Stumbling in the Dark

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I once told a sophist physicist that I considered Introduction to Electrodynamics[1] by Griffiths a religious book. He replied that most people wouldn't agree, but he saw what I meant.

I need to back up a bit. Back when I was a high school student, my parents and I hiked to an overlook in Glacier Park. The end of the trail looked down at a mountain lake called Hidden Lake. It's a beautiful place, with mountains, trees, ripples on the lake and all that. Normally, in a situation like that I would entertain myself by throwing rocks into the lake, but the overlook was too far away for that. Instead, teenage Josh was looking at the lake with a pair of polarized sunglasses, and then taking them off, and repeating this. Teenagers. (Roll eyes)

What I had noticed was that sunlight reflected off the lake, but if I put the polarized sunglasses on, the reflection disappeared, and I could see down into the water at the rocks below. I wondered why that was.

Meanwhile, humans have been doing a lot of experiments. They try things like rubbing amber with fur, and finding these funny rocks that point in one direction when hung from a string and if you push a cart harder it goes faster. Things like that.

Most of the experiments don't do anything useful, but some of them are very interesting. People realized if you wiggle a magnet, you can get a electric current. If you move electrons you get a magnet.

Maxwell noticed if you put these two effects together, and guessed what happens to the magnetic field when you charge a capacitor, then a changing magnetic field creates a changing electric field, and a changing electric field creates a changing magnetic field. This keeps going thru space. Maxwell noticed that the speed of this just happened to match the speed of light. The equations did have a mistake: the speed of light was a constant, which didn't make sense, since it should have been different depending on the relative velocity of the sender and receiver. Einstein later sorted this out and realized that Maxwell's equations were right and some of Galileo's were wrong.[2]

But enough about science, back to me. I somehow managed to annoy few enough teachers that I graduated from High School and went to college.

College seemed like the in thing to do.

I took a two semester class called Electricity and Magnetism.[3] We used Griffiths' Intro to Electrodynamics book. In that class I learned about Maxwell's equations. It is kind of amazing how Maxwell's equations, which are just about four to six equations can describe practically everything we experience except gravity. From the force keeping me from falling thru the floor, to the light coming in the window and being reflected from a mirror, to forces moving electricity thru wires, it's all in Maxwell's equations.

For studying for the final test I read Surely You're Joking Mr Feynman,[4] and did the review problems. One of the review problems was to calculate what happens to a light wave that hits a conducting surface. It took a good six sheets of paper, but I finally figured it out. The reflected light came out polarized.

Suddenly, I became enlightened several days later,

[1] Introduction to Electrodynamics (3rd Edition) by David J. Griffiths

[2] This story is stolen from Griffiths

[3] PHYS 317 with Dr. Dana Longcope and PHYS 318 with Dr. Carla Riedel

[4] Surely You're Joking, Mr. Feynman! (Adventures of a Curious Character) by Richard P. Feynman, Ralph Leighton, Edward Hutchings and Albert R. Hibbs

and realized that I had calculated what I had seen in the lake since the light was hitting a conducting surface. The wave of light hit the water, and only some of it reflected. My eyes saw the reflected part, but with the sunglasses I couldn't see the reflected polarized part. It made sense, and I understood it. It's nice when the world makes sense.

Science can tie together magnets and static electricity and light reflecting off of a lake. Science rebinds us to how the world is.

Of course, all is not easy in science. It requires careful thinking, and isn't always fun. I'd written a paper, and I had been working on it on and off for over a year, and then I submitted it to a journal. I had put a lot of work into it and I was happy with the paper when I sent it in. It came back with the peer review's comments; a list of twenty plus things that the reviewers didn't like. My first thoughts were not happy thoughts, and went something like: *why are you bugging me, couldn't you just leave well enough alone? I've already put huge amounts of time writing this thing.*

The really sad part is that the reviewers were right, and they had thought of things that I hadn't and I needed to fix.

Science requires being wrong, because the first thought that comes to mind is often wrong. Being wrong is not fun, but it is very necessary to realize that I am often wrong, because if I don't I will never be able to move from my current wrongness, to being less wrong.

