The Simple Truth

By Abraham Loeb on December 16, 2019

*I*n a recent meeting about our research project, my postdoc raised the question: "should we make our model more complex so that our analysis of the data would not appear too trivial?" I was struck by this suggestion and felt obligated to explain: "simplicity is a virtue, not a bug. As physicists, we should seek the simplest explanation to data. Excessive mathematical gymnastics is used as the only way to show off in branches of theoretical physics with scarce or non-existent experimental data."

In today's fierce job market, fledgling scientists are attempting to impress their senior colleagues with lengthy derivations, marked by challenging mathematical complexity. A second postdoc told me recently: "the most fashionable trend for demonstrating exceptional skills in my research field involves writing extensive papers, sometimes longer than hundreds of pages. I am facing the strategic dilemma of whether a complicated paper would be more beneficial for my future career than a short insightful paper."

It is clear that accomplishing the trendy task requires more sweat, but is science supposed to be hard labor? Not always. Our task as scientists is to better understand mother Nature. And in the spirit of Occam's razor, if the answer is simple - why make it complicated?

Complex predictable projects may seduce funding agencies by forecasting what they may find, but at the end – they are less influential than short reports of unexpected results. Few readers have the time to go through long papers and so the appreciation of their extensive content tends to be superficial. On the other hand, an accessible short insight tends to stimulate follow-up work by the broad scientific community. The wider influence and appeal of brief insights improves job-market prospects, contrary to the naïve expectation of some postdocs.

The attraction to complexity is shared by senior scientists who wish to make their work nuanced and less accessible to scrutiny. Although sophistication can be valued as the trademark of the elite, science is better served if its results are expressed in a simple and transparent language. Last month I was asked by a reporter: "how do you manage to explain your science so clearly and in such simple terms?", to which I replied: "because I describe only things that I understand and admit what I do not know." Complexity could be used as make-up to cover the unflattering pimples of ignorance.

The physicist Richard Feynman said: "Just as a poet often has license from the rules of grammar and pronunciation, we should like to ask for physicists' license from the rules of mathematics in order to express what we wish to say in as simple a manner as possible."

Simple insights can occur instantly without hard labor and lead to an exhilarating feeling that the mathematician Henri Poincaré called "sudden illumination". When Julian

Schwinger and Richard Feynman suggested two different approaches to explain experimental data in *Quantum Electrodynamics*, it appeared complicated to decide which one should be used until the 24 year-old physicist at that time, Freeman Dyson, demonstrated elegantly that they were equivalent. Freeman had the simplifying insight on a Greyhound bus ride and afterwards said: "it is impossible for me to judge whether the work is as great as I think it may be. All I know is, it is certainly the best thing I have done yet." He was rewarded with a permanent faculty appointment at the Institute for Advanced Study in Princeton, alongside Albert Einstein. Both Feynman and Schwinger shared the Nobel Prize thanks to his simplifying revelation.

Unwarranted complexity often advocates fine tuning of parameters. The more fine-tuned a theory is, the less explanatory power it possesses relative to the simple truth. A classic example is the mathematically sophisticated Ptolemaic theory of epicycles for describing the motion of planets as compared to the simpler Newtonian alternative. The situation is similar for reverse-engineering flexible theories like cosmic inflation or the multiverse by introducing new free parameters to fit new data. This argument was quantified in a recent paper that we wrote with Feraz Azhar, a philosophy postdoctoral fellow at *Harvard's Black Hole Initiative*, who just fulfilled his job-market aspirations by accepting a junior faculty position a few months ago while making this point.

Although simple results appear trivial in retrospect, discovering them is a rare privilege. Complex arguments which are born after tedious labor can be regarded as fruits that are in plain sight but difficult to reach. Rare insights, on the other hand, are low-hanging fruits often hidden from view. These two options are the only ones left when all the visible low-hanging fruits were already picked up.

ABOUT THE AUTHOR

Abraham Loeb
Abraham Loeb is chair of the astronomy department at Harvard University, founding director of Harvard's Black Hole Initiative and director of the Institute for Theory and Computation at the Harvard-Smithsonian Center for Astrophysics. He also chairs the Board on Physics and Astronomy of the National Academies and the advisory board for the Breakthrough Starshot project.

(Credit: Nick Higgins)