Genesis according to Science, in the New Millennium

There was no explosion at the origin of the Universe

And God said: "Let there be light." And there was light.
And God saw that the light was good, and He separated it from the darkness.
And God called the light "Day" and the darkness "Night."
And there was a sunset and a morning, the first day.
- From the book of Genesis.

Whatever the reading, it is difficult not to be captivated by the extraordinary beauty of the verses of Genesis. Never mind that scholars have discovered that they were adapted from much older descriptions of Mesopotamian mythology; nor that we can object that this narrative does not hold up in any way with the knowledge that is taught today in schools and universities. In fact, there are many books written, of a very diverse nature, where these comparisons are established, in which I will not go into here (with only one exception, actually). To choose a book, although in Catalan, I will give the reference to Teodor Suau's: *From chaos to the cosmos: a reading from Genesis 1-11*, from Publications of the Abbey of Montserrat (ISBN 9788484156116).

Who has not heard of the Big Bang? Those two short words are the ones that have somehow replaced the Genesis account of the creation of the cosmos in our cultural baggage. A different thing is the part of the same biblical story that refers to the creation of living beings, and of man and woman. Darwinian theories have taken charge of this.

I have already referred to the Big Bang several times. In fact, it was the title of my first contribution to the *Divulcat blog*. But, every day I realize that I have still done too little: the completely wrong idea that there was a great explosion at the origin of the universe remains so ingrained that it costs a lot to change it. Before giving, once and for all, the current scientific description, the one that is in accordance with our knowledge today ─well into the twentieth year of the new millennium─ I will repeat the story that is found everywhere and that we, the scientists, have seen that it is completely false. It corresponds to the scientific knowledge of ninety years ago, that of the 30s of the 20th century. And much has happened in the meantime.

The story of the big bang that never was

I will not repeat what I have already explained on other occasions and in greater detail. The (false) description, extraordinarily attractive and sold as having a scientific basis, is this. The whole universe was reduced, at the beginning of time, to a "primaeval atom" or a "cosmic egg" ─enormously small, as compared to the current universe, but very large in comparison to an actual atom. It had, of course, a density and temperature much higher than anyone can imagine. At the origin of time, this atom exploded with a great roar, spreading the matter and energy it contained throughout the universe and giving rise to the expansion that cosmologists still detect today. This huge explosion is called the *Big Bang*, words that literally have this very meaning. And that's it!

Such a description, I repeat, dates back to the 1930s and has very little to do with what we now know it occurred. However, since it is so simple, a bit mysterious but credible, and since the cosmological model continues presently to receive the name of "the Big Bang model" and, as it is quite true that big bang continues to mean big explosion, the consequence is that there is no way to erase this cartoonish, totally wrong image about what happened at the origin of the cosmos. And we continue to find it in books, encyclopedias, articles and blogs galore. Not even the specialists dare to dismantle it, not to go against the overwhelming current. This makes me very sad and prompts me to take it as my peremptory duty to insist, once more, on this point.

To begin with, disguising myself as the great Salvador Dalí and imitating his unmistakable voice, I dare to ask: *Where did the hen came from, which laid that "cosmic egg"?*

More seriously, a few years after the formulation of this model, nuclear physicists already realized that it could not be right. It was impossible that all the matter-energy of the cosmos could ever have been concentrated in a primeval atom, for many diverse reasons that I will here not detail. And, to finish this point, it is good to know that already when Fred Hoyle, the author of the expression *"Big Bang"*, spoke these words for the first time ever, he expressed very clearly that he was *not* referring *at all* to an outbreak of matter, but rather to a gigantic *expansion* of space that should be able to *"create"*, from the geometry of space itself, *"all the matter and energy of the universe"* (those were his textual words). But this is much more difficult to understand. Hoyle himself believed that it was in fact *impossible!* But Alan Guth, with his cosmic inflation, showed that it could be achieved. And the difficulty to understand this, is the reason why so many continue to take up the cartoonish and erroneous version, which even a small child can understand.

As I explained in my last entry on the *Divulcat blog* (on the cosmological constant), it was recently discovered that the first person to try to create matter and energy from space itself was Albert Einstein. He did so in early 1931. Unfortunately, he did not achieve his purpose, as he was unable to find a specific mechanism to carry it out. And the manuscript with his calculations he left it abandoned in a drawer of his desk. But I shall not go this way, for this time I want to be concise and get straight to the point; unlike on other occasions, when I may have lost myself in too many details.

Next, I will make an up-to-date account of what happened at the origin of *everything*. I must warn that it is not the only possible story, since there are others that are also reliable. In addition, not everything that I am going to tell has been experimentally tested (I will specify this at the end).

