

COSMIC PERSPECTIVES



Edited by S.K. Bhowmik, D.C.V. Mehta and C.V. Vishveshwara

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978-0-521-06890-1 - Cosmic Perspectives: Essays Dedicated to the Memory of M.K.V. Bappu

Edited by S. K. Biswas, D. C. V. Mallik and C. V. Vishveshwara

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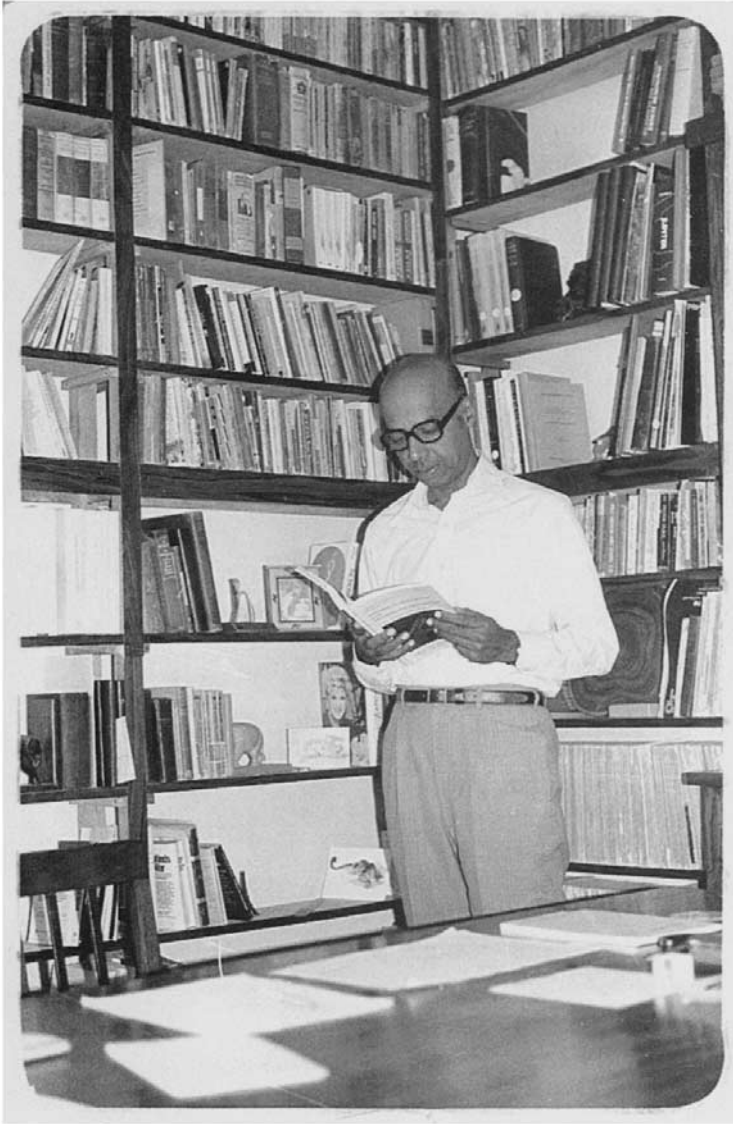
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M.K. Vainu Bappu

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M.K.V. Bappu*

EDITED BY

S.K. BISWAS

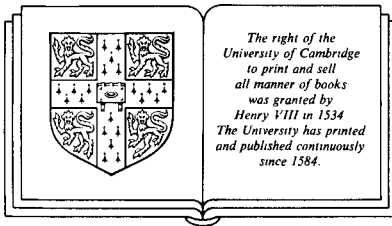
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Preface

The contemplation of the heavens has been one of the most enduring adventures of the human mind. The awe and inspiration this evoked since the earliest of times led naturally to the growth of astronomy and cosmology. They, in turn, helped the development of other sciences including mathematics. Astronomy as it grew permeated every sphere of human activity. On the one hand, it profoundly influenced human thought at the highest level; on the other, it served totally utilitarian purposes as in navigation, time-keeping and agriculture. As it evolved, it revealed an increasingly clear picture of the material world. However, the inevitable gaps in man's knowledge were often sought to be filled in by irrational beliefs leading to myths and religious dogma. Consequently, astronomy has also been a battlefield for the fierce conflict between enlightenment and ignorance. The latter persists to this day in the form of astrology and related pseudoscientific pursuits. Astronomy is thus a force which seeks to liberate man while its perversion keeps millions slaves to superstitions.

