Every mathematician knows that there are 17 wallpaper patterns. Moreover most of us will own at least one book that includes a proof of this. We all know the drill: classify the symmetries of the plane, discover that symmetries form groups, classify the wallpaper groups. It is a lovely application of beautiful mathematics but can anything new be said about it? This book is about symmetry and wallpaper patterns, and I have to admit that I expected to be told a familiar story with perhaps the only difference being the high quality of the accompanying illustrations. I was wrong. Yes, the book does contain a proof that there are 17 wallpaper patterns, but its approach is completely different from what I have seen before.

This book is written by someone whose love for mathematics suffuses every page. He does a very good job of taking an idea for a walk. He starts with a very simple idea – what happens when we plot the curve:

\[ f(t) = e^{it} + \frac{1}{2} e^{6it} + \frac{i}{3} e^{-14it} \]

in the complex plane? It turns out to have fivefold symmetry. But why? (The curve in question was one the author had chosen more or less at random as an exercise for calculus students studying parametric equations. The unexpected symmetry was the trigger that began the thoughts that ultimately resulted in this book.) The question of where the symmetry comes from leads to a discussion of how to encode reflections and rotations – complex conjugation and multiplication respectively, and a method of creating and classifying rosettes. When you have a rosette you can unfurl it to produce a frieze. And so on. By thinking of symmetries in terms of functions and waves, rather than of the figures in space these functions define, the author is able to employ the techniques of Fourier series, differential equations and other perhaps unexpected things. There are interesting diversions along the way, and I found many new ways of looking at familiar material which could be incorporated into exercises or challenges for interested students. The classification of the 17 wallpaper groups gets slightly repetitive (one might almost say periodic) but that probably can’t be helped.

The style is chatty and informal, but proper mathematics is very definitely included and not brushed under the carpet. The author says he has three potential audiences in mind: the working mathematician, the advanced undergraduate and the “brave mathematical adventurer”. I can certainly agree that the first two categories are well catered for. In particular there are exercises in each chapter with hints and solutions provided within a few pages, which guide the reader through the material in a helpful way. The brave mathematical adventurer will not get far without at least some calculus, but a bright sixth-former prepared to put in a bit of work would probably find it worth the effort.

The book itself is very nicely produced – a good clear layout with plenty of empty space; easy to read typeface and carefully edited text. The exercises and comments are clearly displayed at the side of the text. The
colour illustrations, produced by the author from his own photographs using the rosette, frieze and wallpaper functions he develops in the book, are very appealing. To steal from William Morris: put nothing in your book that you do not know to be useful or believe to be beautiful. The author of this book seems to have followed this precept. It would make a good addition to any university library.

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THE MAGIC GARDEN OF GEORGE B AND OTHER LOGIC PUZZLES

The logician, philosopher, magician and concert pianist Raymond Smullyan, who is now 96, has been providing us with entertaining collections of logic puzzles ever since he published *What is the name of this book?* in 1978. This latest follows a similar format, offering a mixture of interesting puzzles, “monkey tricks” designed to catch the reader out, dreadful jokes, and insights into serious mathematics.

The book has two parts. The first presents a range of mathematical and logical puzzles, variations of the kind which will be familiar to readers of Smullyan’s previous collections. I particularly enjoyed the headache-inducing Cornelius McSnurd. This curious fellow knows, on Mondays and Tuesdays, which propositions are true and which are false, but on Wednesdays and Thursdays he is confused and believes all and only those propositions which are false. Furthermore, on Mondays and Thursdays he always tells the truth, while on Tuesdays and Wednesdays he always lies (and on Fridays, Saturdays and Sundays he never speaks). We are asked, amongst other puzzles, how many questions we need to ask McSnurd (on one of his non-silent days) to ascertain what day of the week it is.

The second part gives the book its title. George B’s garden is full of flowers, each of which on any given day is either red or blue. The garden has the property that, “For any flowers A and B – whether the same or different – there is a flower C which is red on those and only those days on which A and B are both blue.” Smullyan then develops this ingenious floral version of Boolean algebra. It’s a lovely idea, though in solving the problems I did tend to find myself mentally translating the statements about flowers into their Boolean equivalents.

The book’s foreword is dated 2006 and the preface 2005, which suggests that it has been awaiting publication for some time. This is of significance only for a logical puzzle which requires one to use the information given to identify the partners in two married couples; the recent legalisation of same-sex marriage is a game-changer for such puzzles!

If you have enjoyed Smullyan’s previous books, this one is self-recommending. If you’re new to them, I’d suggest starting with *What is the name of this book?* And if you have a low tolerance for suggestions like Smullyan’s easy way to tell the sex of a bird (offer the bird some seed, and if he eats it, the bird is male...) then this is probably not for you.

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