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Masami Ouchi · Matthew Hayes

Lyman-alpha as an Astrophysical and Cosmological Tool

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Swiss Society for Astrophysics and Astronomy
Edited by Anne Verhamme, Pierre North,
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Cover illustration: Lyman-alpha line overlaid on a photo of Matterhorn. Credit: [Vincent Favre (http://www.cristaldegivre.com) & Myriam Burgener]

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Preface

Hydrogen is the most abundant element in the universe, as first understood by Cecilia Payne-Gaposchkin in 1924. The Lyman α line is the strongest line of this element, making it especially important in many astrophysical topics and particularly in cosmology. Because this line falls in the ultraviolet, it has long remained unused for observational reasons, until astronomical satellites opened the UV window and until galaxies were discovered at high enough redshift to make it accessible to ground-based telescopes.

Since then, the hydrogen Lyα line has acquired ever increasing popularity to probe the deep universe, through the use of either its absorption or its emission. The Lyα forest seen in the spectra of high redshift quasars reveals the presence and distribution of absorbing gas in galaxies that would otherwise go unnoticed, and star forming galaxies can be seen to the edge of the observable universe thanks to the intensity of this line in emission. Spectroscopic confirmation of the highest redshifts known to date is generally based on the Lyα line. However, the very visibility of this resonance line when seen in emission is linked with its extremely high opacity, so that the interpretation of the Lyα profile is far from straightforward. Careful modeling is needed to understand the observations, because transfer effects are important enough to prevent, for instance, any simple translation of the line position and width in terms of mean radial velocity and velocity dispersion.

The 46th Saas-Fee advanced course of the Swiss Society for Astrophysics and Astronomy, entitled *Lyman-α as an astrophysical and cosmological tool*, took place in Les Diablerets, a mountain resort of the Swiss Alps. Exceptionally, as many as four lecturers (instead of three according to tradition) have contributed to this successful course: Mark Dijkstra, J. Xavier Prochaska, Masami Ouchi, and Matthew Hayes. The four contributions to this book review respectively the theoretical aspects of the Lyα line formation, and three aspects of how this line is used in extragalactic astronomy: absorption of intervening hydrogen clouds in the line of sight of quasars, Lyα emitting galaxies at high redshift, and detailed emission and absorption processes in local galaxies. Such topics cover much of today's endeavours in observational cosmology, so this book should prove useful and timely for many Ph.D. students as well as more advanced researchers. We are aware of an extragalactic bias, in the

sense that this book does not adress more local applications of the Lyα line, such as the study of exoplanet atmospheres. Even so, students in the latter field may still find interest in at least Mark Dijkstra's theoretical contribution.

We thank Mrs. Myriam Burgener, the Secretary of the Département d'Astronomie de l'Université de Genève, for her very efficient help in the organization of the course and for her presence during the whole event. This course, attended by 65 participants from many countries, was sponsored by the Swiss Society for Astrophysics and Astronomy, the Swiss Academy of Sciences, the Ecole Polytechnique Fédérale de Lausanne (EPFL), and the University of Geneva.

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