Interstellar NH in Translucent Sight Lines

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The detection of interstellar NH by Meyer & Roth (1991, ApJ, 376, L49) toward ζ Per and HD 27778 was initially somewhat surprising, as the observed N(NH) were more than an order of magnitude higher than the values predicted by then-current chemical models. Because the gas-phase pathways for NH production initiated by $N^+ + H_2$ and $N + H_3^+$ both appeared to be too slow, Meyer & Roth conjectured that NH might instead be formed primarily on grain surfaces (e.g., Mann & Williams 1984, MNRAS, 209, 33). That picture received further support from subsequent high-resolution spectra of NH toward ζ Oph (Crawford & Williams 1997, MNRAS, 291, L53), which ruled out a higher-temperature path starting with $N + H_2$. The $N^+ + H_2$ path might be adequate, however, if the fine-structure excitation of N^+ and the rotational excitation of H_2 are included. Moreover, recent simulations suggest that the abundance of NH may also be enhanced by a higher cosmic-ray flux – as appears to be needed for producing the observed abundances of H_3^+, OH, and HD (e.g., Shaw et al. 2008, ApJ, 675, 405). Whatever the source, an enhanced abundance of NH could provide a significant source of CN, which has tended to be somewhat underproduced in current models.

In order to investigate the origin(s) and behavior of NH, we have measured column densities of NH and other molecular species in eight additional sight lines – including four more heavily reddened sight lines exhibiting much higher N(NH). For this small sample, comparisons of N(NH) with the column densities of CH, CN, OH, C_2, C_3, CO, CH^+, H_3^+, and HD indicate that NH is strongly correlated with CN and (perhaps) C_2, but less well correlated with the other species. The strong correlation between N(NH) and N(CN) suggests that NH is a significant precursor to CN and that NH (like CN) traces relatively dense gas. We will discuss these observed relationships and explore NH production using the Cloudy code, which is being modified to incorporate the necessary grain surface, N^+ excitation, and photo-chemical processes.

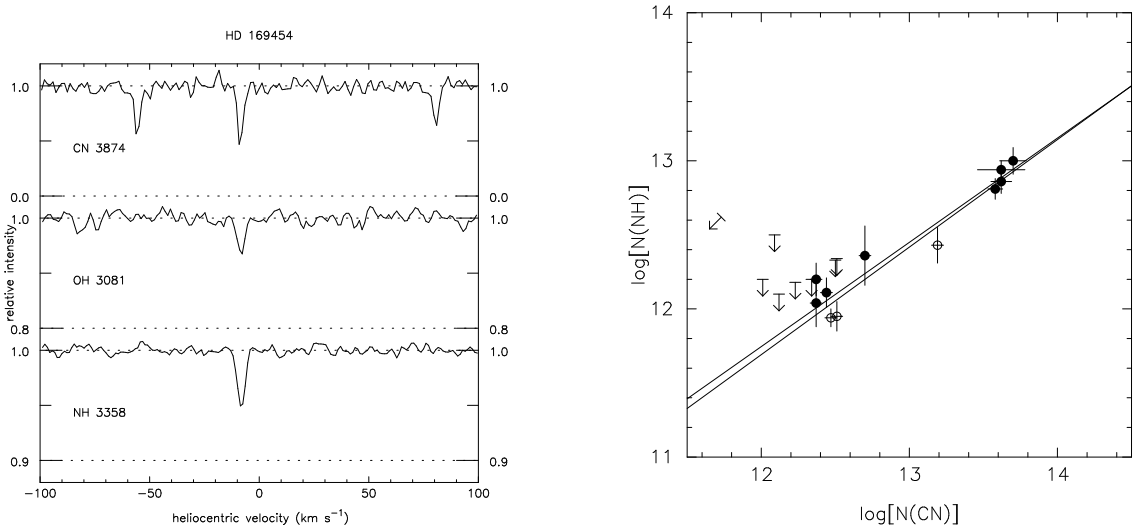

Fig. 1.— (*left*) Interstellar absorption from CN λ3874, OH λ3081, and NH λ3358 toward HD 169454 [$E(B-V) = 1.12$], observed at resolutions of 2.5–3.75 km s^{-1}. (*right*) Observed strong correlation between N(NH) and N(CN), with correlation coefficient $r = 0.96$ and slope ~ 0.7. Open symbols denote sight lines previously detected in NH; solid symbols denote new detections of NH.