M500 NEWSLETTER No. 16 September 1974

Editor: (Mrs) Marion Stubbs, Southampton

THE MATHEMATICS OF CRYSTALLOGRAPHY, Part II - Michael Gregory

The following errors crept into Part I (M500/14), first text page:

Line –8 ... $= + \left(\frac{c}{1}\right) \sin\beta$ Line –6 ... $= \frac{1}{c \sin\beta} - \frac{h}{a \sin\beta}$

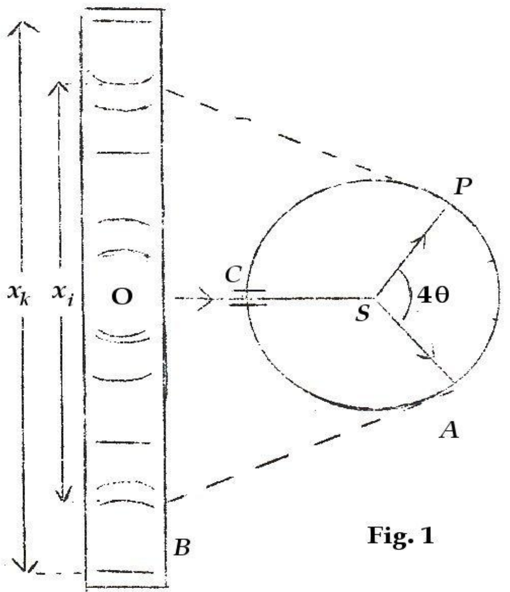

Fig. 1

The powder method is frequently used to obtain X-ray diffraction patterns. A thin cylinder of the finely powdered sample is formed on a glass fibre coated with gum, and placed along the axis *S* of a cylindrical film held by a metal camera. (One arrangement is shown in Fig. 1A). A beam of X-rays (of one wavelength *A*) enters through a fine tube *C* and strikes the randomly oriented particles at *S*. Some particles will be in positions in which the Bragg equation is satisfied ((θ_1, d_1) is a solution of $\lambda = 2d \sin\theta$).

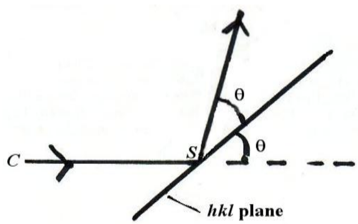

Fig. 2

Because of the random orientation, the diffracted beam forms a cylinder of half angle 2θ (Fig. 2), of which a slice is recorded on the film shown in Fig. 1B. Knife edges form the lines at x_k apart, knowing the angle between them (α_k, around the film) we have

$$\frac{x_i}{x_k} = \frac{360^\circ - 4\theta}{\alpha_k}; \text{ therefore } \theta = 90^o - \left(\frac{\alpha_k}{4x_k}\right)x$$

and if we measure x_k and x_i for each line on the film we can calculate θ for each line. Using tables of θ (in degrees and decimals) against $\sin^2\theta$ or *d* (interplanar spacing) we can attempt to analyse the film and sample.

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To identify the material we find the *d* values, and visually estimate the intensity of each line, and refer to the A.S.T.M. Powder Diffraction file. This consists of an index to the *d* values of three strongest lines of many thousands of substances. Selecting a number of possibilities (say 5–10, it helps if you know something about the material, e.g. a mineral, an iron compound or an aromatic substance) you find the card for each substance which shows the recorded *d* values, intensities for the whole pattern, cell constant and Miller indices if these are known. Matching your data with that on the cards it is usually possible to decide what the material is.

To see how to determine the cell constants from the film when no detailed data is recorded, let us consider a specific example. We have obtained the $\sin^2\theta$ values in column 1 and suspect that the material is hexagonal (from the shape of the crystallites or because a number of similar substances are hexagonal). We have to find integers *h k l* and constants *a*, *c* such that

	$\sin^2\theta$	$h\,k\,l$		
m	0.0751	100	100	100
n	0.1060	001	002	101
o	0.1236	–	–	002
p	0.1987		–	102
q	0.2253	110	110	110
r	0.3004	200	200	200
s	0.3532			
t	0.4240			
u	0.5034			
v	0.5257			
w	0.5566			
x	0.5785			

$$\sin^2\theta = \frac{\lambda^2}{3a^2}(h^2 + hk + k^2) + \frac{\lambda^2 l^2}{4c^2}$$
$$= A(h^2 + hk + k^2) + Cl^2.$$

Start by assuming $A = 0.0751$, line *m* has *h k l* = 100 (or *m* is 100), we notice that this gives *q* as 110 and *r* as 200 (what about *v*?). We try *n* as 001 but this does not account for *o* so we abandon that idea. Notice that not every *h k l* combination has to be used.

Trying *n* as 002 gives $c = 0.0265$, which does not explain *o* and *p* with sufficient accuracy. If *n* is 101 then $A = 0.0751$ giving $C = 0.0309$ so *o* could be 002 (this looks promising, are the other lines accounted for?). We notice that for *p*, 0.1987 = 0.0751 + 0.1236 so p is 102. If you have followed so far you might like to try indexing the remaining lines yourself, see the end for my solution. When the indexing is complete we can use the A and C values to find a and c knowing the wavelength (in this case $\lambda = 1.542 \times 10^{-10}$ m).

