Essential Radio Astronomy

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Essential Radio Astronomy. James J. Condon and Scott M. Ransom. 373 pp. Princeton U.P., Princeton, NJ, 2016. Price: $85 (hardcover). ISBN 978-0-691-13779-7. (Gordon McIntosh, Reviewer.)

Radio astronomy has provided a unique perspective on the universe for about 80 years. During that time there have been two canonical texts on the subject: Krauss' *Radio Astronomy* (first published in 1966) and Rohls and Wilson's *Tools of Radio Astronomy* (first published in 1986). *Essential Radio Astronomy* will take its place alongside these as a standard textbook and reference for radio astronomers.

Radio astronomy is a mix of engineering, physics, and astronomy. This book covers these disciplines with good attention to detail and excellent in-text references for further research. The engineering aspects of radio astronomy deal with antennas and radiometers (various sorts of receivers and spectrometers). The factors that limit a telescope's effectiveness at coupling radiation into the receiver system are presented including spillover, the effects of surface roughness, pointing, and primary mirror distortion.

The book offers very nice developments of various radiation mechanisms. The Larmor formula describing the radiation from accelerating charges is developed and used extensively. In fact it would have been useful if the authors had provided a little more foreshadowing of the importance of this particular formula to prepare the reader for its use throughout the text.

The book presents a thermodynamic approach to blackbody radiation. I present the same development of blackbody radiation when I teach modern physics. In this development, a new space of indices is used to calculate the density of states available for the radiation. I remember one student's amazement that physicists can just imagine new spaces when it suits their purposes. I think it is good for texts to include examples of imaginative mathematical tools, such as this index space, that have been developed by physicists to solve problems.

Free-free radiation, synchrotron radiation, and spectral lines each receive their own chapter for development and examples. The synchrotron chapter includes the effects of special relativity necessary to explain synchrotron radiation and also develops the special relativistic explanation of superluminal radio sources. Superluminal radio sources are observed to have apparent motions in excess of the speed of light and are now a well understood example of special relativity that could be used in various physics or astronomy courses. The spectral line chapter includes a discussion of molecular lines and the 21-cm line of hydrogen. The Bohr model of the atom is used as a basis for the discussion of recombination lines and molecular lines. This model is sufficient to describe the examples used in the text, but it would be appropriate to indicate more clearly the limitations of this model for quantum-mechanical calculations.

Chapter 6 addresses the wonderful physics of pulsars and their radiation at various levels of sophistication. Pulsars (rotating neutron stars) provide a laboratory for extreme physical conditions of gravitational and magnetic fields. The authors use basic physics principles, accessible to first-year physics students, to determine the moment of inertia of the pulsar. The chapter ends with a presentation of the extreme accuracy possible through the timing of pulsars and the application of this timing to detect gravitational waves affecting a network of pulsars.

I commend the authors for their commitment to clarity with respect to dimensions and dimensional analysis. Radio astronomical units can be very confusing. It is good to specify the units for each quantity and in each example calculation. And as stated several times in the text, different astrophysics authors have different conventions for various quantities—the handedness of circular polarization, brightness, flux and flux density, and spectral index. It is good to have authors aware of these inconsistencies and warn readers about their existence.

As another example of the possibility for confusion and the authors' attention to detail, there are 14 different physical parameters indicated by the word "temperature" usually preceded by some adjective. These temperatures are all defined clearly in the text and listed in Appendix G.

Overall, I think this is an excellent text that will be widely used for future instruction and reference. It provides interesting historical and background information, well-explained theoretical developments, many of which are accessible to students early in their physics education, and appropriate examples to illustrate astrophysical applications.

Gordon McIntosh is a Professor of Physics at the University of Minnesota, Morris. His professional activities include molecular radio astronomy, particularly silicon monoxide maser observations, and high altitude ballooning.

BOOKS RECEIVED

John Stewart Bell and Twentieth-Century Physics: Vision and Integrity. Andrew Whittaker. 476 pp. Oxford U.P., New York. 2016. Price: $44.95 (hardcover) ISBN 978-0-19-874299-9.

My Dear Li: Correspondence 1937–1946. Werner and Elisabeth Heisenberg (edited by Anna Maria, translated by Hirsch-Heisenberg and Irene Heisenberg). 327 pp. Yale U.P., New Haven, CT, 2016. Price: $40 (hardcover) ISBN 978-0-300-19693-1.

Data Analysis for Scientists and Engineers. David L. Robinson. 406 pp. Princeton U.P., Princeton, NJ, 2016. Price: $75 (hardcover) ISBN 978-0-691-16992-7.

Quirky Quarks: A Cartoon Guide to the Fascinating Realm of Physics. Benjamin Bahr, Boris Lemmer, and Rina Piccolo. 337 pp. Springer, Berlin, 2016. Price: $39.99 (paper) ISBN 978-3-662-49507-4.

The Oxford Handbook of Philosophy of Science. Paul Humphrey (ed.) 939 pp. Oxford U.P., New York, 2016. Price: $175 (hardcover) ISBN 9780199368815.

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