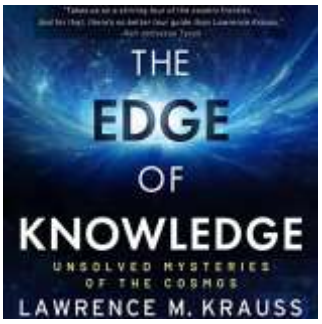

The Edge of Knowledge
Unsolved Mysteries of the Cosmos©
by Lawrence M. Krauss

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Lawrence M. Krauss' latest book 'The Edge of Knowledge' wants to explore the 'known unknown' and even ventures into the 'unknown unknown'. He makes the big fundamental sweep across the pertinent subjects that are determining our universe: Time, Space, Matter, Life, Consciousness.

Time covers from Einstein to the 'big bang', black holes and the inflation theory all aspects of the 'known'. When discussing the origin and nature of time a lot of "ifs" and references to the 'singularity' (quantum fluctuation in a false vacuum) is made, i.e., trying to describe the unknown. Assuming the cosmic inflation theory is the proper description of our universe it would imply some ideas about time, in particular the beginning of time. Krauss' summary: I am tempted to say time would have emerged after the beginning, but of course that is incorrect if there is no time at all. That is part of the problem of dispensing with time. All our intuitive notions about phenomena no longer apply.

Space deals with Cosmic Microwave Background radiation (CMB), wormholes, multiverses and the fate of our universe as result of the observed expansion depending on the shape of the universe (open, closed, or flat). Despite the progress achieved with satellite measurements and refined earth based sensors the debate is not entirely settled. Krauss' argumentation quotes all the well-known research scientists in his field referring to a lot of 'eternity'- and 'infinite' definitions are used, which are hard to understand, however I liked Krauss' quotation of Woody Allen: "Eternity is a long time, especially near the end", which I can associate with.
Penrose argues that at late times in the evolution of our universe, after matter like stars and galaxies have largely disappeared into black holes, the universe will be such that length itself loses its meaning. Lengths, which for the long dead observers who lived on the stars and galaxies separated by vast expanses of space, could then, he argues, be identified with lengths much smaller than those in a subsequent, later universe would now call the Planck-length. In short, the birth of new universe could emerge out of the death of an old one, with all the vast expanse of space between dying black holes in the old universe too small for the observers who evolve in the new universe to even measure. In doing so, and by requiring some new unusual physics, Penrose argues that the new universe could avoid the nasty singularities of a Big Bang and could naturally have the particular features our current universe seems to have. Sound crazy? Krauss thinks it probably is. But sometimes crazy ideas are true. Just not very often...

Matter: The author dives deep into the question of 'what is the world made of'?
In 1936, after the discovery of the *muon*, a heavy cousin of the electron, in cosmic ray showers, the Nobel Laureate and experimental physicist, I. I. Rabi, famously quipped "Who ordered that?"
We are still asking the same question.
As an answer, Lawrence Krauss gives us a highly academic lecture of the development of the 'standard model' of particle physics, guiding us through neutron decay, the discovery of the Higgs boson, string theory, super symmetry, quarks and invisible matter, the 'grand unification' up to the discovery of the neutrino mass at the end of the last century, and into the 'craziness' of quantum

mechanics.
The author closes with his Harvard colleague Sidney Coleman's speculation: "Quantum mechanics subsumes and replaces classical mechanics", but at the end of the chapter Krauss raises some doubts and concludes:
"Fortunately, nature doesn't care about what we can understand or what we can currently define. What is, is, and as marvelous and crazy as our quantum reality may be, and even if almost all physicists now would probably bet that that is the way our universe truly works—and perhaps the way all universes must work—we have to admit we really don't know. What we can say with confidence, however, as I hope I have illustrated [in the previous chapters of the book] is, that the imagination of nature far exceeds that of humans, so unless we keep probing it, letting experiments drive our understanding, the known unknowns will never change".