The data above has been idealized to give a simple example. In practice the $\sin^2\theta$ values might have an error of $\pm$ 0.0005 so the decision whether a set of indexes is correct is less definite than above. If a second substance (or phase) is present the diffraction patterns both appear on the film so we could identify both components of a mixture. If there is only a small proportion of impurity, its pattern will be weak and we might have great difficulty in trying to index these lines using the constants of the predominant substance.

For more detailed information about the positions of atoms within a crystal structure, X-ray methods using a single crystal (which may be very small) are employed. The calculations are lengthy even by computer standards and many books are devoted to the subject.

I know you have been waiting for this bibliography; there are many good texts on various aspects of crystallography, of which I can mention only a few:

Elements of X-ray diffraction, B. D. Culllity. £4.90. Addison-Wesley, 1956
For many views of the subject from the earliest days to 1962:
Fifty Years of X-Ray Diffraction, ed. P. P. Ewald, 1962, approx £3.
Published by N.V.A. Oosthoek's Uitgevers Mij, Netherlands, who also publish Crystallographic Book List, ed. H. D. Megaw, 1965 approx. £1.40.

For the inside story - not just research - behind the D.N.A. structure: The Double Helix, J. D. Watson, 1970, 25p. Penguin.

The Miller indices for the example given are: s 103, t 202, u 113, v 210, w 211, x 203, giving constants

$$a = 3.249 \times 10^{-10} \text{ m}, \quad c = 4.384 \times 10^{-10} \text{ m}.$$

It is no particular substance.

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MORE MATHEMATICS DAY SCHOOLS IN CAMBRIDGE

Students from other regions are most welcome to come if they so want. It is hard to predict the programme of these day schools now, but in general they will contain a few review sessions and a study and solution of the specimen examination papers. Detailed programmes will be available about a fortnight before the day school. If students from regions other than 06 (East Anglia) wish to come to any of these day schools, would they please write to the Regional Office saying they intend to be present and also indicating whether or not they want lunch provided (about 60p.); would you also ENCLOSE A STAMPED SELF-ADDRESSED ENVELOPE as this will remove most of the burden off us. Maps of Cambridge and parking spaces will also be included.

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Ed: The mind boggles at the very idea of ‘a few review sessions', let alone the rest of it. (See Yvonne's letter elsewhere in this issue for the state of famine we in the South endure.) Unfortunately, the first train (6am-ish) from Southampton does not reach Cambridge until 10.45am or I would be there. It would be nice if someone would provide Day Schools in London???

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M50O/17 looks pretty full already, so rest easy folks and do your revision, unless your pen is wont to write of its own accord. No. 17 will be sent out early in November, assuming I'm not dead with exhaustion and depression. You can think up some jolly-fun items for No. 18 Christmas issue in the meanwhile.

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ARE WE TYPICAL? - Eddie Kent

This is occasioned by the communication from “Sinbad” in issue no. 13 of M500. The enumeration of points is his.

(1) Sinbad states that mathematicians are more likely to be male than female. I hope that when he counted all the known mathematicians he included the rest of the world and not Mudcombe. If he did so would he please publish

his figures because I find his assertion surprising and his conclusion bumptious.

(2) I'm lost on this one. Does ‘vertical’ mean ‘at the highest point’ or not? If it does the final adjective of my previous paragraph can be used again. If not, do we tell HW and FG Fowler or leave them to find but for themselves?

(3) Who has a sense of humour? Anyone doing M202 will know what gloriously funny book Halmos has written; and I laughed out loud at the end of the introduction to K of M201. I think people who tell jokes have less a sense of humour than a feeling of inferiority and those who watch for a reaction are on the point of suicide; (one certainly hopes so).

(4) Mathematicians do communicate, but not with fools. They avoid committees because these valuable institutions generally consist of social scientists, politicians and others who think with or through cotton wool.

(4b) Mathematicians are more nearly in contact than most others with the only real world - the one inside. Sinbad is making the common mistake of confusing this grubby collection of objects which is polluting the globe with reality.

(5) The division of mathematicians into 'applied' and 'pure' is merely another example of unassimilated chauvinism and need not detain us.

(6) As an attempt to enumerate the physical characteristics of a mathematician I offer the following: they are hairy. (That is, they generally tend to have some hair somewhere on their body. Notice the converse is not necessarily true. I don't think any more can be said with certainty. This is probably enough, however, since it excludes all but a finite number of computers.

As we have run out of numbers, consider this: A technologist to a mathematician is as a novelist to a poet; one particularises the generalities of the other.

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<u>THE PETITION</u> - Sue Davies (list 11)

On the thorny subject of course provision, I am sure no student feels qualified to decide what courses are needed - our basic plea is simply for more courses, on any subject, to provide some element of choice; the present allocation of 8 credits for maths is disgraceful.

I have about 50 petition signatures so far, from M500 and my local tutorial group, which, while encouraging, is not really sufficient to give the Faculty much support in its fight for a larger credit allocation. If there are any more signatures still to come (particularly from those who have promised to collect signatures at study centres), could you let me have them as soon as possible?

You asked for comments on Problem Corner. I love the problems, but think for our peace of mind you should perhaps only accept problems for which solutions are provided, which could be made available on request to frustrated readers. If anyone has a solution to the triangle problem (No. 14 Problem 3), would they please put me out of my misery. I have tried plane geometry, trig, and (on the advice of a mathematical expert) complex numbers, all to no avail.

