Lecture 3. Objectivity and measurement

The thrill and adventure of science are exemplified by relativity theory.

Development of any science proceeds from less general to more general, i.e. in an inductive direction. For example, close to the beginning of science the relativity theory could not stand. The same is even true for the Newtonian theory. However, this inductive direction of development is an optical illusion.

The whole pattern is a series of leaps out and then a return to the observational data. The deductive method consists of leaps into the unknown, and this is not a rationally justifiable step in science. While it is true of every type of thought, in science there is testing which eliminates those leaps inconsistent with observational data. The language of empirical science is characterised by the readiness to be falsified. A non-empirical science is a system of tautologies.

The further spread of data is covered by additional leaps. That is to say, sweeps into the deductive direction with wider and wider spreads comes from the very nature of science. Merely to leap out to a hypothesis covering observations at hand is just to develop an *ad hoc* hypothesis. The truly scientific hypothesis covers more than the available observations; it is a leap in the dark, and so gives scope for falsification.

The principle of falsifiability is an attitude, not a logical position.

How do we start research?

According to Bertrand Russell in *The Scientific Outlook* [1931], 'the particular facts, A, B, C, D, etc., suggest as probable a certain general law, of which, if it is true, they are all instances. Another set of facts suggests another general law, and so on. All these general laws suggest, by induction, a law of a higher order of generality of which, if it is true, they are instances.'

This is really a method of *ad hoc* hypotheses. One cannot really start scientifically in this way, for no tests are possible.

How then can we start? We can start by observations, but then we don't know what to observe. But what to observe is most important for science. A high degree of exclusiveness is vital in this respect, e.g. what one observes now in the room is of no scientific value whatsoever, and never will have any value. The other idea is that we start with hypotheses. This too is impossible, as one wouldn't know what hypothesis to suggest. That is, both observationalism and hypothesism are alone quite impossible. You must not look at the problem in this abstract way. You have to realise that one starts science in an already formed situation.

Today every scientist begins his research career by being put on a problem, or by himself seeing something unusual in some scientific story and then finding a problem and investigating it.

Thus one can go backwards and backwards, but one will say: 'What about the first scientist?' The answer is that this raises no difficulty, for historically science comes from something not science, i.e. there is an origin of science from superstitions or fairy tales. And still science retains this character in its leaps into the dark, but the particular new character of science is the testing for falsifications. That is, science really begins with the first falsification of a superstition.

Take the particular case of early science of 5th century BC in Athens, where there was some medical science. You have also some superstitions, e.g. Herodotus says snakes grow on trees. So too, if we don't accept the falsification idea, we have many examples even now of such false observations. You see too easily that which you wish to see.

The real beginning of physical science in a narrow modern sense can be dated back to a falsification in the 5th century BC. Before that there was just speculation about the world, e.g. what the world was made of, but without any attempt to say why these statements were made. They were just dogmatic statements. Then Parmenides developed his ideas as a deductive theory – a chain of inferences from a fundamental assumption

What is can be
That which is not cannot be
Nothing cannot be
There can be no void, i.e. no empty space
The world is packed full
There can be no motion

What we think we observe is just delusion – a world of dreams i.e. in clash between reason and observation, reason is supreme. That is still true. For example, if you see a magician taking a rabbit out of a hat, obviously the observation is wrong.

Both Parmenides and Democritus identified being with fullness. Thus we have the Democritan idea of little atoms (beings with fullness) and empty space, i.e. it preserved as much as possible of Parmenides with these atoms moving about in empty space.

This Greek atomic view was different from our atomic theory. The nothing or void has played an increasingly larger role, as we have at present little but nothingness. Lucretius was in the tradition of atoms and void, like Locke, and Bertrand Russell. With this goes, curiously enough, hedonism, which was added by Epicurus. Russell and others don't realise this, which is indicative of how scientific tradition is often handed on unconsciously.

There is a close connection between the old atomism and the modern atomism, the connection being through Descartes. This Greek atomic theory was a physical theory of the first order. Compression, rarefaction, condensation, were explained in terms of models – usually with a type of casual observation, but it still was a Greek physics of a high standard.

