

Florence Jessie MacWilliams (1917-1990)

Florence Jessie MacWilliams, one of the first women to publish in coding theory was born in 1917 in Stoke-on-Trent, England. Her early college education was at Cambridge, where she obtained her BA in 1938, and her MA the following year. In 1939 she joined the famous mathematician Oscar Zariski, well known for his work in algebraic geometry, at Johns Hopkins University, following him to Harvard University to study with him for a year. There was a break in her studies for many years following her marriage in 1941 to Walter MacWilliams, an engineer, and the birth and raising of three children, two sons and a daughter.

In 1958 MacWilliams joined Bell Telephone Laboratories as a computer programmer. Her husband had already been working there after the war. During that time, R C Bose (one of the co-inventors of the Bose-Chaudhuri-Hocquengham (BCH) codes) visited Bell Labs to give a talk, and MacWilliams was inspired to work in the area. She aspired to become a member of the Bell Labs technical staff for which a PhD was required. In 1961, at the age of 44 she returned to Harvard to obtain a PhD which she finished in a remarkably short period of about a year. She worked with the mathematician Andrew Gleason to produce her thesis entitled, "Combinatorial Problems of Elementary Group Theory". Interestingly, her daughter Anne who later obtained a PhD in Mathematics, was a student in Harvard at the same time.

MacWilliams' thesis contains one of the most important combinatorial results in coding theory. Among error-correcting codes, linear codes occupy an important place, as their structure can be used to prove useful properties, and also to design elegant decoding algorithms. Each codeword in the code is associated with a weight, and one can therefore define a weight distribution for the codewords. MacWilliams gave a formula that related the weight distribution of a linear code to that of its dual code. Error bounds can be derived from weight distributions and therefore these results were not merely of interest to mathematicians but also to engineers. Her magical result was critical in proving an important bound on code rate, called the 'linear programming bound'.

Jessie MacWilliams inspired her daughter Anne to work in mathematics as well. In an interview, N J A Sloane, a well-known coding theorist in Bell Labs, said that he came to know the famous mathematician J H Conway through Anne. In 1968, Anne, who was a graduate student of John Thompson, (who won the Fields Medal in 1970), wrote to her



mother that there was a lot of excitement in Cambridge as J H Conway had just discovered a new simple group. This was connected with a certain packing of spheres in twenty-four dimensions. Anne described it in her letter, as a very tightly packed basket of gooseberries – only twenty-four dimensional gooseberries. This was the Leech lattice, which the mathematician John Leech had discovered the previous year. Conway had discovered the automorphism group for this lattice. Correspondence with Leech led Sloane towards joint work with Leech, then Donald Coxeter and finally Conway himself.

In the years from 1962 to 1976, MacWilliams produced important results on algebraic constructions and combinatorial properties of codes. She worked on cyclic codes, generalizing them to Abelian group codes. With H B Mann she gave a solution to a difficult problem involving certain design matrices. Interestingly she did joint work with J Thompson, her daughter's PhD advisor, on self-dual codes and projective geometry codes. One of her significant achievements was her encyclopedic book, *The Theory of Error-Correcting Codes*, written in collaboration with N J A Sloane (North Holland 1977). This is perhaps the most comprehensive text on the algebraic and combinatorial properties of error-correcting codes, and of abiding interest to both mathematicians and engineers. It was one of the major works responsible for laying the foundation for a revolution in communication technology that is being played out even today. In 1983 MacWilliams gave the first Emmy Noether lecture of the Association for Women in Mathematics.

MacWilliams retired from Bell Labs in 1983. A conference was held in her honour in December 1981 and the May 1983 issue of the *IEEE Transactions on Information Theory* was dedicated to her. Eminent coding theorists and mathematicians like E W Berlekamp, E F Assmus, H Van Tilborg, Robert Calderbank, J H Van Lint and N J A Sloane contributed to this issue. She devoted the rest of her life to her home, grandchildren and her garden. She passed away in May 1990 at the age of 73.

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