

The Physics of NASCAR

How to Make Steel + Gas + Rubber = Speed

Diandra Leslie-Pelecky
Dutton, New York, 2008. \$25.95
(286 pp.). ISBN 978-0-525-95053-0

Reviewed by Giovanni G. Fazio

As a physicist and an avid fan of IndyCar racing, I read with considerable interest Diandra Leslie-Pelecky's *The Physics of NASCAR: How to Make Steel + Gas + Rubber = Speed*. NASCAR stands for National Association for Stock Car Auto Racing, and auto racing is the number one spectator sport in the US, as measured by attendance.

IndyCar racing involves open-wheel cars, in which the wheels are outside the body of the car. In contrast, NASCAR racecars may look like ordinary cars to the casual observer, but they are far from ordinary. They have engines with 850 horsepower at 9000 revolutions per minute and reach speeds of 200 mph, fast enough to cover

the length of a football field in 1.02 seconds. The physics of what makes a car go that fast and still stay on an oval racetrack is fascinating. Even more interesting is that many of the car's properties, such as chassis size and

shape, engine size, car weight, and so forth, are fixed and tightly regulated. Because of the small permissible differences between cars, a thorough understanding of the physics becomes even more critical if a racing team is to achieve the highest speeds possible. After traveling hundreds of miles, a car may win by only seconds, or even

hundredths of a second.

Leslie-Pelecky is a professor of physics at the University of Texas at Dallas and has worked extensively with K–12 teachers and schools. In her book, she describes the many applications of physics in racing, and as I was reading it, I realized that using examples from auto racing would be a good and interesting way to introduce physics to high-school students or even students in an introductory college physics course. The author discusses the mechanical structure of the frame and sheet-metal “skin” (usually made of low-carbon steel); the solid-state properties of the materials; optics of the paint; thermodynamics of engine combustion; fluid mechanics; engine dynamics such as power, torque, and horsepower; aerodynamics; force and motion; acoustics; and electromagnetic radiation. A major factor in winning a race is the car's aerodynamics and the wind-induced downforces applied to the vehicle. Wind-tunnel tests and computational fluid dynamics become quite important. One interesting phenomenon is so-called drafting, in which two cars, one behind the other and separated by inches, can travel 3–5 mph faster on a superspeedway than a single car can. The physics of drafting makes for some interesting driving tactics during a race.

Because the major car parameters are fixed, it is the small variables that race teams must fine-tune to make their cars go faster. Those variables—there are about 25 of them—are correlated. To “setup” a car means to adjust the spring tension, shock absorbers, sway bars, tire pressure, weight distribution, the angles of the splitter in front and the wing in the rear, and more. To make matters even more challenging, the setup can change with track temperature, with conditions, and, indeed, from track to track. Rather than take an ad hoc approach, car crews use computers to analyze data from multiple variables to reach the winning combination.

Leslie-Pelecky's book is easy and enjoyable to read; it has no equations, and anyone with a high-school education can handle the science. I did find a few discrepancies between diagrams and ac-

companying text, and I thought the section on tire friction during a turn could have benefited from inclusion of the coefficient of friction and vector diagrams analogous to those the author used in her discussion of an impact with a wall. Likewise, the chapter on the car's suspension system could have used diagrams to help readers understand the system's structure and operation.

Interspersed with the treatment of the physics are Leslie-Pelecky's observations of the car owners, drivers, pit crew, and mechanics. Some readers might say such narrative distracts from the physics, but the people she encounters are fascinating. They come from interesting and varied backgrounds and are an inherent part of what makes racing exciting. Mention of them makes the book more enjoyable.

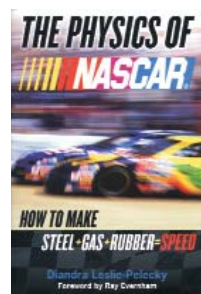
Normally, I am not a NASCAR fan: I find IndyCar racing, in which cars reach 235 mph, more fascinating. However, after reading Leslie-Pelecky's book, I caught myself one weekend watching a NASCAR race on ESPN and paying particular attention to all the physics that I learned from her book. Even if you are not a NASCAR fan, read *The Physics of NASCAR*. It may change your mind.

Applications of Synchrotron Radiation

Micro Beams in Cell Microbiology and Medicine

Ari Ide-Ektessabi
Springer, New York, 2007. \$159.00
(218 pp.). ISBN 978-3-540-46424-2

In the past few years, developments in hard x-ray microprobe instrumentation and methods have improved our understanding of the role trace metals play in life and in causing disease. The results have led to considerable interest from researchers in the life sciences who want to use microprobe instruments with high spatial resolution and trace-level sensitivity. Nonetheless, the literature is missing a comprehensive book that focuses on the biological and



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medical applications of such devices and could also serve as a reference for interested scientists and students. Although *Applications of Synchrotron Radiation: Micro Beams in Cell Micro Biology and Medicine* by Ari Ide-Ektessabi, a professor at Kyoto University's International Innovation Center in Japan, covers some of its material well, it does not succeed in filling the gap.

