The poetry of *physics*
vs.
the "doing" of *Physics*

2.1 Poetry as "Language Engineering"

Communication requires a consensus about language. We have dictionaries to help stabilize that consensus; we have poets to help keep it evolving. I am not much of a poet, but I identify with their part of the task: I use the dictionary words (making up "new" words like *quark* has always seemed a little on the tachy side to me; why break rules if they are fair?) but I sometimes try to decorate their meanings with a lot of connotations and allusions and specific details *in a given context* that are not in any dictionary and would be inappropriate in another context. This is a fun ego trip; it is also necessary whenever one is trying to make a point that goes a little beyond where existing language leaves off – which isn't far from where we live daily.

Unlike most poets, however, I will do my best to spoil the mystery of my private terminology: whenever I realize that I am using a word in a specific sense that transcends the dictionary meaning and its colloquial connotations, I will try to call attention to it and explain as much as I can about the differences. Poets don't do this for a very good reason: part of the magic of poetry is its ambiguity. Not just random ambiguity like dictionary words out of context, but coherently ambiguous; a good poet is offended by the question, "What exactly did you mean by that?" because *all* the possible meanings are intended. Great poetry does not highlight one meaning above all, but rather manipulates the interactions between the several possible interpretations so that each enriches the others and all unite to form a whole greater than the sum of its parts. Unfortunately, the reader/listener can only appreciate this subtlety *after* mastering the nuances of the language in which the poet writes or speaks. Those who have mastered the language of Physics do indeed rely upon the same sort of "coherent ambiguities" to get their points across, or else no one would be able to discuss quantum mechanics at all (to give the prime example); this is why I have given the subtitle *Physics as Poetry* to this collection of *HyperReferences*. But at the beginning we are learning "science as a second language" and it is best to minimize ambiguity where possible.

The first and obvious example is the word *PHYSICS*. If I mean the (hypothetical) orderly behaviour of the (hypothetical) objective physical universe, I will write "physics." If I mean the sociopolitical human activity, the consensual reality prescribed by a set of conventional paradigms and accepted models about said universe, I will write "Physics." Unlike some deconstructionist sociologists, I believe the former exists independently of the latter. Or at least I have a commitment to that *æsthetic*. . . .

2.2 Understanding *physics*

First let's examine some of the assumptions with which a physicist tries to comprehend the universe. The most important of these is the assumption that there *is* a universe. That is, that there is a real, substantial, external "physical" reality[1] which is the same for everyone, which we interact with directly and perceive directly through our senses, which are usually fairly trustworthy as far as they go. In other words, the opposite of Solipsism (look it up if it's unfamiliar; you should know your enemy). This could be wrong, of course, but if you are really God in the universe of your own imagination, why not imagine an objective, consistent universe with other people in it so we can get on with this? I did, heh heh.

Given that assumption, we physicists go on to postulate that the universe obeys the same rules in all places and at all times. Yes, yes, there are lots of speculations about changes in the "laws of physics" *as we know them now*, such as Inflation in the Early Universe and all that, but if that was how it happened and if there was a good reason for it then those *are* the laws of physics; we just (once again) accept that what seem like laws today are just a local or temporary approximation or special case of something more general and more subtle. This happens all the time (on a scale of decades or centuries) in Physics.[2] Whatever we observe, we have an unshakeable conviction that there is a perfectly sensible reason for it. That does *not* mean that we *know* the reason, or ever will, or are even *capable* of understanding it, but <u>we try to</u>.

These are the personality traits that make a physicist. First was the æsthetic commitment to the idea of a "real world." Second is the urge to understand why things behave the way they do (or just are the way they are); this could be labelled *curiosity*, I suppose, but the physicist's trait is usually a bit more obsessive-compulsive than connoted by that innocuous word. Third is the *arrogance* to assume that we *can* understand virtually anything. There are examples of systems which can be proven to be *intrinsically unpredictable*, but that doesn't faze the physicist; we are smugly satisfied with our understanding of the unpredictability itself.

So how does this make us like poets? It's hard to explain, but for both physicists and poets there's a thrill in the moment of "Aha!" when all the grotty little details finally come together in our presumptuous little heads and synthesize a sense that we "get it" at last.[3] And for both poets and physicists, the most common vehicle for this epiphany is the **metaphor**.

Therefore be not surprised when I haul out one bizarre image after another with great pride to show yet another way of looking at angular momentum, or waves, or Relativity. And remember, you don't have to be a *good* poet to love poetry....

2.3 "Doing *Physics*"

There is more to this story, of course. Whether for some excellent, deep reason or just because of the practical benefits to society, professional Physicists are also almost always selected and trained

[1] Boy, what a bunch of loaded terms! For now I will have to fall back on the old standby, "*You* know what I mean...."

[2] There, did you notice the distinction between *physics* and *Physics* in that long sentence? Watch carefully!

[3] Whether we actually *do* "get it" accurately is not terribly important, as long as those other traits keep bringing us back to the real world to *test* our newfound understanding.

to enjoy "doing Physics." You will hear this phrase used frequently among Physicists. What does it mean? How do you "do" the underlying principles governing the behaviour of the universe? You don't, of course; when we use this phrase we are talking about capital-P Physics, the human enterprise.

There are several aspects to "doing Physics." I will list them in what is, for me, today, ascending order of "enjoyability." There is no reason why anyone else should agree with this order, but I believe in full disclosure.

