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Not just an iceline tracer: Detection of a N_2H^+ Surface Layer in the Protoplanetary disk around TW Hydrae

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Previous work in determining the carbon monoxide (CO) iceline, a feature of protoplanetary disks believed to regulate CO-rich planetesimal formation, has utilized diazenylium (N_2H^+) emission as a direct indicator of CO gas poor regions. Recent theoretical works on N_2H^+ distribution have suggested the existence of a surface gas layer rich in N_2H^+. If present, this layer could complicate the use of N_2H^+ as a direct CO iceline tracer. In this study, we sought to understand how the surface layer is regulated by different parameters and how its presence influences predictions to observation. We report the first detection of the N_2H^+ J=7–6 line from a protoplanetary disk, and compare the fluxes of this line and a suite of N_2H^+ lines from archival data against thermochemical model predictions to test the existence of the N_2H^+ surface layer. By varying the abundance of CO and N2, we find that in order to fit the 7-6/3-2 line flux ratio, models of the TW Hya disk must include a surface layer and an abundance ratio $X_{N2}/X_{CO} \geq 1.0$. Additionally, we obtain a model fitting three available observed N_2H^+ emission line fluxes, including the new J=7–6 line flux, and fit all available fluxes with this model within 2σ. We demonstrate that high J-transitions are better tracers of the surface layer, while lower transitions are better tracers of N_2H^+ closer to the midplane. We determine that J=7–6 emission is a good surface layer tracer, enhancing our understanding of the relation between N_2H^+ and the CO iceline.