OBITUARY

MARGARET HILARY MILLINGTON (née ASHWORTH)

Margaret Hilary Ashworth was born on 22 March 1944 in Halifax, Yorkshire where her father was Assistant Head Postmaster. She attended Haugh Shaw Primary School from 1949 to 1955 and then the Crossley and Porter School for Girls until 1962, when she went up to Durham University as a member of St Mary's College.

Her undergraduate career was quite outstanding and she must surely be placed amongst the most brilliant mathematics undergraduates at Durham. She obtained more than twice the marks required for a first class honours degree and, together with an equally successful undergraduate contemporary, Sheila Trelease (now Sheila Greaves), also of St Mary's, set a record in that respect which is unlikely to be surpassed.

After graduating she went to St Hugh's College, Oxford to work for a D.Phil. with A. O. L. Atkin who had migrated from Durham to Oxford and the Atlas Computer Laboratory. Atkin recalls how favourably she impressed her examiners at the first year Diploma oral examination, with her poise, her speed of response and her sound knowledge of mathematics. Thereafter she worked with Atkin, specialising in the study of modular forms, and incidentally becoming a capable computer programmer. She was awarded the D.Phil. in 1968.

In 1968 Margaret married Lieutenant A. H. Millington of the Royal Electrical and Mechanical Engineers.

For the next two years she held a Science Research Council Fellowship which allowed her to work at any institution conveniently situated for her husband's current posting.

Her husband had been posted to Germany for two years and she had been teaching there in an Army Education Centre when a brain tumour was diagnosed and she died in March 1973.

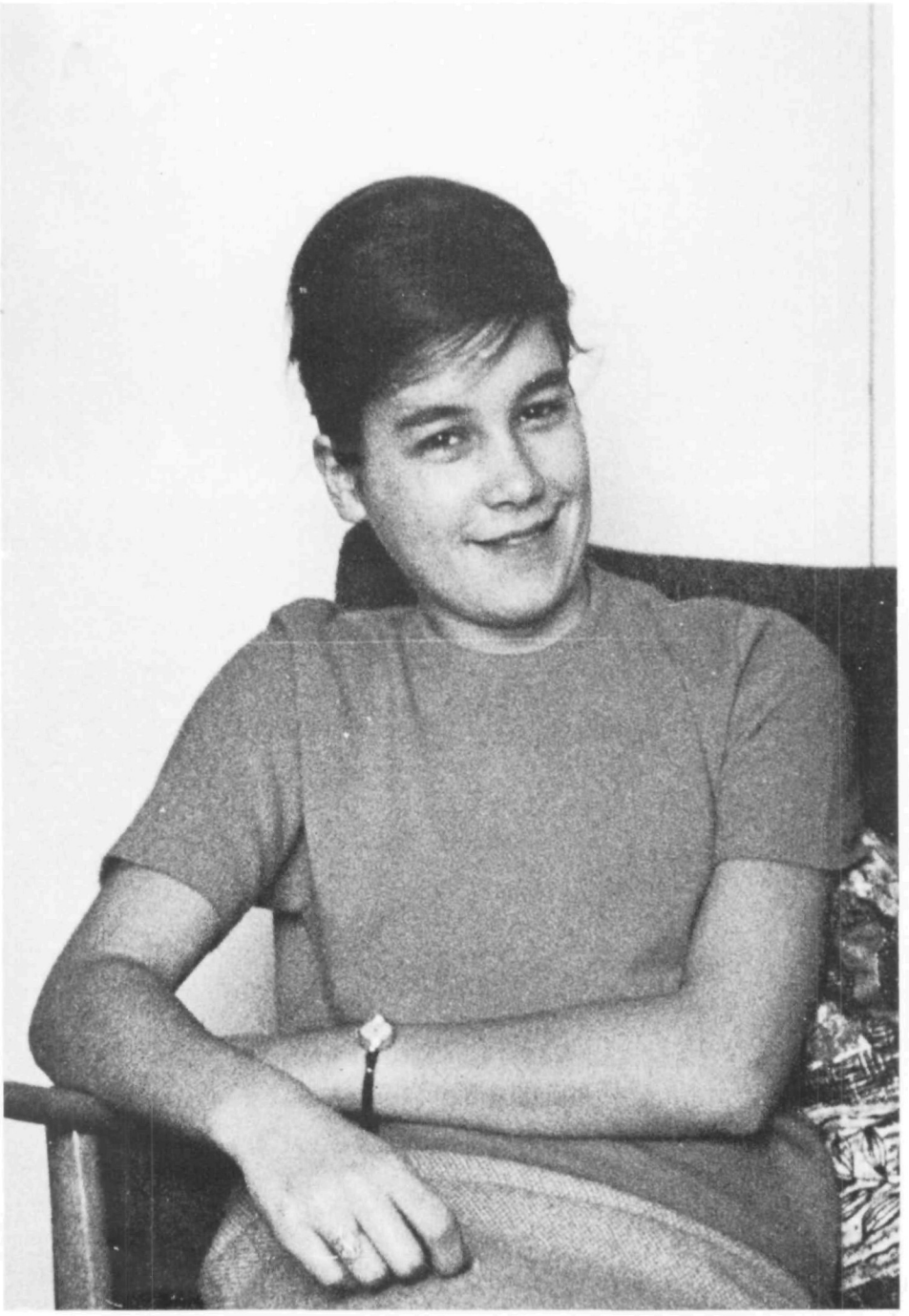
Mathematical work

Margaret Millington's published mathematical work, consisting of two papers and her D.Phil. Thesis, involves three widely varied topics on modular forms, one of which has proved to have great significance: I discuss them below in increasing order of importance.

