Fritz Zwicky in the 1930s, the fruitless hunt for the cosmic deceleration parameter, the history of Einstein's cosmological constant, and some of the many ways astrophysicists now measure dark matter. And the text offers some delightful salvos against those who claim that the end of science is nigh or that scientists don't change their minds until the "paradigm shifts."

The book is less enchanting in its stories of the past decade. The writing is more technical, with too many self-citations by Ostriker. The general reader might not care who did what in modern theory, whereas the physicist will care about those details, since the participants are alive and well known today. The astonishingly precise and presumably accurate measurements and implications of the cosmic microwave background fluctuations do not get the detailed treatment needed. There are no diagrams to illustrate how telescopes work, how spectrometers work, or how cosmic microwave background radiation is measured.

As the project scientist and one of the three principal investigators for the *Cosmic Background Explorer* (*COBE*) satellite, and now senior project scientist for the *James Webb Space Telescope*, I am attuned to the how and why of measurements. I wish those questions had been addressed in this book, given that most of the recent progress in cosmology has come from improved technology, especially in space missions. With few exceptions, cosmological theory is driven by surprises in measurement, and most of those surprises are discovered with new equipment. For convincing proof of that, see Martin Harwit's brilliant book, *Cosmic Discovery: The Search, Scope, and Heritage of Astronomy* (Basic Books, 1981).

The book also gets some of the details about *COBE* wrong; it misstates Earth's age (it is 4.6, not 3.7, Gyr); and on page 207 it gives an incorrect calculation of escape velocity. Overall, though, *Heart of Darkness* is a cheerful and accessible introduction to some of the most fascinating topics in astronomy today. It presents the concepts clearly, tells the stories about the discoverers with remarkable detail, and explains the logic leading to the hypotheses of dark matter and dark energy. I would not hesitate to recommend it for both general readers and scientists.

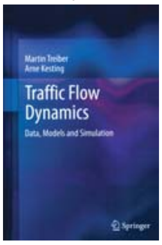
John C. Mather
NASA Goddard Space Flight Center
Greenbelt, Maryland

Traffic Flow Dynamics
Data, Models and Simulation

Martin Treiber and Arne Kesting
(translated from German by
Christian Thiemann)
Springer, 2013. $89.95 (500 pp.).
ISBN 978-3-642-32459-8

Many governments around the world view traffic jams as a serious problem. Vehicles in traffic jams emit higher concentrations of pollutants, and the people in those vehicles waste valuable time. For those reasons traffic-flow research should be advanced. The knowledge gained could help increase flow and reduce jams, which would lead to improved efficiencies and a cleaner environment.

But is such research physics? I think that after reading Martin Treiber and Arne Kesting's *Traffic Flow Dynamics: Data, Models and Simulation*, you will agree that it is. Of course, traffic flow is not governed by Newton's laws. As a consequence, research in the field inevitably relies on empirical data, which is used to construct a theory for the dynamics of vehicles—self-driven particles. Indeed, it is difficult to overemphasize the importance of empirical traffic data. After all, only with observational data can one judge whether an explanatory model is correct.



Traffic Flow Dynamics is divided into three parts. The first part is devoted to discussing highway traffic data. It contains one of the book's nice features—color figures that help readers to appreciate what traffic phenomena really look like and to understand them quantitatively.

In the second part of the book, the authors describe almost all the important achievements in the field—the history of theoretical research on traffic flow dates back to the 1930s—up to the present with simple, self-contained explanations. Also included here and throughout the book are unique end-of-chapter problems and detailed solutions that elucidate traffic-flow theory. The authors offer detailed explanations of traffic-flow modeling based on observed data. For example, in one problem, they address the question, Why does the other lane look faster when you're stuck in congested flow?—a traffic-dynamics analogue to Why does the grass look greener on the other side?

In 2000 Treiber proposed the "intelligent driver model," which has become a standard and often-used model in various traffic simulators. It is simple, yet it can produce realistic acceleration profiles and a plausible behavior of individual cars on the highway. A detailed and original explanation of his model, which cannot be found in any other book is, of course, given here.

In evaluating such models, one important feature worth testing is traffic-flow stability. Traffic flow becomes unstable when the traffic density gets too high. That instability is related to the onset of a traffic jam and determines the capacity of traffic flow; its occurrence in a model can be compared with real data. Actually, several kinds of traffic-flow instabilities are in play, but they are not easily distinguishable, and the distinctions among them can be confusing, especially to students. The various instabilities are treated comprehensively in *Traffic Flow Dynamics*, and the book's figures and calculations make them easier to understand. The authors also briefly address, in one paragraph in the instability chapter, the hot and controversial research exploring the existence of "phantom traffic jams" said to arise without an accident or other physical blockage. On this topic, I don't entirely agree with the authors, but their discussion is worth reading.

The final part of the book applies traffic-flow theory to solving traffic jams; that is, the topic shifts from why traffic jams occur to how they can be solved. This attention to the practical, too, is a unique feature. It's a pity that there's currently a big gap between traffic-flow science and traffic engineering, but this book admirably connects the physical mechanisms leading to a traffic jam with such engineered solutions as adaptive cruise control and ramp metering.

I expect that *Traffic Flow Dynamics* will bridge the different fields involved—physics, mathematics, computer science, traffic engineering, and others. I also think it will be a useful guide for students who want to make the jump into a fascinating area of research.

Katsuhiro Nishinari
University of Tokyo
Tokyo, Japan

Quantum Computing Since Democritus

Scott Aaronson
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Scott Aaronson's *Quantum Computing Since Democritus* is lively, casual, and