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PROBLEM CORNER No. 16

TMA M100 05 - Bob Escolme, M100

The following is an adaptation of an old problem. Any resemblance between this problem and the one appearing in this year's TMA M100 05 is less than fortuitous.

The primitive terms of dining club geometry are a club P, whose members are called diners, a dining room Q whose elements are called dinners and a set of meals N called the attendance relation. Four of the (umpteen) axioms of dining club geometry are as follows.

(1) N is a subset of the Cartesian product $P \times Q$ of diners and dinners. If $p,q \in N$ we say diner p attended dinner q and ate one meal.

(2) $p_i, p_j \in P \Rightarrow \mathbf{a} \wedge (\mathbf{b} \vee \mathbf{c})$,

where $\mathbf{a} \Leftrightarrow p_i = p_j$

$\mathbf{b} \Leftrightarrow \{x \in Q\colon (p_i, x) \in N\} \cap \{x \in Q\colon (p_j, x) \in N\} \neq \varnothing$

c $\Leftrightarrow$ the solution set of **b** contains not more than one dinner (or, cutting out the rigmarole, every two diners have one, and only one dinner in common).

(3) $q_i, q_j \in Q \Rightarrow \mathbf{e} \vee (\mathbf{f} \wedge \mathbf{g})$

where **e** $\Leftrightarrow q_i = q_j$

f $\Leftrightarrow \{y \in P: (y, q_i) \in N\} \cap \{y \in P: (y, q_j) \in N\} \neq \varnothing$

g $\Leftrightarrow$ the solution set of **f** contains not more than one diner (or every two dinners have one, and only one diner in common).

(4) There exist four distinct diners p_1, p_2, p_3, p_4 and $\{x \in Q: (p_i, x) \in N\} \cap \{x \in Q: (p_j, x) \in N\} \cap \{x \in Q: (p_k, x) \in N\} = \varnothing$ for all i, j, k satisfying $i \neq j \neq k \neq i$; $i, j, k = 1,2,3,4$ (or no 3 of the given 4 diners attended a dinner at the same time).

Use these axioms (and no others) to answer the following questions.

(a) Show that any dining club geometry contains more than 4 diners.

(b) What is the minimum number of diners consistent with the axioms?

(c) What is the minimum number of dinners consistent with the axioms?

(d) What is the minimum number of meals eaten?

(e) What is the minimum number of chairs a dining club with the minimum number of members should possess in order that no diner attending a dinner has to eat standing up?

(f) Draw a geometrical figure to illustrate your answers to the previous questions.

(NB The easier questions carry more marks than do the more difficult ones, so don't put yourself out.)

<u>GOAT-GRAZING</u> - John Brown

A farmer owns a circular field and he wants a goat to eat exactly half the grass in the field. If he tethers it to a point on the circumference what is the ratio $\frac{\text{Length of rope}}{\text{Radius of field}} = \frac{L}{R}$ in order to achieve this?

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<u>YET MORE OF THE HOOP SAGA</u> R. Ahrens

For those Who are still interested, this is part 2 of the story which began in M500 No. 11.

To make use of the facts stated in Part 1 we have to spend a little time discussing methods of constructing hoops.

General method: Suppose $(K, +)$ is a set with a closed binary operation + which is commutative and associative and has left and right cancellation i.e.

$\forall\, x, y \in K, x + y = y + x,$
$\forall\, x, y, z \in K, x + (y + z) = (x + y) + z,$
$\forall\, x, y, z \in K, x + y = x + z \Rightarrow y = z$, and
$y + x = z + x \Rightarrow y = z.$

If we can find 2 automorphisms, σ and τ of $(K, +)$ with the property that σ and τ commute with each other and $\forall x \in K$, $\sigma(x) + \tau(x) = x$ then we can construct a hoop (K, o) where o is given by

$$x \mathrm{~o~} y = \sigma(x) + \tau(x).$$

Can we recognise that some of the hoops we know are of this type? Take the arithmetic mean on $\mathbb{R}$ - the real numbers. (K, +) is $(\mathbb{R}, +)$ in this case.

Multiplication by ½ is an automorphism of $(\mathbb{R}, +)$, ($\frac{1}{2}(x + y) = \frac{1}{2}x + \frac{1}{2}y$ and it is certainly one-to-one and onto). So take $\sigma = \tau =$ (multiply by ½) then $\sigma(x) + \tau(x) = \frac{1}{2}x + \frac{1}{2}x = x$ as required and $x \mathrm{~o~} y = \frac{1}{2}x + \frac{1}{2}y$.

Try fitting the rest of the examples of hoops given by John Bennett in M500 10 to this method (SAQ 5).

Prove that the method above does give a hoop (SAQ 5).

Prove that a hoop constructed in the above way also satisfies the following:-

$$\forall\, x, y, z, w \in K,\ (x \text{ o } y) \text{ o } (z \text{ o } w) = (x \text{ o } z) \text{ o } (y \text{ o } w) \qquad \text{(SAQ 6).}$$

Now every hoop that I know is of the above type so they all satisfy the rule in (SAQ 6). I will call a hoop with this property a *special* hoop.

