

---

# *Mathematica* in Action

**reviewed by Mark McClure**

In 1991, I was a graduate student teaching in Ohio State's fledgling Calculus&*Mathematica* program. After the course, I found myself searching for information on uses of *Mathematica* beyond calculus. The book I found was Stan Wagon's *Mathematica in Action*. This book has had a strong impact on how I work with *Mathematica* and it is a pleasure to write a review of the second edition [Wagon 1999].

At first glance, *Mathematica in Action*, is a book about *Mathematica*. There is a brief introduction to *Mathematica*, Chapter 0, and the uses of many built-in functions are illustrated throughout. More importantly, however, *Mathematica in Action* is a book about mathematics and this is where the book's strength lies. While comprehensive reference materials and texts on programming fundamentals are essential to the serious *Mathematica* user, perhaps the best way to learn to use *Mathematica* is to play firsthand with code illustrating a variety of mathematical concepts. This is exactly the approach taken here.

The book has 26 chapters, after the introduction, with a wide variety of topics. A smattering of the topics includes: basic 2 and 3 dimensional graphics, more complicated graphics including penrose tiles and fractals, numerical mathematics, and number theory including public-key encryption and prime certificates. The final seven chapters are aptly termed "advanced projects" and investigate problems such as the four-color theorem, the Riemann hypotheses, and the Banach-Tarski paradox. Even the professional mathematician is likely to learn many things from this book.

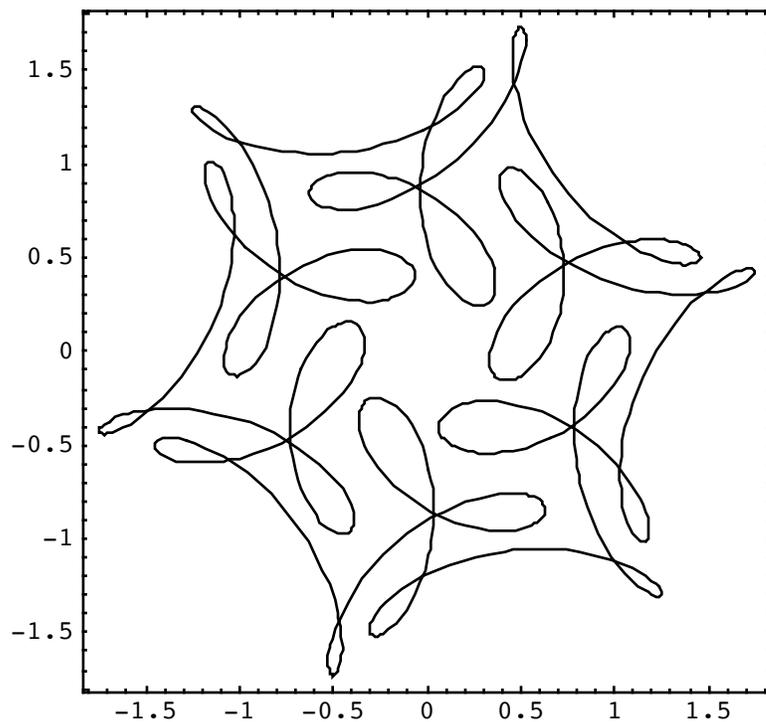
The applications range from simple one-liners to fully developed packages. Here are three examples to illustrate the spectrum. The choice of examples is somewhat arbitrary and shows my predilection for graphics. Not all of the book's applications involve graphics.

The first example, from section 1.7, is a one-liner yielding a pretty parametric plot. The result is a triple orbit, such as the path of a ship in orbit around the moon relative to the sun.

```

ParametricPlot[Evaluate[{Cos[t], Sin[t]} +  $\frac{1}{2}$ {Cos[7 t], Sin[7 t]} +
 $\frac{1}{3}$ {Cos[-17 t +  $\frac{\pi}{2}$ ], Sin[-17 t +  $\frac{\pi}{2}$ ]}, {t, 0, 2  $\pi$ },
AspectRatio  $\rightarrow$  Automatic, Frame  $\rightarrow$  True, Axes  $\rightarrow$  False];

```



In spite of the simplicity of this example, it illustrates an important point. Wagon is a mathematical enthusiast who keeps up with current work. In fact, the above image was taken from a recent article in *Mathematics Magazine* [Farris 1996]. The results of the author's readings are incorporated in an extensive bibliography.

The next example, from section 17.4, plots all of the Gaussian primes less than 50 in absolute value. All the necessary concepts involving Gaussian primes are outlined in the chapter.

