Book: The 4% Universe: Dark Matter, Dark Energy and the Race to Discover the Rest of Reality Book: Quantitative Understanding of Biosystems: An Introduction to Biophysics Book: Edison's Electric Light: The Art of Invention Book: The Edge of Physics: Dispatches from the

2011 Phys. Educ. 46 718

(http://iopscience.iop.org/0031-9120/46/6/M02)

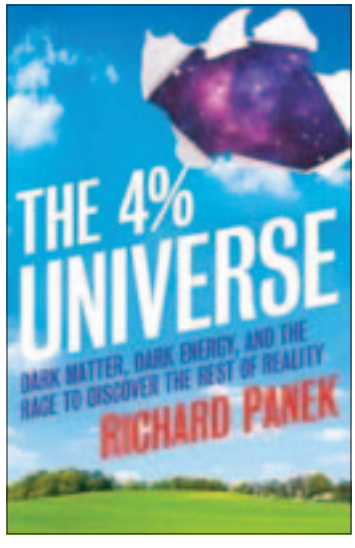
BOOK: THE 4% UNIVERSE

Book researches the Universe

This is an ambitious attempt by Richard Panek, a science writer, to explain the science background to the history of the cosmological and the Hubble constants, and to chronicle the race by two competing teams of scientists to determine these to increasing degrees of accuracy.

The prologue describes an event in 2009 that revealed the results of contemporary research into dark matter. The commentary then turns to the history of astronomy and more recent research into the origin of the Universe. The book introduces this story by examining the work of scientists, mainly from the US. The story of the contributions of Vera Rubin runs throughout the book. Rubin was one of the first astronomers to look seriously for a connection between gravity and galaxies, and the story of her career and persistence in pursuing dismissed ideas is well documented. (She also featured in a BBC documentary, *Most of Our Universe is Missing*, which gives a more European perspective on the same topic.)

In the notes at the end of the book Panek gives a very long and impressive list of the physicists, astronomers and cosmologists



he has talked to or corresponded with. Much of the book consists of quotations from these interactions and also from e-mails sent and discussions between the scientists. While these extracts give an insight into the personalities, interaction, co-operation and competition, the science at times is obscured and also confused, for example in the section that introduces the anthropic principle. There are no illustrations in the book, not even a graph to illustrate the Hubble Law, which features repeatedly in the story.

I began to read this book hoping that it would be as engaging as Watson's *The Double Helix*, and thinking it would be one to add to the recommended summer reading list for A-level physics students (16–18 year olds). While the book does give interesting information about the background to research in this area, I now think that this is a book for teachers rather than students.

Ruth Wiltsher

WORTH A LOOK

The 4% Universe: Dark Matter, Dark Energy and the Race to Discover the Rest of Reality

Richard Panek

Rating: ★★

Price: £10.99

Details: Published 2011 by Oneworld, paperback, 296 pp, ISBN 9781851688210

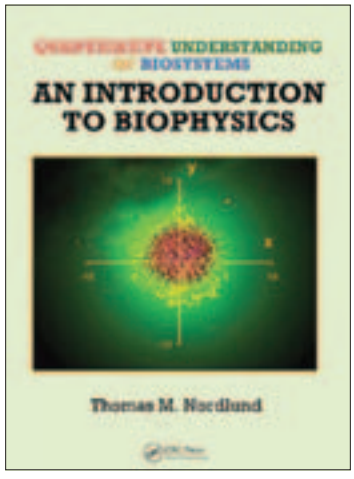
BOOK: QUANTITATIVE UNDERSTANDING OF BIOSYSTEMS

Text applies physics to biology concepts

Novels written in the first person or documentaries on television that have a voiceover guiding you through the on-screen content are similar in the sense that you are in a comfortable position being read a story, much like a parent to their offspring at bedtime. The opening pages of Nordland's text remind me of this wherein the author 'talks' to you about the theme, which is obviously a passion. The scope of the textbook is to bring various disciplines together without putting off the non-mathematically or physically minded biologists or chemists and doing the same for

physicists. What is also clear is that this book is an introductory course that has many excellent references for further study and useful resources included (in addition to the accompanying DVD contents).

