The point of departure: Bohr's 'The unity of human knowledge' (1960)

Hans Halvorson

When Niels Bohr delivered the lecture "The unity of knowledge" in 1960, he had been internationally famous for many years. He had been awarded the Nobel Prize in physics thirty eight years earlier, and he had subsequently transformed (the rather small capital city) Copenhagen into a world center of theoretical physics, in fact, into the birthplace of quantum mechanics. When Bohr delivered this lecture, he was an old man, no longer contributing directly to the cutting edge of scientific research, nor developing new philosophical insights. In fact, most of the things that Bohr says in this lecture are things that he had said, in some form or other, many years before.

What's special about "The unity of human knowledge" is that Bohr summarizes the main themes of his philosophical outlook in just a few pages. While some passages might seem telegraphic, or even cryptic, they serve as pointers to themes that run throughout Bohr's thought and that shaped his scientific practice. Another reason to focus on this lecture is that it is one of the last summarizing statements from what is arguably the greatest generation of theoretical physicists in history. I think any fair reader would grant that Bohr, as his peers Schrödinger, Einstein, Heisenberg, Pauli, and Weyl, thought and wrote with a sort of humanistic and philosophical depth that we don't see anymore. In fact, this kind of interdisciplinary thinking is actively discouraged by the focused technical education of today's natural scientists.

Niels Bohr was born in 1885 in Copenhagen, Denmark. The country

was just at the tail end of what the literary scholar Georg Brandes called "the modern breakthrough", a movement that signalled a shift from the dominant cultural Christianity (Lutheranism) to a more secular, diverse, open-mindeded, and scientific culture. Bohr was the beneficiary of a culture that was still old-fashioned enough to give the humanities a central place, but that was hoping that the empirical sciences — with improved experimental and mathematical technique — would open new vistas for the human mind. Bohr's childhood mentors included hard-headed scientists (such as his own father, the physiologist Christian Bohr, and the physicist Christian Christiansen), and also richly humanistic thinkers (such as the philosopher Harald Høffding). For reading material, Bohr inherited the riches of the Danish Golden Age — such as the works of Søren Kierkegaard (1813-1855), and of Kierkegaard's own teacher, Poul Martin Møller (1794-1838) — on top of the even larger treasure chest of ideas produced in the previous centuries in Germany and England.

When Bohr delivered this lecture in 1960, the locus for research in theoretical physics had shifted away from Copenhagen, and from Europe in general, over to the United States, to institutions such as Princeton (Wheeler, Wigner), Cal Tech (Feynman, Gell-Mann), and UC Berkeley. The next generation of Nobel Prize winners didn't grow up in the shadow of medieval churches, but of the skyscrapers of Manhattan. For this newer generation of physicists, mostly Americans, the "problem" of Bohr's article simply did not exist, because there was no knowledge outside of physics that was worth having. I cannot overemphasize this difference of perspective. Bohr had believed that the discovery of quantum mechanics had provided an "epistemological lesson", revealing that knowledge in physics is not different in kind from knowledge in other human endeavors. But the physicists of the 1960s did not have the ears to hear Bohr's lesson. They appear to have resolutely maintained — perhaps unreflectively — that the kind of knowledge provided by physics raises human beings above the pitfalls that one encounters in the more "human" disciplines

such as psychology of philosophy. To quote Steven Weinberg directly: "we should not expect [philosophy] to provide today's scientists with any useful guidance about how to go about their work."

In comparison to Weinberg's *Dreams of a Final Theory* (1992), where the physicist is portrayed as achieving a God's eye view of reality, Bohr's "The unity of knowledge" exudes intellectual humility. Bohr claims that humans achieve insight and knowledge via several different practices such as literature, art, and religion. Bohr does not portray the physicist as occupying a privileged place among other human knowers. In fact, Bohr suggests that the kind of knowledge that can be gained in physics can be gained only by excluding oneself — at least temporarily — from obtaining other kinds of knowledge. While he may not state this view explicitly, it should be clear that he thinks the complementarity of knowledge *within* physics is not all that surprising, given that we are already familiar with complementarity between domains of knowledge. In short, some kinds of knowledge can be gained only at the expense of — at least temporarily — surrendering other kinds of knowledge.

