like creation of whole universe from nothing, people in general refuse to believe anything was violated, and so explaining it in a short text like this becomes impossible since it is not only a matter of physics or science but also a matter of overcoming cultural (or often religious) prejudices.

So, for difficulties with human prejudices I skip the relation of the "big bang" theory to the expansion of the universe. The curious characters can find it in any popular science book on astronomy.

The more interesting thing, the subtle relation of the expanding universe to the principle of conservation of energy is that this principle requires the existence of an effect called *dynamical friction*, which consist of exchange of kinetic energy of any moving object in the universe with its environment. In general it is the loss of kinetic energy of the object but it may be also a gain and then the effect is called *sling effect* and is used to accelerate spacecrafts to send them farther and farther away from the sun.

The *dynamical friction* happening to photons would cause them to have resdhift exponentially changing with the distance they travel. And exponential change with distance looks roughly as proportional to the distance for not too big distances. So many people came up with an idea that the observed Hubble's redshift might be caused by such "friction" and they called it "tired light effect".

So the subtle violation of the principle of energy that requires astronomers who believe that the universe is expanding to believe also that energy can be created form nothing, is that they have to assume that the "tired light effect", which the light would have, is constantly compensated by the creation of this additional energy that the photons would lose to *dynamical friction*.

While discussing this thing with astrophysicists I've learned that astrophysicists apply a rationalization here, that seemingly bypasses the problem, by assuming that this *dynamical friction* in case of photons is not compensated (which seemingly saves the principle of conservation of energy) but is *negligible*. There exists even a *back-of-envelope* Newtonian calculation brought up by all astrophysicists asked about the problem, which seems to support this *negligible* value of *dynamical friction* for photons. However this *back-of-envelope* Newtonian calculation can be legally applied only while certain condition is met, namely the velocity of the object to which "Newtonian attractive force" is applied, has to be much smaller than the speed of light, which is obviosly not met in a case of photons. So that the *dynamical friction* is *negligible* is just a wild guess and so it is actually assumed by astrophysicists without a proof. This lack of proof is of course a bad thing.

However it is even worse in the field called "cosmology".

The cosmologists don't assume that the effect of *dynamical friction* for photons is *negligible* but that it is *exactly zero*.

So the cosmologists openly violate the conservation of energy through their math and they say that "energy is not conserved in general relativity". They also refuse to discuss this issue so it is not possible to learn from cosmologists why they prefer rather non conservation of energy than non expanding universe. My attempts to discuss this problem resulted in rejection of my questions from the official physics discussion newsgroup on the internet (sci.physics.research), as "too speculative". I also received an explanation why such questions are "too speculative". As Prof Baez the moderator in sci.physics.research wrote (http://www.lns.cornell.edu/spr/2001-04/msg0032116.html):

"It is always surprising when it happens, but sometimes to learn more about the world we must stop asking certain questions...

... namely, those based on false assumptions."

The false assumption according to Prof. Baez is that the energy is conserved. He also wrote to me on another occasion: "Jim, it is not conserved", when I kept bothering him with questions how he imagines energy is conserved in a simple case of a falling brick, since he wrote me also that it is conserved only in Newtonian cases. I thought that a falling brick might be such a case but apparently Prof. Baez didn't and it seems that he thinks that energy is never coserved "in gravity", and so finally I had to figure out all the gravitational implications of the principle of conservation of energy myself. Which probably is a job better suited for a gravity physicists than for a sculptor, unless there are no gravity physicists interested in such issues which surely seems to be the case. I just keep wondering what are those scientists paid for.

The cosmologist can't discuss the issue of conservation of energy since the violation of conservation of energy is built into the math that they apply through the assumed symmetry of mentioned earlier g_{ik} tensor. This math that they use doesn't correspond to any physics that would be able to explain this math. So the only thing that cosmologists can say is that math has priority over physics and since their math predicts non conservation of energy the principle of conservation of energy (physical one, induced only through experiments) is invalid in their opinion. They call this math "general relativity" and it is almost the same as *Einstein's general relativity* (that to avoid confusion I call most of the time *Einsteinian gravity*) but with an additional assumption that g_{ik} tensor is symmetric (while *Einstein's general relativity* doesn't require this property from g_{ik}).

Such an assumption makes the *tired light effect* (or *dynamical friction* for photons) nonexistent (note: not *negligible* as astrophysicists think it is, but *exactly zero*). In other words, the math of the expansion (called Friedmann's solutions, or Robertson-Walker-Friedmann model) is based on an assumption that the so-called *tired light effect* doesn't exist. While it is a right assumption, the wrong part of it is that in the world where the principle of conservation of energy is valid there exist a relativistic effect, which simulates *tired light effect* exactly but is not represented by anything (and can't be because of symmetry of g_{ik} tensor) in Friedmann's solutions. That, as I found, is the reason why the contemporary general relativity (not Einstein's general relativity though) has to violate the principle of conservation of energy.