The title is accurate as a description of the course contents, it is clear that the main thrust is to provide an understanding of biological systems, at various scales, in a quantitative manner. There are interesting and important considerations when going from non-living to living systems, and ideas that are taught at high-school level such as Brownian motion or ideal gas theory are shown to be essential for understanding biological processes. Indeed, moving from either first-year undergraduate-level biology, chemistry or physics to biophysics requires a different approach and the text not only leads students towards this but does not baulk at applying 'advanced' maths if the topic requires it. The author is humble in his assessment of the book as



an introduction because it excels as a course text and is structured so that all relevant background material is present, but where it may be lacking, the references are clear. Moreover, the exemplars, problems and study guides are liberally distributed throughout the text providing excellent resources for the diligent student.

It was a pleasure to read an anecdote regarding the physics joke about the 'spherical cow' because this is an excellent example of how the book brings the worlds of biosciences and physical sciences together, by quantitative understanding of processes in real systems rather than (often necessarily) simple models.

James Perkins

WE RECOMMEND

Quantitative Understanding of Biosystems: An Introduction to Biophysics

Thomas M Nordlund

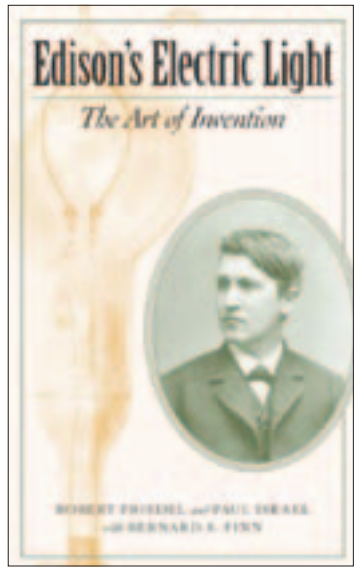
Rating: ★★★★ A bit hefty and expensive but a useful library resource

Price: £57.99

Details: Published by CRC Press, hardback, 583 pp plus CD-ROM of resources, ISBN-10 1420089722, ISBN-13 978-1420089721

BOOK: EDISON'S ELECTRIC LIGHT

Edison's light still shines



It is more than 120 years since Edison revealed his incandescent lamp to the world. This book tells the story of that invention. For any scientist who enjoys the experimental side of his or her profession then this book highlights the methods, successes and failures of one of the great experimental inventors of all time. It follows the tortuous path from the basic idea to the birth of the first carbon filament bulb in the 1880s. But can a subject like this be a good read? Surprisingly it is. While there are moments when the book gets a little bogged down in the detail, the pace is still there and you are able to share the highs and lows associated with the intense experimental research at Menlo Park—Edison's first experimental research laboratory. This is one of those books that, once you give it time to grab your interest, you cannot put down.

Its 200-plus pages take you

on a tortuous ride from the basic idea to the first illuminated streets in New York, and is well worth the effort getting into it. Edison was a true genius and this book shows him at his workaholic best.

John Kinchin

WE RECOMMEND

Edison's Electric Light: The Art of Invention

Robert Friedel and Paul Israel

Rating: ★★★★

Price: £15.50

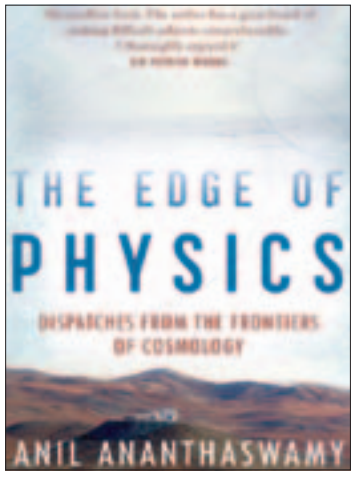
Details: Published by John Hopkins University Press, paperback, 248 pp, ISBN 9780801894824, www.press.jhu.edu

BOOK: THE EDGE OF PHYSICS

Anecdotes explore cosmology

This generally well written book combines three major ingredients in roughly equal parts: travelogue; depictions of various technicians, engineers and experimentalists interacting at work; and discourse about how and what we know or don't yet know about the Universe. (With ordinary matter such as stars and planets making up only 4% of the cosmos, an awful lot remains darkly unknown.) The first two ingredients ensure an engaging narrative and demonstrate the huge ingenuity and determination necessary at the cutting edge of science. The third essential ingredient conveys the significance of many contemporary cosmology research projects, most of them exploring dark matter and dark energy.

