SO_2 in Giant Exoplanet Atmospheres with JWST : From Hot Jupiters to Sub-Neptunes

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The detection of sulfur dioxide (SO_2) is one of the key results from the first years of JWST transiting exoplanet atmospheric characterization. JWST's broad near-infrared wavelength coverage has enabled the discovery of this molecule, a key tracer of photochemistry and planet–star interactions. The detection of SO_2 in a new atmospheric regime—a warm Neptune exoplanet, HAT-P-26b ($R_p \approx 6\ R\oplus$, $M_p \approx 18M\oplus$)—bridges the gap between previous detections in hot Jupiters and smaller sub-Neptunes. This discovery highlights the importance of disequilibrium photochemistry across a broad range of exoplanet atmospheres, including those cooler than 1000 K. We derive precise constraints on carbon, oxygen, and sulfur abundances, indicating an atmospheric metallicity of ~10× solar and a sub-solar C/O ratio. The elevated CO_2 abundance and a possible H_2S detection may also reflect sensitivities to the thermal structure, cloud properties, or additional disequilibrium processes such as vertical mixing. We also reanalyze JWST observations of ten other giant exoplanets and compare their SO_2 abundances, finding a correlation with atmospheric metallicity. This trend is consistent with the predictions of Crossfield et al. (2023), showing a steep rise in SO_2 abundance at low metallicities, followed by a more gradual increase beyond ~30× solar.