PHILIP STEIN 1890–1974

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Philip Stein, who died in London on 7 January, 1974, was born on 25 January, 1890, in Lithuania. His family came to the Cape Colony in 1897. After school in Cape Town he graduated at the South African College, which is now the University of Cape Town. He then went on to Cambridge where he spent three years working for the Tripos. After various posts in South Africa he was appointed in 1920 to a lectureship in what was then Natal Technical College in Durban, where he remained until his retirement, becoming a Professor in the Univeısity of Natal when that was established.

Stein began serious research in mathematics when at the age of 36 he went on leave of absence to Cambridge and worked on the theory of functions under the supervision of Littlewood. It was at this time that he produced the paper **[1]** by which he is best known to workers in the theory of functions of real and complex variables. This gives a proof of the fundamental result of Riesz on which the theory of conjugate functions in L_p spaces depends. The proof involves an ingenious use of Green's formula and is still the most elegant proof of the theorem: for this reason it is frequently quoted in the literature and has served as a model for arguments, in particular those of Spencer, generalizing the Riesz inequality.

The paper [3] which has been the inspiration for much further work by N. B. Slater and others arose out of a problem which had applications in statistical mechanics and was proposed by R. H. Fowler to Littlewood and by him to Stein. Let $f(x) = \cos 2\pi x + a\cos 2\pi(\theta x + A) - c$ with $a \neq 0$, $|c| \leqslant a+1$, $0 \leqslant A < 1$, and let $n(X)$ be the number of zeros of $f(x)$ in $[0, X]$. Stein found precise formulae for the limit of $n(X)/X$ as X tends to infinity: for irrational θ the limit depends only on a, c, θ; for rational θ it may take one of three values as A varies.

In the late 1940's Stein began to work, in collaboration with R. L. Rosenberg, on problems on numerical analysis; their joint publication **[4]** brought him into contact with Professor Olga Taussky–Todd. She writes that this paper is now a classic. As a result of this Stein visited the National Bureau of Standards and there wrote three papers **[6]**, [7], **[8]**. [9] is the work referred to by numerical analysts as the Stein theorem. In the 1960's Professor Olga Todd suggested further problems to Stein; these are not yet completely solved, but he gave a partial solution of one in **[12]** and wrote another much quoted paper with Pfeffer **[13]**, a former student of John Todd. This is concerned with the problem of Lyapunov stability of matrices. Lyapunov characterised stable matrices A (that is, matrices with characteristic roots with negative real parts) by the existence of a positive definite hermitian matrix G

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such that $AG+GA^* = -I$. The problem posed by Olga Todd and dealt with by Stein is that of the range of $AG+GA^*$ for a fixed stable A when G runs through all positive definite matrices.

His active mathematical life continued for many years after his retirement: he taught for some years in the University of Makerere and also for a period in University College, Cardiff.

Stein was an excellent and conscientious teacher and a force stimulating mathematics at all levels in South Africa for the many years of his active life. His quiet humour, his liberal outlook and his general reasonableness will be remembered by his many friends.

Publications of P. Stein

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3. " On the real zeros of a certain trigonometric function ", *Proc. Cambridge Phil. Soc.*, 31 (1935), 455–467.

4. With R. L. Rosenberg, " On the solution of linear simultaneous equations by iteration ", *J. London Math. Soc.*, 23 (1948), 111–118.

5. " A note on inequalities for the norm of a matrix ", *Amer. Math. Monthly*, 58 (1951), 558–559.

6. " The convergence of Seidel iterants of nearly symmetric matrices " (Notes on numerical analysis —6), *Mathematical tables and other aids to computation*, 5 (1951), 237–240.

7. " A note on bounds of multiple characteristic roots of a matrix ", *Journal of Research of the National Bureau of Standards* (*U.S.A.*), 48 (1952), 59–60.

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9. " An extension of a formula of Cayley ", *Proc. Edinburgh Math. Soc.*, 9 (1954), 91–99.

10. With J. E. L. Peck, " The differentiability of the norm of a linear operator ", *J. London Math. Soc.*, 30 (1955), 496–501.

11. With J. E. L. Peck, " On the numerical solution of Poisson's equation over a rectangle ", *Pacific J. Math.*, 5 (1955), 999–1011.

12. " On the ranges of two functions of positive definite matrices ", *J. Algebra*, 2 (1965), 350–353.

13. With Pfeffer, " On the ranges of two functions of positive definite matrices ", *I.C.C. Bulletin*, 6 (1967), 81–86.