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A population study of hot Jupiter atmospheres

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Abstract

In the past two decades, we have learnt that every star hosts more than one planet. While the hunt for new exoplanets is on-going, the current sample of more than 3500 confirmed planets reveals a wide spectrum of planetary characteristics. While small planets appear to be the most common, the big and gaseous planets play a key role in the process of planetary formation. We present here the analysis of 30 gaseous extra-solar planets, with temperatures between 600 and 2400 K and radii between 0.35 and 1.9 Jupiter radii. These planets were spectroscopically observed with the Wide Field Camera 3 on-board the Hubble Space Telescope, which is currently one of the most successful instruments for observing exoplanetary atmospheres. The quality of the HST/WFC3 spatially-scanned data combined with our specialised analysis tools, allows us to create the largest and most self-consistent sample of exoplanetary transmission spectra to date and study the collective behaviour of warm and hot gaseous planets rather than isolated case-studies.

We define a new metric, the Atmospheric Detectability Index (ADI) to evaluate the statistical significance of an atmospheric detection and find statistically significant atmospheres around 16 planets. For most of the Jupiters in our sample we find the detectability of their atmospheres to be dependent on the planetary radius but not on the planetary mass. This indicates that planetary gravity is a secondary factor in the evolution of planetary atmospheres. We detect the presence of water vapour in all the statistically detectable atmospheres and we cannot rule out its presence in the atmospheres of the others. In addition, TiO and/or VO signatures are detected with 4σ confidence in WASP-76 b, and they are most likely present on WASP-121 b. We find no correlation between expected signal-to-noise and atmospheric detectability for most targets. This has important implications for future large-scale surveys.