Life: In this chapter, not necessarily the domain of a theoretical physicist, Lawrence Krauss feels compelled to add his observations from a theoretical physicist's point of view as well: Among existential questions he addresses the great mystery of "*How did life originate*? .
After an extensive discussion of all so far proposed theories covering the seminal 1952 Miller-Urey experiment and the progress made possible by ever more sophisticated satellite experiments, as well as the surprising breakthroughs provided by the measurements of the James Webb Space Telescope (JWST) Lawrence Krauss sums up his opinion as:
"The existence of life in our universe seems miraculous, but it need not be a miracle. The mysteries surrounding the origin of life, its variety, and its possible future are fascinating and provocative. The fact that we don't yet fully understand these things is not evidence for God or that we live in some vast video game created by some more advanced civilization (which of course begs the question of whether they live in a video game, and so on).
Rather, it is simply evidence of not understanding, and that motivates trying to find out the answers. Not only are we not likely to be special gifts of creation, but the possible existence of lifeforms with nothing in common with us lends further incredulity to the incredibly non-humble suggestion that the universe was made for us.
It represents perhaps the most important new object lesson that thinking about life in the universe is likely to teach us: that there are more things in heaven and earth than are currently dreamt of in our imagination.
But, as I have previously stressed, absence of evidence isn't evidence of absence. Therefore, one cannot prove there is not a hidden grand designer. One can just argue that there appears to be no need for one."

Consciousness: After having read this chapter, I felt dizzy because of the enormous complexity taking place in our brains every second, thus producing what we call consciousness and free will – yet this process seems so simple, because every human being uses it virtuously from an early age on. Lawrence Krauss himself is a vivid example of how much one individual can know so much about a field which is not even his main profession and yet draw plausible conclusions which might not be in sync with mainstream science or philosophy.
Krauss' sober conclusion is "In short, we have to play our hand with the cards we are dealt. A scientific approach to human cognition should account for the fact that, operationally, as far as internal mental states are concerned, awareness of self is as real as awareness of the external world, and if we want to understand the latter, then debating the existential reality of the former may not be productive. As far as our minds are concerned, both "self" and "real" are inextricably linked by consciousness. What matters is how consciousness creates our experience of both. And it is that thorny and complex fundamental issue, as fundamental as any question we have about our place in the universe, which continues tochallenge us".

The sentence which stuck with me is a quote from Antonio Damasio that "future robots, if they are to have any hope of self-awareness, will need to have a *body* that requires regulation in order to persist". That sounds plausible to me.

The book 'The Edge of Knowledge', British title 'The Known Unknowns' is a WOW- book because the author is dealing among other subjects with the question whether it is possible to know everything – and Lawrence Krauss' book demonstrates, that at least the author knows all the knowns of his profession and more!

What I liked most about the book is Krauss' stressing of the breakthrough role modern astrophysics plays by relying on highly sophisticated, robotic spacecraft and satellite probes to advance our knowledge with predicted or unexpected results.
On the other hand, although we have accumulated so much knowledge about our universe and ourselves in it – Krauss remains ambiguous about the final answers to the existential questions but is confident that future generations of scientists will still get closer to them.
Just when finishing this book recension the SPIEGEL magazine was publishing an article about a German JWST Max-Planck Institute experimenter group (Thomas Henning et al.) having detected water and other life supporting elements, in particular carbon compounds and hydrogen cyanide (HCN) in the granular dust clouds of protoplanetary disks forming planets i.e., life could have been embedded in the grains of the primordial soup already. [1]

What is also appreciated is, that Lawrence M. Krauss as an enthusiastic and dedicated scientist is not on a "missionary" trip, but maintains a noble attitude of a scientist to readily admit "We don't know (yet)" throughout his book.

Reference:

[1] https://www.mpia.de/jwst-ausstellung/henning and SPIEGEL Magazine Nr. 33, 12 August 2023