Obituary of Michael Hillas

Emeritus Professor Michael Hillas

Colleagues will be sorry to learn of the death, on 26 November 2017, of Emeritus Professor Michael Hillas, at the age of 85 after a short period of ill-health. The following obituary has been prepared by colleagues and friends.

Michael Hillas's remarkable abilities as a physicist were first recognised during his undergraduate and post-graduate days at Leeds. After acquiring his BSc (1955) and PhD (1958), Michael went to Harwell with the rare distinction of holding a fellowship. There he worked on an experiment to study high-energy cosmic-rays (the nuclei of atoms from outer space, some of which have energies of many Joules) using an array of ~ 90 Geiger counters deployed over 0.6 km2 in a field 'outside the wire' to detect the 'extensive air-showers' that the most energetic particles produce. Inside the wire, the UK's nuclear weapons program was being developed. He returned to Leeds in 1959 as a lecturer making it understood that he would not work on the embryonic air-shower experiment that was being developed under the leadership of Professor J G Wilson at Haverah Park, near Harrogate. He had been scarred while running the cosmic-ray detectors at Harwell where he had to repair cables in the field at night after rabbits had eaten through them. Wilson did eventually get Michael involved in the interpretation of data from the Haverah Park project though Michael kept well away from the operation of the instrument itself. He was promoted to a Readership in 1969 and to a Personal Chair in Physics in 1990. His scientific passion was cosmic-ray physics and his unique skills were a major factor in the very high international standing in which the Department was once held in this field. He was awarded the Rutherford Medal of the Institute of Physics in 1998. In support of this nomination, one referee wrote "if there had been a Nobel Prize for cosmic rays, Michael would have it". In 2005 he was awarded the Gurang Yodh Prize by the International Cosmic Ray Community "for his significant and outstanding contributions to the field of cosmic ray astrophysics".

Michael had outstanding talents both as an experimental physicist and as a numerical modeller of physical phenomena. While at Harwell in 1959, along with Cranshaw, he measured the absolute difference between the charges of the proton and the electron, showing it to be less than 10-20 times the electronic charge: this remains one of the best measurements of this quantity. At that time, some years before the discovery of the

microwave background radiation, it was thought that a charge difference between these two particles might contribute to the expansion of the Universe. However, it was unquestionably his quite remarkable ability to combine unusually penetrating physical insight with extraordinary powers of calculation that led to the works for which he will be best remembered. At a young age he could add and subtract logarithms in his head while in the days before computers or electronic calculators were available, his prowess on the slide rule was legendary. He had engraved the logarithms of the fundamental constants on the back of his 5-inch slide rule and consequently could estimate the magnitude of effects with extraordinary speed. Using the calculating power of modern computers, he developed a world-renowned series of Monte Carlo calculations which embraced algorithms of great ingenuity and beauty. With these he was able to achieve results more elegantly and more rapidly than any of his competitors or imitators. Indeed, his record on any computing device showed him to be vastly superior to any one else in his ability to attain results of importance with high efficiency – and he always had a good idea of the answer before he ran the program.

With a combination of insight and calculation, he developed new ways of looking at the showers initiated by the high-energy cosmic rays, thus playing a pivotal role in maximising the interpretation of the information which came from the cosmic-ray experiment at Haverah Park, helping to bring that work to international prominence. His deep knowledge of astrophysics and his ability to think laterally led to the proposal that the experimentalists in Leeds, who had previously enjoyed the relative comfort of the Yorkshire Moors, should move their activities to the South Pole: ten years of very successful work there was thus initiated.

His final Monte Carlo program for high-energy shower studies, known as MOCCA, was used extensively in the design of what became the Pierre Auger Observatory, the largest cosmic ray detector ever built and which now covers a land area of the size of West Yorkshire in Western Argentina. The program was written in Pascal and despite this language being foreign to most of the Auger Collaboration, its value was such that it became very widely used, notably by the Nobel Laureate, Jim Cronin, during a sabbatical visit to Leeds in 1991, and was even translated into FORTRAN.

The work for which Michael will perhaps be best remembered started in the late 1980s when he pointed out that techniques could be developed to separate gamma-rays from hadrons in the cosmic rays at an energy of around 1012 eV using large mirrors to detect the Cherenkov light which these low-energy cosmic-rays produce in the atmosphere. This insight has led to the opening-up of a new astronomical window and the "Hillas parameters", the wedges which forced open this window, are used world-wide. An enormous international collaboration of over one thousand astronomers from 27 countries has been formed to build the Cherenkov Telescope Array at a capital cost of around €300 M. Scientists from Durham, Leicester, Liverpool and Oxford Universities are involved, though regrettably there are none from Leeds University where the fundamental ideas for the instrument were born.