Prove both the distributive laws from the special property and the x o $x = x$ axiom. (SAQ 7)

Unsolved problem:- are there any hoops which are not special?

Can we reverse the above construction? The answer is Yes.

Theorem 2. If (K, o) is a special hoop take any element of K (a say) and define a new binary operation # on K as follows

$$\forall\, x, y \in K,\ x \# y = R_a^{-1}(x) \text{ o } L_a^{-1}(y).$$

Then # is commutative associative with cancellation and a is an identity element for #. (This means that if K is finite then (K, #) is an abelian group). Also R_a, L_a are 2 commuting automorphisms of (K, #) where

$$R_a(x) \# L_a(x) = x,\ \forall x \in K.$$

Proof: (i) # is commutative.

$\forall\, x, y$ (a o x) o (y o a) = (a o y) o (x o a) by special property.

We could rewrite this as $L_a(x)$ o $R_a(y) = L_a(y)$ o $R_a(x)$.

Now apply the automorphism R_a^{-1} to both sides

$$R_a^{-1}(L_a(x) \text{ o } R_a(y)) = R_a^{-1}(L_a(y) \text{ o } R_a(x)),$$

$$R_a^{-1}(L_a(x) \text{ o } R_a^{-1}(R_a(y)) = R_a^{-1}(L_a(x)) \text{ o } R_a^{-1}(R_a(x)),$$

$$L_a(R_a^{-1}(x) \text{ o } y) = L_a(R_a^{-1}(y)) \text{ o } x \quad (L_a \text{ and } R_a^{-1} \text{ commute}).$$

Now apply L_a^{-1} to get $R_a^{-1}(x)$ o $L_a^{-1}(y) = R_a^{-1}(y)$ o $L_a^{-1}(x)$; i.e. $x \# y = y \# x$.

Associativity. This is similar to above but start with

$$[a \circ (a \circ x \circ a)] \circ [(a \circ z \circ a) \circ ((y \circ a)]$$
$$= [a \circ (a \circ z \circ a)] \circ [(a \circ x \circ a) \circ (y \circ a) \circ a].$$

("Where the hell did that come from?", I hear you cry. I worked backwards from the answer of course.)

This is the special law with

$x \leftrightarrow a$,
$y \leftrightarrow a \circ x \circ a$,
$z \leftrightarrow a \circ z \circ a$,
$w \leftrightarrow (y \circ a) \circ a$.

Now apply L_a^{-1} twice and R_a^{-1} twice – leads to $x \# (z \# y) = z \# (x \# y)$; but # is commutative, so $x \# (y \# z) = (x \# y) \# z$.

The details of above and the rest of the proof of Theorem 2 form SAQ 8. It is now possible to see where we are going. If we can show that a hoop of order 10 must be special and then show that an abelian group of order 10 is no good for constructing hoops we are finished. See next episode .

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REPLIES TO DR IAN KETLEY (ref M500/14)

Lytton Jarman

Whilst talking to Bob Margolis (via Staff Tutor Telephone Service) the other day, he asked me when I was going to write something for M500. The learned articles which it contains rather scares a below-average maths student like me and I have fought shy of making a contribution. Dr Ketley's letter in No.15 is enough to frighten away even those who got a grade 1 in 202 last year. To make a glib and unqualified statement that a contributor's "mathematics is unsound" in such a vindictive way is not a very helpful contribution from a tutor.

I assume we are unique in the Maths Faculty in having such a Newsletter made up of voluntary contributions and produced in many hours of what would be the editor's free time. Does Dr Ketley wish us to close down unless the contributions comply with his high personal ideals? No - let us have more contributions with even less sound mathematics. In any case, Michael

Gregory's mathematics will always be far superior to mine so if I write then we should see a further splendid explosion from friend e^n Ketley. I would have expected a tutor to have given helpful comments on the mathematics in M500 rather than criticise the student contributors.

I do hope that no-one is discouraged by this outburst as I know the hard work that the editor has put into M500 is very much appreciated by math's students in the Midlands, and we do have many wonderful tutors. I am lucky to have one of these this year.

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Willem van der Eyken

Ian Ketley, in his provocative Personal View on M500, suggests that “mathematically speaking, the OU hasn't exposed very much.” I was not sure, judging the context of that remark, whether he meant that students of the OU were not really absorbing the mathematical ideas from year to year, or whether he was really criticising the content and range of the OU courses themselves.

I have long wanted to know, from those who had experienced other university mathematics courses, how the OU material and range of mathematics compared with more traditional courses. On my own limited view, based on one rather new university maths department's first year exam papers, there were quite a few areas (Rolle’s Theorem for one) which appear not to be covered by M100 or M201; moreover, the standard of these papers appeared to be rather higher than the OU exam papers, so far as I know them. On the other hand, an Oxford maths Honours graduate thought highly of the content of M100, which he described as a mixture of post O-level and second-year university material (he himself had never done any computing during his years at Oxford, where he graduated some three or four years ago). It would be interesting to hear from those people who can speak from both sides of the fence whether (a) the level of OU maths compares to the requirements of more conventional departments and (b) whether the content is either more narrow or - as I intuitively feel - rather wider than the average undergraduate might meet at a conventional university. In all this one has to remember that the backgrounds of OU maths students are very different from those who come to university from the sixth form, with many years of O, A and possibly S level mathematics teaching behind them.