During a five-year period from 2004 to 2009, Ananthaswamy visited the historic observatories on Mount Wilson and Mount Palomar, which led the way with ideas about an expanding Universe and dark matter; the Cryogenic Dark Matter Search situated deep underground in the Soudan mine, Minnesota; the underwater neutrino telescope in Lake Baikal; the Very Large Telescope in Chile's Atacama



desert; the Keck optical telescope on Mauna Kea; the Karoo region of South Africa, which is bidding to build the Square Kilometre Array, a gargantuan radio telescope; the IceCube neutrino telescope in Antarctica; the Large Hadron Collider at CERN; and a media briefing in Cannes about ESA's Planck satellite mission.

This book is full of engaging anecdotes and detailed descriptions of apparatus. Ananthaswamy gives clear explanations of each experiment, including why it is located where it is, even when the chosen environment is extreme and operationally difficult. Interspersed within the narrative is an exposition of the Standard Model of particle physics, key questions for Big Bang cosmology today and plans for the next generation of cosmological data gathering. As expected, the general theory of relativity gets repeated attention, as do cosmic background radiation and gravitational lensing. There are incidental asides about Scott's Antarctic expedition, plate tectonics and climate change.

Peter Campbel

WE RECOMMEND

The Edge of Physics: Dispatches from the Frontiers of Cosmology

Anil Ananthaswamy

Rating: ★★★★

Price: £16.99

Details: Published 2010 by Duckworth Overlook, London, 280 pp, ISBN 978-0715637043

EQUIPMENT: VOICEBOX

Voicebox kit discovers the physics and evolution of speech

Several experiments are proposed covering the generation of sound and the application of physics to the human voice. Two of these experiments involve the buzzing reed kit (SEP 265) and the vowel resonator kit (SEP 266).

Both pieces of apparatus are—as usual with Mindset's apparatus—simple but effective. (Mindset is the new name for MUTR, which markets the apparatus associated with the Science Enhancement Project.)

Buzzing reed kit

This is simple and very easy to build. It consists of a split plastic tube and a plastic reed. The two halves of the tube are joined, sandwiching the reed between them. By blowing into the assembled oscillator a number of sounds can be generated when used in association with the vowel resonator kit. On its own the buzzing reed kit is limited in its use. I was surprised to find that it was sold on its own and not part of the vowel resonator kit. However, this allows more than one student to use the kit and so does have some logic to it.

Vowel resonator kit

This bit of equipment has very little use on its own, but the kit allows the formation of different vowel sounds when used in association with the buzzing reed kit. Consisting of a number of

cut lengths of plastic pipe/foam tube, these are joined together with masking tape—although I found it just as easy to hold the simple combinations together. Sounds that mimic 'oo', 'ih' and 'ahh' can be produced. At first my efforts did not sound anything like the sample sounds provided; these were obviously produced by a practiced performer. However, after advice from a musical colleague I did manage to produce a reasonable approximation to the sample sound.

The apparatus is easy to use and with younger students would make an ideal practical investigation into the human voice. For older students the use of Audacity1 or similar software to analyse the frequency range of the sound produced would be an excellent extension.

These two pieces of apparatus really need to be used together; they are extremely limited on their own and as such I would have expected them to come as a combined set. When joined they allow a range of experiments that would interest students. As always the apparatus is simple but excellent and can, with a little ingenuity, be extended into a more diverse investigation into the structure of the sounds produced.

Individually they are just two parts of one kit, and are limited in what can be done with them, together they are an interesting extension to the usual sound experiments.

John Kinchin

WE RECOMMEND

Voicebox: The physics and evolution of speech, Buzzing reed and Vowel resonator apparatus

Mindset

Rating: ★★★★

Price: £3.50 (buzzing reed kit), £6.50 (vowel resonator kit)

Details: SEP 265 (buzzing reed kit, www.mindsetsonline.co.uk/product_info.php?products_id=1009788) and SEP 266 (vowel resonator kit, www.mindsetsonline.co.uk/product_info.php?cPath=18_622_623&products_id=1009789) www.download-audacity.com

EQUIPMENT: TRACKER 4

Free software tracks motion

Tracker is one of those pieces of software that is worth spending time getting to know. Its usefulness increases with knowledge. Initially it seems to be like any other motion-analysis software, but this is where your first impressions will turn out to be wrong.

