Science by simulation, volume 1 by Andrew French, pp 288, £40 (paper), ISBN 978-1-80061-121-4, World Scientific (2022)

This is at least as much a book about mathematics as it is about physics and it should be of interest to teachers of able pupils at any age from 13 to undergraduate. Andrew French begins by asserting that to appreciate science fully "you have to build the associated mathematical models yourself", and, like several physics teachers of my acquaintance, he deplores the dilution of mathematical content in school physics in the name of accessibility. French worked as a Radar Systems Engineer and now teaches at Winchester College, and with the material presented here he shows how able pupils can be given stimulating and profoundly educational experiences without a lot of expensive laboratory equipment.

I was absolutely delighted to read the first main chapter in which the famous and tragic outbreak of plague in the Derbyshire village of Eyam in 1665 is modelled in a variety of ways—as done initially in conjunction with a College production of *The Roses of Eyam*. French presents a series of population models and solution methods of increasing sophistication, developing different mathematical and computational techniques as required; the former include stochastic methods such as the Poisson distribution. The analytical and numerical methods used deploy MATLAB and other commercial software, and there is a photograph of an amazingly Heath-Robinsonesque machine built specially as an analogue illustration of one of the solutions. Towards the end of the chapter the models are applied to the COVID-19 pandemic, French arguing that a graph of the number infected (I) against time would have been a better metric than the universally-quoted r (he considers that the most likely definition of r, which has never been defined entirely explicitly, is $1 + \delta I / I$). It is easy to imagine this work enthusing pupils to an exceptional degree.

The introductory chapter discusses a simple experiment: for a cup with a hole in the bottom, how does the time needed for the cup to sink depend upon the size of the hole? This requires minimal equipment and is well suited to the construction of a model. Subsequent chapters are rather more prosaic. Bayes' Theorem is explored, with nice coloured plots to illustrate the diagnostic conundrum, together with the splendid inverse problem: how accurate does a diagnostic test need to be? The logistic mapping and its associated bifurcation diagram receive a chapter, including analysis of the simpler cases; the Mandelbrot set is introduced, mainly as motivation for the use of complex numbers. All these are topics that many teachers will already be using in their classrooms when the relevant syllabus material requires illustration, though here we are given some rarely-seen technical details. Rather more advanced, perhaps, are the equations for the double pendulum, the probabilities of different configurations being plotted in phase space. A chapter is devoted to exploring the "International Standard Atmosphere", an idealised model of the variation of air pressure and temperature with altitude, and here quite a lot of concepts and equations are used. Chapter 7 discusses the geometry of rainbows, chapter 9 the radar equation together with linear chirps and matched filtering, and chapter 10 models of the earth and their uses for navigation. The last two chapters take us firmly out of the classroom and into the 'real world': modelling money and mortgages (plenty here for social education) and 'Power to the People' in which the difficulties of obvious alternatives to first-past-the-post in voting for the UK Parliament are discussed and a recommendation presented.

As a whole, the chapters are undoubtedly heterogeneous in approach as well as in content, and I suspect that the rationale behind the choice of material presented reflects the specific needs of physicists. The subtitle of the book is *A mezze of*

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mathematical models, and presumably volume 2 will in due course be more directed to applications. Meanwhile, the material on the atmosphere, on rainbows and on radar can be used for group or individual investigations on a rather smaller scale than the Eyam material, though some skill would be needed to avoid mere replication. The book is largely well-written (despite an odd preference for "shall" over "will") and is very attractively presented with few typos that I noticed.

I thoroughly agree with the view that potential physicists should be given open-ended tasks that develop their enthusiasm and intellectual curiosity, and not just be restricted to the content of examination syllabus. French shows conclusively that it can be done, and provides the material and knowledge that would otherwise be stumbling blocks. All school physics or mathematics department with any interest in real education within their subjects should have a copy of this book—and, perhaps above all, those who think they can't do it.

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The one true logic: a monist manifesto, by Owen Griffiths and A. C. Paseau, pp 232, ISBN 978-0-19-882971-3, Oxford University Press (2022).

This book has been written by philosophers for philosophers. As a mathematician with a long-standing interest in mathematical logic, I found the philosophy hard going. I fear that as a result my attention flagged, and as a result the criticisms I make below may reflect my failure to understand what the authors were saying, rather than defects of the book itself.

The authors' aim is to present a logic which captures the semantic consequence relation of *cleaned up* natural languages. They say that a cleaned up language is one 'purged of ambiguity' but nothing more precise than this. This left me wondering whether self-referential sentences such as 'this sentence is false' are allowed in a cleaned up language and, if so, how it would be dealt with in their system of logic.

For the authors a *true logic* consists of a language ℓ and a formalization process which translates a statement s of the cleaned up natural language into a sentence $Form_\ell(s)$ of ℓ so that for all statements s and all sets S of statements, s is a logical consequence of S, if, and only if, $Form_\ell(S) \vDash_\ell Form_\ell(s)$, where $Form_\ell(S) = \{Form_\ell(s) : s \in S\}$.

Here $\vDash_\ell$ is the semantic consequence relation of model theory introduced by Tarski:

$\Sigma \vDash_\ell \sigma$ if, and only if, every model of the set of sentences Σ is also a model of σ. A model of a sentence is a structure which provides an interpretation of the non-logical symbols in such a way that the sentence is true when the logical symbols are interpreted in the standard way.

For the authors of this book, 'the standard way' is as in classical two-valued logic. You might have expected in what is said to be a monist manifesto that detailed arguments would be given for rejecting alternatives to classical logic, and in particular intuitionistic logic. However these are dismissed rather quickly. A lot of weight is put on the argument that while many logicians have studied non-classical logics, 'virtually all logicians use a single (classical) logic in their metatheory'.