UNIFORMITY OF NATURE: THE INDUCTIVE FOUNDATIONS OF SCIENCE

After first exam

After a long time, we figured out we can't use pure reason to figure out things about the real world. We have to actually observe the world.

Many observations are imperfect. If we need to measure something in numbers, and that number could take on any real value (fractions, decimals, etc.) then we can't get perfect accuracy. This is just one source of our uncertainty about nature. But even still, it's not the most fundamental source. Some things are whole numbers. How many planets are we on? One…not 1.337 planets.

Now that we are done with the first test, I can tell you without you worrying about it being on the test. You now know that there are two kinds of logic (by one reckoning): deductive and inductive. Deductive has guaranteed conclusions if the premises are guaranteed and the logic is valid. Inductive logic just supports the conclusions, it can't guarantee it, even if the premises really are true.

I mentioned that to establish any set of premises about the world, it takes another argument, and that another. Ultimately, for natural things, it all seems to rest on inductive reasoning. This is why we can't have guarantees in science. What is that inductive reasoning?

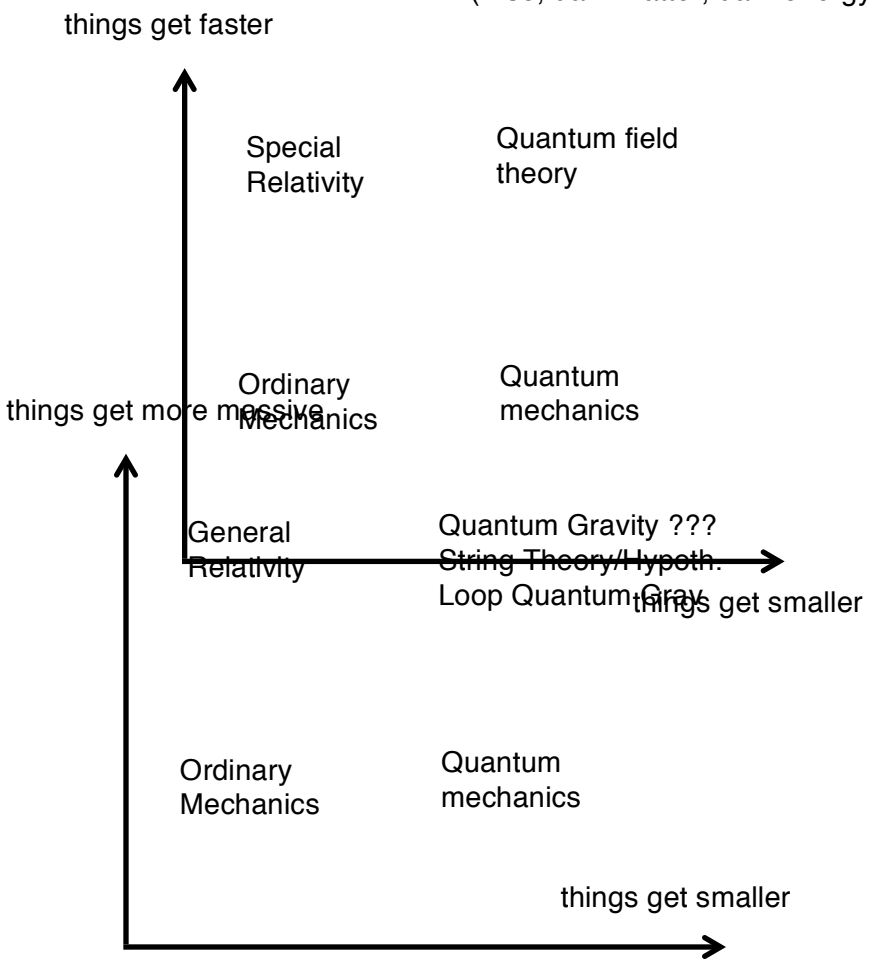
For as long as we've been measuring, it seems the world obeys some natural laws. There is order to how nature behaves, and this is true everywhere and everyWHEN that we've looked. These are hard and fast rules that everything from people, to plants, to rocks, to atoms never violate. But even if this is always what we've seen, we don't know any reason why nature MUST obeys these rules and not some other rules…or even any rules at all. It could be the laws of physics stop working tonight at 7pm. It hasn't happened as long as we've looked but that's just an inductive argument. Why won't the laws of physics stop working tonight?

**The laws of physics didn't stop working last night, or the night before, or any other time we know about. Therefore, the laws of physics probably won't stop working tonight…but they could.

This problem is called the uniformity of nature. Nature seems to be uniform, obeying very regular patterns, laws of behavior. They don't have to, as far as we know. But they do. How far have we looked? Well we've known about some of these laws for roughly 300 years (Principa mathematica, 1687 in Latin, 1728 in English). Millions of studies since that time have used the laws of physics built up since then, or those deductively derived from them, as part of their premises. There have been modifications but those modifications have been consistent with them in the domains where they overlap (compare to the Correspondence Principle of quantum mechanics formulated by Niels Bohr in 1920). Those tests could have invalidated these laws, but they haven't. These tests count as mountains of evidence for these laws because if they were wrong, the predictions wouldn't be true. That's a few hundred years, and on Earth. What about elsewhere and elsewhen?

The speed of light is finite, so when you look outward in space you look back in time, because the light was emitted from distant objects a long time ago. You can look out and peer into the past and into the distance at the same time. The laws of physics are consistent here too. The most general models we have are all consistent with what we've seen as far as we can tell. General relativity, and the particle physics of stars are consistent with what we observe.

Let me tell you more of a scope of what physics knows and doesn't know. I can't tell you everything. But this can help.



There's one more thing. The laws of physics on our scale, not at the center of a black hole, or anything like that but in our everyday lives, are understood. There could be deeper laws, but what they have now, since the discovery of the Higgs boson, are consistent with everything we measure for our everyday lives. We know how atoms work and we are made of atoms. But there are trillions of trillions of atoms in one human being. Even if we know the equations, all the computers on earth are not enough to solve those equations in any reasonable amount of time. This is like knowing the rules of chess. We understand those rules now. We know how nature plays its game. But knowing the rules of chess and being playing chess well are two different things. We as humans will press on.

This class will start with ordinary mechanics:

The goal of physics in general is to understand how things behave at as deep a level as we can. Doing this, for many, many things comes down to understanding how and why things move (or don't move).

Mechanics: Goal = to understand and predict motion of objects.

System = object we care about.