Science And The Question Of Origins I: Creation And The Big Bang

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After the primeval fireball: An artist's concept of the early universe. (Adolf Schaller/NASA)

By Marcelo Gleiser

This will be the first of a series of postings on how modern science deals with the ancient question of origins. For as long as we have records, different cultures have dealt with the question of the origin of all things. Where did everything come from? Across history, creation myths have tried to deal with this issue from a supernatural perspective. In most (but not all!) cases, a God, or Goddess or an ensemble of gods create the world and its inhabitants. For us in the West, the most familiar creation narrative(s) is that of Genesis 1 and 2. Here, an all-powerful God creates all that is ex nihilo: creation out of nothing. God, an absolute power that transcends the limits of space and time, decided for mysterious reasons to create the world. In most creation narratives, the absolute power separates light and shadow, cold and hot, man and woman, that is, it polarizes reality: only a transcendent power existing beyond the separations that we perceive in everyday reality can possibly create that reality.

Science has slowly but surely encroached on what was once religion's exclusive territory. It is now perfectly legitimate to research questions related to what I call the "three origins": cosmos, life, and mind. In fact, to many scientists, these are the most fascinating questions. How far can science go in explaining the origin of the universe, the origin of life, and the existence of consciousness? Today, I wanted to say a few words about the origin of space and time, aka, the big bang.

During the twentieth century, our knowledge of the universe underwent an extreme revolution. In 1924, American astronomer Edwin Hubble showed that the Milky Way, our home galaxy, is one among billions of others, separated by millions of light-years. In 1929, Hubble revealed to the world that the universe is expanding: these galaxies are moving away from each other, at speeds that increase with their separation. Soon, this expansion was interpreted as the expansion of space itself: contrary to popular belief, galaxies are not like shrapnel from an explosion, but are carried away by the stretching of space itself. As Einstein's general theory of relativity showed, space (and time) is plastic, amenable to stretching like a rubber band. Playing the movie backwards, as we go back into the distant past, galaxies are moving towards one another up to the point where they are on top of each other: matter reaches enormous densities and pressures and the temperature soars. Close to the beginning of time, the universe was incredibly hot and dense. It is this initial state, highly unstable, that unleashed the expansion of space that we call the big bang.

In truth, things are not so simple. There may have been a phase even before this one, which we call inflation, where the universe stretched with speeds above that of light. But for now, let's stick with the view of the cosmos circa 1970. (I will get to the next 40 years soon enough.) The question then is, ok, but how did this compressed ball of matter come to be?

Here things get messy. Classically, the theories we use to describe the primeval fireball break down. Energies go to infinity, the "size" of the universe goes to zero. Clearly, something is wrong. And what's wrong is that you can't use classical theories to describe the origin of the universe. You need to incorporate quantum effects. The problem is that we don't have a theory that marries classical gravity with quantum mechanics. The leading contenders, superstrings and loop quantum gravity, are still far from providing answers. Even so, we do know that, in the beginning, space-time was quantum mechanical. As such, energies can fluctuate according to the uncertainty principle and, amazingly, the universe itself can be a quantum fluctuation with zero energy: the scientific version of creatio ex nihilo. Out of quantum nothingness comes space. Let's suppose that we have a theory that does this in acceptable, empirically-validated ways. Is this the solution to the origin of the universe? I'd say it is a solution, a scientific version of creation. It turns out that science needs a framework, a scaffolding to operate: principles, laws, concepts such as energy, space, time, matter. It's always possible to contemplate reality beyond all of this, beyond the reaches of scientific conceptualization. In other words, since science can't explain itself, it can't completely answer the question of the origin of all things. Unless, of course, science becomes something new, capable of coming up with the "theory of theories," that explains even why there is such a thing as science and a universe that follows certain rules and not others. But that seems to be very far away.

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