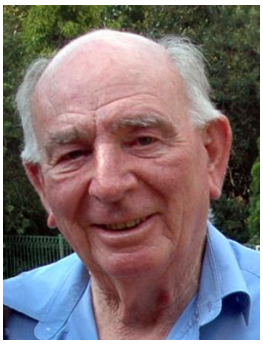
DAVID EDWIN PROCTOR B.Sc(Eng), PhD

(1932 – 2020)



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Dr David Proctor died in Johannesburg on 26th September 2020 of complications following surgery. He was 88. He had spent his career at the National Institute for Telecommunications Research (NITR) of the CSIR based, initially, on the campus of the University of the Witwatersrand ("Wits"), in Johannesburg and then at the former Observatory site in the city. Born in Johannesburg and educated at Kearsney College, a private boarding school near Durban, the young Proctor moved around the country, depending on where his father, a Methodist minister, happened to be serving at the time.

After leaving school David Proctor's interest in radio and electronics led him to work as a technician at the NITR, but it was clear that he had the academic ability to attend university. However, money was tight. Fortunately, the Faculty of Engineering at Wits had the foresight to set up a part-time process by which ex-servicemen, returning from the war, were able to complete their degrees over six years. And so, after spreading the first two years of the degree over four, while continuing to work at the NITR, he graduated with a degree in electrical engineering in 1962 and immediately became a research officer at the NITR.

In 1967, at the instigation of the NITR Director Dr Frank Hewitt, who had detected UHF emissions from lightning during his own research in the early 1950s, Proctor established a new research programme with the purpose of measuring and characterising such radio emissions that occur during lightning activity. In doing this he was following in the footsteps of Basil Schonland and Dawid Malan who had made fundamentally important discoveries in the field of lightning research when based at the Bernard Price Institute of Geophysical Research at Wits many years before. Proctor's dedicated and almost single-handed research programme was to become his life's work and over the following thirty and more years he established himself as one of the leading authorities in the world in the field of lightning investigation using both radio and radar techniques.

The test site was situated north of Johannesburg at Nietgedacht. It consisted of two intersecting baselines, roughly 30 and 40 km long, at the ends of which were situated VHF (253 MHz) radio receivers with an additional one at their point of intersection. The network's purpose was to receive the sferics (lightning-induced radio noise) produced by the lightning stroke processes and from them to determine the position and other features of the emitting sources in three dimensions. The fifth receiver provided redundancy to confirm the adequacy of the locating system. Proctor pioneered this intermediate baseline, time-of-arrival (TOA) technique, which included dedicated microwave links to feed the data directly from each receiver to the "home" station at the intersection of the two baselines. Subsequently, for operational reasons, the observing frequency was moved up to UHF (355 MHz). The accuracy of the method depended on knowing the positions of the five radio receivers very precisely and for this purpose Proctor used a Tellurometer, the microwave distance-measuring instrument invented by Dr Trevor Wadley, also at the NITR, to fix those positions to within 10 cm.

The radio receivers, as well as most of the ancillary equipment, were designed and even constructed by David Proctor himself. In doing this he displayed his prodigious talent as an electronics engineer who was also more than a little handy with a soldering iron. At the home station, the output of each channel was displayed on two cathode ray tubes (CRTs) that operated alternately to accommodate the “flyback” at the end of each horizontal sweep. All the screens were photographed by two rotating drum cameras on a common shaft. Accurate timing was provided by a 1 MHz crystal-controlled clock. Thus, twelve CRTs were involved, two of which were spares. As Proctor rather laconically remarked many years later, “Even those who enjoy reading records that can be deciphered easily, found that reading the more complicated variety was a mild form of torture …”. He estimated that it took about one man-month’s effort to locate 100 sources accurately.

