There must be another way next time. Each time we get into this log-jam of too much trouble, too many problems, it is because the methods that we are using are just like the ones we have used before. The next scheme, the new discovery, is going to be made in a completely different way. So history does not help us much.

I should like to say a little about Heisenberg's idea that you should not talk about what you cannot measure, because many people talk about this idea without really understanding it. You can interpret this in the sense that the constructs or inventions that you make must be of such a kind that the consequences that you compute are comparable with experiment – that is, that you do not compute a consequence like 'a moo must be three goos', when nobody knows what a moo or a goo is. Obviously that is no good. But if the consequences can be compared to experiment, then that is all that is necessary. It does not matter that moos and goos cannot appear in the guess. You can have as much junk in the guess as you like, provided that the consequences can be compared with experiment. This is not always fully appreciated. People often complain of the unwarranted extension of the ideas of particles and paths, etc., into the atomic realm. Not so at all; there is nothing unwarranted about the extension. We must, and we should, and we always do, extend as far as we can beyond what we already know, beyond those ideas that we have already obtained. Dangerous? Yes. Uncertain? Yes. But it is the only way to make progress. Although it is uncertain, it is necessary to make science useful. Science is only useful if it tells you about some experiment that has not been done; it is no good if it only tells you what just went on. It is necessary to extend the ideas beyond where they have been tested. For example, in the law of gravitation, which was developed to understand the motion of planets, it would have been no use if Newton had simply said, 'I now understand the planets', and had not felt able to try to compare it with the earth's pull on the moon, and for later men to say 'Maybe what holds the galaxies together is gravitation'. We must try that. You

could say, 'When you get to the size of the galaxies, since you know nothing about it, anything can happen'. I know, but there is no science in accepting this type of limitation. There is no ultimate understanding of the galaxies. On the other hand, if you assume that the entire behaviour is due only to known laws, this assumption is very limited and definite and easily broken by experiment. What we are looking for is just such hypotheses, very definite and easy to compare with experiment. The fact is that the way the galaxies behave so far does not seem to be against the proposition.

I can give you another example, even more interesting and important. Probably the most powerful single assumption that contributes most to the progress of biology is the assumption that everything animals do the atoms can do, that the things that are seen in the biological world are the results of the behaviour of physical and chemical phenomena, with no 'extra something'. You could always say, 'When you come to living things, anything can happen'. If you accept that you will never understand living things. It is very hard to believe that the wiggling of the tentacle of the octopus is nothing but some fooling around of atoms according to the known physical laws. But when it is investigated with this hypothesis one is able to make guesses quite accurately about how it works. In this way one makes great progress in understanding. So far the tentacle has not been cut off – it has not been found that this idea is wrong.

It is not unscientific to make a guess, although many people who are not in science think it is. Some years ago I had a conversation with a layman about flying saucers – because I am scientific I know all about flying saucers! I said 'I don't think there are flying saucers'. So my antagonist said, 'Is it impossible that there are flying saucers? Can you prove that it's impossible?' 'No', I said, 'I can't prove it's impossible. It's just very unlikely'. At that he said, 'You are very unscientific. If you can't prove it impossible then how can you say that it's unlikely?' But that is the way that *is* scientific. It is scientific only to say what is more likely and