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The spectral theory of Sturm-Liouville operators is a classical domain of analysis, comprising a wide variety of problems. Besides the basic results on the structure of the spectrum and the eigenfunction expansion of regular and singular Sturm-Liouville problems, it is in this domain that one-dimensional quantum scattering theory, inverse spectral problems, and the surprising connections of the theory with nonlinear evolution equations first become related. The main goal of this book is to show what can be achieved with the aid of transformation operators in spectral theory as well as in their applications. The main methods and results in this area (many of which are credited to the author) are for the first time examined from a unified point of view.

The direct and inverse problems of spectral analysis and the inverse scattering problem are solved with the help of the transformation operators in both self-adjoint and nonself-adjoint cases. The asymptotic formulae for spectral functions, trace formulae, and the exact relation (in both directions) between the smoothness of potential and the asymptotics of eigenvalues (or the lengths of gaps in the spectrum) are obtained. Also, the applications of transformation operators and their generalizations to soliton theory (i.e., solving nonlinear equations of Korteweg-de Vries type) are considered.

The new Chapter 5 is devoted to the stability of the inverse problem solutions. The estimation of the accuracy with which the potential of the Sturm-Liouville operator can be restored from the scattering data or the spectral function, if they are only known on a finite interval of a spectral parameter (i.e., on a finite interval of energy), is obtained.