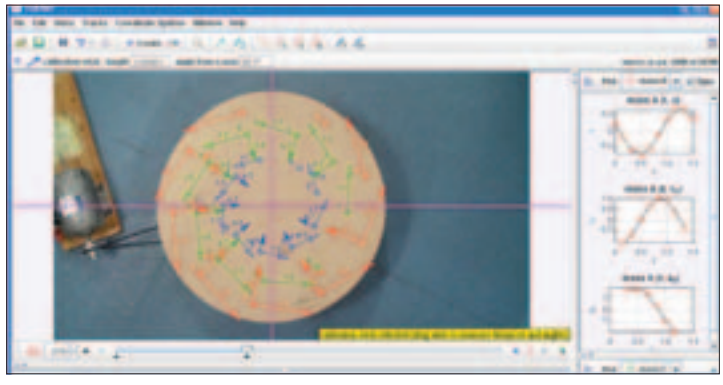
First of all the software is free, a good start for impoverished schools. The second point is that it comes with a number of examples and a reasonable help file, although this could be better in some cases.

Importing a video could not be easier. Most video formats are acceptable and these were handled with ease. Using a fair range of video input devices, Tracker readily took in mobile phone cameras, webcams, digital cameras and even a professional-quality movie camera.

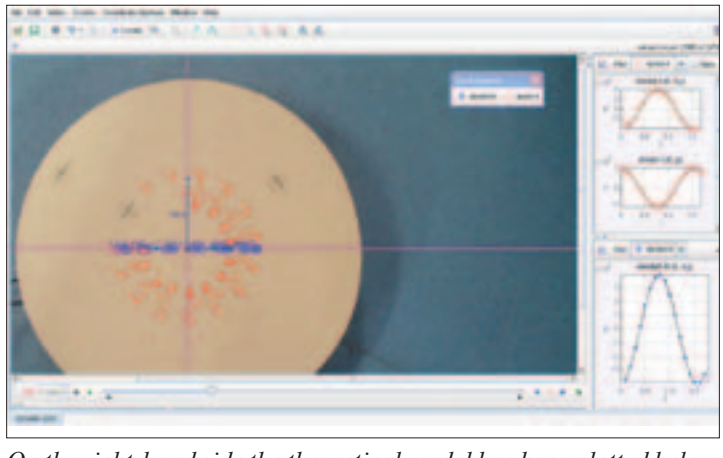
Once inserted, it was again easy to create a point mass and track the motion. It is worth thinking about how you will mark your point. A circle with a cross or similar will allow easy identification of the target point. Shift clicking on a designated point will mark it. It will usually then move on to the next point automatically. You can auto-track and I have found this useful. However, I did find this frustrating when it decided that it couldn't recognize the next point. In many cases this was down to my choice of marker, but occasionally it just didn't want to oblige no matter what I tried.

Once marked the analysis options are superb.

Plotting the motion vectors is as simple as clicking the relevant icon. Either velocity or acceleration can be shown. It is also possible to create a theoretical model and fit this to the data. This is very powerful and allows students to play with the data and really get to understand what the different parameters mean. Using simple harmonic motion, it allowed the students to understand what the different components of $x = A\sin(\omega t)$ did to the model and how it related to the real data they had in front of them.



Circular motion modelled. The different speeds of the points at different radii can easily be seen.



On the right-hand side the theoretical model has been plotted below the actual data (top and bottom graphs on the right-hand side).

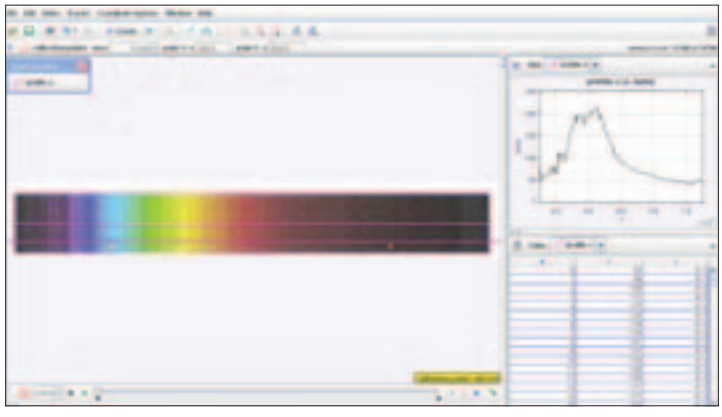
Many more models can be demonstrated. In a short review it would be impossible to cover them all. However, Tracker will also analyse dynamic motion with more than one object and allow forces to be shown and incorporated into motion analysis. Gradients and areas under graphs can be shown and calculated allowing Tracker to be used at GCSE (14–16), A-level (16–18) and above. I have not done justice to the range of activities available

to users of Tracker.