Bohr's appreciation of the value of non-scientific knowledge is notable because Bohr himself was a scientist. Bohr cannot be accused of special pleading on behalf of his discipline. In contrast to Weinberg's claim about physics not needing philosophy, Bohr is essentially asserting that all the disciplines need each other. But more is true. Bohr is implicitly claiming that philosophy provided him with insight that enabled him to meet the challenges of quantum physics. In particular, from philosophy and literature, Bohr had learned "essential aspects of the situation with which we are all faced" (p 66). Bohr's creative contribution to the foundation of physics had been to suggest that physicists were running into situations where these "essential aspects of our situation" could not be ignored. In fact, before the emergence of quantum mechanics, it was presumed that these aspects of our situation were not essential — indeed, that they could be safely ignored while describing

the world from the point of view of physics.

What are these essential aspects of our situation? Bohr invokes this phrase right after presenting a passage from a novella by the Danish philosopher Poul Martin Møller. The central point is that a certain character — the so-called "licentiate", i.e holder of an advanced degree — is not a transcendental subject who can describe reality from the God's eye view. No, the licentiate himself is part of that reality, and so if he is to describe it, he must "split" himself into two parts, a subject and and object. Bohr claims, in fact, that any objective description of reality "demands the contraposition of subject and object" (p 66).

This talk of "contraposing subject and object" would probably sound completely alien to Feynman, Gell-Mann, and Weinberg — not to speak of the current generation of physicists. In fact, Weinberg would probably have called it philosophical jibber-jabber that couldn't possibly help physicists find their way, and very likely would lead to ever-deeper confusions. In fact, this way of talking would even sound alien to contemporary philosophers in the anglo-american tradition, for whom the fundamental question is — following the godfather of American analytic philosophy, W.v.O. Quine — "what is there?"

It can be challenging for contemporary readers to understand Bohr's claims because his thought developed in such a different context than the one we live in today. Bohr learned much of his philosophical worldview from his philosophical mentor, Harald Høffding, who was famous in Denmark and well-known in Europe, but who is unknown to most contemporary readers of Bohr. Høffding wasn't trying to answer "what is there?", at least not without also facing up to the critical question, "what position am I in to know and speak unambiguously about what there is?"

Let's quickly summarize the important developments up to the time of Bohr, before explaining how Bohr adapted this philosophical outlook to the problems faced in atomic physics. Before Immanuel Kant, many European

philosophers — and most notably, Kant's predecessor, Christian Wolff — attempted to describe the world as God himself would. After studying the works of Hume, Kant became convinced that a certain kind of scientific aspiration was based on an illusion that humans could escape the conditions of their finitude. The solution, suggested Kant, was not skepticism, but to realize that human science (Wissenschaft) must draw its objects from the world of experience — i.e. from the phenomenal world.

Kant's successors found the picture he left to be unsatisfactory. In particular, Johann Gottlieb Fichte argued that it was unacceptable to posit a noumenal domain that lies forever beyond the human ability to cognize. Thus, Fichte added a dynamic element to the relationship between subject and object, where the subject is always trying to break down the wall between them. Fichte's idea was taken even further by Hegel, who believed that his dialectical method permitted him to completely abolish the split between subject and object.

The overall effect of Hegel's dialectic is, in one sense, a return to pre-kantian naivety, where reality is transparent to thought. But in mid-nineteenth century Denmark, Hegel's approach was taken to be pretentious and unrealizable in practice. Danish philosophers such as Frederik Sibbern, Poul Møller, Søren Kierkegaard, and Rasmus Nielsen argued that objective description requires a *division* of the world into subject and object, rather than an *identification* of subject and object.

