

Introduction

Most scientists work in fields for which the foundations are well established, and I am one of those. I have worked in two quite disparate fields, X-ray crystallography and star and planet formation. That is one of the joys of academic life — if you find something that interests you then you may pursue it and nobody will stop you from doing so. My two fields of research, together with peripheral material, cover an interesting range. An interest in star formation must include consideration of galaxy structure and, one stage back from there, the beginnings of the Universe that produced those galaxies. A study of the formation of planets must, perforce, include the origin of the Earth and a consideration of the way that it has evolved to its present state. My current interest in crystallography is in the structure of proteins and one stage removed from that is a consideration of the processes that enable life to occur, which depends on the environment offered by the Earth, and also the factors that distinguish living from non-living systems. In 1953, when Crick and Watson produced their revolutionary model of DNA, I worked on the floor above in the Cavendish Laboratory and shared in the excitement of that watershed discovery.

While science has explained a great deal there are two key events in the history of the Universe for which science has produced no satisfactory explanations: the cause and origin of the Big Bang that originated the Universe and the origin of life that eventually led to the variety of living forms that exist today. If we accept the Big Bang then our scientific knowledge can take us from there to the material structure of the Universe as we know it. If we accept the formation of a first primitive life form then our science can take us through the evolutionary pathways to *homo sapiens* — us.

My life has been spent in education and I strongly believe that a well-rounded, intelligent citizen should understand, amongst other things, the general principles of science that are so important in today's society. I am not saying that all well-rounded citizens must be scientists; that would be absurd and even undesirable. We live in a civilised society and make our contributions in different ways and all those ways are important. What I began to think about was the possibility of describing all the steps from the Big Bang to the evolution of mankind in words and pictures without resorting to any scientific equations. Could it be done and, if so, could I do it? To make my decision harder I had promised in previous writing *not* to try to explain the Big Bang in future writing — the reason I gave being that I had not got the basic understanding to do so. Ah well — I am human and imperfect!

For most of the time I was at the Cavendish Laboratory, its Head, the Cavendish Professor, was Sir Lawrence Bragg — one of the great British scientists and popular educators of the 20th Century. He made most of his contributions in the form of lectures — and I am going to write — but I thought it worthwhile to read again some of his pronouncements on giving a successful popular lecture. I came across the following passage in his writings:

“A guiding principle of a popular lecture is that of starting with something with which the audience is thoroughly familiar in everyday life, and leading them further with that as a basis. The survey of the new country must be tied on to fixed points which are already in their minds. This is one of the most difficult tasks facing the popular lecturer. He may be honestly trying to avoid technical language; but it goes further than that. He has to put himself in the place of the intelligent layman and realise that ideas and experiences so familiar to him are unexplored country to his listener. This may seem to be stressing the obvious; but I venture to stress it because I have rather special opportunities to assess the effect of popular scientific talks, and they often pass completely over the heads of the audience because an otherwise excellent talk does not establish an initial *rapport* with the listener's knowledge and experience.”

Writing the chapters of a book is not the same as giving a series of lectures but there is some commonality in the two processes. A lecturer can engage with his audience on an eye-contact basis and if he has a warm and friendly personality, as Lawrence Bragg certainly had, then his audience will be the willing recipients of his message. A compensating advantage of writing is that the reader can go back and check what he has previously read, something not possible in a lecture.

Another piece of advice that I heard Lawrence Bragg give verbally is never to try to cram too much information into a single lecture. It is common for inexperienced lecturers to do this but after a while they get the message that the problem of preparing a successful lecture is less about what to put in than about what to leave out. Of course that counsel of perfection cannot always be followed in its entirety; there is essential information and somehow or other that must be imparted. What I shall do is to leave out anything that is not *essential* to the task in hand. This will expose me to the risk that scientific purists will criticise what I write as incomplete or even misleading. Angular momentum, a concept I shall be mentioning, is a vector, not a scalar, quantity and I do not mention that. The nature of the quantity is irrelevant in the way that I refer to it so I do not give its nature. Misleading? I think not. If you, as a reader, happen to know the difference between a scalar and vector quantity then that is fine. If you do not, then you certainly do not need to find out what they are for the purpose of understanding what I write here.

I think that the narrative I present gives a logical, sequential and causally-related set of events that go from the Big Bang to man. Others may wish to present a different narrative but the story I present is *my* story as *I* see it.