## COMPUTERS IN RADIOLOGY.

*G.B. Greenfield, L.B. Hubbard. New York, Churchill Livingstone, Inc., 1984, $30.00, 196 pp*

This brief, clearly written, and generously illustrated introductory discussion of computers and their application in radiology is a pleasure to read. The text is divided in two halves with a middle buffer zone. The first half is a description of computers without any discussions of imaging applications. The second half of the book describes techniques of medical imaging which require computer processing. The middle transition chapter introduces digital image processing, appropriately linking the two halves of the text.

The first half consists of three chapters entitled "The Evolution of Computers," "Anatomy of a Computer," and "Physiology of a Computer." The evolution chapter is a brief overview of history of computer development and definition of some generic concepts.

The anatomy chapter is a discussion of hardware including distinctions in computer sizes and interesting illustrations of logic circuits and gates. Registers and the organizational layout of a digital computer are described with an example of the flow in a simple program. Peripherals and mass storage devices are also described.

The third chapter on physiology deals with software. It begins with an overview of the different types of software, the concept of an instruction set, and the binary and hexadecimal number systems. The description of operating systems, assembly language, and higher level languages, particularly Basic and Fortran, with a comparison and example programmed in both languages, are especially well written and helpful in understanding the functional differences between the two languages. This and the previous chapter on hardware provide a good information source for a brief introduction to microcomputers.

Chapter 4 is the break point in the text, linking the general description of computers to digital radiographic imaging. This chapter on digital image processing emphasizes differences between analog and digital parameters and the process of analog to digital conversion. Images illustrating matrix size and depth of gray scale are shown but unfortunately not with the same data set, so that, appreciation of the change due to the parameter of interest is not optimal. Image quality in this chapter is not as good as others in the text, although the line drawings and tables are good. The density histogram is described and used to illustrate one approach to image processing. Examples of a simple edge enhancement program and smoothing filter are also presented.

Chapter 5 begins a series of chapters on applications of digital computers in radiology. This chapter on digital radiography begins with a description of the digital image detection, i.e., the conversion of transmitted x-ray intensity to a digital map. It includes area, line, and spot scanning approaches and then expands on scan projection radiography as used in one popular CT scanner. Dual energy scan projection radiography is also described but no illustration is given, though the authors peak our interest by stating that the results are dramatic. No images are shown in this section, only line drawings, and the captions are too brief. A description of a digital subtraction angiography system is well presented with liberal drawings, printed large for easy viewing.

Chapter 6 describes computed tomography (CT). A noticeable difference from the previous chapters is the expanded content of the figure captions. The chapter begins with a definition of a CT image, including representative pixel and voxel dimensions. Data acquisition techniques referring to the different generations of CT scanners are described. A comprehensive description of spatial and contrast resolution is included. The problem of partial volume is illustrated and a good explanation is presented of the artifacts caused by beam hardening and scatter. Unfortunately no images are shown to illustrate these effects. A general description of reconstruction techniques is provided but there is no discussion of filters used in the reconstruction algorithms. This chapter provides a useful overview of CT but lacks a description of filtered back projection reconstruction to supplement the straight back projection example that is presented.

The next chapter on nuclear magnetic resonance (NMR) is primarily devoted to defining the physics of NMR and the mechanism for image formation. There are some minor errors in terminology, probably due to the attempt at brevity. There is very little direct discussion of computers in this chapter, most of the 21 pages are devoted to physical principles of NMR and the basis for imaging.

The final chapter, entitled "A Computerized Radiology Department," is a discussion of general concepts of storage, retrieval, and transmission of digital images and communication systems (PACS). There is also a brief mention of computerized diagnosis and computer aided instruction. In a "computerized radiology department," the authors include digital radiography, digital ultrasound, CT, and NMR.

There is an appendix to this text on mathematics, divided into five topics. The first is basic math concepts, primarily calculus. Second is matrix algebra with a substantial description of matrix manipulations which then flows into the third topic of Fourier transforms. Following the Fourier transform discussion there is a brief and clear explanation of convolution. The final topic is dual energy subtraction which seems a bit out of place with the previous four topics. The book ends with a 13-page glossary.

I recommend this text as an introductory overview of digital computers and their application in radiology. For the most part the quality of the paper, print, and figures is excellent. The figures are plentiful, clear, and large. The nuclear medicine practitioner should be warned that there is no mention of computer applications in gamma ray imaging.

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## NMR TOMOGRAPHY OF THE HEAD

*R. Bauer, O. Lauer, K. Morike, U. Bauer.* Stuttgart, New York, Gustav Fischer Verlag, 1984, $61.40, 150 pp

This text is a timely one, and is bound to find itself on the bookshelf of those interested in nuclear magnetic resonance

(NMR) from many specialties. It is the first in what will be a long line of text-atlases regarding this new technology. This particular book dedicates itself solely to NMR tomography of the head, but is much more than just an atlas. The text is divided into three sections. The first section is an overview of basic NMR physics and technology. The next section, which is the bulk of the book, is an atlas of the brain as viewed through multiple NMR imaging techniques. The final section is a sampling of a few pathologic studies in order to emphasize relevant points. The following will be a review of each of these sections in detail.

