

HCN AND C₂H₂ IN CARBON STARS

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At the low temperatures of cool carbon star atmospheres polyatomic molecules form. Most abundant of these for the temperature range 2500 - 3000 are HCN and C₂H₂ (Fig. 1).

These molecules have numerous bands at wavelengths where a major part of the stellar flux is transported. This opacity could therefore be of great importance when constructing models for cool carbon star atmospheres, but has not been included in earlier models.

Models without the HCN and C₂H₂ opacity show a strange transition to "thin", high-pressure atmospheric structures when T_{eff} is decreased below about 2900 K (Fig. 2). This is caused by the decrease in opacity when the diatomic carbon molecules - important opacity sources - are depleted due to formation of HCN and C₂H₂. These "thin" models predict Na D and H₂ quadrupole lines which are far too strong compared with observed lines.

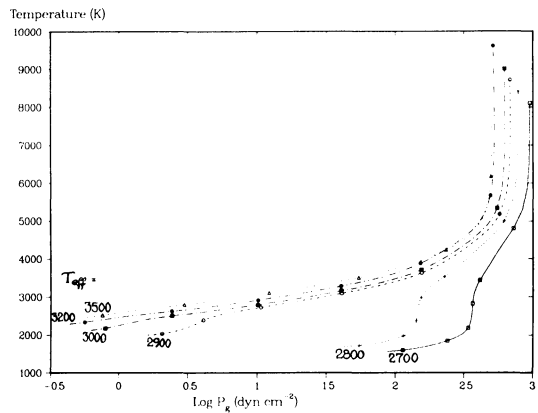
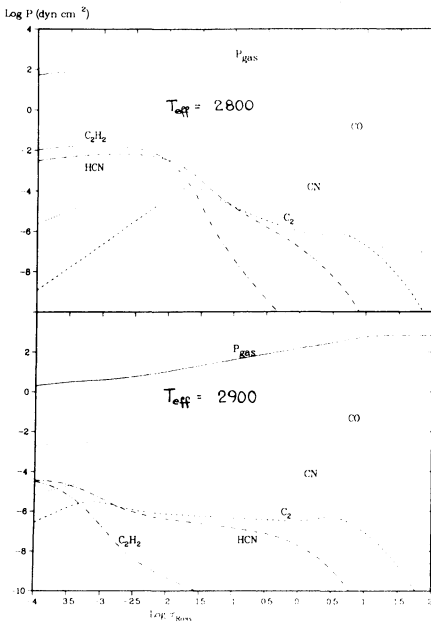


Figure 2

Figure 1

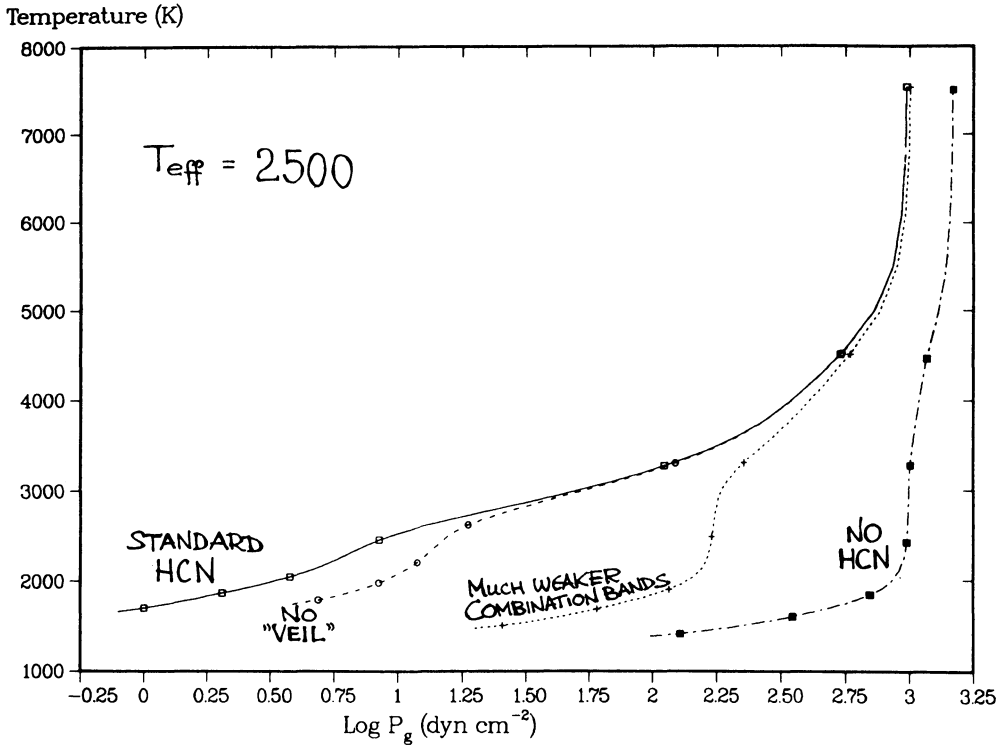


Figure 3. Note the large drop in pressure at $T_{\text{eff}} = 2500$ K (1-2 orders of magnitude!).

No important effect at $T_{\text{eff}} = 3000$ K.

Calculation of HCN (and C_2H_2) opacity. In the laboratory mainly the fundamental bands have been studied. No sufficiently detailed *ab initio* quantum mechanical calculations exist (yet). We have therefore assumed that the transition probability for a combination band relative to the transition probability for a fundamental band scales as the corresponding ratio for other, more well-studied molecules.

We calculated the strengths of many ($\sim 10^6$) lines and added the rest of the total bandstrength as a "veil" of continuous opacity. We then transformed this opacity into smooth ODF's (Opacity Distribution Functions) in the wavelength region 1μ to 12.5μ .

When this opacity was added in the model atmosphere calculations, great effects on the structure were found for the lower temperatures.

Reference:

Eriksson, Gustafsson, Jørgensen & Nordlund, 1983: *Astron. Astrophys.*,
in press

DISCUSSION

Wing: Do the computed abundances of polyatomic molecules in carbon stars show a dependence on the luminosity? I am interested in the possibility of using the observed infrared bands as spectroscopic luminosity indicators.

Eriksson: We have not computed any synthetic spectra yet, but will in the near future.

Taylor: Do you expect to find even larger molecules such as HCCCN in these atmospheres?

Eriksson: When T_{eff} becomes still lower than 2500°K you will find larger molecules but also dust formation will be important then.