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# Radio Recombination Lines

## Their Physics and Astronomical Applications

*by*

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*To our children and grandchildren, to  
their children, and to all of the next  
generations, who may benefit from a  
deeper understanding of the universe in  
which they live.*

# Preface

Recombination lines at radio wavelengths have been – and still are – a powerful tool for modern astronomy. For more than 30 years, they have allowed astronomers to probe the gases from which stars form. They have even been detected in the Sun.

In addition, observations of these spectral lines facilitate basic research into the atom, in forms and environments that can only exist in the huge dimensions and extreme conditions of cosmic laboratories.

We intend this book to serve as a tourist's guide to the world of Radio Recombination Lines. It contains three divisions: a history of their discovery, the physics of how they form and how their voyage to us influences their spectral profiles, and a description of their many astronomical contributions to date. The appendix includes supplementary calculations that may be useful to some astronomers. This material also includes tables of line frequencies from 12 MHz to 30 THz ( $\lambda = 10 \mu\text{m}$ ) as well as FORTRAN computer code to calculate the fine-structure components of the lines, to evaluate radial matrix integrals, and to calculate the departure coefficients of hydrogen in a cosmic environment. It also describes how to convert observational to astrophysical units. The text includes extensive references to the literature to assist readers who want more details.

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