

There's plenty of room at the bottom

A famous American physicist called Richard Feynman gave a lecture on 29th December 1959. He called the lecture, *There's plenty of room at the bottom*. Professor Feynman gave a vision in his lecture of a world in which atoms could be controlled and directed. Here are two short extracts from his lecture.

I would like to describe an area of science in which little has been done, but in which an enormous amount can be done ... [this is] the problem of manipulating and controlling things on a small scale ... It is a staggeringly small world that is below. In the year 2000, when they look back at this age, they will wonder why it was not until the year 1960 that anybody began seriously to move in this direction.

Near the end of the talk he said,

... we can do chemical synthesis. A chemist comes to us and says, 'Look, I want a molecule that has the atoms arranged thus and so; make me that molecule.' The chemist does a mysterious thing when he wants to make a molecule. He ... mixes this and that, and he shakes it, and he fiddles around. And, at the end of a difficult process, he usually does succeed in synthesizing what he wants ... But it is interesting that it would be, in principle, possible (I think) for a physicist to synthesize any chemical substance that the chemist writes down. Give the orders and the physicist synthesizes it. How? Put the atoms down where the chemist says, and so you make the substance. The problems of chemistry and biology can be greatly helped if our ability to see what we are doing, and to do things on an atomic level, is ultimately developed - a development which I think cannot be avoided.

Questions

1. What is the world 'below' that Feynman is talking about?
2. Why is Feynman's talk now regarded as a 'classic'?
3. How does Feynman describe chemistry?
4. What is Feynman's vision for chemistry?
5. Has Feynman's vision been realised?
6. How do you think his talk was received in 1959?
7. In what ways might 'atomic science' (we now call it *nanoscience*) develop in future?