Cosmic Origins Spectrograph: Observations of a Translucent Cloud toward HD 204827

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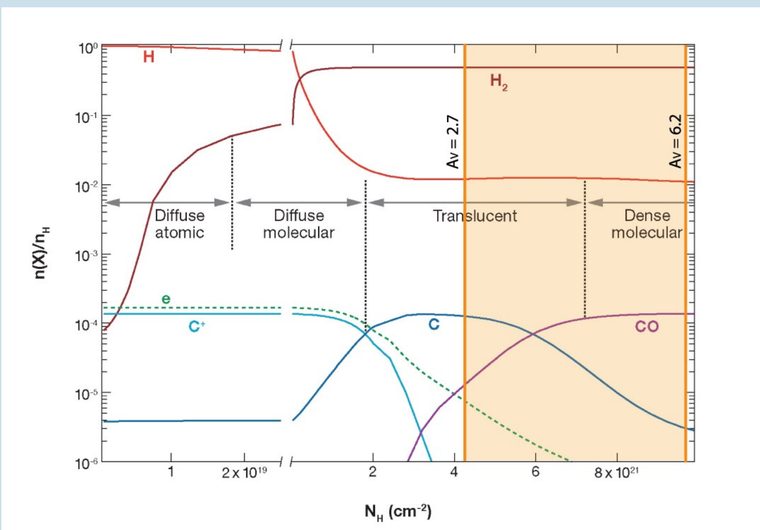
Introduction

Translucent clouds represent a middle ground between the diffuse and denser interstellar medium. In these clouds, where the total dust extinction lies in the range of A_V = 1.5 to 10 magnitudes (Black and van Dishoeck 1989) hydrogen is predominantly in molecular form, and carbon becomes neutral and then molecular (in the form of CO). The figure below illustrates the physical conditions in interstellar clouds (Snow and McCall 2006).

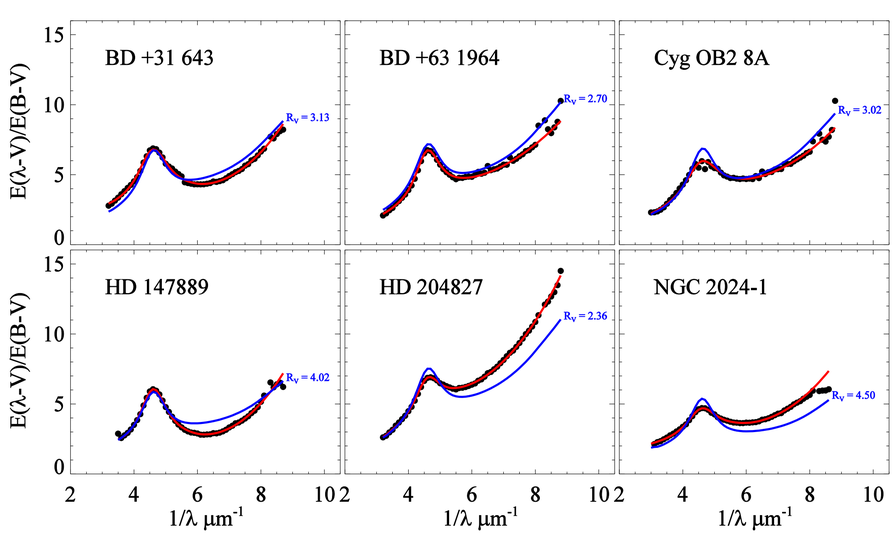


A theoretical model showing abundances of H I, H_2, C^+, C, and CO in diffuse, translucent, and dense molecular clouds. Ann. Rev. Astron. Astrophys 2006. 44:367-414.

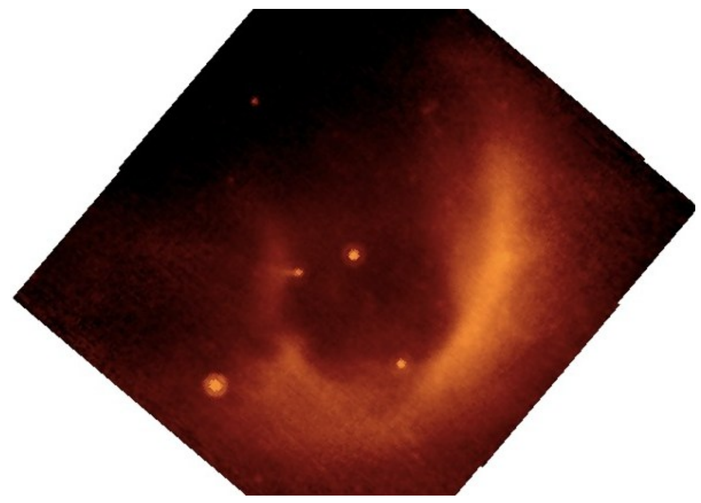
With its unprecedented sensitivity the Cosmic Origins Spectrograph is able to obtain UV spectra of stars behind translucent clouds. The star HD 204827 is a spectroscopic binary with spectral types O9.5 V + B0.5 III, V = 7.94, E(B-V) = 1.11, a total extinction A_V of about 3.5, very steep far-UV extinction. The line of sight has the highest molecular content ever seen in a translucent cloud observable in the UV (with the exception of NGC 2024 1, a borderline dark cloud).