A measure of the value of any research is its publication in the international scientific literature. Proctor published his first paper in the U.S. *Journal of Geophysical Research* in 1971. It was not to be his last. Between 1971 and 1997 he published twelve papers, all involving detailed analysis of the results obtained from that time-of-arrival network as well as from the radar system that augmented it. The radar experiments followed on from the work of Hewitt when Proctor, in the mid-1970s, pressed into service three synchronised radar transmitters, their respective receivers and their associated antennas that operated on wavelengths of 5.5, 50 and 111 cm. Their purpose was to locate the source of lightning and to measure how its properties changed according to the probing radar wavelengths. In addition, two other radars, operating at very much shorter wavelengths of 3 and 5.5 cm, were also used. On purely theoretical grounds the longer wavelength radars were expected to receive reflections from the lightning strokes which were invisible at the very much shorter wavelengths. This proved to be the case and it confirmed that intervening precipitation was shielding the lightning emissions at that shortest wavelength. Of particular interest were the estimates Proctor was able to make of a parameter called the radar cross-section of the lightning stroke. He concluded that the radar echoes received were caused by many reflectors distributed throughout the volume of a cloud. This work, along with that carried out in New Mexico at about the same time, is regarded as the most thorough conducted to date.

In 1986 the CSIR experienced a convulsion - and an ensuing crisis - when it was decided that all its research had to have some definable commercial objective and, even more alarmingly, that it had to be self-funding. Pure science, whose applications were undefined - and in many justifiable cases was impossible to define in those terms - was essentially doomed. As a result, the NITR ceased to exist and David Proctor was summarily transferred to a unit carrying the uninformative title of EMATEK where he soon saw his research come to a precipitate end. However, he managed to persuade the Water Research Commission to support him and his miniscule team in a project with the objective of determining how lightning was related to precipitation while also considering lightning phenomena in their own right. In the subsequent internal CSIR report that was never published in the scientific literature because Proctor himself was required to bear the costs of publication, he was able to show, from the 773 lightning flashes measured with his TOA network, that lightning exhibited peaks of activity at two altitudes, nominally 5.3 and 9.2 km above sea-level, but with their characteristics being markedly different. In addition, his radar network mapped 658 flashes and from those results it emerged that lightning begins in regions with the highest electrical charge which is where the smallest raindrops were to be found. It was intended that an aircraft be used to fly into those parts of a cloud where lightning flashes begin in order to discover what characteristics were peculiar to that relatively small region. Though Proctor designed the necessary equipment to do this, the six flights that were undertaken all took place on days when there were no storms! Since the aircraft was not dedicated to this project other more pressing needs always took priority when, as luck would have it, suitable

meteorological conditions were just waiting to be exploited. In his closing comments to that 1993 report to the Water Research Commission, Proctor paid particular tribute to his technician, Dick Uytenbogaardt, “for his wisdom and for many hours of diligent and intelligent labour”.

Whilst out in the scientific wilderness Proctor received an invitation to contribute to a book called “Handbook of Atmospheric Electrodynamics” which was published in 1995. He wrote the chapter entitled *Radio noise above 300 kHz due to natural causes*.

He was awarded the PhD degree from Wits in 1977 based on a thesis entitled “A radio study of lightning”. His last two papers were published in the *Journal of Geophysical Research* in 1997. In one, he collaborated with four U.S.- based authors in comparing time-of-arrival techniques with another powerful method that used an instrument known as an interferometer to determine the features of lightning. It transpired that the two methods mapped two distinctly different aspects of the complex lightning stroke process and so were complementary. Thus, as is so often the case in scientific research, new avenues immediately opened up for exploration. Both papers bore Proctor’s home address of Honeydew, South Africa, because his lifelong affiliation with the CSIR had, by then, come to an end. He had retired in 1992 while his two colleagues, who had assisted him for so long, had been retrenched by the CSIR the year before.

David Proctor had a remarkable career as an engineer, a radio scientist and geophysicist. His contributions to the understanding of the processes involved in the lightning stroke and all its attendant features was very significant and they are recognised as such among the world-wide community of scientists working in that field. His publications in the international scientific literature undoubtedly brought much prestige to South Africa

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In 1963 he married Judy Stone. They had four sons, all engineers.

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