Also incorporated are tools to analyse optical data. I found this most useful and have used it to analyse photographs of laboratory spectra. Once again nothing more than a webcam or camera is needed to do quite sophisticated analysis of a wide variety of spectra and diffraction patterns (e.g. a single-slit diffraction intensity at different wavelengths, using different-coloured laser pens).

Its ease of use is once again impressive. Accessing a photo (poor-quality, low-resolution) image of the solar spectrum from the internet allowed me to quickly show that the maximum wavelength was around 550 nm, although I must admit that I could have been much more careful with my calibration points.

Tracker in mechanics, optics and mathematics is just outstanding and where there are minor faults they are easily forgiven considering the software is free and works in a way that is easy to understand. It is one of the most useful pieces of software that I have and just goes to show that sometimes high-cost software is not the best.



Analysis of a spectrum.

Tracker is provided by the Open Source Physics project and is available for download at www.cabrillo.edu/~dbrown/tracker.

John Kinchin

WE RECOMMEND

Tracker 4

Open Source Physics

Rating: ★★★★★

Details: www.cabrillo.edu/~dbrown/tracker

BOOK: LABVIEW

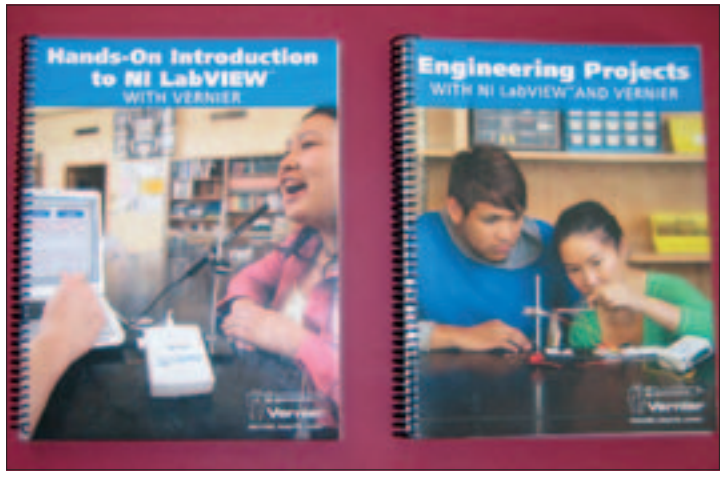
Books support LabVIEW™ software

If you are thinking of purchasing LabVIEW™ 2009 Education Edition (see my article and review in the July 2011 edition of *Physics Education*) or the just released updated version, LabVIEW™ 2010 for Education, and you'd like to use them with Vernier SensorDAQ®, LabQuest or LabQuest Mini, the two books in this review will provide support.

Hands-On Introduction to NI LabVIEW™ with Vernier explains clearly how LabVIEW™ programs called virtual instruments (VIs) are constructed with graphical code on the block diagram with the displayed instrument on the front panel. It is a revision and extension of the earlier edition *Hands-On Introduction to NI LabVIEW™ with Vernier SensorDAQ®*, which, as its title suggests, was for use only with SensorDAQ®.

Through copious screenshots the operations by which code is placed onto the block diagram and wired are explained in a hand-holding manner, which is ideal for newcomers to LabVIEW™. Useful exercises are provided to give students and teachers experience of developing VIs, which put sound wave graphs on screen much as you would expect on an oscilloscope. Follow-up VIs are developed, which bring in analysis of sound waveforms giving details of frequency and amplitude and allowing additional filtering. Fast Fourier Transform (FFT) analysis is then brought in to complete the likely needs with a microphone sensor. Simple thermometer display VIs are developed displaying both graphs and thermometer-type

bars, and then extended to show how a warning message VI could be constructed to indicate that the temperature had exceeded a particular value. While unlikely to be of use in science education, one program is developed that allows conversion from Celsius to Fahrenheit and vice versa; little amendment would be needed to substitute Celsius to Kelvin, or any other conversions that crop up. All have debugging and contextual help advice. Full details can be seen on the Vernier website at www.vernier.com/lwv.



For use in science education I would have liked to have seen exercises related to XY graphs and best-fit lines: plotting voltage-current graphs to see if components obey Ohm's law, or finding absolute zero by plotting a pressure-temperature graph and extrapolating back. They would only have required the purchase of an additional current probe and gas pressure sensor. Also how to obtain integrals/areas under graphs, and first and second derivatives with respect to time plotted as displacement-time graphs.