Observations of HD204827 in HST Program 12542 comprised 3 sessions of 10 orbits each. These sessions were spaced 2 months apart (Nov 2011, Jan 2012, Mar 2012) in order to capture spectra at different phases in the orbit of the binary pair. This facilitates the suppression of stellar features relative to the interstellar lines of interest.

Extinction Curve Comparison



Extinction Curves from IUE. Note the steep rise in the ultraviolet for HD204827



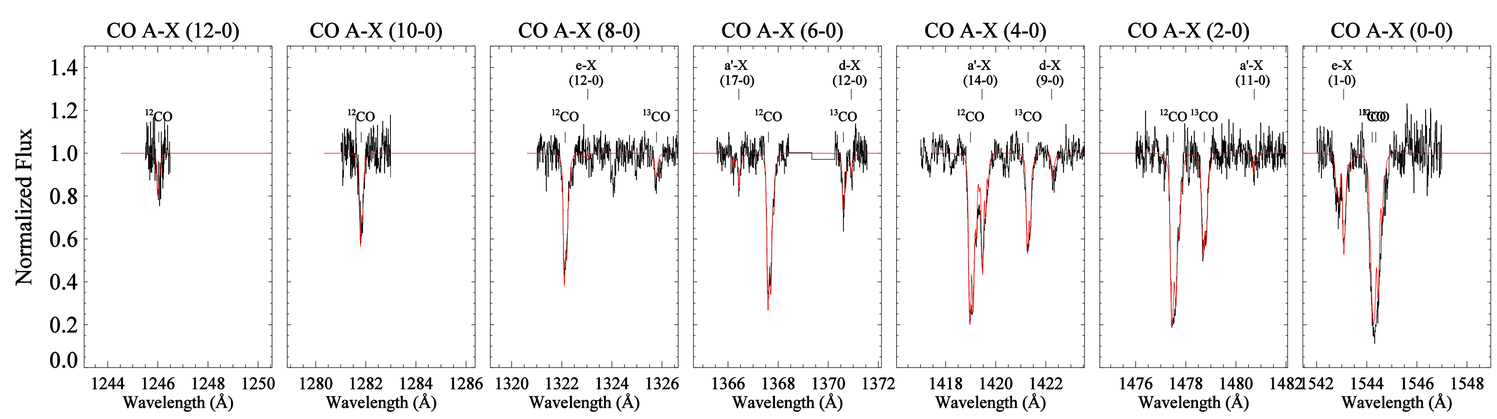
Infrared image of the nebula surrounding HD 204827, the bright star at the center of the image. (Image from Spitzer/MIPS 24 micron; unpublished. Courtesy K. Gordon and G. Clayton.)

Column Densities

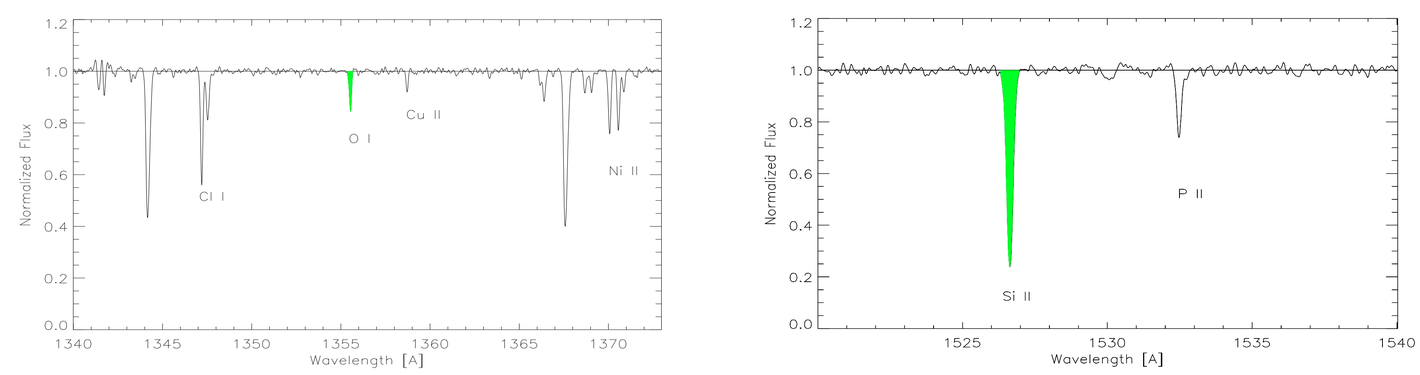
	Atomic/Ionic
Species	**Column Density**
Ca I	25.0 (10^9 cm^{-2})
Ca II	61.9 (10^{11} cm^{-2})
K I	42.0 (10^{11} cm^{-2})