Niels Bohr learned this way of thinking from many of his teachers, not only Høffding, but perhaps even from his father, Christian, who had been a student of Rasmus Nielsen. Høffding was both an astute historian of modern European philosophy, and himself an opinionated philosopher. Høffding would have taught Bohr the historical narrative from Hume through Kant through Hegel, and then to the Danish philosophers who rejected Hegel's program. Furthermore, Bohr would have heard Høffding say that the subject-object distinction is the "main epistemological problem of philosophy". And he

would have heard Høffding say that in each act of knowledge, a line is drawn between subject and object, although this line must be redrawn in each subsequent act of knowledge. Høffding had been taught this claim by his teacher Rasmus Nielsen, whose rejection of Hegel followed in the footsteps of Sibbern, Møller, and Kierkegaard. If Bohr's education had been restricted to physics, then he might have simply assumed that the goal of physics is just to say how the world is, from the God's eye point of view. But that common-sensical, or even naive, understanding of knowledge had already been rejected by Kierkegaard, Nielsen, and Høffding. By receiving a thorough grounding in the philosophical tradition, Bohr was prepared to meet the challenges that physics faced at the beginning of the twentieth century. In fact, Bohr's complementarity interpretation of quantum mechanics can be seen as a straightforward development of Høffding's epistemology.

The thought of European philosophers of the modern period might be considered to be esoteric, and of little relevance to the progress of contemporary science. What's the likelihood that the great physicists of the late twentieth century — Feynman, or Gell-Mann, or Weinberg — read the works of Schopenhauer, or Fichte, or Spinoza, or Kant? More to the point, what's the likelihood that these great physicists read their philosophical forebears with appreciation, and with a sense of continuing their legacy of understanding the human condition in the world? There is simply no chance that these physicists read more than a page or two of the philosophical classics. After the second world war, there was simply no unity of science in the old-fashioned, and broader, sense of "Wissenschaft", that is the systematic attempt to gain insight into the structure of the world we live in. Part of the problem was, no doubt, that science had just become too big. But another part of the problem was that physics, the newly crowned Queen of the Sciences, didn't know what to do with the methods and ideas of other sciences. It seems that the strategy of post World War II physics was to ignore the other sciences, occasionally proferring the excuse that, ultimately, everything would be reduced to physics.

Bohr, Einstein, Schrödinger, Heisenberg, Weyl, etc. were "scientists" in an older and broader sense of the word. Their education included, as a matter of course, classical works of philosophy, and there is documentation showing that most of them continued to wrestle with the thought of these philosophers throughout their lives. (e.g. Schrödinger kept extensive notebooks on his reading of Schopenhauer.) Bohr exemplifies this integrative way of thinking in his 1960 lecture, but without being fully explicit about many of his sources. He does name one philosopher, Poul Møller, but unfortunately, almost nobody who reads Bohr's article will know who Møller is, or what his views were. (In fact, none of Møller's writings have yet been translated from Danish into English, or into any other world language.) The key point for us is that Møller is a representative of the Danish resistance to the philosophy of Hegel, and in particular, to Hegel's view that science should aim to overcome the distinction between subject and object.

Besides believing that the human knower could shed his finitude to become one with the Idea, Hegel also thought that all science proceedes from a single source. Not surprisingly, then, Hegel had little respect for, or understanding of, the particular empirical sciences such as biology, chemistry, or physics; and this is one reason why Danish thinkers such as Sibbern and Nielsen thought that Hegel's view was inadequate to the phenomena. When Bohr stood at the podium in 1960, a different problem threatened, viz. that there might be no common thread to hold the particular sciences together. This danger was the impetus for Bohr's lecture and his choice of title. For Bohr, there is *no* Queen of the Sciences, and that leaves us with an unfinished intellectual task: to understand the relations of the sciences to each other, and how each of them can contribute to the core human project of finding our place in the world.

So, it would behoove us to understand Bohr's lecture as an attempt to communicate his worldview, and to explain how his worldview both formed, and was formed by, the development of quantum physics. We might also just

find that Bohr has a message that addresses some of the increasingly difficult problems that science faces in the contemporary world.