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Ed: Rolle’s Theorem is M231 material.

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<u>John Carter - M100</u>

The response to my letter in M500/14 was tremendous! On the first evening the phone hardly stopped ringing. Everyone who rang had words of encouragement and good advice. I am very grateful. In addition to this, I received through the post a considerable number of past papers. Perhaps you can squeeze in a few words of thanks from me to my invisible donors. (I am writing to those who aren’t anonymous - Sinbad being an irritating one because he wrote me an interesting letter to which I am unable to reply.)

Ian Ketley’s letter particularly interested me. I was initially upset by the tone of the letter but subsequently found many of the points he made were not unreasonable.

First, there is no question of MOUTHS being unsound (nor does Ian suggest this). From my experience and observation of it, MOUTHS is a resounding success. Certainly it is far too good an idea to be restricted to one course or one area. Ian's objections are aimed at M500 and not at MOUTHS.

Let me tell first of my reaction to M500. The technical articles and brainteasers/puzzles I quickly read. If anything sticks it would be a miracle; certainly I don't consciously understand a thing. The Sinbad or van der Eyken articles, or similar, I read with great interest and get pleasure from. All the letters are of interest. Of course, the Editorial is always relevant and a valuable contribution. Does this mean that I am opposed to the technical articles? No - an emphatic NO. For two reasons: the first is that these articles impress upon me my own ignorance, and provide a spur for my self-improvement (isn't this what studying is all about?); the second is that I keep M500 and ‘one rainy day' will dig them out, naturally after (!) I've got my OU degree, and then perhaps will understand them. Certainly they should be of interest. For the students who do understand the articles now, they should have the enjoyment of them. If there is a question of the articles being unsound then surely publishing them (if space permits) allows others to refute the arguments and content, and could lead to lively issues.

However, it must be said that if for space reasons there is a choice between a couple of letters and a technical article, then I'd rather have the letters printed. As a direct answer to Ian I would say don't read what doesn't interest you (I don't!); if you believe an article unsound, refute it - we value your response; and finally, remember that M500 is OU student standard and intended primarily as a discourse between students - not, I hope, to be taken too seriously by the 'mathematical community'.

I enjoy M500. It is a link that unites me with other students. As such, my response is necessarily emotive - may M500 flourish and continue to give pleasure.

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Datta Gumaste

Could some expert mathematician please explain:

(a) Why cannot a student who by definition is not an expert express his views about what courses he would like to study?

(b) In what way mathematics students of other universities have wider exposure to mathematics than OU students?

Whatever may be the structure of maths B.A. degree, surely the real question is what kind of mathematics graduate any university produces or should produce - what sort of skills he will have acquired, what insight he will have had in certain areas of mathematics, how open and flexible his mind would be, how independent or adventurous he is likely to be to undertake a

journey in the world of mathematics, how many theorems he will have attempted to prove on his own, how many moments of sheer joy he will have experienced ... .

It's time that expert mathematicians enlighten the students by answering these or similar questions.

The mathematical community at large should be more than glad because there are *n* people from different walks of life who a few years ago hadn't a clue what functions, sets or relations are, but who are now trying to understand set theory, struggling to appreciate fixed point theorem, and attempting to see the grandeur of the construction of natural numbers from sets.

Surely, to do mathematics and to enjoy its beauty is the right of every sane human being. In exercising this right it is likely that a learner will make noises which are different from the noises made by an expert.

But then an expert is perhaps an expert because he has patience to listen to any non-sense of a non-expert, and he might be more of an expert if he finds something significant in that non-sense.

It may be too early to judge the quality of an OU maths student (who are these judges, anyway?) but the enthusiasm of an OU student who is also a parent may well create a real taste for mathematics in the minds of his children.

To what extent are the expert mathematicians responsible for the well-known unpopularity of mathematics?

Not being an expert, nor indeed aspiring to be one, I find M500 quite interesting, and some pieces very moving - see for example M500/13 p.5: “An OAP view of the OU”. This piece is as lovely as many mathematical results I have met so far.

It's nice to be ignorant, and - who knows - it might be instructive.

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Sinbad

Yah! Boo! and Sucks! to Dr, Ian Ketley. M500 is our playground and who needs a rotten old academic to boss us about.

Seriously though folks, as they keep on saying, surely M500 was never exclusively intended to be a showcase for high fliers, but rather an exercise in communication and mutual assistance between ordinary guys, like you and me and our (allegedly) chubby ed.

In my non-introspective scale of values it is far more important that an Arts student like Beth Taylor should actually want to read a mathematics news sheet, than that some far-off professor in a distant ivory tower might chunter disapprovingly into his beard.

Remember folks that judged on these "highest academic standards" Einstein himself was a lousy mathematician. Would that a single one of us should fail so successfully.

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Ed. 34-28-40 (fact). When are you going to join MOUTHS, Sinbad?

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From the Editorial Sister (B.Sc. Maths. London)

There is really no point in sending me M500 - I only flick through it and lose it, as I have when I would like to refer to an article I heartily endorse - worrying about the image of the students presented and the general trend. Poetry, I thought - what we all feel but only poets can express. Give him my thanks. I thought it was me, getting old.

