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# **Predicted ARIEL Phase-Curve Observations of Neptune-Class Exoplanets from 2D Chemical and Thermal Modeling**

**J. Moses<sup>1</sup>, P. Tremblin<sup>2</sup>, O. Venot<sup>3</sup>, Y. Miguel<sup>4</sup>**

<sup>1</sup>Space Science Institute, Boulder, CO,

<sup>2</sup>CEA, CNRS, Univ. Paris-Sud, Univ. Paris-Saclay, Gif-sur-Yvette, France,

<sup>3</sup>LISA, UMR CNRS 7583, Univ. Paris-Est-Créteil, Créteil, France,

<sup>4</sup>Leiden Observatory, Univ. Leiden, Leiden, Netherlands

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ESA's *Atmospheric Remote-sensing Infrared Exoplanet Large-survey* (ARIEL) mission, due to launch in 2028, will acquire simultaneous visible photometry and near-infrared spectra of ~1000 exoplanets that transit their host stars (Tinetti et al. 2018, *Exp. Astron.* 46, 135). The infrared molecular bands of many species that are expected to reside in the atmospheres of transiting-exoplanet targets are included in the 1.25–7.8 micron spectral range covered by ARIEL. To investigate the role of chemistry in ARIEL phase-curve observations, we use a two-dimensional (2D) thermal-structure model and pseudo-2D chemical kinetics model to predict the altitude and longitude variation of atmospheric temperatures and constituent abundances at low latitudes on Neptune-class exoplanets that orbit at different distances from their host stars. Our models predict that the low-latitude vertical profiles of temperature and species' abundances vary significantly with longitude and with planetary equilibrium temperature ( $T_{eq}$ ). Day-night temperature contrasts are found to increase with increasing planetary  $T_{eq}$ . We also find that horizontal transport-induced quenching acts to homogenize species' abundances with longitude on our Neptune-class exoplanets, similar to what is expected to occur on hot Jupiters (Cooper & Showman 2006, *ApJ* 649, 1048; Agúndez et al. 2014, *A&A* 564, A73). Our models have implications with respect to phase-curve observations of Neptune-class exoplanets with ARIEL. For example, we find that the atmosphere remains near thermochemical equilibrium and that temperature variations dominate phase-curve variations on very hot Neptunes, whereas disequilibrium chemistry is important on cool Neptunes but their emission does not vary much with planetary phase. Our models reveal a “sweet spot” in  $T_{eq}$  space such that intermediate-temperature Neptunes have phase curves that are affected by both global temperature and abundance variations, revealing interesting atmospheric processes. This sweet spot in  $T_{eq}$  shifts to lower temperatures as metallicity is increased, making cool higher-metallicity Neptune-class planets appropriate targets for ARIEL phase-curve observations.