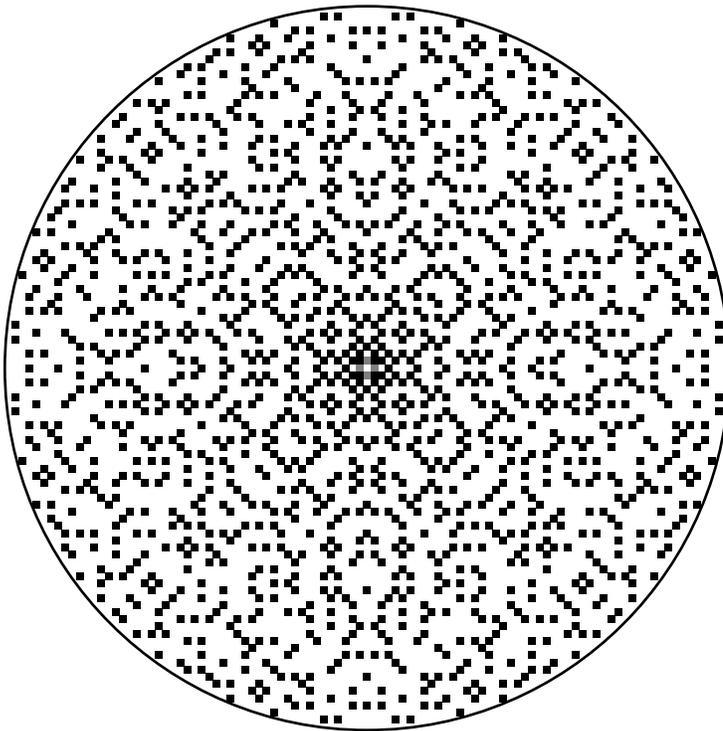
```

boxes[{x_, y_}] := Rectangle /@
  {{x, y}, {y, x}, {-x, y}, {y, -x}, {x, -y}, {-y, x},
   {-x, -y}, {-y, -x}};

GaussianPrimePlot[n_, opts___] := Show[Graphics[{
  Circle[{0, 0}, n + 0.5],
  {
    {GrayLevel[0.5], boxes[{1, 0}]},
    boxes[{Re[#], Im[#]}] & /@ Select[Flatten[
      Table[a + b I, {a, 0, n}, {b, 0, a}],
      Abs[#] ≤ n && PrimeQ[#, GaussianIntegers → True] &
    ] /. {x_?NumericQ, y_} → {x, y} - 0.5}],
    opts, AspectRatio → Automatic];

GaussianPrimePlot[50];

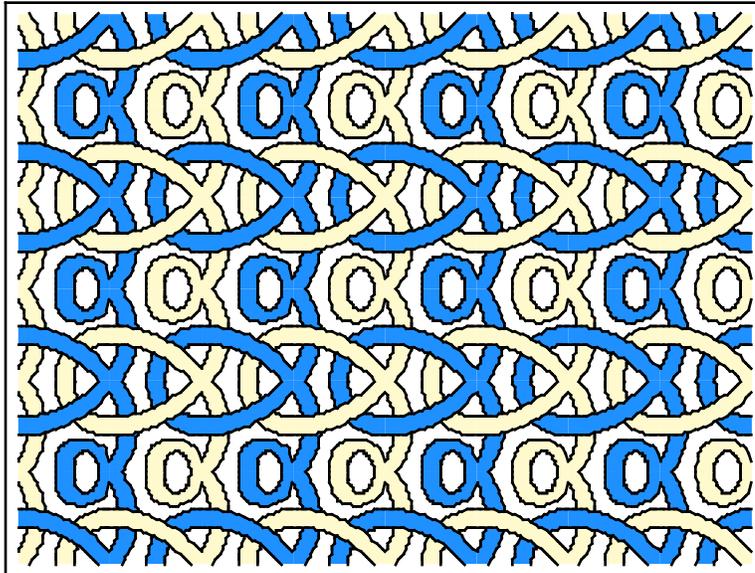
```



This example is clearly a bit more advanced than the last and underscores the fact that Wagon not only keeps current on recent work, but contributes to it. This code is further developed later in the chapter to illustrate ideas in an article by Wagon which appeared in the *Monthly* [Gethner, Wagon, and Wick 1988].

The final example uses a package (on a CD which comes with the book) by Wagon and Rick Mabry to automate a process due to M. C. Escher.

```
Needs["Escher`"];
EscherTiling[{{1, 1}, {-1, -1}},
  Motif -> EscherCurves[24], Size -> {8, 6}];
```



The **Escher** package is fully developed and its use requires only a modest understanding of Escher's notation. This notation and the mathematics behind the package is fully explained chapter 22. The next two chapters also come with fully developed packages, the **PlaneGeometry** package and the **GraphColoring** package.

If the job of a  $\beta$ -tester is to break software, I suppose that part of a book reviewer's job is to find problems. My only complaints are minor and seem to stem from *Mathematica*'s limitations as a publishing tool. For example, there is a font problem in the code at the bottom of page 37 and the output at the bottom of page 49 seems to indicate that  $2931374143 \mid 50!$ . Slightly worse are missing curly brackets in the definition of **groupExtend** on page 557. Finally, the bibliography, while extensive, has a confusing labeling scheme and several mistakes. For example, there are two references labeled [GW] half a page apart..

Again, these complaints are minor. I have been through the book extensively and virtually all of my complaints are listed in the paragraph above. This should be taken as a compliment for a work of this magnitude. The bottom line is that *Mathematica in Action* is an outstanding book containing many examples of real uses of *Mathematica* for the novice, intermediate, and expert user.

## References

- Frank Farris 1996. Wheels on wheels on wheels -- surprising symmetry. *Mathematics Magazine*. 69:185-189.
- E. Gethner, S. Wagon, and B. Wick 1998. A stroll through the Gaussian Primes. *American Mathematical Monthly*. 104:327-337.
- Stan Wagon 1999. *Mathematica in Action* (2nd edition). Springer-Verlag NewYork