In Practice

It has been said that science *is* the refinement of questioning. The game for the ages, which the curious human mind plays with Nature. Stretching back into the old days, when wise men—Socrates, Plato and Aristotle, to name but a few—pondered the deepest mysteries of the cosmos, which is now more-or-less known as philosophy. And finally culminating with the technological consummation of empirical knowledge, that is modern science. What separates science from the menagerie of human endeavors is its ability to uncover the *objective truth*—that which is the same for everyone. We can only witness the *objective truth* by means of experiments, the bread and butter of scientific inquiry. This summer I have caught a glimpse of the difficulties involved in ascertaining such empirical data with experiments—something that theorists try to remember and science classes nearly leave out. In principle, I had a 10 week lab position working on the novel material graphene. But, *in practice*, I had an eye-opening and truly unforgettable journey into the 'scientific method.'

Before arriving at Berkeley I had only encountered science in class and in the literature. Boy was I missing out. The real action is in the laboratory. The first day was like Christmas—everything looked shiny, new and ready for my eager hands. I began learning about cryogenics, solid-state physics and vacuum chambers. Quickly I realized that it would take little to no time to learn *how* to operate the apparatus found in the laboratory, however, to *understand* a piece of equipment, is an other story altogether. For example, when I was first confronted with the ultra high vacuum chamber I was speechless—what could possibly go in *that* thing. While I was quickly assured that it would soon become as familiar as a toaster, I could still not get past the unfathomable engineering that must have been required to construct and operate such a marvelous thing!

I have found in my life that (emotional) experience is the essence of learning. How can I *know* something, if I do not interact with it? Now, when it comes to science, there is no experience like lab experience. In the lab you need to get stuff done, your on a mission—the clock is ticking. One of the first things I had to get done was a new 'switching box.' For this mission I had to solder 20 connectors to 10 switches and make sure everything was grounded to the same ground. It was a quick job: drill the holes in the metal shop, design the electronics, fasten the electronics and solder the electronics. Nevertheless, despite the brevity of the project, it immediately conferred upon me the supreme sense of *understanding*. This little box that I created was my own—I knew every nook and cranny. It was then that I rediscovered the importance of "hands-on experience."

It was not long before the experiences started pilling up: atomic force microscopy, origin data analysis, and, of course, presentations. One of the more memorable experiences was the day that our first graphene sample arrived: we had to journey up the hill to Lawrence Berkeley National Laboratory. It was only here that we could image our sample—in one of the most advanced scientific buildings on the surface of our planet—at the Advanced Light Source. Optical microscopy was the first order of the day. Afterwards, we confirmed the location and status of the sample, then we preformed our initial measurements. We reproduced the Dirac point at room temperature using the lock-in amplifier; a successful start to the graphene project! It was a glorious moment, a taste of satisfaction. Over this summer I have learned that some days in the lab are long and boring, and some are short and fun—but the best are those that *never end*, and that day was one of them.

Many more days have passed and my hands have built quite a few devices. My experiences here have played no small role in my life, and will no doubt continue to shape how I conduct my own inquiries. "Philosophy begins with wonder," as Socrates proclaimed. In principle one could ignite awe with theoretical 'parallel universes,' but, I now realize that, *in practice,* it is our mission as scientists to unveil the shroud of ignorance that envelops the human condition—with *objective truth*.

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