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Margaret Corbett

Dr. Ketley shows that he has little sympathy with the isolation of the OU mathematics student. We may feel a strong urge to practise our newly acquired language and find we know nobody to practise on. As it stands M500 provides a forum in which a student's ideas may be discussed. If a piece is "half-baked" then it should be criticised by anyone who feels like joining in, but let us have the criticism in M500 so we can all see and learn.

Selection of non-OU mathematical publications seems hard, and access may be difficult for some of us. It may be that this difficulty in trying to choose successfully for oneself from the mass of published work is one of the reasons for the requests for “higher level mathematics specialities”, which Dr. Ketley finds so presumptuous.

“How mathematics develops” is, I agree, not at all clear after doing just a little work on OU courses but such information is not secret. Surely the development of mathematics is a suitable subject for conversation, even for speculation? Why not tell us what are the mathematics courses available at Southampton University! Again, instead of maintaining the negative attitude of his ‘Personal View’, I urge Dr. Ketley to tell us more.

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Bob Margolis - a *PERSONAL* reply to Dr. Ketley

Like John Carter I was very irritated by a first reading of Ian's letter. During a calmer re-reading I felt a strong sense of déjà-vu. Ian was accurately describing me and my contemporaries at a London College long before the OU was anybody's pipe dream. Most of his points are, of course, valid, but they have nothing to do with the OU except that students have to communicate by the written word rather than the spoken word over coffee in a common room.

It would be very interesting to know why it is considered mathematically O.K. to make the wildest conjectures and blunders in conversation but never in print.

I would like now to look at some of the specific points raised. I'm not at all sure whose hands M500 is getting out of. It has no pretensions to be anything but a discussion forum and if the editor is going to do any selection it should certainly be in the direction of promoting discussion at the expense of discourse. However, I am not sure how an editor who does not claim subject expertise could possibly act as a universal referee for all articles. The solution is surely to print and let the expert readership shoot the offending article down.

To deal with the criticism of the Crystallography piece, I discover that the author has merely been guilty of the standard crime of not giving sources for standard introductory theory. An introductory text on (say) ring theory would not normally give the history of all the basic theorems.

Finally, I feel sorry that Ian has attacked ‘N-ary’. Perhaps N-ary's critics might like to discuss his ideas with him privately, and write up a detailed account of why they feel his ideas to be unsound.

I fear that mathematics is too short of light-hearted publications to be able to afford to lose M500.

(Footnote: “... as someone who does not even know what a simple group is ...” - President London Mathematical Society thanking Prof. Gorenstein after a lecture on same.)

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Ed: That looks enough for one issue. More next time, if it continues to pile in. Far from cutting out discourse in favour of discussion, I try to maintain a balance, as far as anyone has written anything of either type. It seems logical!

16 page 13

<u>Andrew Arblaster - M201</u>

I think M500 readers, particularly those doing or who have done M202 might be interested in one of the funniest books I have ever read. To give the flavour of the book, here is the jacket blurb.

“There was a time when every bookshop displayed a selection of soporific tracts expounding the principle that mathematics could be made easy. All that is now past, and the idea that mathematics really is difficult has regained its freedom. Dr Linderholm's pioneering opus *Mathematics Made Difficult* is the handbook of the new liberation. As you read the book the ability to count, let us say, begins to haze out. You are gradually coaxed deeper into the eerie landscape of central mathematics.

Forgetful functors stare back at you between wild trees; arrows fly in all directions; your feet become entangled in an undergrowth of morphisms; your eyes behold the universally repelling object. Not since ‘Alice in Wonderland’ has mathematical wizardry been used to such lunatic effect.

Incidentally, I think the book itself is a refutation of Sinbad's claim (M500/13) that mathematicians have no sense of humour.

Linderholm, Carl E. *Mathematics made difficult*. London: Wolfe Publishing Ltd. £2.75

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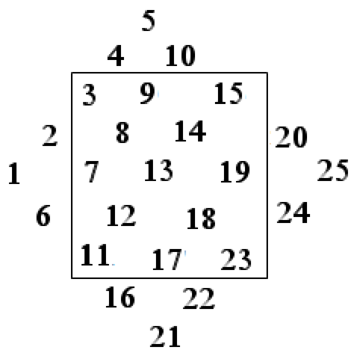
SQUARES - R. H. Smith - M201 etc.

A method of making squares that I call the mechanical way may be unknown to M500 readers. It is illustrated for the square of 5, and applies to any odd number greater than 1.

Arrange the 25 numbers in diamond formation. Rule off the square.



The shape 20, 24, 25 fits the blanks directly opposite – 20 between 3 and 7, 24 between 7 and 11, 25 between 8 and 12. Similarly for the other shapes which are carried across the figure.

3	16	9	22	15
20	8	21	14	2
7	25	13	19	25
26	12	5	18	6
11	4	17	10	23

in which rows, columns and diagonals add to 65

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MATHS-MISQUOTE - Peter Weir

"The moralist cannot deny that, generally speaking, well-bred people addicted to mathematics are much more likeable than the virtuous are."

Honoré de Balzac. 'Cousin Bette'.

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16 page 15

COMPUTING – IS IT MATHEMATICS - A cynical view

"A computer programmer stands in the same relation to mathematics as a glassblower does to physics", said an unknown professor of mathematics. Average commercial computing, the type of computing most people encounter, is most certainly of this ilk.

