

UNIVERSITY OF YORK

**Presentation address by Dr Bernard Kay on the occasion of the conferment of the honorary degree of Doctor of the University upon Professor Sir Roger Penrose, OM, FRS on 14 July 2006.**

Vice Chancellor,

It is a great honour and a great pleasure to present to you Professor Sir Roger Penrose, Emeritus Rouse Ball Professor of Mathematics at Oxford University.

Sir Roger is one of the world's leading mathematicians and mathematical physicists. More than anyone else, he is responsible for the remarkable flowering of the general theory of relativity in the '60s and '70s of the last century, through his introduction of new algebraic and global geometrical techniques. The theorem he proved in 1965, based on his beautiful "closed trapped surface argument", was crucial to the revolution in both theoretical and observational cosmology which took place in the subsequent decade and which led to our understanding that the black hole, rather than being just some curious mathematical solution to Einstein's general theory of relativity must, in fact, be a commonplace real astronomical object. (In fact, these days, thanks to a combination of theory and observation, we know that, in addition to stellar-size black holes, there's almost certainly a black hole with the mass of a million suns or more at the centre of every big galaxy.) And in fact Roger was the first person to define in mathematical terms exactly what a real black hole is. Further mathematical arguments by Stephen Hawking and others, inspired by Roger's pioneering work, also laid the foundations for our current understanding that the universe began with a big bang around fourteen thousand million years ago.

It has been said of Einstein's work on special relativity that, if Einstein hadn't done it, then someone else surely would have done it soon afterwards, but that, if he hadn't come up with general relativity, then no-one else would have. Much of Roger's own work is of this latter type. And it is often far ahead of its time too. For example, Roger's theory of twistors may be seen as a logical next step in the chain of mathematical discoveries, beginning with the introduction of the square root of minus one by Cardano and Bombelli in the mid 1500s, and followed by Hamilton's discovery of the quaternions in 1843 and Dirac's discovery of spinors in 1928. But it is a logical next step that most likely would not have been taken by anyone else. Roger argued, back in the 1970s, that, amongst their many applications, his twistors should lead to a great simplification in the so-called "Feynman diagrams" that are used every day by high energy physicists to predict the results of the collisions of elementary

particles. But only now, after more than twenty years, are Roger's twistor diagrams being talked about, as one of the latest hot topics, and used, by a new generation of high-energy theorists.

Sir Roger's contributions to the intellectual world are on a far broader front than mathematical physics alone, broad as that area is in its own right, and the set of tools and talents and knowledge he brings to bear both in solving problems, and in choosing which problems to try to solve, encompasses not only the mathematical and the physical but also the philosophical, the literary and the artistic. Together with his father, Lionel Penrose, he is the inventor of some of the impossible figures later made famous in the drawings of M.C. Escher. Also related both to mathematics and to art is his interest in aperiodic tilings of the plane. After many years of trial and error, he discovered an extraordinarily simple way of tiling the plane aperiodically with only two simple shapes of tile which has remarkable mathematical properties and which is also of relevance to the more recent experimental discovery of quasi-crystals. I hadn't realized, until I came to prepare this presentation, just how widely known this work is, and indeed, how closely associated in the public mind the name "Penrose" is with the word "tile", or, at least, how closely associated they are in cyberspace. I use the free e-mail service, "googlemail", which has the slightly disconcerting feature of displaying discreet adverts on the side of the messages which are related to the content of the messages. Naturally, while preparing this talk, I sent and received some e-mails which mentioned the name Roger Penrose and, not surprisingly, adverts appeared saying things like "Buy Roger Penrose's book 'The Emperor's New Mind' on Amazon". But it took a while before it dawned on me why there were also adverts saying things like "Tile your kitchen floor in York: 20% discount."!

In addition to his research papers, Roger has written a number of books, some aimed at experts, and some at a wider audience. His thesis in the book I just mentioned, "The Emperor's New Mind", is that the brain does not work like a digital computer and that consciousness must arise by certain processes in the brain which have to do with the mysteries of quantum mechanics. But, in the course of arguing for this thesis, the book also presents, in its preparatory chapters, lucid expositions, accessible to the intelligent layman, of many of the important branches of mathematics and of theoretical physics. Because of this, we, here in York, list it as part of the preliminary reading we recommend to students about to start our mathematics degree course. His most recent book, "The Road to Reality", is devoted to the laws of physics in general and to his recent ideas for the solution of some of the great still-unsolved problems concerning the laws of physics. This book too has some lucid expositions of some branches of mathematics and theoretical physics, this time a bit more advanced than those of "The Emperor's New Mind". I would like, here and now,

to recommend this latter book as further reading to all our happy mathematics graduands this morning!

Sir Roger was elected a Fellow of the Royal Society of London in 1972 and a Foreign Associate of the United States National Academy of Sciences in 1998. He won the Science Book Prize in 1990 for "The Emperor's New Mind". He has also won the Adams Prize from Cambridge University; the Wolf Foundation Prize for Physics (jointly with Stephen Hawking for their understanding of the universe); the Dannie Heinemann Prize from the American Physical Society and the American Institute of Physics; the Royal Society Royal Medal; the Dirac Medal and Medal of the British Institute of Physics; the Eddington Medal of the Royal Astronomical Society; the Naylor Prize of the London Mathematical Society; and the Albert Einstein Prize and Medal of the Albert Einstein Society. In 1994 he was knighted for his services to science and in 2000 he was appointed to the Order of Merit. In 2004 he was awarded the De Morgan Medal of the London Mathematical Society for his wide and original contributions to mathematical physics. He has been awarded honorary doctorates by many universities around the world.

Vice Chancellor, it is an honour to present to you Professor Sir Roger Penrose for the degree of Doctor of the University *honoris causa*.