Hence the answer of question: 'How does one start in science?' You pick up a problem. There are two possibilities now: (i) go to a Professor, (ii) read in the literature and find inspiration there. 'What can I do about a problem?' (i) hypotheses, (ii) observations.

You have to get familiar with the whole background of the problem, not only with the technical side. Good research has always to consist of thinking about what you are doing, attempting always to develop hypotheses, and seeing how they fit and how they can be tested.

Problem of objectivity of research

The above statement makes science dependent on a historical situation. The Hegelian school of thought emphasises rightly that all scientific thought is relative. That is, it is dependent on a certain time, and relative to a certain background. It is a sad accident that Einstein's theory is called the relativity theory and so used to support this general idea, but it could as well be called the absolutist theory, for velocity of light is absolute not relative to some system of coordinates as heretofore thought.

The relativity of science, i.e. its dependence upon a certain time, is a trivial matter and not a deep truth. For example, you can say that we have the 16th century and the 18th century views, but no absolute truth. But this is not true, for even if you can't get at truth, at least one can make definite decisions. The standards in science do not change, and there is progress in one direction. We abolish a theory not because it is no longer true, but because it was never true; for example, that the Newtonian theory is not true. We can thus make progress, and can find a new theory that covers a wider field than the older, and so on. Hence there is no relativity in science. We can ask questions and get yes or no answers. One can, of course, have a kind of relative truth; just the best theory at this time, but this does not mean any relativity of truth. It is just how far we have gone till today. The acceptance of a theory has a time index, but not because of relativity of truth.

The Hegelian school in the form of the Marxist school has also another relativity, not only of time, but also a social relativity. That is, it is not only the time, but also the society you live in, or even the class you live in that determines your science. Hence the doctrine that there is a proletarian science and truth, and a bourgeois science and truth.

This is a serious attack on the unity of mankind, which opens the way to the worst evils. For example, it was put into action by the Nazis with their German truth, etc. Hence would follow the complete breakup of the unity of mankind.

Further, people say that this relativity is not so serious in physics, but is serious in sociology, where there is so much class interest involved. That there, there are two kinds of truth that will never meet.

This is a complete misunderstanding of the whole objectivity of science. Science is a social or corporate enterprise because of its origins and methods. This has been missed by a whole school of sociologists of knowledge (Mannheim). They have missed the social character of science. The mistake was to find the objectivity of the individual scientist in physics, but not in the social sciences. That is, the sociologists of knowledge miss the whole point that science is made objective solely by the social nature of scientific method and criticism. This delusion is due to the dilettantism of these people who have never seen a physicist in their lives. They miss the whole friendly-hostile view of scientists for each other, which is the nature of their cooperation. This depends on the basis of a common medium of language and rationality. Once you break this, you will really destroy science and the whole of civilisation with it.

Science is essentially a public thing: hence the tremendous importance of libraries, where science is for all to look at it. That publicity gives the objectivity to science. Objectivity does not mean that the result is objectively true, but that it is open for discussion by everybody and so it is objective in method.

Measurement in science

A numerical theory is easier to test than a qualitative theory. The moment a theory can predict mathematical values, and is combined with a theory of precision of measurement, it becomes a better theory in that it gives much more opportunity for falsification. Qualitative predictions cannot be refuted so easily.

Two problems result:

1. Degrees of testability – the more *a priori* the falseness, the better it can be tested. Hence we want the smallest number of parameters in equations, e.g. if we have enough, we can fit it to any number of observations, and hence it is no longer falsifiable.
2. The smaller the number of parameters, the more universal the theory, and the more testable it is. A higher degree of generality is thus important as inductivists state, but it also means that one can test with a greater degree of precision, e.g. Einstein's theory as against Newton's. A theory of higher universality must have greater or at least equal precision, i.e. the same or a smaller number of parameters than the theory of lower universality. The direction of progress is towards greater generality, greater precision (i.e. greater testability, fewer parameters).

Even in a qualitative field one may have the same point of going beyond testability, if one adds enough complications.