I call this relativistic effect that simulates the "tired light" the *general time dilation*. It is an effect that in space containing matter the time rate slows down exponentially with the distance at which the time rate is observed, which creates an illusion of accelerating expansion of the universe and "anomalous" (as astrophysicists who believe that the universe is expanding call it) acceleration of space probes. However I didn't know that yet when I was wondering, because of the math of "general realtivity" predicting non conservation of energy (which I considered to be a defect of the theory) whether the universe is expanding at all.

If it didn't then it was interesting what would be the reason for the Hubble's redshift.

So one morning in February 1985 I started to think about what might be happening to a photon that is coming to us from a distant galaxy that could make that photon having longer wavelength than photons that come from the same kind of source of light but located close to us. I have been thinking about it many times before (using proverbial *back-of-envelope calculations*) and got many results so lame that I couldn't think that they explain the illusion of expansion of the universe. I've always thought that the result come out so lame because some of my simplifying assumptions, which I did to facilitate the calculations, were illegal. I just didn't know which of them.

So this time, unlike all other times, I decided to do the calculations without *any* simplifying assumptions that might be relevant to the results. Within a few hours I got a result that looked reasonable (a simple formula with one square root and no free parameters) which, as a by-product, implied that if Hubble's constant were 50 km/s/Mpc (which at that time was an estimated value of H) and the universe were not expanding its mass density should be ~$3x10^{-27}$ kg/m^3.

Since I didn't know the density of the universe, to check my result I phoned my friend who had the *Encyclopedia Britannica* to look it up. It turned out that the density of the universe is not known, but it is estimated from about three times less to about three times more than what I've got.

This was an indication that I may be on the right track, and it was enough for me to share my calculations with the scientific world. I was sure that the scientific world will be extremely happy that someone finally had enough time to solve the problem of the Hubble's redshift. I thought that then the scientific world would take over from there to fit the result into general relativity about which I didn't know a thing at that time except that it is approximated arbitrarily well by the Newtonian gravity while certain conditions are met, and so it didn't matter that I did my calculations with Newtonian math only since this time I met those conditions.

I also noticed that all other times I didn't meet those conditions because of the approximations that I introduced to simplify the calculations. By the way, as I learned later, all astrophysicists do the same erronous approximations when they try to estimate redshift in a stationary universe, which they know some must exist because of *dynamical friction*. Anyway this time my calculations, without simplifing assumptions, has predicted a *non negligible* redshift in an amount exactly as it is observed in the universe and so I've thought that they might have been right.

First I sent the calculations to my friend, a math professor, who a few years earlier had been teaching general relativity at Harvard University, Cambridge, Massachusetts. When my friend told me that the calculations don't have any formal errors, I sent them to *Nature*, a scientific journal I was subscribing to at that time. The editor from *Nature* returned my paper with a short note that in his opinion the results are *too speculative*. I was awfully surprised and curious what the speculative part might be and I asked the editor to be more specific. The editor replied that his opinion may be wrong but it is final.

I started checking my math again. It seemed that there was no way of changing anything in it if it was supposed to agree with the rest of physics. The density of the universe didn't want to come up any different. I didn't discover any speculative part neither. I used only regular physics that I learned in school.

So I started to study gravity seriously to find out whether I didn't make some subtle error in my reasoning.

I bought myself many books on general relativity including the well over a thousand page book known as "MTW Bible" and started reading them. Soon I noticed that I had questions that books don't answer, so I took a two-semester course on general relativity at Harvard University, Cambridge, Massachsetts to be able to discuss those issues with the teaching professor.

When the professor asked students to ask questions about things they don't understand I asked him a rather simple question about the "particle horizon". The question was what are the velocities of galaxies behind the "particle horizon" with respect to someone who is in vicinity of those galaxies but connected to the earth with a rigid rod (a thing possible only in imagination and therefore called "gedanken experiment"). The professor had been silent for a very long time, and when silence became annoying he said that as long as he teaches general relativity nobody asked him such a question and so he had no idea what the answers might be. That was strange because it seems to be the first obvious question to ask about the phenomenon of (alleged) expansion of the universe. The professor also said that he was not a relativist but a particle physicist and so he is not a good source of information on gravity.

So I learned that general relativity is at least not that well understood by its teachers and asking them questions hasn't much sense and can even embarras them on occasions. So I continued to study without asking any more questions. After a while I found out that the constant in my differential (Newtonian) equation that determines the behavior of photons is called by cosmologists the *cosmological constant of Einstein's universe*. It was rather an unusual event since my calculations were purely Newtonian. As it was mentioned, at the time when I made those calculations I had no idea what general relativity or "cosmological constant" is.

