Physical Attraction

A scholar at M.I.T. explains magnetism and its technological miracles.

DRIVING FORCE
The Natural Magic of Magnets.
By James D. Livingston.
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By Marcia Bartusiak

THE first thing magnetism attracts is the imagination. The seed of a future science career can be planted when a child contemplates a compass needle's determined drive to point northward. "I can still remember — or at least believe I can remember — that this experience made a deep and lasting impression upon me," Albert Einstein recalled in his autobiography. "Something deeply hidden had to be behind things."

In "Driving Force: The Natural Magic of Magnets," James D. Livingston, a senior lecturer in materials science at the Massachusetts Institute of Technology, reminds us that nearly every major modern invention relies at some point on magnetic force: VCR's, cassette players, telephones, radio, television, washers, dryers, refrigerators, vacuum cleaners, clocks, printers, microwave ovens and anti-lock brakes.

Just reading the data off your computer's hard drive is a magnetic feat of heroic proportions. "The relative speed between disks and heads today is about 100 miles per hour, and this is with the head flying about 50 nanometers above the disk," Mr. Livingston says, adding that this is "analogous . . . to flying a jumbo jet a few millimeters off the ground." Magnetic resonance imaging, or M.R.I., can see past bone to take a vivid 3-D snapshot of the body's soft tissues — the brain, blood vessels or a developing tumor — all because the myriad protons spinning inside us act like magnets.

The roots of these technological miracles can be found in ancient philosophers' fascination with the humble lodestone. "For what is more strange than this stone?" wrote the Roman scholar Pliny in A.D. 77. Nature, he said, "has endowed the magnet with senses and hands." By now, of course, we can understand the workings of a refrigerator magnet (it creates a tiny island of magnetism on the steel door) and the secret behind anti-theft sentries at department store entrances (fields generated by magnets hidden in the merchandise trigger an alarm).

"Driving Force" informs us that magnetic audiotapes originated in 1898 when a Danish engineer, Valdemar Poulsen, stretched a steel piano wire across a laboratory. He figured out that a telephone transmitter rolled along the wire could induce in the line a magnetic pattern, or memory, of words spoken into the phone's mouthpiece, and a receiver run along the wire would regenerate the sound. Hitler used the first plastic tape, coated with iron oxide particles, to record his wartime broadcasts. The process is now so ubiquitous that "the dollar value of magnetic recording devices produced in California's 'Silicon Valley' exceeds the dollar value of semiconductor devices produced there."

Having worked more than 30 years at General Electric, specializing in magnet research, Mr. Livingston spiritedly champions the "neo-magnets," neodymium-iron-boron alloys discovered 13 years ago. A hundred times more powerful than the older carbon steel magnets, these supermagnets allow the miniaturization of hundreds of technological devices. "Very few of the teenagers listening to the latest rock or rap through their earphones today," he points out, "realize the debt they owe to improved permanent magnets." He wonders why the newly discovered high-temperature superconducting magnets, which have few applications as yet, are getting all the press.

Mr. Livingston presents this engaging information in a quaint, instructional style. And while his intent is to reach a general audience, he occasionally includes a bit of physics jargon that cries out for translation: "A high magnetic anisotropy indicates a *potential* for magnetically hard properties, but the material will have the desired high coercivity only if it can be processed to produce a microstructure that obstructs domain-wall motion."

He describes his book as a "whirlwind tour" of magnetism. That it is — a hodgepodge of magnetic wonders without an overriding theme to pull the chaotic assortment together. "Driving Force" offers a limited view of magnetism's magic. A deeper examination would have been even more magical. □

Marcia Bartusiak, who teaches science journalism at Boston University, is the author of "Through a Universe Darkly" and "Thursday's Universe."