“Exploring Quantum Physics through Hands-on Projects”, David Prutchi and Shanni R. Prutchi, John Wiley, Hoboken, NJ, 2012. 261 pp, ISBN 978-1-118-14066-6 (pbk): $76.95.

In the Introduction, the authors state that their goal is "to build an intuitive understanding of quantum mechanics through hands-on construction and replication of the original experiments ... We have worked and reworked the math so that it is accessible to anyone with a knowledge of high school algebra, basic trigonometry, and if possible, a little bit of calculus". For the most part, they have met and exceeded these expectations in this unique little book, which combines simple explanations of the basic principles with practical experiments that the high school or college instructor, or a well-equipped amateur scientist could perform. The apparatus are described in great detail, to the extent of giving circuit diagrams, part numbers from McMaster-Carr, and photographs of the home-made apparatus. The flavour of this book book is reminiscent, for those of us old enough to remember, of.the "Amateur Scientist" articles by C.L. Stong in Scientific American.

Chapters 1 and 2 discuss the wave and particle aspects of light, respectively. Here we find experiments on wave optics done on a more accessible scale by using microwaves generated by a Gunnplexer from a surplus radar gun, and apparatus to observe the photoelectric effect. Chapter 3 deals with atoms and radioactivity, The reader learns how to build a CRT from chemistry glassware and a refrigeration pump, and duplicate Thomson's experiments on the properties of the electron. Instructions are also given on how to modify a surplus civil-defence Geiger counter to count alpha, beta, and gamma rays, and to build a demonstration of Rutherford scattering.

The heart of the the exposition on quantum mechanics starts in chapter 4, where we build a diffraction-grating spectroscope, couple it to a digital camera, and analyze the spectral lines of various gases. The authors' explanation of the Rydberg series by Bohr on page 114 could immediately have been made more complete with a simple half-page derivation based on either requiring the orbital angular momentum to be quantized in units of h-bar, or by requiring the circumference of a circular orbit to be an integral number of deBroglie wavelengths; this is certainly within the scope of high-school math that the authors set as the boundary conditions of the book. The connection between allowed orbits to deBroglie waves is eventually stated on page 138, but by then the Rydberg formula has been long passed.

Regarding safety generally, I'd like to see each experiment have its associated hazards highlighted in a box, rather than just have a general note on safety hidden in the introductory chapter. The senior author is an electrical engineer and knows how to handle high voltage safely, but amateur scientists working in the home may not. I fear some novice may buy some speaker wire from the dollar store and use it in place of proper SHV cables to power the photomultiplier!

I am unhappy that the authors tell us that smoke detectors are a source ^{241}Am but that in the US, it is illegal to pry open the encapsulation. This is practically an invitation to do just that! The radioactive source is safe as encapsulated, but there are limitless possibilities for abuse once removed. What if someone drills into the speck of radioactive Americium, pulverizes it and then inhales the dust?

The discussion of the Mach-Zehnder interferometer on page 192 in incomplete; it is not obvious from the information given that one path results in constructive interference, and the other path in destructive interference. There needs to be a discussion of the phase changes at the interfaces, as discussed, for example, at

https://www.cs.princeton.edu/courses/archive/fall06/cos576/papers/zetie_et_al_mach_zehnder00.pdf

The note at the bottom of page 207 should read "two spin one-half particles", not "two minus one half spin particles".

Chapter 8 (Entanglement) discusses the most fascinating, yet most difficult aspect of quantum physics. Here the book falls a little short. I suspect that a reader who starts the book needing to learn about interference and the photoelectric effect from scratch will find this chapter too steep a learning curve. The treatment here is more brisk and less thorough than elsewhere in the book, and some statements are unclear. For example, the first sentence on page 231 states that "this joint measurement does not allow Alice to determine the individual polarizations of either [photon] A or x...". But a single measurement NEVER allows one to determine the initial polarization of a SINGLE photon, in the sense of determining that it is 50% polarized or 80% polarized, relative to some axis; this can be determined only by making measurements of pass/nopass through a polaroid at a fixed angle, for a sample of many photons. It is therefore not clear how it is possible, as stated in the next sentence, that this single measurement can determine the relative polarizations of the two photons A and x. It would be more accurate to say that a single measurement forces a collapse of the entangled wavefunction of the two particles so that they are forced into a particular relationship between the polarizations of photons A and x. This chapter is nevertheless valuable, even if only to give the reader a glimpse of the awesome possibilities of quantum teleportation and quantum cryptography.

This book, by virtue of the extravaganza of experiments described in detail, would be a superb foundation of a lab-based course in quantum physics. It will be particularly valuable for lab instructors. With the caveats mentioned above, it is highly recommended.

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