The average systems analysts or programmer's job consists to a large extent of merely deciding what needs to be done, and specifying in a small or large amount of detail how it is to be done, without actually doing it. Viewing this in the abstract sense, is it much different from the job of, say, a draughtsman or a quantity surveyor? These people do not claim to be in a mathematical (as distinct from arithmetical) discipline.

Mathematical pretence is not restricted to computing, by any means; some statistical howlers observed in the august medical journals would disgrace any O-level drop-out.

It is not that mathematics cannot be applied to computing as we know it - ask any M202 student. A lot of the results do, in fact, point to what cannot be done. A paper in a computer journal recently took l½ pages to say that it is practically impossible to prove that a particular computer program will or will not work.

So how does M251 come to be offered by the Maths Faculty, of all people? An alien being, shown an M251 and an M202 unit together would think them written in different languages. Where M251 introduces a concept by: 'here is an example of a ... ' and goes on to the next point, M202 defines precisely.

Is commercial computing as a discipline really much more mathematics than art?

(Signed): "A Glassblower for 5½ years"

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Ed: The author is a MOUTH, but just scared to come out in the open! Please don’t start a glut of Anon contributions, or we'll end up like *Sesame* or something from the Dark Ages of Student Anonymity (which this publication is dedicated to defeat).

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Yvonne Kedge

I have never before as an OU student felt so lonely and isolated as I have this year.

My tutor is so far away and remote that any verbal contact can only be made by a long-distance telephone call, and the three 2-hour tutorials that we have been allocated this year are so far away that they appear to be an unwise drain on my desperately precious time and rapidly dwindling energy.

Personally, I would much prefer the OU Maths Faculty to reduce expensive television broadcasts and provide adequate tutor facilities and tutorial time, such as Day Schools, when ‘local’ 2-hour tutorials are so far away.

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CAR FOR SALE

FIAT 128, 1973(M). White. h.r.w. undersealed. £895 o.n.o. (HP available.) Yateley

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Ed: Owner is an M500 subscriber, but not (yet) a MOUTH!

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THE INSTITUTE OF MATHEMATICS AND ITS APPLICATION8 - Tony Brooks

- Is the representative body for qualified mathematicians.
- Arranges conferences, symposia and lectures on mathematics and its applications, throughout the United Kingdom.
- Is actively involved in mathematical education from school level to postgraduate university level.

- Holds its own Graduateship examination of honours degree standard.
- Administers the schemes and examinations for the Higher National Diplomas and Certificates in Mathematics, Statistics and Computing, and in Computer Studies, at present available in more than 70 polytechnics and colleges of technology.
- Publishes a Journal (six issues a year), the scope of which is original research in all areas of the application of mathematics; special emphasis is given to numerical analysis.
- Publishes a monthly Bulletin containing articles of wide interest which is available for sale and is supplied free to members.
- Publishes books available at reduced prices to members.
- Is one of the constituent members of the Council of Science and Technology Institutes with the Institute of Biology, the Royal Institute of Chemistry, the Institute of Metallurgists and the Institute of Physics.

Membership of the Institute, in the grade of Fellow, Associate Fellow, Graduate or Licentiate, is open to those holding appropriate academic qualifications and experience.

There is also a grade for students. Details and forms may be obtained from: The Secretary, The Institute of Mathematics and its Applications, Southend-on-Sea, Essex.

(taken from an official description issued by the I.M.A.)

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THE SORT TREE - Margaret Corbett

In M251, ‘An Algorithmic Approach to Computing’, we learnt a technique for sorting which is adaptable to make the problem of ranking a number of data values much easier. This technique may be found useful by students of MDT241.

The problem of ranking a set of data can be divided into two parts:
(1) Sorting the data into ascending or descending order.
(2) Allocating suitable ranks.

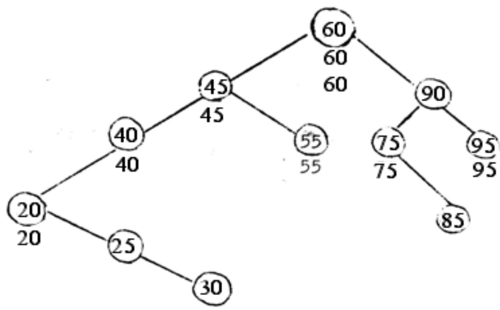
If the set consists of only a few data values, sorting is done quite satisfactorily by inspection, but if there is a larger number it is so easy to make mistakes that the necessary repetitions become laborious. The technique explained in M251 is that of forming a Sort Tree.

The tree consists of nodes, the points at which data values are written down, and branches. The tree is formed by writing the first data value in the centre of the page. This forms the 'root node'. The second data value is compared with the first and a branch is made to the left if it is smaller than the first, or to the right if it is larger. It is written down at the end of its branch and forms the second node.

The rest of the values are put in one by one. The tree is always entered at the root node. A branch to right or left is followed after comparison with the value of every node encountered, until a new branch is made when the value being entered forms a new node at the end of the new branch. Thus each node is at the end of one branch, and may have up to two branches leaving it.

Tied values are noted beneath the nodes, as shown in the example.

Dates: 60, 45, 40, 90, 60, 55, 20, 95, 95, 45, 75, 85, 20, 75, 40, 25, 55, 60, 30



With the data values arranged in this form it is quite easy to list them in order before allocating ranks. Any mistakes made in forming the tree show up clearly and can easily be corrected.