Truth in science is interesting, because in some sense, there is no absolute truth. With sufficient evidence, any scientific belief can be overturned, like some of Galileo's laws were by Einstein. The key is to pay attention to why a belief might be true or not. Darwin wrote about this:

"I had, also, during many years followed a golden rule, namely, that whenever a published fact, a new observation or thought came across me, which was opposed to my general results, to make a memorandum of it without fail and at once; for I had found by experience that such facts and thoughts were far more apt to escape from the memory than favourable ones. Owing to this habit, very few objections were raised against my views which I had not at least noticed and attempted to answer." wrote Darwin in his autobiography.[5]

Science may not be able to find absolute truth for all time, but it often can find mistakes. One of Feynman's definitions of science is "If I do this, what will happen?"[6] So, if I have a theory, and it says X will happen, but instead Y happens, something is wrong, it might be the theory, or maybe the experiment was done wrong, but we know we need to figure out the error. Err and Err and Err again, but less and less and less.[7]

In some sense, we test our understanding of the world constantly. The transformer that is powering the laptop I write this sermon on would not be able to lower the voltage without Maxwell's equations working as the electrical current is converted into magnetic fields and then back into lower voltage electrical current. If electrons could always be any energy instead of being forced into discrete levels, the diodes inside it would not work, and the current would not become direct current.[8] Maxwell's equations and quantum mechanics and more science, are all demonstrated in just a plain old transformer.

Once upon a time Nasrudin was walking home. It was only a very short way and upon arrival he can be seen to be upset about something. A young man comes along and sees the Mullah's distress.

"Mullah, pray tell me: what is wrong?"

"Ah, my friend, I seem to have lost my keys. Would you help me search for them? I know I had them when I left the tea house."

So, he helps Nasrudin with the search for the keys. For quite a while the man is searching here and there but no keys are to be found. He looks over to Nasrudin and finds him searching only a small area around a street lamp.

"Mullah, why are you only searching there?"

"Why would I search where there is no light?"[9]

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[5] `http://www.gutenberg.org/ebooks/2010` The Autobiography of Charles Darwin by Charles Darwin

[6] Richard Feynman, The Meaning of It All, The Uncertainty of Science

[7] From The Road To Wisdom? by Piet Hein

[8] For some cool descriptions of transformers, diodes and other things see: Practical Electronics for Inventors by Paul Scherz

[9] `http://en.wikibooks.org/wiki/Nasrudin`

Science searches in the light, science has expanded the light, but still, Science searches only in the light.[10]

In the Bible God challenges Job, and now humans with science and technology have entered the realm of what was thought reserved for God. We have journeyed to the springs of the sea, and walked in the recesses of the deep.[11] We have been to the storehouse of the hail,[12] and the place where lightning is dispersed.[13] We have cut channels for the rain,[14] and brought water to a desert, and make it sprout with grass[15] and potatoes. (For some reason the book of Job forgot to mention the potatoes.)

Yet complicated as our accomplishments in science and technology are, as much work and thought as it took to find things like the Higgs boson, the complexity of the physics we know is much simpler than accomplishing Micah's simple seeming task of acting justly, loving mercy and walking humbly[16] in humans with 100s of billions of neurons in our society of billions of humans.

We search in the light of science, and we expand the light of science, but yet we are stumbling in the dark for how to create justice and love in our society. Our genus Homo has survived over two million years, yet do we even have the wisdom to survive with science the next 100,000 years?[17]

Carl Sagan spoke "For the first time, we have the power to decide the fate of our planet and ourselves. This is a time of great danger, but our species is young, and curious, and brave."[18]

[10] See for example Groping in the Dark: The First Decade of Global Modelling, Edited by Donella Meadows, John Richardson, Gerhart Bruckmann

[11] Job 38:16

[12] Job 38:22

[13] Job 38:24

[14] Job 38:25

[15] Job 38:27

[16] See Micah 6:8

[17] See for example Surviving 1000 Centuries: Can We Do It? by Roger-Maurice Bonnet and Lodewyk Woltjer

[18] Carl Sagan, Cosmos: A Personal Voyage, The Shores of the Cosmic Ocean