The 'Vanishing of coefficients of certain modular forms', one of her three thesis topics, was done partly in collaboration with me and J. Lehner and relates to a technical curiosity of the subject.

It was during the London Mathematical Society's Durham Symposium on Modular Forms in 1983 that Professor Atkin drew my attention to the fact that no Obituary of Margaret Millington had appeared in the Bulletin. The importance of her contribution to the subject was made manifest at the Symposium and it was felt to be appropriate to publish this brief tribute.

The biographical details were contributed by Miss Kathleen Cross and Mrs Sheila Greaves, who were contemporaries of Margaret Millington at St Mary's College. The mathematical tribute was written by Professor Atkin, as were some of the personal reminiscences. [*Obituaries Editor.*]



MARGARET HILARY MILLINGTON
(née ASHWORTH) 1944–73

Her second thesis topic, and also that of her two papers, is purely group theoretical, and exploits the representation of subgroups by permutations of the left cosets. Certainly the theory was well known, and in those days group theorists turned up their noses at it (although nowadays every finite group theorist has blossomed into an expert on modular functions), but the detailed application to prove the existence of certain desired types of subgroup was new, and capably done. Both before and after Margaret's papers more eminent modular theorists have made heavy weather of the method: an exception is the excellent work of Stothers, who has continued and extended the technique.

Her third thesis topic was an attempt to synthesise and clarify the numerous congruences of Ramanujan, Wilson, Wilton, Kolberg, Lahiri, *et al.*, between the Fourier coefficients of cuspforms and sigma functions (sums of powers of divisors), extending to noncuspforms with poles and to more recondite functions such as sums over divisors in complex quadratic fields. Although she did not interpret the answers in a meaningful way, she did develop a technique for proof which was wholly systematic, and proved that for various fixed prime $q \leqslant 13$ one could expand all the relevant series in q-adically convergent power series with some fixed function as the variable, and with an effective bound on how many terms need be taken to ensure that the results be exact modulo q^{α} for fixed α. Thus for any set of functions among which a congruence is proposed, one may first make the best possible guess by some routine linear algebra, and then prove it using Margaret's technique.

Shortly after this, Serre conjectured his remarkable interpretation of the congruences for cuspforms in terms of l-adic representations, and his work and that of Swinnerton-Dyer is by now classical, the final gap being closed by Deligne in 1974.

The presumed connection between the 'monster' simple group and certain modular functions implies certain congruences between the Fourier coefficients of these functions: these congruences were all proved (and in one or two cases slightly better ones) by Atkin, Fong, and Smith, using the q-adic expansion technique of Margaret. Here, it should be noted that since the functions are not holomorphic, the deep modern theory of Serre, Deligne, *et al.*, is not applicable at all.

After her D.Phil., Margaret was awarded an SRC Postdoctoral Fellowship and commenced work on the problem of classifying newforms in the sense of Atkin and Lehner in the case of nontrivial character. This problem was later solved in one sense by Li, and by Atkin and Li: Rankin also arrived independently at many of the same conclusions. However, there is a classification finer than that of Atkin and Lehner, Li, and Atkin and Li, which involves consideration of the irreducible representations of the factor groups $\mathrm{PSL}_2(\mathbb{Z}/q^{\alpha}\mathbb{Z})$ and generally $\mathrm{PSL}_2(\mathbb{Z}/m\mathbb{Z})$, where the matrices have entries in the ring of integers modulo m. This approach was initiated by Hecke in two of his last papers, where he considered the case $m = q$ prime only. Pizer, Shemanske, and Hijikata, using theta series and quaternion algebras, have also attacked the classification problem, and it would be a bold person who would claim to have the final word. Margaret was making some progress, and was also considering forms of half-integral dimension, when her tragic death put an end to her researches.

Margaret was somewhat conservative both as a mathematician and as a person, inclined to speak when spoken to, but then to say her piece clearly and at reasonable length. She adapted very readily to changing conditions, first to Oxford after Durham, and then to America in 1966–67 when she visited the universities of Maryland and Wisconsin with me. Obviously her interests and ideas were heavily influenced by mine, but her own contributions were relatively greater than those of the average graduate

student, and the excessively modest disclaimer which she insisted on adding to her thesis, against my advice, is misleading. I have no doubt that, had she lived, she would have made exciting original contributions to a field which has at last come into its own again, after nearly a quarter century in the doldrums, and where there are now at least twenty first rate people of her generation working actively.

Bibliography

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