I have found this method very helpful with ranking problems. It is limited practically by the size of the paper and the neatness of layout required so that it is only applicable for a very large set of data if there are many tied values and hence a relatively small number of nodes.

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ERROR IN THE S_4 GROUP TABLE PUBLISHED IN M500/15 - Hugh Tassell

Apparently P = O, an unlikely circumstance. Suggest P = $\frac{1234}{2143}$.

$$A_4 = \begin{cases} I & B & E & G & J & L & N & P & Q & S & U & W \\ e & b & c & bc & bc^2 & c^2 & a & ab & ac & abc & abc^2 & ac^2 \end{cases}$$

Some solutions (alleged) to No. 15 Problems: -

(1) Richard Ahrens' Sunshine Problem

Assign permanent sunshine to polar points. Ignore fractions of a day. In any one date that every non-polar point spends as much time in sunshine as in darkness, assuming dark hemisphere same size as light. Hence in a year the same applies. Since time in dark = time in light for each point, each point spends same time in sunshine.

(2) Bob Margolis' Toilet roll

MST282 students unavailable. Brief comment: is tower block taller than length of roll?

(3) Datta Gumaste's Partial solution: if n divides k, n divides k^n and n divides $k^n - k$, so n does not divide $k^n - k + 1$. If n does not divide k, and problem becomes: does n divide $k^n - k$?

16 page 17

My problem (M500/14) is still unsolved at this end, and, presumably, at all other ends as well. It produces more sub-problems than I have time to look at. There is a misprint in the problem as displayed in No. 14 though the correct problem should be easily deducible.

$L = S + N - 1$ should read $L = S + I - 1$.

(Hugh also sends a solution to Rabbits, but no room - in No. 17 if space, or contact him direct. - Ed.)

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SUNSHINE SOLUTION - Richard Ahrens

1. If A and B are 2 points on the same parallel of latitude then they have equal sunlight, because their day by day experience is the same.

2. If A and B are 2 points equidistant from the equator but on opposite sides of it they have equal amounts of sunshine. One has the same experience as the other but 6 months earlier or later. (At the opposite side of the earth's orbit.)
3. If A and B are diametrically opposite points - i.e. at opposite ends of a line through the earth's centre, then whenever A is in sunshine B is in darkness, so sunshine at A = darkness at B. But by (2) we know that

sunshine at A = sunshine at B

$\therefore$ sunshine at B = darkness at B.

There is nothing special about B.
Every point on the earth's surface is in sunshine for exactly half the time.

COLLINEATIONS - (Problem Corner 14) - Sue Davis

G is a group of order 168. Subgroups of order 2, 3, 4, 6, 7, 8, 24 (none normal). Conjugacy classes of order 1, 21, 24, 26, 42, 56. Full proofs submitted - again for no. 17 if space permits - Ed.

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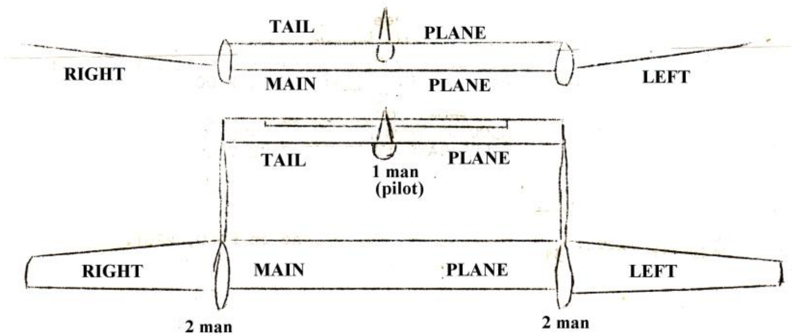
MAN-POWERED FLIGHT - George Dingley

A proposed block design

At first I had given serious consideration for a contra-rotating helicopter, but this has one serious drawback and that is its inability to glide and hence take advantage of air currents.

Having reluctantly discarded that idea, then what should my design be? First, it should be a five-man operated machine. Second, it should take off under its own power. These two requirements are complimentary. Third, it should have all the attributes of a glider.

So let us design for a one-man powered machine and for two-man powered machine. The diagram illustrates these designs.



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16 page 18

BRITISH SOCIETY FOR THE HISTORY OF MATHEMATICS - Marion Stubbs

RESIDENTIAL CONFERENCE AT YORK UNIVERSITY

The conference commences with dinner at 6.30 pm on Friday and disperses after lunch on Sunday. The fee for the weekend is £12, comprising about £10 for accommodation, hire of the lecture rooms, etc. and the remainder for the speakers' expenses. York require to know the exact numbers a fortnight before the conference.

Miss S. Mills (Birmingham University)
Dr J. M. Johnson (Hatfield Polytechnic)
Dr E. J. Aiton (Didsbury College of Education)
Mr L. F. Rogers (Digby Stuart Coll. of Ed.)
Mr J. Grey (BBC, Open University)
Dr M. R. Mehdi (Birkbeck College)

The annual subscription to the B.S.H.M. is currently £1, and non -members should add this to their conference fee. I intend to be there, and would be glad to meet prospective AM289 students.

SECOND STAFF-MOUTHS: Peter Hartley.