Astronomy and cosmology present innumerable fascinating aspects in their impact of human knowledge and their interaction with different areas of culture and civilization. At the same time, they continue their exciting quest for understanding nature. The present volume is an attempt to bring together these diverse facets of astronomy and cosmology.

The need for such a book was felt by the editors and some of their colleagues some time ago while exploring the possibility of bringing out a special issue of the bimonthly journal, *The Bulletin of Sciences*. This journal is edited and published by a group of working scientists and is devoted to discussions of the interaction of science with society. When leading experts in the various fields related to astronomy responded favourably to our request to write, we realised that a book covering such a wide spectrum of topics was indeed possible.

The articles in this volume focus broadly on important areas such as history of astronomy, the interaction of astronomy with society, science and culture, the structure and exploration of the universe, origin of life and man's place in the universe. In cosmology emphasis has been placed on nonstan-

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standard approaches for the reason that standard scenarios have been extensively elucidated in other books. The last two articles in the book are a departure from convention. One is a keen analysis of astrology while the other is a delightful journey into the world of fantasy and imagination.

This book is dedicated to the memory of Professor M.K. Vainu Bappu. Vainu Bappu was one of the architects of modern astronomy in India and built institutions devoted to research in astronomy and cosmology. It is our hope that this volume is a fitting tribute to a man whose vision was broad enough to embrace all aspects of astronomy.

We are grateful to all the contributors who so warmly responded to our request to write. We thank the Cambridge University Press for their help and cooperation in bringing out this volume. It is with great pleasure we acknowledge the enthusiastic response of Dr Simon Mitton, Editorial Director, Science, Technology and Medicine, Cambridge University Press, and the subsequent support received from him.

We acknowledge the valuable help of Dr Sabyasachi Chatterjee and the encouragement given by the Government of Karnataka without which the project could not have got off the ground. We thank Dr Margaret Biswas for editorial help. We are grateful to the Directors of the respective Institutes where we work, Professors C.N.R. Rao, J.C. Bhattacharya and V. Radhakrishnan, who supported the project and provided institutional facilities to make it a reality. We also thank Ms Moksha Halesh, Ms R.K. Lakshmi, Ms Meena Krishnan, Ms Meenakshi, Mr S. Rajasekharan and Mr A.M. Batcha for secretarial help, Mr K. Govindan, Mr Raju Verghese and Mr C. Ramachandra Rao for drawing and photographic work and Mr G. Chandramohan for editorial help.

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Foreword

Science and culture

It is an honour to introduce a book which is dedicated to the memory of a distinguished astronomer and a good friend, the late Professor M.K.V. Bappu. As all of us who knew him soon found out, he was interested not only in the scientific aspects of astronomy but also in its history and relations with society. The essays presented in this book are a fitting tribute to the memory of a man of such wide interests. Vainu Bappu would, I feel sure, have appreciated them.

Astronomy has always played a major part in the development of science. As Tycho Brahe pointed out in the 16th century, to comprehend what we see in the sky we must look at what lies at our feet (*suspiciendo = despicio*); to comprehend what lies at our feet we must look at the sky [*despiciendo = suspicio*]. A glance at modern high-energy physics shows us how true that still is.

But that is not the only way in which astronomy is valuable to science. Astronomy and medical science have always been the principal ambassadors at the court of public opinion. That medical science is useful is transparently obvious to anyone and its credentials are accepted by society without question – there is no branch of science for which it is easier to get public support than research into cancer. The credentials of astronomy on the other hand, are accepted by society for quite a different reason. Although its practical value is not generally recognised, astronomy is seen as something which is worth doing in itself. It affords all of us, no matter how little we know about mathematics, quarks or biochemistry, a glimpse of the wonder and immensity of the mysterious Universe in which we find ourselves. As such it is a major link between science and the man and woman in the street.

