24 Old and Outdated Tales of the History of Science II: Externalism

To recap: Whether we are talking about Koyre or Randall or Crombie, the Internalists believe that Science has a privileged protected, autonomous inside. Intellectual contents, theories, ideas, methods develop, and change, and evolve **through their own logic, immunised from any effect of social, political, economic context, except perhaps that a 'bad' context might disrupt or hinder science**. The Internalists can differ amongst themselves about what the 'inside' is. For Koyre, the inside is proper conceptual background, proper metaphysics. When that gets established the sciences can develop within the framework. For Randall and Crombie the 'inside' is 'scientific method' which once developed, produces science as its result. So, they differ on that, but they all have a protected intellectual inside. The Internalists were largely responding to, and frightened by, the challenge in the 1920s and 30s of what came to be called Externalist historiography of science. There are a number of versions of Externalism, but the main and most challenging version was put forward in the 20s and 30s, by Marxist historians of science, especially by Boris Hessen and J.D. Bernal.

The general Marxist Externalist position is that modern Western Science is the handmaiden of Capitalism. Modern science begins when the early commercial capitalist economy arises over and against the Medieval feudal economy. So modern science is a sudden creation that has been borne along in history with Capitalism. This means that Externalism believes and teaches a revolutionary view of science. Science starts suddenly in the 16th and 17th century. Recalling the Internalists, we have Koyre telling us about a sudden birth or break in metaphysical background that allows science to suddenly develop. Crombie and Randall teach historical continuity, smooth and slow development. The Externalists have an opposing view because Capitalism is a dramatic new social and economic formation; it was not there before in the Middle Ages and in the early modern period it emerges, hence science is modern, because it is a child of early modern capitalism. Let's look in detail at one classic marxist, externalist view.

J.D. Bernal was a member of a very distinguished scientific intellectual family. He was a noted scientist and a Marxist, a very important intellectual in the 1930s through to the 1950s. He was part of the group of British scientists who moved in this Marxist political direction in the crisis of the Depression and the war against Nazi Germany. Bernal taught himself the history of science from a Marxist perspective, and he wrote a four volume text book on the history of science from a Marxist viewpoint called *Science inHistory*. The paperback edition is the largest selling history of science textbook in the English speaking world.

According to Bernal and other people of this school, the emergent commercial (not industrial) capitalism of the 16th and 17th century, together with the expansion of overseas trade, international banking, and the capitalism of colonial and imperialistic wars, brought along with it difficulties, problems, and questions of a technical and practical nature. If the commercial, trading economy was expanding, then various technical and practical bottlenecks and difficulties would appear in it: questions which we would now consider to be questions of applied science and technology. Science (modern science that is) was the result of attempts to answer and solve those practical and technical problems thrown up by the early growth of commercial capitalism.

Science grew up as an attempt to solve, in a systematic and co-ordinated way, these practical problems in the emerging commercial capitalist economy.

Bernal and others can point to many areas of development which posed problems in 16th and 17th technology and technics, areas like mining, warfare, navigation, chemistry. For example, in mining: questions such as how do you make your mines bigger, deeper, and more efficient; how you get the products out of the mines; and all the problems of metallurgy. Or, consider problems of casting large and strong enough cannon; or, problems of navigation, cartography, ship-building. You cannot navigate the world, or control and develop shipping and navies unless you solve the practical problems in these areas: practical, 'applied scientific', problems of warfare, fortification, ballistics, and gunpowder; of the development of firearms, and warships. (Of course, it wasn't so much capitalists at war but the states that backed the capitalists.)

Bernal argues that it is obvious the existing Aristotelian natural philosophy of the time, which had been handed down from the Greeks, Christianised in the Middle Ages, and institutionalised in the Universities, was incapable of even addressing, let alone solving these kinds of problems of applied science and technology. As we have seen all along, Greek and Medieval natural philosophy was not mathematical, practical, or experimental enough. Indeed, its overriding values and institutional impetus were towards the moral and religious training of the elite, not towards the posing and solving of practical problems.

