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SpS1-High-resolution infrared spectroscopy at high and low altitudes

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1. Introduction

The advantages of a high altitude, dry site for ground-based astronomy at infrared (IR) wavelengths are well-known: the lower temperature and pressure associated with increased altitude reduce the emissivities of both atmosphere and telescope, and a lower atmospheric absorption improves the transmission of IR radiation. The next generation of IR instruments under development (for ELTs) will open up a new discovery space, particularly in high-resolution (HR) spectroscopy, which will not have a space-based counterpart and has proven to be a powerful tool for studying all stages of stellar evolution (e.g. Jaffe *et al.*, 2003). I present here a summary of quantitative work into transmission-dependent aspects of HR IR spectroscopy at high and low altitudes †.

2. Findings

Modelled transmission profiles have been successfully used to improve telluric line removal in HR IR spectra (Mandell *et al*, 2008, Smette *et al*, 2009). Accurate transmission modelling is complex, requiring a detailed knowledge of vertical atmospheric profiles in T, P and molecular constituents. The combination of models and experimental data can lead to a better understanding of the interplay between these factors.

The largest transmission gains with altitude are found in spectral regions dominated by water absorption; species with high abundances in the upper atmosphere, such as O_3, show only a moderate improvement. The regions benefiting the most from high and dry sites are the 6.5 μm region of M-band, between 6.5-8 μm (N-band) and the entire Q-band (17-25 μm), which is dominated by water line absorption.

The relative velocity between Earth and a (galactic) science target can be used to Doppler-shift diagnostic spectral lines from behind their telluric equivalent. This technique is commonly used for e.g. 13.7 μm C_2H_2 absorption (also for 4.7 μm CO emission), where an improvement of 25% in transmission can result from this method (depending on the target co-ordinates). In targets that push the limits of the instrumental sensitivity the observing efficiency is much improved when observing from a high-altitude site.

References

Jaffe *et al.*, 2003, *ApJ* 596(2), 1053
Mandell, A. *et al.*, 2008, *ApJ* 681, L25
Smette, A. *et al.*, 2009, *these proceedings*

† Work presented here uses the 2008 edition of HITRAN, the Reference Forward Model (RFM), more information: http://www.atm.ox.ac.uk/RFM/index.html, and a standard tropical atmosphere profile.