If we were to ask the man and woman in the street what they believe to be the role of science in society, their answer would depend on when and where we asked that question. In medieval Europe, if we could have found anyone who had ever heard of science, they would have told us that an understanding of the natural world is something which we inherit from the Ancient Greeks. Don't bother with scientific research, they would have said, just go into the library and read the works of Aristotle, Galen and St Thomas Aquinas. Everything worth knowing about the natural world has already been written down.

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This medieval view of science is separated from ours by two principal ideas. Firstly, it was religion, not science, which really concerned people in those days. The major task of medieval learning, at least in Europe, was to clarify our relation to God, not our relation to nature. For that reason science interested scholars only in so far as it illuminated theology; they did not value it for its practical applications which, in any case, were minimal. Secondly, society had not yet adopted an idea which we now take for granted, the idea of progress. Utopia for them was in the next world; the golden age of this world was in the past, not like ours in the future.

In the 17th century things began to change. A major prophet of the practical value of science and technology to the welfare of society appeared early in that century. Francis Bacon's grand design (*Novum organum*) was to 'restore and exalt the power and dominion of Man himself, of the human race, over the Universe'. For him knowledge was power, the power to improve life on Earth by useful inventions.

The next three centuries proved Bacon to be right, and by the end of the 19th century scientific research had laid the foundations of completely new industries. Knowledge, as Bacon forecast, had met with power, and the successful applications of science had firmly established the idea that we can improve the world by our own efforts, the idea of progress. Utopia was now in this world, not in the next. And so if we had consulted the man and woman in the street towards the end of the 19th century they would probably have seen science as an active means of progress. 'Of course scientific research is worth bothering about!', they would have said, 'it has brought us better health, travel and communications and a much wider variety of goods and entertainment than ordinary people have ever had before.' Indeed ordinary people had come to regard the improvement of their standard of living as a proper objective of government and they looked to science to make it happen. Although, like Bacon, they valued science mainly for its contributions to material progress, they were still interested in its new ideas. In those days science was more intelligible to the layman than it is now and there was a considerable enthusiasm for popular science.

Today, so recent surveys tell us, we can expect much the same answer to our question about science; but it is likely to be less enthusiastic. The modern litany no longer prays to the Lord for deliverance from lightning, tempest, fornication and the other deadly sins of mankind, but prays to the government for deliverance from pollution, over-population, nuclear war and the other deadly sins of science. Nevertheless, the surveys do show that most people still hold science in high regard and believe it to be essential to progress. Broadly speaking society values science more for new things than for new ideas. Indeed most people think of science as a clever box of tricks, a *modern cargo cult*. This is not only because applied science has been so

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successful, but also because the ideas of modern science are increasingly difficult to understand.

In this climate of opinion it is, of course, relatively easy to see the importance of applied research to society. It is, however, more difficult for the man and woman in the street to understand the vital contribution of basic or 'pure' science to the continued health of applied research. Indeed there is, I believe, only one really fireproof argument to justify basic research to a society which has learned to value science mainly for its utility. It is the simple argument that basic research is the seed-corn from which the practical benefits which we expect to reap from applied science must eventually grow. This may seem a rather obvious point to labour, but I have read official report after report on the support of basic science and have found that this argument is never articulated with the force and clarity which it deserves. Perhaps the reason is that the authors of those reports enlisted the help of economists, who on this topic are worse than useless, instead of consulting the historians of science.

An essential point which demands a knowledge of history is that although there is an all too obvious need for applied research to be relevant to the needs of society, the well-meaning, and often self-righteous, demand that all research should be obviously relevant to those needs is a serious threat to the long-term future of science. The history of science shows that society has been well served in the past by basic research which, although it may have been influenced by social needs, was not constrained by them; it was largely guided by the internal logic of science. Even the principal exponent of the social uses of science, Francis Bacon, was concerned to make this point when he wrote (*Novum organum*):

Nature to be commanded must be obeyed.