At this point Bernal recognises a difficulty. The main developments of the scientific revolution, things like Copernican astronomy, Newtonian physics, Harvey's circulation of the blood, development of the microscope or telescope, or the development of calculus, do not seem, when you look at them closely, motivated by the desire to solve technological problems, nor do they seem capable of it. There were spin-offs from 17th century science into practical areas, but they were only that -- spin-offs. You know from your own study of Kepler, Copernicus and Newton that in the first instance they simply were not sitting down and solving problems of how to forge a better cannon or how to build a bigger warship that wouldn't capsize. They were working on problems of astronomy, abstract physics, and natural philosophy. Ones which do not seem focused upon the problems that Bernal wanted to stress. Bernal knew that and he had two lines of explanation for these difficulties, these anomalies, in his historiographical theory.

One line of his argument is to say that things do not change overnight. The thinkers of the 17th century were still concerned with natural philosophical and religious issues. This explains why they are not obviously engineers or technologists. The other thing, which is equally important, is that Bernal has a little escape clause: Look, he says, the really important thing about 17th century science was the invention of scientific method. Above and beyond all their lingering religious and natural philosophical interests, and their beginnings of technological interest, was the creation of scientific method. This was the real fruit of this impetus from capitalism: the mathematical, experimental method of science. And, the important thing about scientific method is that whilst it did not produce a lot of technological outcomes in the 16th and 17th century, from the late 18th and on into the 19th and 20th century it has produced those technological payoffs. So, Bernal's answer is that there is a delayed reaction, relayed through method. Bernal apparently believes that technology is the product of science, via scientific method!

Bernal was following in the footsteps of Boris Hessen, whose importance as a scholar lay in first systematising a Marxist approach to the history of science, (although it is there implicitly in Marx and Engels themselves). Hessen, a Russian intellectual and physicist, was a leading figure in the early Soviet Union, who disappeared in the Stalinist purges in the 1930's. Every four years the International Congress of the History of Science is held. For the first time, in 1931, the Soviet Union sent a delegation. It included Hessen, and was headed by the famous Soviet philosopher and politician, Bukharin, who also was killed in the 30s. They arrived by airplane, which In 1931 was a most modern and dramatic form of transport, as representatives of the emerging new socialist world order. Both these men came to the Conference to teach a thing or two to the supposedly outmoded bourgeois idealists, (their name for Internalists). Hessen gave the most famous conference paper in the history of the History of Science discipline. It was called 'The Social and Economic Roots of Newton's *Principia* '. His paper disturbed people such as Koyré and his older mentors because even if Hessen's argument was easy to dismiss when applied to Newton, there was the haunting possibility that the general Marxist-externalist thesis was a real threat to Internalism.

The particular example through which Hessen chose to demonstrate his thesis was Newton. Newton had spent his life as a University professor, becoming famous for his achievements at the highest level of mathematical and physical theory, and we have seen his intense concern with a kind of 'post-mechanist' neo-Platonic natural philosophy. The point is, if you could turn Newton into an applied technologist, a servant of the rising capitalist middle-class, then you could make a very strong Marxist Exernalist argument. Hessen went through all the arguments which we reviewed in regard to Bernal, arguments about the general nature of early commercial capitalism, and all the problems that it created. Hessen then focused on Newton's *Principia*. He did this because it was the first systematic general theory of physics and mechanics. Newton's laws are what engineers, applied physicists, and applied mathematicians still used in 1931.

Hessen argued by textually deconstructing the *Principia* . He argued that if the *Principia* was about physics and if many of the problems of commercial capitalism were essentially problems of applied physics (ballistics, ship-building, hydro-dynamics, pumping out mines), then Newton's *Principia* was, in effect, the answer to them. In a very round about way this is true, because the answers to those questions do lie in mechanics. Hessen though, seems to confuse that point with what the *Principia* has between its covers from the standpoint of its 17th century readers. Newton's *Principia* is obviously not a textbook of applied physics, because it does not talk about pumping out mines, or shooting cannons, or building ships. The *Principia* tells of the general Laws of Motion, and tells you how to apply Kepler's Laws, and Mechanics, and Gravity, to problems of celestial mechanics ie: astronomy. Hessen implies that Newton's text is tantamount to solving practical problems because it is about physics. Hessen's view is that Newton's *Principia* is by extension and in effect the ultimate answer to the kinds of problems that the rise of commercial capitalism brought about. By viewing Newton's *Principia* in that way, Hessen attempted to support his more general externalist thesis.

