



First Observations of Uranus' H₃⁺ Vertical Profiles with JWST

Paola Tiranti¹, Henrik Melin¹, Luke Moore², Emma Thomas¹, Katie Knowles¹, Tom Stallard¹, James O'Donoghue³, Kate Roberts², and Khalid Mohamed²

¹Department of Physics, Mathematics & Electrical Engineering, Northumbria University, Newcastle upon Tyne, UK

²Center for Space Physics, Boston University, Boston, MA, USA

³Department of Meteorology, University of Reading, Reading, UK

Uranus' tumbling magnetic field, which switches polarities every half rotation (8.6 h), generates a dynamic and complex plasma environment which is still poorly understood. JWST Programme #5073 observed Uranus continuously for a full rotation (17.24 h) to investigate ionospheric dynamics and temporal variations. We use JWST/NIRSpec (which covers the wavelength range between 3-5 μ m) to extract H₃⁺ emission lines and use this ion to probe physical and chemical properties of Uranus' ionosphere. Here, we present the first-ever H₃⁺ temperature and ion density vertical profiles up to 8,000 km above Uranus' planetary limb across different longitudes. We find global median temperatures of 430 \pm 5.0 K with peaks between 3,000 – 4,000 km across all ULS longitudes. We observe localised temperature enhancements at lower altitudes (800 - 1,500 km) between 50 – 100° ULS and 250° ULS longitudes, corresponding to Uranus' northern and southern auroral regions. Ion densities peak ($\sim 10^8$ m⁻³) at 1,500 – 1,700 km, decreasing sharply above 3,000 km. The total H₃⁺ emission intensity distinctly peaks within the identified auroral longitude bands. This work provides crucial constraints for magnetosphere-ionosphere coupling models and offers new insights in the mechanisms driving Uranus' aurora. Additionally, these parameters will help quantify the role of auroral heating in shaping the overall planetary budget in the upper atmosphere as well as establish essential context for future missions, including the proposed Uranus Orbiter and Probe (UOP).