- **Politics** — explicitly sociopolitical activities usually involving distasteful compromises.
  - **Applying for grants**: Mercifully, novices are spared the dirty work of grantsmanship for the first few years of their involvement with Physics.
  - **Getting papers published** as distinguished from *writing* papers, which (along with giving lectures) falls more into the "fun" category. If a novice writes a publishable paper there will usually be some mentor willing to do the dirty political work of getting it published (usually in return for co-authorship).
  - **Managing equipment**: The ugly part of experimental science is bound up in the politics of getting money to buy equipment, organizing it and finding places to set it up, keep it running *etc.* so that the novice experimenter can focus on actually getting the apparatus to *work*, which is (relatively speaking) the fun part.
  - **Managing people**: Although the practice of Physics has an intrinsically solitary aspect, many projects can only reach fruition when many people join in a common effort; in these cases it is arguable that the most important people involved are those who provide leadership and organization. Fortunately, in Physics such positions are rarely occupied by those who just like telling others what to do. Physics has room for an astonishing variety of personal styles, which makes it a rewarding field in which to be an administrator, providing of course that one enjoys people generally.

  I am not a very enthusiastic manager, as you may have surmised, but even in politics there is room for real satisfaction. There can be quite a thrill in obtaining a few billion dollars for the construction of the world's greatest accelerator or managing a huge army of Ph.D. physicists to accomplish a spectacularly ambitious task taking hundreds of person-years of intense effort; however, like all forms of satisfaction related to power, these fade with familiarity and eventually demand greater and greater achievements to maintain the glamour. If you get aboard this vehicle, be sure to plan carefully where you want to get off.

- **Craftsmanship** — the fulfillment of the artisan.
  - **Tinkering with the apparatus**: Before experimental equipment or theoretical models can be used to conduct a conversation with Nature, they have to be working properly. Achieving this state is nontrivial. In fact it takes most of the effort; once the apparatus it working and configured for the desired task, "getting the answer" can be just a matter of "turning the crank" and watching the results pour out. But first you must get to know the equipment intimately, and there is only one way to do that: by using it.

- **Problem solving**: This is an *absolutely essential* aspect of "doing Physics" that is often neglected by novices, with catastrophic consequences. It is one thing to understand physics and quite another to be able to put that understanding to work. A good metaphor is the difference between a brilliant automotive mechanic and a great driver. It will help a lot if you know how your car works, but winning the Molson Indy takes something else. Driving experience will also help you be a better mechanic, and that's an aspect of this metaphor I want to explore later. But for now I can't emphasize strongly enough that *most of the hard work* in a Physics apprenticeship is in learning how to *solve problems* — and the *only* way to learn that is by *doing it* — a *lot* of it. This puts most people off at first. I know it did me.
- **Engineering**: Once you know how to solve problems, you pick the ones you want to solve and you learn how to put the solutions to work in the real world. This is what I call Engineering, the art of making Technology work. Lots of people will be offended by the fact that I placed this rather extensive field of endeavour so far toward the "not so enjoyable" end of my ordered list of Physics activities; they should not be. For one thing, this is just a list of my personal tastes. For another, just because I don't *enjoy* Engineering as much as (for instance) writing does not mean I don't *appreciate* it; in fact, some of the most satisfying work I have ever done would fall into this category. Just as the most enjoyable activities can be made unpleasant by excess (writing a Ph.D. thesis is rarely a *pleasant* experience, but it is almost always a *satisfying* one), drudgery in the service of an inspiring goal can leave very pleasant memories.

Not surprisingly, I like an athletic metaphor for Craftsmanship in Physics: competing in the World Championships may be the ultimate experience for the athlete, but it represents a very tiny fraction of the athletic experience, most of which consists of endless gruelling workouts that are rarely pleasant but always rewarding, both in terms of the final goal and in terms of hard-won accomplishment. There is only one way to find out what you can do, and that's by doing it.

- **Teaching** — sharing your understanding.
  - **Lecturing**: finding a really nice way to get across to others what I have just figured out myself.
  - **Writing**: same as lecturing except one gets more time to perfect one's delivery. Here I include the electronic version(s) of "writing" as a natural extension of words on paper; the Web also offers an opportunity to use more tools similar to those one might employ in lectures, like sound and images.

I am not counting the "political" aspect of professional teaching — organizing lectures, preparing and marking homework and exams, making judgements about other people's performance and submitting those evaluations in the form of marks. This has little to do with the fun part of teaching except insofar as the one makes a place for the other to happen.

- **Learning** — the interface between *Physics* and *physics*.
  - **The glimpse of Nature**: When you finally finish fiddling with the apparatus (whether theoretical or experimental) and it seems to be working, it makes a sort of conduit through

which a shy Nature can reveal her secrets;[4] such moments are rather rare, and too often occur when the experimenter (or theorist) is dead tired, but one glimpse is usually all it takes to make it all seem worthwhile.

- **The epiphany**: After you have assembled all you know about a new subject and stirred the mix long enough, something starts to congeal and the primal "Aha!" bursts through all the layers of confusion to enlighten you for a while. For me this almost always takes the form of a **metaphor** that lifts my comprehension from the realm of *Physics* and plants it in the Platonic ideal world of *physics*. (Or so it seems; but after all, Reality is what we make it....)

[4]If anyone is offended by my gender-specific reference to Nature, tough. That's the metaphor that works for me. If I were a different gender myself, maybe I would prefer a different one.