

Preface

The understanding of empirical traffic congestion occurring on unsignalized multi-lane highways and freeways is a key for effective traffic management, control, organization, and other applications of transportation engineering. However, the traffic flow theories and models that dominate up to now in transportation research journals and teaching programs of most universities cannot explain either traffic breakdown or most features of the resulting congested patterns. These theories are also the basis of most dynamic traffic assignment models and freeway traffic control methods, which therefore are not consistent with features of real traffic.

For this reason, the author introduced an alternative traffic flow theory called three-phase traffic theory, which can predict and explain the empirical spatiotemporal features of traffic breakdown and the resulting traffic congestion. A previous book “The Physics of Traffic” (Springer, Berlin, 2004) presented a discussion of the empirical spatiotemporal features of congested traffic patterns and of three-phase traffic theory as well as their engineering applications.

Rather than a comprehensive analysis of empirical and theoretical results in the field, the present book includes no more empirical and theoretical results than are necessary for the understanding of vehicular traffic on unsignalized multi-lane roads. The main objectives of the book are to present an “elementary” traffic flow theory and control methods as well as to show links between three-phase traffic theory and earlier traffic flow theories. The need for such a book follows from many comments of colleagues made after publication of the book “The Physics of Traffic”.

Another important objective of this book is to give an introduction to methods of spatiotemporal traffic congestion recognition and prediction, on-ramp metering, speed limit control, and some other freeway control and dynamic management methods whose theoretical basis is three-phase traffic theory. The importance of this subject can be explained as follows. Almost all other traffic flow theories and the associated freeway control and dynamic management methods assume the existence of a *particular* (fixed or stochastic) highway capacity of free flow at a highway bottleneck and, therefore, they use the highway capacity as a basic parameter of dynamic traffic management models. In this book we show and explain how and why the application of a particular highway capacity in methods for dynamic

freeway traffic management like on-ramp metering, speed limit control, or dynamic traffic assignment, is not consistent with features of real traffic.

Through an application of the principle “no more results than are necessary”, I hope to present traffic flow theory and control in a manner understandable to a broad audience of readers interested in traffic phenomena. With this aim, the book also includes an extended glossary with definitions and explanations of terms used.

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The Long Road to Three-Phase Traffic Theory

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