The book is split into two parts. In the first, the author offers brief coverage of synchrotron radiation, x-ray fluorescence (XRF), x-ray spectroscopy, detector basics, and beamline layouts. In the second, he discusses biomedical applications, from the structurally straightforward analysis of single cells to the more complex analysis of tissue sections. The book's subtitle is broad and may be misleading to some readers because the text's contents are, perhaps necessarily, more narrow. The author limits his scope to a discussion of hard XRF microscopy and microspectroscopy. He omits such areas as soft x-ray microbeams, microbeam irradiation, and microdiffraction, which is a good choice because it would be difficult for him to cover those diverse areas comprehensively, but it still may disappoint some readers.

Applications of Synchrotron Radiation, unfortunately, covers its subject matter unevenly. The author focuses on experiments and instrumentation with which he has experience, and he uses that experience to provide some well-detailed experimental descriptions. However, several critical technologies and developments either have been omitted or are mentioned only in passing. For example, Ide-Ektessabi does a good job describing the approaches used to analyze XRF spectra, but he does not cover x-ray focusing optics, even though the technique has relevance in the generation of microbeams and has been critical in propelling x-ray microscopy forward. His topic selectivity continues into the discussions of experimental details in that he does not present the broad range of options and necessary considerations for both sample preparation and experimental configuration. For instance, an adequate discussion of artifacts associated with chemical fixation is absent, despite the fact that the preparation technique is used almost exclusively throughout the described experiments. Cryogenic techniques to probe frozen hydrated samples, and thus avoid fixation artifacts, or to investigate freeze-dried samples

are not mentioned at all.

Moreover, a number of comments in the book are incorrect, and some are severely misleading. For example, the author repeatedly states that x-ray microprobe analysis is nondestructive. While in some cases radiation damage may not become apparent, that statement is not true for biological samples in general. In particular, radiation damage must be taken into account in microspectroscopy.

The descriptions of the biomedical applications are the best part of the book, and the author's hands-on expertise does make a difference. The applications, such as to metals in embryonic stem cell differentiation or in neurodegenerative diseases, are most interesting and relevant, and the procedures and approaches are explained well. Yet Ide-Ektessabi sometimes makes sweeping conclusions drawn from what seem to be limited data sets; at other times he leaves the reader perplexed by presenting observations without interpretation. That part of the book is also hampered by the somewhat dated nature of the featured experiments and instrumentation, a particularly unfortunate oversight in a rapidly evolving field. For instance, today's instruments can resolve intracellular distributions of metals and other elements on the level of individual organelles—well below what is depicted in the book. That spatial resolution clearly has a major impact on the types of biological applications that are possible.

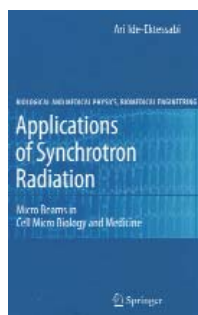
The biological and biomedical applications of x-ray microprobe analysis represent a growing, vibrant area of research in which new instrumentation and applications are constantly being developed. For a detailed discussion of technical aspects of XRF, albeit one not focused on biomedical applications or on microprobes, interested readers can consult the *Handbook of Practical X-Ray Fluorescence Analysis* (Springer, 2006), edited by Burkhard Beckhoff and colleagues. For a glimpse at the numerous studies being carried out, readers need only turn to one of several recent reviews on the subject matter, such as Christoph J. Fahrni's article, "Biological Applications of X-Ray Fluorescence Microscopy: Exploring the Subcellular Topography and Speciation of Transition Metals," in the April 2007 issue of *Current Opinion in Chemical Biology*.

Unfortunately, as much as interested scientists and graduate students may long for a comprehensive book on the

applications of synchrotron radiation, they may have to wait a little longer.

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A History of the Kennedy Space Center

Kenneth Lipartito and Orville R. Butler

**U. Press of Florida, Gainesville, FL,
2007. \$39.95 (478 pp.).
ISBN 978-0-8130-3069-2**

Kenneth Lipartito and Orville R. Butler's *A History of the Kennedy Space Center* is the most comprehensive review ever done of the nation's rocket-launch center. It traces the program from the US Bumper rocket initiative in the late 1940s to the space shuttle *Columbia* disaster in 2003 to the International Space Station (ISS) and beyond.

Lipartito, a professor of history at Florida International University, and Butler, an associate historian at the American Institute of Physics, discuss the interactions among the researchers, developers, and manufacturers, and their disdain at attempts by the operations engineers and technicians at NASA's Kennedy Space Center (KSC) to give input in the design and manufacturing processes. Development centers have rarely taken operations requirements of the space program into consideration in their design process; that omission has led to inefficiencies and costly delays. Also, it took many years for KSC to refute the space hardware designers' "ship-and-shoot" mentality, that is, the philosophy that once a rocket or payload has been shipped, it's essentially ready to go. Management approaches and techniques vacillated from the early German hands-on operations to US Air Force program management methods, and they eventually incorporated elements of both.

The first director of KSC, Kurt Debus (July 1962–November 1974), characterized by many as the center's "father," was a member of Werner von Braun's team at Peenemünde in northern Germany. A charismatic leader who carried a dueling scar on his face from his college days in Germany, Debus was