The first section on NMR physics and technology (30 pages in length) does quite a thorough job of reviewing the breadth of this topic at the level needed by the clinician while maintaining a concise format. Interestingly, the book is written in both German and English, the lefthand column on each page written in German while the righthand column is in English. Figure legends are also printed in both languages. The physics and background section begins with nuclear magnetism and spin resonance and includes all the appropriate mathematical expressions that one might wish to reference at some time in the future. The authors do quite an effective job at describing the relaxation phenomena $T_1$ and $T_2$. They go on to describe the standard pulse sequence and interpulse timings with diagrams which are adequately described by their figure legends. Image production and reconstruction follows with primarily a discussion of convolution filtered back projection, leaving two-dimensional Fourier Transformation (2DFT) a topic for more extensive texts. The next section reviews alternation in image brightness and contrast based upon choice of imaging parameters for each of the major pulse sequences. The authors are truly to be congratulated for doing such an outstanding job in describing and displaying a very complicated sequence of concepts. They describe verbally, and then show pictorally with images, information which can be seen in the NMR decay curves for various tissues. It is the combination of the interpretation of curves and seeing their effects in the images which truly allows one to understand how choice of NMR imaging parameters can affect the ultimate visual appearance of the image.

The middle section of the book, which is the bulk of the text (89 pages), is an atlas of the normal human brain as imaged in the three planes. The authors' imager was a .15 Tesla Technicare resistive system, installed at the Hausstein Clinic near Deggendorf in Germany. In general, I would say the images are somewhat noisier than many of the better images published more recently, but this does not detract at all from the usefulness of this atlas-test. In fact, the image quality depicted herein shows just how clinically useful images of this quality can be. There are three subsections to the atlas. The first being the sagittal and parasaggital slices, the second being the transverse slices, and the third being coronal slices. In each section sequential slices are shown with early and late spin-echo images, inversion recovery images, and a spin-echo image which is interporated between the current slice and the next slice. This particular feature of interpolating images gives one a real sense of continuity going from page to page, from slice to slice. At the bottom of each page the position of the current slice is shown in the other two planes; for example, in the coronal section at the bottom of the page would be a sagittal slice and a transverse slice showing the position of the current coronal image set. For each slice on the facing page is a blowup of a spin-echo image with all the parts of the image labeled to the side. As a neurologist and an anatomy enthusiast, I found this section of the text particularly, useful. As are many clinicians, I am most familiar with the transverse and coronal plains when viewing images. However, the section on the sagittal and parasaggital images was particularly useful in helping me to grasp a true three-dimensional appreciation for the structure of the human brain. This type of information will be of great value to those persons who will be interpreting these images clinically.

The final section of the book (25 pages) is a small sample of 11 selected cases chosen to demonstrate and support certain concepts previously described in the text. This by no means can be considered a comprehensive atlas of pathologic cases as depicted by NMR images, however, the authors very effectively build upon the previously described information and make certain new points. The ability to detect pathology exceeded that of the x-ray computed tomographic scan in several of the reported cases, thus showing how these images can be clinically useful despite their lesser signal to noise. Additionally, it is well demonstrated that quite large lesions can be made to "disappear" depending on the pulse sequence timings used. This underscores the necessity of being able to generate multiple images from an NMR study in order to adequately sample the range of $T_1$ and $T_2$ inherent in the lesion, and to maximize the contrast between the lesion and the normal brain. One other feature of interest in this section is what they refer to as their "sagittal volume image" is which a nonslice selected sagittal image is created. In two sagittal volume images of multiple sclerosis cases, diffuse antero-posterior periventricular areas of prolongation of $T_2$ were manifested as brightness within the image, and elegantly demonstrated the natural tendency for this pathology to cluster around the ventricles.

I feel that the text will be a valuable addition to the library of any clinician interested in NMR imaging or interested in the care of the neurologically diseased patients. There is more than enough overview of basic physics in NMR technology to allow this test to serve as a reference for this type of material. However, the strongest point to be made for this book is its excellent review, of normal anatomy in the sagittal, transverse, and coronal planes imaged through the different pulse sequences (primarily spin-echo and inversion recovery). Most importantly, however, this book fills a void in the nuclear medicine, radiology, neurology, and neurosurgery literature.

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**PULMONARY NUCLEAR MEDICINE: TECHNIQUES OF DIAGNOSIS OF LUNG DISEASE**
*H.L. Atkins, Ed. New York, Marcel Dekker, Inc., 1984, 360 pp, $69.75, hardcover*

This is the 23rd volume in the series of monographs "Lung Biology in Health and Disease." There are 15 contributors, almost all of them are very well known in pulmonary medicine and in nuclear medicine. The chapters are well arranged starting with lung physiology and anatomy, followed by ra-