It would, of course, be nice if we could enlist public support for science on account of its cultural value. The arts have monopolised the popular definition of culture for years, perhaps we could steal some of their prestige for science. It shouldn't be impossible; after all the ideas of modern science are no more outrageous and lacking in popular appeal than many of the pictures and objects which we are called upon to admire as art, and personally I find the picture of the world presented by modern science more interesting and inspiring than most modern art. Furthermore, as Tom Wolfe has so wittily shown (*The Painted World*), the cultural values of the arts are not determined by what the public likes, or even by what the people with money like, they are determined largely by a small clique of art experts. Could scientists perhaps learn their secrets?

What is the cultural value of basic science? In trying to answer this question I am reminded that the 19th-century philosopher F.H. Bradley defined

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philosophy as the finding of bad reasons for something which one believes by instinct. It is the word culture which always makes me feel uncomfortable. It conjures up visions of people peering at incomprehensible pictures in an art gallery while they try to think of something original or polite to say, or of people dancing round a maypole waving coloured handkerchiefs. My latest dictionary isn't much help, it defines culture as 'the appreciation and understanding of literature, arts and music'; it says nothing about science. If we were to accept this definition then clearly the most significant contributions of basic science to culture would be, not ideas and understanding, but new processes and product, such as developments in printing, photography, sound recording, radio, television and so on, all of which have had an obvious effect on literature, arts and music and all of which owe a lot to basic science.

However, I suggest that we forget that narrow definition and take the meaning of culture to include not only the arts and customs of a society but also the complex of perspectives, values and ideas which underlie its world-view.

In medieval times, as I have said, the world-view of western culture was closely linked to its religion. People looked to religion to answer the great questions about life and for guidance as to what was right and what was wrong. The Renaissance, the Enlightenment and the Scientific Revolution destroyed the medieval world-view, and today the world-view of most of us is more closely linked to science than to religion. In medieval times it was almost true to say that it didn't matter what you said as long as it was religious; today it is almost true to say that it doesn't matter what you say so long as it is scientific!

People will always want to know what there is in the world and why. In earlier times when they asked what is the Sun and why it was put in the sky, they would have been told that it is a ball of fire and was put there by God to give us light. Nowadays they would be told that it is a ball of hot gas, fuelled by the conversion of hydrogen into helium, that it got there by condensation from a gaseous nebula and that the question of why it is there has no scientific meaning.

To try and answer our questions of what and how, but not of why, is broadly speaking, the principal cultural function of science. The importance of comparing our beliefs with what we actually observe in the world cannot be overestimated. If we fail to maintain that link between belief and reality, then there is no longer 'nature's truth', there is only 'your truth' and 'my truth', and society is in danger of losing the important distinction between fact and fiction and between science and magic. You have only to look at the persecution of witches in the 17th century or at the racial theories of the Nazis to understand why Francis Bacon said, 'God forbid that we should give out a dream of our imagination for a pattern of the world.'

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The pattern of the world which is progressively revealed to us by science is not a simple catalogue of facts. It shows us new perspectives of the world seen in the light of our latest knowledge. It brings us radically new and dynamic ideas without which our understanding of ourselves and of the world around us would remain stagnant. Furthermore the actual doing of scientific research promotes values which our society needs.

First let us look at the perspectives. Modern science teaches us to see many questions in much broader perspectives than before. Nowadays scientific studies of the environment, acid rain, the effects of nuclear war and so on, must all be based on a view of the planet as a whole, on a view which is not only international but is global. That is a particularly valuable lesson at a time when so many of our most important problems are no longer national, but have become global.

Moving farther away from home, astronomy, geology and biology have transformed the perspective in which we see ourselves in time and space. They have shown us that we live on a minor planet of a minor star in a galaxy of billions of other stars, and that our own galaxy is only one of billions of other galaxies. And that is not all; they have also transformed our picture of ourselves in time. We now see ourselves in an evolutionary perspective in which everything, galaxies, stars, chemical elements and living things have evolved from a primeval fireball. In this picture the whole of human history is no more than the tick of the cosmic clock.

