

KELT-9b AS A PREVIEW OF THE ELT ERA

Probing 3D dynamics and thermochemical regimes with GIARPS

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GAPS



INTRODUCTION

Ultra-Hot Jupiters (UJ) are extreme laboratories for atmospheric physics. With temperatures exceeding 2000 K and synchronous rotation, they develop strong day-night thermal gradients, strong winds, and chemistry that varies across the planet. High-resolution spectroscopy is now sensitive enough to reveal this complexity, showing that UJ atmospheres must be treated as 3D systems. Among them, **KELT-9b** ($T_{\text{eq}} \sim 4000\text{K}$) stands out as the hottest known UJ, offering a natural laboratory to test the limits of atmospheric physics.

METHODS

Observations of KELT-9b were obtained with **GIARPS** at the 3.6 m TNG.

HARPS-N VIS	R 115'000	λ 0.3-0.7 μm
GIANO-B NIR	R 50'000	λ 0.9-2.5 μm



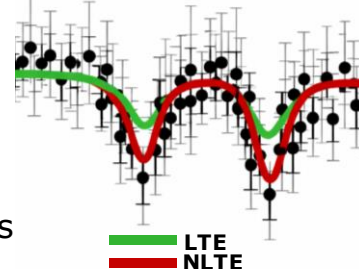
We corrected the spectra for telluric contamination applying Principal Component Analysis (PCA) and aligned them to the planetary rest frame using the system's orbital parameters. We then applied the **cross-correlation** technique to search for the Doppler-shifted signal of chemical species, using synthetic single-species model (Fe I, Mg I and CO).

LOCAL COMPLEXITY

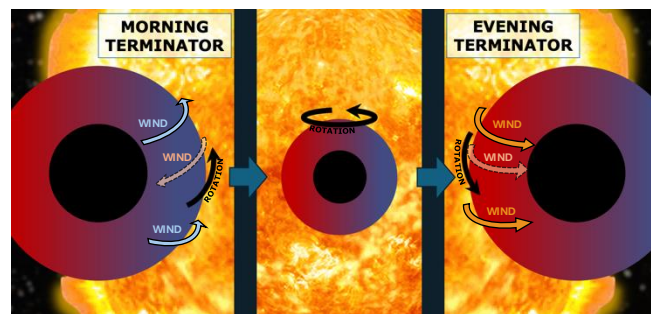
Upper atmospheric layers in UHJs are highly irradiated and collision-poor.

LTE $\rightarrow$ NLTE

NLTE assumptions **modify** *temperature profile* and this changes *absorption line strengths and number*.

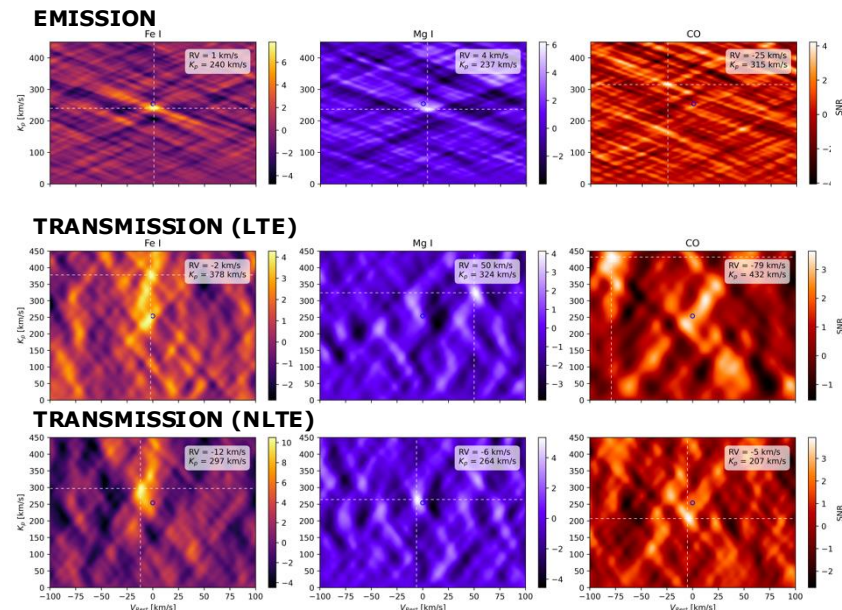


GLOBAL COMPLEXITY



Temperature difference between terminators, thermal atmospheric expansion and circulation **distort** the cross-correlation signal.

RESULTS



Fe and Mg – emission and transmission detections
CO – only transmission measure
Each species shows **different velocity patterns**. This suggests a 3D dynamics that 1D static model cannot reproduce.

NLTE assumption **significantly improves** the detection compared to LTE.

Methodology used for 3.6m telescopes is the same that will be used for ELT

Solving the challenges of UHJs is a key step in moving to the characterisation ever smaller planets.