

## Sagan's salt: the salt of science

The unknown -> questions -> answers -> knowledge: this is a process that has been going on since man appeared on the Earth. The continuous effort to understand how life in the universe works and the need to be aware of what surrounds us is something intrinsically human, leading to what is generally referred to as "knowledge." According to the French philosopher August Comte, considered the founder of Positivism, human knowledge developed through three successive stages in history: the religious stage, the philosophical stage, and the positive or scientific stage. Religion, philosophy and science can in fact be considered as three different approaches to the "knowledge problem," and, at the dawn of the year 2000, scientific answers, if available, are often regarded by many people as truer than the others. But is science the surest and fastest path to knowledge?

The renowned scientist Carl Sagan, in his essay "Can we know the universe? Reflections on a grain of salt", provides the reader with some very interesting considerations about how science and knowledge relate to each other and eventually proves that sometimes full scientific knowledge, although "true," can be quite useless, and other times it could be even impossible for human beings.

In the first paragraph Sagan gives a very effective example of how science can largely differ from conventional wisdom by observing that "even so straightforward a question as whether in the absence of friction a pound of lead falls faster than a gram of fluff was answered incorrectly by Aristotle and almost everyone else before the time of Galileo. " It could take a lot of courage to be a scientist who questions common sense<sup>1</sup>.

The scenario is certainly different nowadays: scientists take very seriously whatever is based on experiment and "the scientific cast of mind examines the world critically as if many alternative worlds might exist." But is science really moving towards the complete knowledge of the world in which human beings live? And to what extent can man really know the universe that surrounds him? As Sagan points out in the fourth paragraph, there are "scientists who confidently state that everything worth knowing will soon be known \_ or even is already known \_." It might look like science is really the "key," but all of a sudden Sagan provides the reader with a completely new perspective: "Let us approach a much more modest question:", he proposes, "not whether or not we can know the universe or the Milky Way Galaxy or a star or a world. Can we know, ultimately and in detail, a grain of salt?"

Even though most people would say that they know what a grain of salt is, they should first ask themselves what the verb "to know" really means. In a grain of table salt there are about 10 million billion sodium and chlorine atoms, and if someone perfectly knew that grain of salt, that would involve knowing, for instance, the exact position of each of those atoms. The human brain could only store one percent of that information. As Sagan points out, the universe seems to be "astonishingly immune to any human attempt at full knowledge." If human beings cannot understand a grain of salt, how could they possibly understand the universe?

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<sup>1</sup> Galileo himself, theorist of the "Scientific Experimental Method," spent the last days of his life in prison, guilty of heresy, after stating that the surface of the Sun was not so perfectly smooth and even as according to the Church.

At the same time that human beings seem to lose any hope of understanding anything in the whole universe, Sagan comes to the rescue with a very helpful point: there are "regularities" in the universe that men can summarize with "natural laws." If someone looked at that grain of salt deeply enough, its predetermined structure would be easily recognized: sodium, chlorine, sodium, chlorine, sodium, chlorine, . . .

As Sagan observes, "it is an astonishing fact that there are laws of nature, rules that summarize conveniently how the world works." Laws of any kind, almost by definition, reduce possibilities, and "the idea that the world places restrictions on what humans might do is rather frustrating." On the other hand, the existence of those prohibitions constitutes the premise of human knowledge. A random universe, where there are no such laws, is not likely to host life and intelligence, and scientific knowledge would be totally impossible.

Sagan goes on providing two more examples where the "true" kind of knowledge that science offers is rather useless in everyday life and sometimes even against common-sense: Albert Einstein's Special Theory of Relativity and Quantum Mechanics. In the first case Sagan notes that, no matter how reasonable or unreasonable the effects of speed of light-travelling may seem, humans are not in the habit of travelling that fast, and knowing Einstein's theory does not help a lot in everyday life. Similarly, the limitations of quantum mechanics is not something that humans usually experience directly. "We would find it startling as well as awkward in sitting-up exercises," Sagan observes, "to find arms outstretched from the sides or pointed up to the skies permitted but many intermediate positions forbidden." That is because human beings do not live in the world of the small. Still, observations from the far infrared spectra show molecular rotation to be quantized. In both of the previous examples there were scientific possibilities and scientific restrictions which humans do not commonly seem to care about. Scientific knowledge, although sometimes considered the most perfect form of knowledge, is not always the most interesting and fascinating one.

There are other forms of knowledge, less "rational" than science or philosophy, which are also aimed towards "the truth in the universe," but are not looking for an explanation of how every single part works. The Christian religion, for instance, regards the existence of God as a dogma, which means something that one believes but that cannot be proved. God is unintelligible and religion does not look for a "scientific knowledge" of him. Fantasy, imagination and intuition are also alternative paths to intellectual discovery that can reach where science cannot. What is forbidden by the laws of nature and is impossible for science is perfect for fantasy.

Let us look at the grain of salt again. Do we really know it? Maybe so, but sometimes it is nice to think that we do not know it really well and that there is more to discover. Sagan himself likes "a universe that includes much that is unknown and, at the same time, much that is knowable." "The ideal universe for us," he concludes, "is one very much like the universe we inhabit." He would guess that this is not really much of a coincidence, and I agree with him.