Sections are also provided on working with While and For loops, decision making, building arrays and how to create and use sub-VIs (the equivalent of subroutines in many other programming languages). It also has a couple of exercises using SensorDAQ®'s screw terminal, how to set it up through the DAQ Assistant VI and then how to control its Analogue Out, Digital Out and Pulse Out facilities.

Ideas for extensions to the simpler tasks are suggested and two more detailed projects—building a sensor control program and cell phone decoder—are posed. The projects have additional information for teachers.

Appendix A gives information about the CD-ROM that comes with the book—it contains all of the chapters and exercises in Microsoft Word format (Word 97 or newer), which can then be adapted, copies of all of the LabVIEW™ VIs used, and installers for Windows and Macintosh computers if required. Appendix B lists the equipment and other supplies needed. Appendix C shows which activities can be developed on which Vernier interface and the sensors needed. Appendix D deals with software installation. Appendix E indicates that there may be small differences in screenshots with the different versions of LabVIEW™ and in using Windows instead of Macintosh computers. Appendix F addresses common programming errors and Appendix G gives some advice on using the book in the classroom or laboratory.

Engineering Projects with NI LabVIEW™ and Vernier is an invaluable follow up for those who have already gained some experience with LabVIEW™. Although its title suggests that it can only be used with engineering or technology classes, much of the book has applications in physics and wider science education.

It begins with a brief 'Getting started' chapter with some information and exercises that will prove essential as the students embark on any of the series of 12 projects with challenges and extreme challenges, each accompanied by information for teachers and programming/construction tips and notes on troubleshooting. They increase in complexity and difficulty as the user progresses through the book. As with the earlier book it is designed for use with Vernier SensorDAQ®, LabQuest and LabQuest Mini, with all bar two projects being available for all three interfaces ('servomotors' and 'PID ping-pong ball levitation' only operate with SensorDAQ®), although some extreme challenges can only be tackled with SensorDAQ®. However, quite a few of the projects require the use of the digital control unit (DCU), one or two use the instrumentation amplifier or power amplifier, and some need the Vernier Breadboard cable, analogue proto board connector

or digital proto board connector, plus a number of sensors and ancillary components.

The simplest project is 'Build a temperature sensor' in which a program is developed to first calibrate and then measure temperature using a thermistor. Background information is provided on the voltage divider circuit and the Steinhart–Hart model relating resistance to temperature. The 'Digital control systems' project addresses automatic temperature control using a light bulb to provide heating, a fan to provide cooling and a Vernier surface temperature sensor to sense the temperature. While it is not difficult, it provides an opportunity to introduce the DCU. The 'LED colour mixer' project involves the use of three RGB light-emitting diodes with the task of mixing their colours to provide other colours. Extensions to this project introduce the use of arrays and pulse-width modulation (PWM). The 'Hot-wire anemometer' project is based on the cooling (by a fan) of a Vernier surface temperature sensor heated by a resistor. Using a supplied calibration curve of temperature against wind speed, a wind-speed indicator can be developed, although at a simpler level the idea is to get a sound file played when a specified temperature is exceeded. The 'DC motor control' project is effectively constructing a tachometer to measure the rotational speed of a motor by sensing an attached propeller blade moving through a Vernier photogate sensor. Background information for a related SensorDAQ® challenge is given for PWM. The 'Light intensity and stepper motors' project involves writing a program that causes a stepper motor to rotate a polarizing filter in front of a fixed one to vary the intensity of light passing through them, and to measure and graph that varying light intensity. An extension suggests investigating how well the data obtained matches Malus' law. The 'Servomotor' project can only be tackled with SensorDAQ®. It involves the use of PWM to control the position of a servomotor. Biologists are not left out with the 'Analysing the heart with EKG' project in which the programming of the Vernier EKG sensor allows graphing of an electrocardiogram. Background information on the key features of an EKG are provided. This project brings to the fore the use of cursors, zooming of graphs and, in a challenge, the use of a peak detector VI. Its extreme challenge can lead students to analyse eye movement. Also with biologists in mind the 'Blood pressure' project involves programming with the Vernier blood pressure sensor and its associated BP Analysis VI. The aim is to create a front panel with a graphical display of live pressure readings as well as an alert to tell the cuff operator when to stop inflating the cuff. These last two projects are useful to show students how LabVIEW™ lends itself to real-world medical physics applications of which there are many. The 'Strain gauge measurement' project brings you back to the realm of physics and introduces the Wheatstone bridge circuit and the use of the Vernier instrumentation amplifier. The 'Propeller-powered pendulum' project appeared to me to be a novel means of automatically controlling the angle of swing of a bar pendulum, the spinning blades of the propeller or fan attached to the bar producing the torque to move the bar. A related extreme challenge involves the use of PID (proportional, integral, derivative) control for which essential background information is provided. PID is also used in the final 'PID ping-pong ball levitation' project in which the task is to enable a ping-pong ball inside a tube to levitate at a controlled position on a current of air produced by a fan. Not an easy task, but one that relates to hovercraft and, although the means of levitation is different, to Maglev transportation. Full details of each of these projects are on the Vernier website at www.vernier.com/epv.

