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

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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 (Tinneti 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 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 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.