It is easy to rebut Hessen if one concentrates on the *Principia*, because the document does not seem to be about the aims of technology. But, this is not the same thing as saying that arguments cannot be made about the impact of social and economic change in the 16th and 17th century on the direction and content of the scientific revolution. Hessen was easy to deflect on his Newton thesis, but not so easy to deflect on the

general issue. Hessen's writing, backed up by people such as Bernal, in the next 10 or 15 years solidly established the Externalist case as a realistic contender on the intellectual scene.

These two views, Internalism and Externalism, are now becoming fossilised. So, it doesn't make sense to enter deeply into one or the other side of this debate. But, we have to be aware of the debate because by taking it apart, by dissecting it, we can see it from the outside, from the wider perspective of explaining the history of science. This has only relatively recently (in the last 15 to 20 years) started to dawn on people, as though we are just now breaking free. The first step towards wisdom about this (defining 'wisdom' as the post confrontation viewpoint) is to recognise what the Internalist/Externalists could not recognise, that they share a number of common underlying assumptions which allow them to engage each other in a never-ending dispute. Let's recap a few of them.

The most important one is that both sides of this dispute agree that there is such a thing as 'Science'--capital S. It is a fairly monolithic thing with a particular nature, which can be discussed. Similarly, you can explain 'it'--both Internalists and Externalists agree on the object of the explanation, 'Science', though each side differs over the explanation. The Internalists say the inside is self-explanatory: the contents of Science, the cognitive perceptual content of Science evolved with an inner logic. The Externalists say that yes, there is a Science, which does have an essence, which consists of ideas and methods, but it does not explain itself; the inside, the intellectual content, is always explained by reference to outside or external factors. Another thing which they share is the 'inside' of science. They both think only of intellectual things when they think of Science: sets of ideas, sets of methods, sets of concepts.

Those are the presuppositions that the Internalists and Externalists agree upon. They can go around forever on this common ground arguing about internal or external explanations. What I am suggesting to you is that in this book, we have seen two viewpoints that begin to take this confrontation to pieces, or if you like 'deconstruct' it.

The first, from Kuhn, is the idea that there is no such thing as 'Science'. It is too big and monolithic an idea to use as a realistic historical entity. Where did Science come from? The Kuhnian (and my) response is: Which particular science or group of sciences are we talking about? In what time period? In what moment of their history and development? The term 'Science' is almost a rhetorical term because it serves a purpose for people who want to make simple statements such as: "Science is method", or "Capitalism invented Science" or "Science evolves by itself". But, you *have* to ask "Which Science?" are we talking about astronomy, chemistry, geometry; what period? what relation to other sciences? You have to get down to historical particulars.

The other point also derives originally from Kuhn, and I have developed it more explicitly: If we want to talk about the 'inside' of a 'science' (for instance astronomy in the 17th century), should we just talk about the ideas and the theories--the intellectual contents that were present then? I think, following Kuhn, that the answer to that is a resounding "NO". If you want to talk about the inside of a science you have to talk about the people and their relations and the institutional organisation of that science.

For example, when we discussed Tycho Brahe as a clever negotiator, he is neither what the Internalists say he is, nor what the Externalists say. Tycho is not a machine for dealing with ideas in isolation from everything except ideas and intellectual things. It does not make sense to view Tycho this way, but this is the way Koyre or Crombie

would view him. As a man who is an empty shell in which ideas take place. Not a 'real' human being in a real social and institutional setting.

