

omist' is only another term for 'chemical atomist', and thus chemists have to be pragmatic. On the other hand, it is very difficult to find an adequate expression for describing the attitude of 19<sup>th</sup> century chemists – 'theoretical light-heartedness' was surely their main attitude. Since 'pragmatic' is a very ambiguous and underdetermined term, it should better not be used in that discussion, however.

Unfortunately, those interested in philosophy of chemistry including theory dynamics do have to develop their own views. In the text, Görs does not exceed the plain statement that 19<sup>th</sup> century chemistry is not describable by Kuhnian concepts. Her rejection of these concepts – rather the concept 'normal science' than 'crisis' and 'paradigm change', I suggest – is not really convincing. We must take into account that there are good reasons – given for example by Paul Hoyningen-Huene – that Kuhn's concepts are founded just on (admittedly 18<sup>th</sup> century) chemistry. In addition, the comparison with Fleck's *Denkkollektive* is not as elaborated as some readers would have expected (three pages at the end of the text). On the other hand, it is surely worth another study to show if and how the stories told by Rocke and Görs fit different dynamical concepts. Anyway, the present book is worthy and useful also without caring about concepts of theory dynamics.

Britta Görs has written a very careful and thoughtful study that is a valuable contribution to the interface between philosophy and history of chemistry from the perspective of the latter. We are looking forward to reading more of this author, who is apparently interested in both.

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#### AUTOBIOGRAPHY OF A NOBEL PRIZE

KARY MULLIS, *Dancing Naked in the Mind Field*, Pantheon Books, New York, 1998, x + 222 pp. (ISBN: 0-679-44255-3)

*Dancing Naked in the Mind Field* is a series of twenty-two short essays (all between three and nineteen pages) on a number of different topics. Mullis won the Nobel Prize for Chemistry in 1993 for his 'invention' of PCR, the polymerase chain reaction (for more on this see *HYLE*, 4 (1998), no. 2, pp. 167-169). This book, then, joins the growing catalog of popular books by Nobel Prize scientists. Not all of the topics raised in the book are related to Mullis' scientific work. This review will focus on the essays about science education and scientific practice (in general and Mullis' own). These are the topics discussed in the book that will not be addressed here: supernatural and unexplained phenomena, astrology, cholesterol and diet, free will and determinism, infected spider bites, and numbers and chronology. The other essays can be grouped into several categories. There are three essays that are PCR-related. Six essays deal with the policy ramifications of scientific practice. Mullis also discussed his own formal and informal scientific education in four of the essays. Finally, there is an essay about the chemical effects of drugs, which might also count as an essay on informal scientific education. In an attempt to make the non-linear linear, I will start with his education.

The first of the education essays, "A Lab is Just Another Place to Play", is a recounting of his first chemistry set in the 1950s, his first lab job after high school at Columbia Organic (a chemical supplier), his undergraduate lab (Georgia Tech), his graduate lab (Berkeley), and finally his lab at the biotech company Cetus, where he ultimately 'invented' PCR. "I Think, Therefore I Wire" is about his fascination, from youth (disassembling a broken Maytag) to adulthood

(skin resistance and Lissajous patterns) with electricity. Mullis discusses practical issues of measurement in the short essay "Avogadro's Number". In particular, he mentions interesting problems about DNA and enzymes encountered on the way to PCR. In "Professional Biochemistry", another short essay, Mullis explains why he pursued biochemistry rather than astrophysics. In part, this is because working in biochemistry allows you to pursue things like cures for insulin-dependent diabetes mellitus, which is one of his current research interests. The stories in these chapters are mostly anecdotal, and like much of the book, amusing. For this reason, they may make science seem more appealing as a career choice, but they add nothing new to the philosophy of science. Before moving on to PCR, I want to mention the essay on drugs as an interlude.

Mullis talks about the history of using and outlawing drugs in medicine, in his essay "Better Living through Chemistry". He starts the essay by listing all the things, now illegal, that were commonly used on kids for various ailments when he was growing up: phenobarbital, benzedrine, and paregoric. Then he tries LSD in 1966 when it is still legal and marijuana (which was not legal). Finally, he discusses experiments with diethyltryptamine. Although this might add to the Mullis mystique and dispel the popular misconception of scientists as stuffed shirts in labcoats, it does not address any big issues. There is no moral to the story, just a personal account of one scientist's journey and reflection on that journey. Now, let us move on to PCR.