Because of this lucky coincidence about the constant in my equation my formula for the speed of the observed apparent expansion of the universe simplified to $H = c/R$ where c is speed of light and R is *Einstein's radius of the universe* or $c/\mathrm{sqrt}(4\pi G\rho)$ where G is Newtonian gravitational constant and ρ is the density of the universe.

I sent my paper with this new form of the old result, to some other scientific journals only to observe its consistent boomerang-like behavior.

Then, seeing that the scientific world may be not interested in finding out how my results look from the point of view of general relativity, and not even whether the universe is really expanding, I started thinking about it myself. I was also curious why gravity experts didn't come upon such a simple solution as mine yet. What might have been the obstacle that prevented them form getting it despite the whole sophistication of the machinery of differential geometry that they were using?

It turned out that what I came upon through my Newtonian calculations corresponded to mentioned earlier non symmetry of g_{ik} tensor of Einstein's Field Equation. A new version, with an addition of the relation of the solution to general relativity and a suggestion that the cosmologists must have overlooked the antisymmetric component of g_{ik} tensor, had the same boomerang-like qualities as all the previous versions.

Unfortunately all the experts are convinced that g_{ik} tensor is symmetric, because its asymmetric part doesn't show up in its *quadratic form* (as if it were a good reason for something to not exist), and that whoever think otherwise must be nuts and perhaps also an evil person who just wants to make all the brightest people in the business look bad out of pure hatered toward them because of his mental inferiority. It was actually what some protectors of expanding universe hypothesis told me. For some reason no better arguments for the expansion of the universe came to their minds. It partly explained the boomerang-like behavior of the paper: editors might have believe in the same thing, because apparently it is how gravity science really works. Which being a sculptor and not a scientist I didn't know.

Later I learned from Richard Feynman's book that it is exactly how "gravity physicists" operate (quote from the book: "It is like a lot of worms trying to get out of a bottle by crawling all over each other. It is not that the subject is hard; it is that the good men are occupied elsewhere. Remind me not to come to any more gravity conferences!").

But of course people who discuss science by attacking character of the discutants are clearly idiots and one can't expect any rational arguments from them, so I kept trying to understand what is going on in science and why cosmologists didn't discover the simple thing that I've seemed to discover.

In short, summing it all, the effect of *dynamic friction* transfers energy between moving bodies in the universe and so it has to produce some (*negligible* according to astrophysicists, but *none* according to cosmologists whose math predicts *exactly zero*) redshift. That the effect is real is confirmed by its applicaiton in practice to accelerate space probes (the mentioned *sling effect*) so there is no doubt that the effect is real. The only problem with this effect is that it can't be calculated in a conventional way (with application of Newtonian "attractive force", the only method the astrophysicists who are generally not experts in differential geometry, know) since this method doesn't apply to objects that move with speed of ligt, which photons unfortunately do. It can be neither calculated by cosmologists, who are generally applied mathematicians and so they could use the differential geometry without difficulty, but since they use symmetric g_{ik} tensor in their theory of spacetime they get exactly zero a priori, and consequently the non conservation of energy, which then they tend to believe that it is a fact of life. It of course suggests, at least to an amateur like me, that the solution to the above deadlock is that the assumption of symmetry of spacetime g_{ik} tensor has to be dropped.

Dropping the assumption of symmetry of g_{ik} tensor shows immediately that there is in the universe a purely relativistic effect that simulates *dynamical friction* for photons. It is a drag acting on each object that moves through the space, and of course it is a feature of g_{ik} of Einstein's Equation, which symmetric g_{ik}, assumed by cosmologists, doesn't have. It is enough to make the mathematics of the expanding universe invalid.

When I learned that the cosmologists don't want even to think about the non symmetric g_{ik} tensor and prefer simple solutions with creation of energy from nothing I tried to find out who else except me believed that g_{ik} tensor was non-symmetric.

It showed up that one of those nuts like me was Einstein himself.

The fact that Einstein believed that g_{ik} must be non-symmetric is not presented in any textbook on gravity. I learned about it accidentally from Einstein's article *On the Generalized Theory of Gravitation* published in April 1950 issue of *Scientific American* when directed to it by a Boston University physics professor. The idea of non symmetric g_{ik} is there to verify that if I am crazy I am in a good company.

To not keep the facts about the universe only to myself and being aware that they can't be published in scientific journals, I placed my results in Compuserve's Astronomy Library (which unfortunately very few people visit). It didn't prompt anyone to discuss the paper.