Genesis, according to the science of 2020

At the beginning there was "almost" nothing: a speck of matter in a tiny space-time that had just appeared from a previous "quantum foam" (in which space and time were not yet distinguishable). And there was also a quantum field, *the Higgs field*, and another, *the inflaton*, ready to act. A spark (the precise nature of which we have not yet fixed) created the conditions for the inflaton to produce, all of a sudden and for an infinitesimal amount of time, a gigantic expansion (which we call *cosmic inflation*) of the fabric of that tiny space. And it created more and more space, and made the universe, which was at first little bigger than an ordinary atom, to become more or less the size of a pea, at most of a grapefruit. And it still continued to expand, although at an increasingly slow pace. When the tremendous inflationary expansion suddenly stopped, almost all that colossal energy was transformed into the elemental components of current matter and energy: *quarks, gluons, leptons, photons* ..., which filled the universe, although a part of the energy was used for heating them (what we call the *reheating* phase). All those elementary constituents formed an enormously hot primordial soup, which we call the *primordial plasma*. An absolutely dark plasma, indeed, since all the photons in it remained confined: when one came out of a matter particle, it could not take two steps that it was already swallowed by another particle. And so over and over again. It was a completely dark universe, without light. And that plasma was beating in unison, as if it were a universal heart (the beats are called *baryon acoustic oscillations*, BAO).

Thereafter, the universe continued to expand at very normal rate, much like the one we now observe. And it became less and less hot, because the expansion itself was cooling it, little by little. And then, when it was 370,000 years old, what is masterfully described in the first verse of Genesis did happen. Suddenly, *there was light!* The temperature had dropped to the point where the first hydrogen atoms could form. And the dark plasma, that is the entire universe, all of a sudden, became fully transparent to the photons, which could travel, for the first time, from end to end of the still very young cosmos. This was the very first light in the universe, an amazing flash of homogeneous and isotropic blackbody radiation that we have now observed with the COBE, WMAP and Planck satellites: the light that reaches us as a cosmic microwave background (CMB), and captivates our souls. It is, indeed, the first light of the universe, of the first day of Genesis. A light that never turns off and continues to travel throughout the current universe. And imprinted on it we clearly distinguish the indelible prints of the last beat of the primordial plasma. Now, please tell me, is this wonderful scene we have unveiled not a thousand times more impressive than a mere explosion, no matter how strong it might have been?

To finish, I once made two narrations, under the form of poems, condensing all of the above: *Inflationary Big Bang* and *The First Light of the Cosmos*.

Comments

As promised, I have managed to put up an updated account in very few words. My description is not fully detailed, but contains the essentials of all we know today. It still leaves too many questions open. But so is Science: we should never expect the absolute, definitive truth from it. Whoever seeks this must go to other sources.

Just as I previously inquired about where the hen was, which laid the cosmic egg, now you could ask me, where did the pre-primordial space-time foam, and the initial tiny dust, the Higgs field, the inflaton, … come from? But let us make it clear, please. It is one thing to put the entire, jibarized universe, well hidden in the top hat, and quite a different one to hide in it just a few poky elements, which not even with the most powerful microscopes imaginable would we ever be able to see. Our top hat is much emptier than the one that the best magician on Earth may show to us. And from them, from these diminutive constituents, and with a "simple" strong blow into the globe of space, we have been able to create our huge universe with all of its material and energetic content. And this, on top, at *zero* energy cost, although I do not have any time to explain this point (I have already done it in other *blogs*). Whoever wants to know more, can read my new book, soon to be published: *Modern Cosmology: from its very origins*.

I must warn that this description lies on the furthest frontier of the fundamental physics that we know. It cannot yet be said that cosmic inflation has been proven. But there are many and very important indications of it. And the alternative theories (of a pulsating universe, in loop cosmology, etc.) what they in essence do is try to recreate quite similar effects, although starting from other principles. What we do have checked without a doubt is that, of the primaeval atom and of the great explosion that many misinformed people still affirm that it took place, there is not the slightest trace. This is indeed 100% sure it never happened!

Another observation, this one for advanced readers, is that I have not talked about the *multiverse*. Actually, the possibility is not excluded that the total universe be infinite, and that all I have described before happened simply in a very small place in this huge multidimensional space-time; that only a tiny patch of it inflated, etc. In other words, my description could refer only to *our* universe. And, like ours, there might be a multitude of other universes, being created and disappearing everywhere. Indeed, *superstring* and *brane* theories do admit these possibilities. But, no physical, real proof of this happening is available, so far.

As usually, I would like to end my story by adverting that we have a long way to go before we can get to answering the questions I have posed. We do not have a theory that unifies quantum physics with gravity. But I have warned, in other occasions, that it is quite possible that this much desired theory, even if we had found it, perhaps still would not be enough to reach the very starting point, *t=0*, the Big Bang *singularity* that shows up in current theories of gravity. Far from discouraging us, this pushes us to continue investigating.

Finally, it is quite healthy from time to time to look back for a while, and gently observe where we came from and all we have managed to understand so far. How we are indeed progressing, step by step, year after year. And do not become obsessed, over and over again, in the same questions that are very difficult to answer and that it is very possible (as our experience of past discoveries shows) that it may take us still one or two hundred years, if not more, to be able to answer them.

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