In the long run this new picture of our place in time and space is likely to have a greater cultural impact than the great voyages of exploration in the 16th and 17th centuries. Most of our current ideas about the meaning and purpose of life, our philosophies and religions, were formed with a very different picture of the Universe in mind, a picture in which the Earth and human life were more central, more significant, in the scheme of things. To be reminded, by the sheer scale of the Universe, that man is not the measure of all things is, I suggest, a good thing, especially in societies which are becoming increasingly irreligious.

Not surprisingly a common complaint about these new perspectives is that they rob the world of meaning; for example Steven Weinberg, writing about modern cosmology (*The First Three Minutes*), remarks that: 'The more the universe seems comprehensible, the more it seems pointless.' No doubt that is true if you expect to find meaning and purpose by looking through a telescope. To my mind these questions are mysteries, and what this enchanting new picture of the universe can teach us is, not that the world is pointless, but that our existing speculations about its meaning and purpose should be set in a much vaster frame.

Now what about the values of science? Science we are often told has nothing to do with values; it can tell us only what we *can* do and not what

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we *ought* to do. But we have only to look at the whole host of ethical problems raised by genetic engineering, nuclear power or by the many other consequences of scientific research to realise that, as the British monk Pelagius told us in the fifth century, it is often difficult, if not impossible, to separate ought from can. In that sense science has a great deal to do with values. It may not provide an adequate rationale for benefaction, but it certainly helps us to do good and to recognise evil. As William Blake wrote (*New Jerusalem*):

He who would do good to another must do it in Minute Particulars.
General Good is the plea of the scoundrel, hypocrite and flatterer, for
Art and Science cannot exist but in organized Particulars.

I must also point out that scientific research is not just the accumulation of knowledge, but is an activity whose success depends upon respecting certain values, the most important of which Robert Merton (*Sociology of Science*) called 'organised scepticism', or in other words, a respect for the truth of fact. One of the greatest dangers to any society is that it should become credulous; the antidote to credulity is scepticism, a passion for the truth of fact, and that is something which is actively inspired and promoted by basic research. As Albert Schweitzer might have said, science teaches us reverence for truth, the truth of fact. Judging by the many cults of unreason, such as scientology, which flourish in our society today, by the fact that we have more astrologers than astronomers and that many of our students appear to believe in creationism, there is a need to promote the value of organised scepticism more actively.

But what about the undesirable effects of science on our values? If we listen to the prophets of the counter-culture as they emerge from the wilderness of industrial civilisation, we hear that science is a spiritual cul-de-sac and that, if we want to save our souls, we must back out of it. Science, so its critics say, has taught us to see the world as an impersonal machine which can best be understood by analysing it into component parts. This Mechanical Philosophy, so they say, has been damaging to society because many of our most pressing problems, particularly social problems, cannot be solved by the analytical methods of science and must be seen as a whole. Science is accused of dehumanising and disenchanting our world-view.

Throughout history these objections to the cultural influence of science have been voiced whenever science has been gaining ground; you have only to look at the works of Rousseau, Goethe, Blake or Wordsworth. Newton himself feared that too wide an application of his Mechanical Philosophy would disenchant the world by reducing the need for God. In our own day these same criticisms have been provoked by the enormous advances which science has made in the present century, culminating in the atomic bomb.

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Their effect has been to make the public less friendly to science, to weaken the ideal of science as a vocation and, generally speaking, to put science on the defensive.

The only comments which I have space to offer are; firstly, that in my experience scientists are not insensitive to human and social problems, in fact they are to be found in the forefront of the various movements which support human rights, conservation and so on; secondly, that these objections are a warning that society must learn to control the practical applications of science more wisely; thirdly, that although science has certainly disenchanting the world by destroying superstition, it is busy re-enchanting it by giving us a picture of nature and of the Universe which is far more wonderful and inspiring than any of us could ever have imagined; and lastly that these criticisms are more appropriate to the classical science of the 19th century than to modern science which is significantly less mechanical and more organic in character.

Now what about the ideas of science? Ever since modern science began, its ideas have been remaking the world. Indeed they were so influential in the 16th and 17th centuries that the historian Herbert Butterfield (*Origins of Modern Science*) writes of the scientific revolution that,

... it outshines everything since the rise of Christianity and reduces the Renaissance and Reformation to mere episodes, mere internal displacements, within the system of medieval Christendom.