Michael also contributed enormous insights to the problem of the acceleration of cosmic rays. At the ‘kick-off meeting’, held in Paris in 1992, that led to the creation of the Pierre Auger Observatory Catherine Cezarsky, who was to become the Director of the European Southern Observatory, reviewed this field. She started by remarking that "Hillas had said it all in 1984". Catherine was referring to a review article in Annual Reviews of Astronomy and Astrophysics on High-energy Cosmic Rays in which Michael had discussed acceleration,

expressing the essentials in a few simple equations illustrated in a single diagram now known simply as ‘the Hillas plot’. This article has had nearly 700 citations. During Catherine’s talk, Michael sat quietly in the audience saying nothing.

By the standards of today, Michael’s early published output would be seen as very low. In fact, he would probably not get a tenured post and, if he had one, would be under regular consideration for redundancy. When he got his chair in 1990, he had published fewer than 30 papers in refereed journals. At least four of his truly seminal ideas, still widely used and including the description of the Hillas parameters, were published only in conference proceedings. No write-up describing the MOCCA code exists. Michael did physics because he loved his subject and was always extremely modest about his achievements. He was not one of today’s high-pressure salesmen: he got enormous pleasure from doing the work and seemed to care little whether others accepted it or not.

After his retirement, Michael remained in the Department of Physics and Astronomy as a Research Professor working on TeV gamma-ray astronomy, the field that he had done so much to create. On the day of his retirement, he revealed to an international audience a new approach (which he had devised only two days before) to the design of the next generation telescopes planned to explore the TeV astronomical domain. This revelation, like many before, was made in a characteristically understated and very modest way.

The outside world knew and revered Michael for his research (many international "names" came to Leeds to a symposium held in his honour in April 1998). Within the Department of Physics and Astronomy, he delighted generations of undergraduates with his inspiring and carefully prepared lectures and with his inexhaustible enthusiasm for helping them to understand the intricacies and beauties of Physics and Astronomy, both in the lecture room and the laboratory. He involved himself very little in committee work within the University or nationally or internationally. On one occasion, he was sent a very lengthy questionnaire by a psychologist who was attempting to discover how people successful in research had achieved their eminence. Michael’s reply was polite but succinct: ‘Such success as I have had, I attribute in part to not wasting my time dealing with questionnaires such as this’. He knew where his priorities lay.

Michael’s creative talents were by no means confined to cosmic radiation and astrophysics. He was an active artist and, within his local Arts club, arranged exhibitions which always included examples of his own work. His sitting room was dominated by a challenging painting reminiscent of the style of Van Gogh. Hand-drawn Christmas cards from him were a visual delight. As an undergraduate, he had taken Geology as a subsidiary subject (Continental Drift was then treated with considerable scepticism) and it remained an absorbing interest throughout his life and especially so after his retirement. He was a keen hill walker and, while delighting in the scenery for its own sake, he always sought to understand the geological background. He collected rocks, pebbles and fossils and avidly followed radio and TV programs dealing with geology.

He had both the ability and confidence to tackle problems which aroused his curiosity in any field, be it evolution, stone circles or economics! An example in geology relates to the ice ages of the past half million years which reveal a 100,000 year periodic component; Croll, and later Milankovitch, proposed that this was due to a variation in the eccentricity of the earth’s orbit which they calculated to have the same period.
Michael thought such a long period was both surprising and unexplained and commenced

simulations. He showed clearly that the perturbing influence of a single additional planet to the Sun/Earth is an example of coupled oscillations which produces a periodic change in the eccentricity, the period being determined by the strength of the gravitational coupling. Venus, and to a lesser extent Jupiter, separately produced significant effects with periods in excess of 100 kyrs. Finally, with all planets included, his results replicated both the period and magnitude claimed by Milankovitch – interestingly Saturn now made a difference, not directly, but through its influence on Jupiter. So clarity was achieved even if the resulting change in solar radiation was much too small to be the sole driving force. His conclusions were never published.

Michael was a quiet and modest man, reserved but with great personal charm. Tributes to him have poured in from all continents including Antarctica. All agree that he had a brilliant mind. What stands out additionally is the strong sense of personal loss. His clear interest in the work of others and his patience and generosity in making suggestions for future development were greatly valued. His eccentricities only added to his charm.

He is survived by his sister, two nieces and a nephew, together with four great nephews and three great nieces.

The funeral service will be held at 12.20 pm on Friday 22 December, at Rawdon Crematorium, Leeds Road, Rawdon, LS19 6JP.