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The Periodic Table in Gaseous Form: First Analysis of the Remarkably Rich Atmosphere of HAT-P-70b

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HAT-P-70 b is one of the most recent additions to the emergent class of exoplanets known as ultra-hot Jupiters: extremely irradiated gas giants that are hot enough to thermally dissociate most of their atmospheric species into their atomic constituents. Due to their elevated temperatures, large radii and short orbital periods, ultra-hot Jupiters are some of the most amenable targets for atmospheric characterization. Here, we present the first analysis of the atmosphere of HAT-P-70 b using high-resolution data from the HARPS-N spectrograph, collected as the planet transited in front of its host star. We individually resolve the Ca II H & K lines, the Na I doublet, and the Hα, Hβ and Hγ Balmer lines. Additionally, we search for neutral and ionized metals using a cross-correlation approach, which allows us to combine the signal from multiple spectral features. In total, we detect the presence of 9 different species (Ca II, Cr I, Cr II, Fe I, Fe II, H I, Mg I, Na I and V I), as well as tentative evidence of additional ones that will require further investigation. Overall, the signals of the detected species appear blue-shifted by a few kilometers per second, suggestive of high-velocity winds transporting material from the day side to the night side. The cores of the Ca II and H I lines form well above the continuum, indicating the existence of an extended envelope. The cross-correlation analysis also reveals the spectral shadow that the planets casts on its A-type host star during transit, which we use to refine the obliquity of this highly misaligned planet. Despite observing only one transit event, our work places HAT-P-70 b as one of the exoplanets with the highest number of species detected in its atmosphere, and it highlights the unique opportunity that ultra-hot Jupiters like HAT-P-70 b provide us with: as different species probe different pressures, we can reconstruct the structure of their atmospheres based on their rich transmission spectra.