I thought also that my paper might be published in an internet news group that might be visited by astronomers and astrophysicists who may be interested in some more rational reason for the cosmological redshift than the expansion of the universe. I sent to sci.astro.research group an ad that a paper with derivation of Hubble's constant from first principles is available at no charge to anyone interested. The moderator (a guy who prevents posting silly stuff in the group) kicked the ad out, advising me that there is a special news group for people with nutty ideas (which unfortunately very few reasonable people visit).

So finally I decided to make my own web page just in case some astronomers or astrophysicists would try to find on the web some rational approach to the problem of the Hubble's redshift. That there was a need for it I have learned while reading on the web an appeal of an astronomer to stop the nonsense with expending universe since it makes astronomers look like idiots.

And so here it is: possibly the first relativistic explanation of Hubble's redshift ever, that respects the principle of conservation of energy and the principle that there is no greater velocity in the universe than speed of light.

It also predicts (possibly accidentally) the "anomalous" drag that space probes Pioneer 10 and 11 experience and that the universe should actually not only look as it were expanding but as if the expansion were accelerating and all numerical values needed for the verification of those predictions. Those both effects are already noticed in the real world and they are puzzling astrophysicists and cosmologists since neither of those effects fits the cosmological theory with expansion of the universe and no cosmological constant (favored as far as I know by Prof. John Archibald Wheeler).

The cosmologists liked to talk about this cosmological constant as the "Einstein's biggest blunder", yet it seems that after "discovery" that the expansion of the universe is "accelerating", which implies the need for the cosmological constant in Friedmann's solutions, they would have to apologize to Einstein. I'm almost embarrassed that those latest findings fit my conclusions from Einstein's theory with this non symmetric g_{ik} tensor that Einstein postulated already in 1950 but which was politely ignored by cosmologists, so they didn't have to talk about another "Einstein's blunder". It reminds one, that Richard Feynman once said that so far in all disputes between Einstein and other scientists the nature has always chosen Einstein's side.

I derived the results in such a simple way that a high school student who hasn't neglected his mathematical education too much shouldn't have trouble with understanding them. It is because I accidentally utilized (not even knowing about it at the beginning) the relation between Newtonian potential and Einsteinian time dilation that translate into each other. This relation together with the relation between time and space gave the simple formula for the Hubble's constant with the speed of light and the radius of curvature of space only: $H_0 = c/R$.

Because the main reason for Hubble's redshift in my derivation is the time dilation it made possible to derive Hubble's constant in a purely Newtonian way. It is because (i) the Newtonian gravity is just the reflection of behavior of the time in the universe and (ii) the curvature of space is uniquely determined by the behavior of time (mathematically, through the fact that g_{ik} is a non Riemanian tensor, or so called "degenerate" tensor that says that "spacetime has zero volume"). So the simplicity of my derivation is just caused by the simplicity of the Einsteinian physics of the effect.

The result is so pretty that even if it is wrong for some reason there is a lot to be learned from it. Error worth of learning about, being still a piece of art even if it is *bad art* (see Theory of Art by the same author for details on why bad art may be still beautiful or *elegant* piece of art). Piece that is fit for museum or a scientific paper, despite having no artistic or scientific value whatsoever (but it is a subject complex enough to need a separate page). The value of it is then to be an example for what not to do which is as much important (if not more in many cases) to know as to know what to do. It is as one of my art teachers said to his students: "I learn from you a lot. It is all about what not to do and why but then this knowledge makes me a much better teacher."

Another advantage of examining my solution is that if it is wrong then it seems that the whole Einstein's gravity must be wrong either and so it would open a way to discovering a new theory of gravity. However neither seems to be a viable option for the time being.

One more amazing thing worth to mention seems to be what I've learned from discussions with various scientistsis. It is that physicists in general, and astrophysicists in particular, don't understand gravity. In particular they don't understand completely the issue of "gravitational energy". They don't know where the kinetic energy of a falling brick is coming from nor where this kinetic energy goes when the brick is thrown up (I had to solve this issue by myself too, since there was no one to ask, and it turned out to be almost as simple as the issue of Hubble'e redshift. Curious readers may find it in The Einsteinian Gravity for Poets and Science Teachers"). This lack of any understanding of gravity refers also to those physicists who teach gravity at various universities around the world (hopefully no big secret has been uncovered at this moment). This lack of understanding is not what I think because I'm so smart. It is what those physicist say. It is even supported by a written opinion of late Richard Feynman who was way smarter than me (Richard P. Feynman "What Do You Care What Other People Think"). It is really amazing that most of 20th and 21st (so far) century physicists have had no idea why things fall on the earth.

Now, dear reader if you read this history up to this point, you may become curious also about the paper itself. So just click here.

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