Appendices A and B are the same as in the first book. Appendix C is particularly useful in that it provides specific information on the Analogue Express VI, the Digital Express VI and Power Amp Express VI, in the contexts of the projects. Appendix D provides an overview of the three interfaces and details of the sensors needed. Appendix E has information on the sensors used, on the DCU, the power amplifier, Breadboard cable, analogue proto board connector and digital proto board connector. Appendix F provides an overview of SensorDAQ®'s screw terminal connector and how to program its use with the DAQ Assistant VI. Appendix G lists the non-consumables and consumables that are needed for each project.

This is a superb resource to take engineering students forward in programming with LabVIEW™, although I hope that science students will also find it useful.

Chris Butlin

WE RECOMMEND

Hands-On Introduction to NI LabVIEW™ with Vernier

Compiled and created by Sam Swartley, aided by many others

Rating: ★★★★

Price: £26.00

Details: ISBN 978-1-929075-21-8

Engineering Projects with NI LabVIEW™ and Vernier

Principal author Michele Perrin, with Steve Decker, Sam Swartley and Dave Vernier

Rating: ★★★★★

Price: £50.00

Details: ISBN 978-1-929075-62-1

Both are published by Vernier Software & Technology, 13979 SW Millikan Way, Beaverton, OR 97005-2886, USA, www.vernier.com, e-mail info@vernier.com. Distributor in UK: Instruments Direct (Services) Ltd, Unit 8 The Courtyard, Stenson Road, Coalville LE67 4JP, www.inds.co.uk, e-mail sales@inds.co.uk, tel 01530 832500, fax 01530 817087

PLACES TO VISIT: DISCOVERY MUSEUM

Newcastle museum offers science enjoyment for all ages and interests

Newcastle is fortunate in having three science centres: Life, the Great North Museum in Hancock, and Discovery. They are all fascinating with good interactive displays; however, for physicists and engineers Discovery, run by Tyne and Wear Archives and Museums, must be the best.

The ground floor of the museum is dominated by the 103 ft *Turbinia*, the world's first steam-turbine driven vessel, which was developed by Charles Parsons, built on the Tyne and launched in 1894. In 1897, at the Spithead review, Parsons demonstrated that *Turbinia* was the fastest vessel in the water, travelling at 40 mph.

The development of the ship was a meticulous process involving models in a pond and many trials. Parsons had to overcome issues of propeller design and cavitation, and his final design used very thin plating and a sharply pointed bow.

Other floors have displays of inventions by local people, including Joseph Swan whose lamps were used in Cragside at Rothbury—the first private house to be lit by hydroelectricity—the home of Lord Armstrong of armament fame and also worth a visit. One lesser known Newcastle inventor was John Henry Holmes who made the first quick-break electric switch. The museum has other sections on fashion, working life and the story of the Tyne to accommodate all interests and ages, with changing exhibitions throughout the year.

On the wet summer day when I visited there were children of all ages actively engaged in the exhibits. There is a cafe, shop and workshops available for school parties and interesting activities on the website.

A visit to the museum is free and so is the audio guide.

Ruth Wiltsher

WE RECOMMEND

Discovery museum

Rating: ★★★★

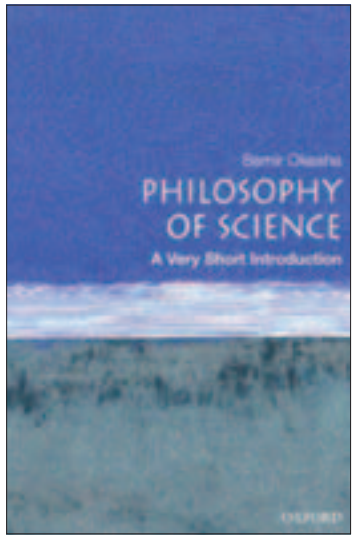
Details: www.twmuseums.org.uk/discovery

BOOK: PHILOSOPHY OF SCIENCE

Philosophy opens up science questions

This is the second book in this series that I have reviewed (the first was about Michael Faraday) and the fourth I've read. Discovering this series has been a real eye-opener and I am drawn to a considerable number of titles on the list (www.veryshortintroductions.co.uk/flash.php) as my experience so far has been wholly positive—good authors, readable if dense books and a sound overview of topics, all backed up with an excellent bibliographies for further reading.