The Mechanical Philosophy of Descartes and Newton certainly penetrated into every branch of the culture of the 16th and 17th centuries; and the ideas of Darwin and Wallace on evolution, of Freud on the unconscious, and of Einstein on relativity have all been profoundly influential in the 19th and 20th centuries. The same will, I feel sure, prove to be true of the many other new and strange ideas of 20th-century physics.

In the present century our exploration of the world with new and more powerful instruments has exposed the limitations of classical science. Much to our surprise we have learned that the behaviour of things which are very large, very small or moving very fast is exceedingly strange and cannot be understood or predicted by the common-sense methods of classical science. Indeed to construct theories which predict this behaviour we have had to revise many of the ideas which, up till now, we had regarded as the very pillars of scientific thought.

As a consequence many of the sacred cows of classical science have sickened and died. For example, we have been obliged to recognise that our classical ideas about the role of the observer in physics are largely illusory. We now realise that all our descriptions of things are not of their intrinsic properties but are metaphors which describe their behaviour when observed in a certain way; this leads to the sort of conceptual paradox which we meet

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in the modern picture of light, in which light is pictured both as a particle and as a wave. In many ways this problem is analogous to that encountered by Christian theologians in their attempts to describe another mystery, the threefold nature of the Trinity.

As another example we have found that our classical ideas about causality do not apply to atomic events and that in predicting individual events we must exchange certainty for probability; even the sacred cows called identity and locality look a bit sick. It rather looks as though physicists will have to give up breeding sacred cows and only breed an animal which is more useful but has a shorter life, the hard working hypothesis. Modern science has not given up the ambition of explaining the world, what it has done is to change what it means by the word explanation.

Many of these new ideas are so abstract and strange that it is difficult to foresee what their cultural effect will be. The classical science of the 19th century, the so-called Mechanical Philosophy, established an image of science which was ruthlessly analytical, mechanical and, generally speaking, lacking in human qualities; it was seen to be supremely self-confident and was widely regarded as the only source of authentic knowledge about the world. By comparison modern science is far less mechanical, more concerned with interactions and form and, generally speaking, more human; it is also more aware of the nature and limitations of scientific knowledge.

A growing appreciation of these new qualities of modern science and of the fact that there is a significant difference between the ideas of science and their practical applications, has already blunted the attacks of the counter-culture on the cultural effects of those ideas. Indeed diatribes against the ideas of science are being replaced by efforts to find common ground; for example by those many recent books which draw rather foggy parallels between modern physical thought and mysticism.

No doubt the acceptance of uncertainty and metaphor by modern physics tends to blur the essential differences between real science and the cults of unreason; nevertheless let us hope that, in the long run, these new qualities of modern science will make it easier to forge links between science and the other branches of our culture, such as art, philosophy and religion. We must forge those links if we are ever to repair the disastrous effects of the modern fragmentation of knowledge and its separation from faith, and so to arrive at a more coherent world-view.

If the 19th century taught us that knowledge is power, the 20th century has taught us that our ability to produce new knowledge greatly exceeds our ability to use the power which it brings wisely. Obviously if we are to get more of what we want and less of what we don't want from science, we must develop wiser ways of choosing how we apply it – better forecasting, assessment and so on.

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But there is something else. As I see it, our best hope of living happily is to try to gain a better understanding of ourselves and of the profoundly mysterious world in which we find ourselves. Modern science can tell us more about the world than any society has ever known before and if we are to make wiser use of that knowledge, we must learn to treat science as an integral and valuable part of our culture and not simply as an agent of material progress. We must accept that the most influential ideas are not necessarily the most practical.

As Jacob Bronowski pointed out (*Science and Human Values*),

The body of technical science burdens us because we are trying to use the body without the spirit.

We must recognise that science, particularly basic science, does have a distinctive and valuable spirit and, as I have tried to show all too briefly, it is a spirit which most modern societies, ruled as they are by the values of economics, would do well to encourage.

R. Hanbury Brown