In roughly ten pages, Mullis recounts the basic version of his 'A-ha!' insight for PCR ("The Invention of PCR"). Here, he succinctly weaves how the work started and progressed at Cetus and also how it adversely affected his personal life. He (and he alone) won the Nobel Prize for Chemistry and the Japan Prize (both in 1993) for his work on PCR. The personal story of winning and receiving these awards is recounted in "The Big Prizes", an essay which includes ob-

servations on what the ceremonies are like as well as reflections on conversations with the empress of Japan, the King and Queen of Sweden, and Hillary Clinton. The last of the PCR essays, the longest in the book, is about his *almost* being a witness at the O.J. Simpson trial ("Fear and Lawyers in Los Angeles"). Mullis was almost called as a defense witness to discuss the labs' handling of the DNA evidence. In the course of this essay he talks about his impressions of the trial as someone who was there, trials by jury in general, and how happy he was to go surfing again when it was all over (the cover photo for the book, by the way, is Mullis with his surfboard). We may learn more about Mullis' experiences, but his general reflections here do not address any of the social or philosophical issues raised by the 'invention' of PCR. The Rabinow book mentioned above is a much better source for these issues. Mullis does have several essays where he is concerned with more general issues about public policy and scientific practice.

The last six essays I will talk about are the topics that are most philosophical, and perhaps the most controversial because of his concerns with the economics of science, the politics of peer review (and peer pressure), and media reporting on science. These themes run through all six of these essays. The most general of the six is "The Realm of the Senses". Here, after some discussion of differences between the empirical and the logical, Mullis defends the idea that physical science should be less concerned with the very small (subatomic physics) and the very large (cosmology), but rather, it should be concerned with medium-sized objects. That is, things in the realm of the senses. As he puts it, "Medium-sized things are still pushing grocery carts around full of their last possessions, international diplomacy still involves threats of explosions, and nobody knows what the weather will be like next fall in Florida" (p. 71). This, if we characterize it as an argument, is not very convincing. It is, though, the closest thing to an ar-

gument that we get in the chapter. He does not tell us, for example, how physicists can help here. Perhaps another way to read him is as claiming that we should only fund physicists concerned with medium-sized things and then we should give the other money to the social sciences. He does not say this, nor am I sure what argument he *might* give for this conclusion. The other essays, which overlap in topics deal with AIDS and environmental issues. The view that emerges from these essays (and, to some extent, the essay on diet and nutrition mentioned above) is that we have to be worried by the non-scientific bureaucrats in charge of agencies like the Environmental Protection Agency and National Institutes of Health, we have to be worried by the non-scientific reporters writing and broadcasting about such issues, and we have to worry about replacing scientific rigor with politically and/or economically correct catchphrases. These are all serious charges and challenges both for scientists trying to keep up with developments outside their particular specialty, and for the general public who no longer know who they can trust for reliable scientific reporting. The issue of media reporting on biotechnology in general is treated in much more detail in Eric Grace's recent book *Biotechnology Unzipped* and the Rabinow book. Grace, in his discussion looks at current studies by universities. Mullis does not cite any studies. His evidence is, once again, anecdotal. When dealing with sorting out the environmental issues ("The Age of Chicken Little"), he closes the essay and the book by saying this:

The appropriate demeanor for a human is to feel lucky that he is alive and to humble himself in the face of the immensity of things and have a beer. Relax. Welcome to Earth. It is a little confusing at first. That's why you have to come back over and over again before you can learn to really enjoy yourself.

The sky is not falling. [p. 209]

I am not sure that this is the best advice. The problem here is that Mullis pontificates and does not argue. He provides reasons for why things might be considered problematic, but his own views are not supported by cogent reasoning. His ideas are certainly worth thinking about, but for those who are interested in the philosophical thoughts of Nobel Prize winners in science, I can more comfortably suggest any of the late Richard Feynman's many popular books. Is Mullis' book entertaining? Yes. Does it definitively answer any pressing questions? No.

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