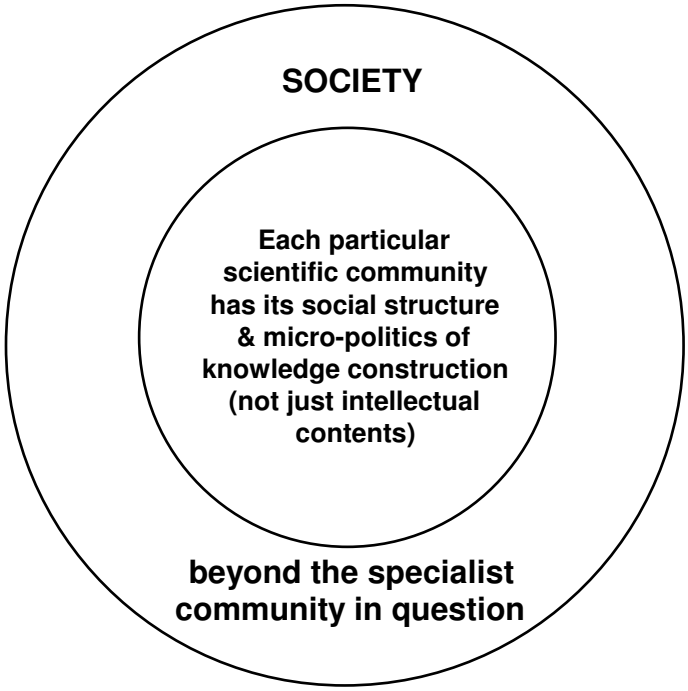
But, neither is Tycho Brahe what Hessen or Bernal would have us believe. Tycho Brahe does not consult with Rudolph II about the practical problems of Spanish imperialism. Tycho Brahe is not a disembodied set of ideas and neither is he a machine for carrying out the immediate practical problems of the capitalists and rulers of his day. He is an astronomer who writes for, and negotiates with, and jockeys for position with, the other professional (or non-professional but educated) astronomers of the day. His secondary audience is the educated public at large but his primary audience is those 20 to 50 professional astronomers in Europe who are going to agree or disagree with his theories.

Tycho is interacting with his set of peers in a social system, a sub-culture called astronomy. This is not the entire social system of western Europe in the 1590s, but a social sub-system, a sub-culture, consisting of the other experts in his field, which of course, is set in the larger society, but it is a sub-culture (community). I might have said "interacting with peers" but that statement goes a little too far: Tycho Brahe's sub-culture, like many other sub-communities of the culture, is not a democracy. There are powerful people and there are marginal people; men who have strong patrons and those who do not; there are men who have access to resources for making bold claims and those who does not. Everyone occupies their own social and political niche in that social structure. If there is one thing that we try to stress in this book it is that scientific facts and claims are accepted or rejected, negotiated in and through the social and political structures of such small communities. (fig. 1)

There is none of this sort of analysis argument in traditional Internalism or Externalism. There is no picture of the 16th century astronomical community as a social, political, institutional, sub-culture in their arguments. All they present is 'Science' which has only an 'intellectual content'. These are the rocks upon which the Internalist and Externalist debate founders. The belief that there is such a thing as 'Science' (capital S) and the belief that inside Science is just intellectual matter is their belief.

The real problem is to figure out what goes on in each of the 'little' worlds of each of the sciences and how they are affected by the 'bigger' world. We should not argue each side of this debate in the terms it was originally set down. We are just emphasising what we have been saying during this course, but now, perhaps, it should take on new resonances against the background of this real, but essentially trivial Internalist/Externalist debate. Neither side in that debate developed the idea that the 'inside' of a science (not of Science--remember Kuhn) is a social site, a sub-culture where micro-politics and the construction, negotiation and destruction of fact- and theory-claims goes on. In the final two Chapter we have to work out the consequences of this post-Kuhnian view and also factor in an understanding of 'Natural Philosophy' as a field of further contention in the Scientific Revolution.

Figure 1


SOCIETY
Each particular scientific community has its social structure & micro-politics of knowledge construction (not just intellectual contents)
beyond the specialist community in question