The philosophy of science is a topic that most teachers only meet peripherally—many will be aware of Popper's ideas on falsifiability or Kuhn's concept of scientific revolutions. What Okasha does in this book is put those key 20th century ideas (and other ideas such as realism and instrumentalism) into their historical perspective. The reader is drawn to see Popper's book as a response to Hume's problem of induction and Kuhn as a response to the idea that we can somehow choose purely scientifically between models. For a total beginner to the topic the book would be slow-going but worthwhile. For someone already a little familiar with the ideas it will open many more doors and help to make the philosophy of science more coherent.



The two final chapters open up questions specific to each science, such as the Newton–Leibniz correspondence, classification in biology and the mind followed by a section on science critics. I say 'open up' questions because none of the big issues are resolved. To some that will seem disappointing but to me it resonates with the whole purpose of science—to explore the unknown.

Okasha makes the subject comprehensible and enjoyable. I thoroughly recommend this book and the series. The companion Very Short Introduction on philosophy by Edward Craig is also very approachable and amusingly written.

Ken Zetie

WE RECOMMEND

Philosophy of Science: A Very Short Introduction

Samir Okasha

Rating: ★★★★★

Price: £7.99

Details: Published by Oxford Paperbacks, 160 pp, ISBN-10 0192802836, ISBN-13 978-0192802835

WEB WATCH

Web offers superconductivity imagery

This month I am looking at websites on superconductivity. As this is a popular subject there is a wide variety of sites ranging from university level to that of the interested amateur. The subject is complicated and difficult. The result is that this is an area where authors can struggle to provide accurate and understandable text and it is a good idea to look at several different sites.

The obvious first choice is www.superconductors.org. This site is very inclusive and excellently organized. The author is Joe Eck who is not a professional researcher but has an interest as a well informed amateur (www.superconductors.org/author.htm). His section on the Meissner effect attributes it to induced currents in the superconductor, but this does not explain why a substance

cooled to superconducting temperatures while in a magnetic field also exhibits Meissner effect repulsion. Other sites give a fuller explanation. He gives a good list of links to other sites.

Hyperphysics at http://hyperphysics.phy-astr.gsu.edu/hbase/solids/meis.html goes into the relationship between induced currents, perfect paramagnetism and the Meissner effect fully. The site contains excellent explanations and diagrams. It is good as a source if you are preparing lessons on the subject because it is very inclusive and generally authoritative. This is a reference site and not suitable for students to use as a research resource.

A different type of site can be found at www.msm.cam.ac.uk/ascg/lectures/introduction. It comes from the materials studies department at the University of Cambridge. It is in the form of video clips. The format of each video is a lecture with the subject being passed from one speaker to another and as such is a professional presentation. This is the site to go to if you want to make an in-depth and detailed study of superconductivity. The quality of the diagrams is excellent. The standard is substantially higher than even second-year sixth-form students could generally manage

and the site would be suitable for teachers or perhaps an exceptionally gifted student. There are, however, sections that might be used as part of a science club lecture. The format is streaming video at the moment but DVD (with higher quality) is possible in the future.

A straightforward site can be found at www.coolmagnetman.com/magsuper.htm. This has a few good pictures of levitation that might be useful.

The best source for superconductivity levitation imagery that I found was www.mn.uio.no/fysikk/english/research/groups/amks/superconductivity/levitation from the University of Oslo. There are video clips, which are more convincing than still photographs. One in particular shows magnet lifting of the superconducting material as it is cooled down. There is also an effect in type 2 superconductors where the magnetic field can partly penetrate the superconductor and become trapped. This means that if the magnet is lifted the superconductor will follow it. The magnetic field is locked to the superconductor by microscopic irregularities. The site contains a number of internal links to other superconductivity pictures and information. This is also a high-standard site with excellent presentation but more accessible than the Cambridge site for top students in the sixth-form.

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