	Molecular
Species	**Col. Density** (10^{12} cm^{-2})
CN	37.4
CH	87.9
CH^+	36.9
C_2	440.0
C_3	10.4

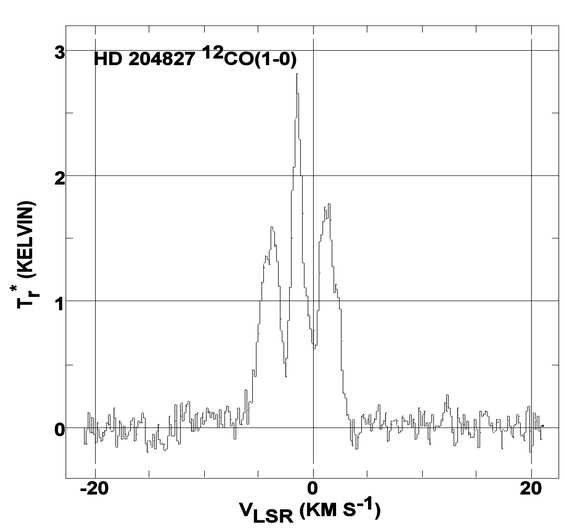
Tables showing measured atomic and molecular column densities for HD204827 (Pan et al. , Oka et al.)



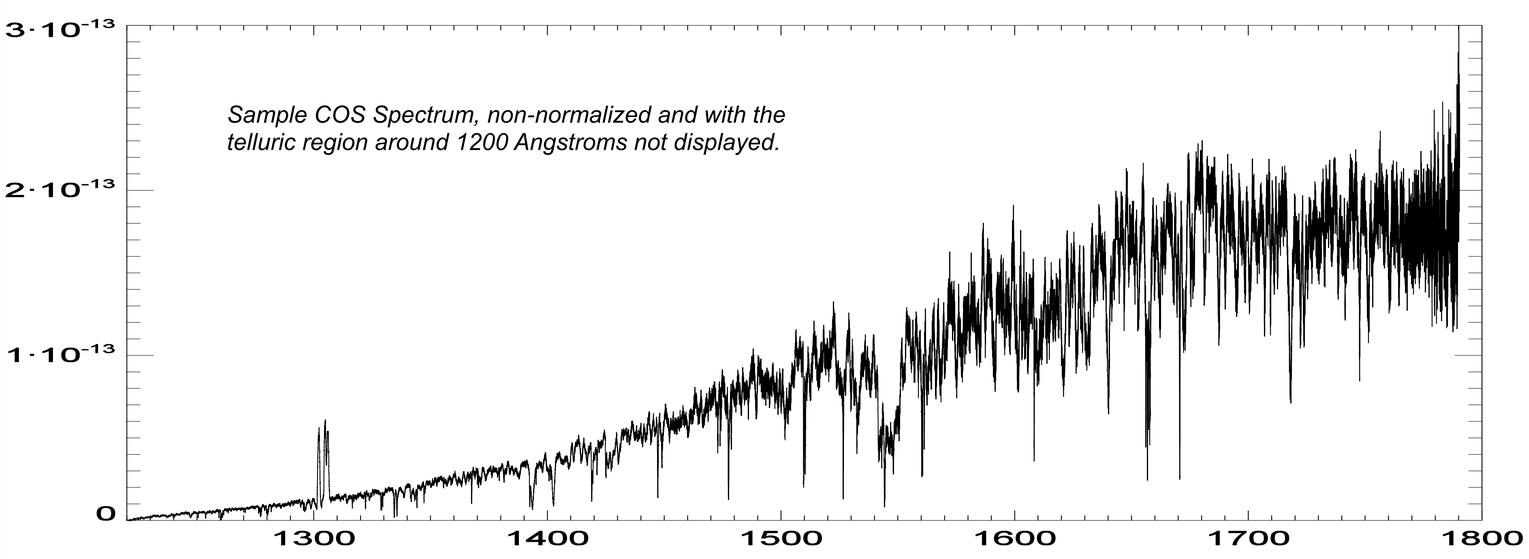
Profile fits of CO absorption bands.



Sample absorption features, O I and Si II, filtered and normalized. Note the Silicon line does not reach zero despite predicted saturation. This is attributed to instrument resolution rather than real phenomena. Emission-like features are artifacts of the filtering process.



2.6mm 12CO J=1-0 emission profile from the ARO Kitt Peak 12-m telescope at 1' and 0.13 km s-1 resolution (Liszt 2008, A&A, 492, 743).



Conclusions and Future Work

From the current processed data, we tentatively conclude that the translucent cloud towards HD 204827 seems to have stronger features and more complex components than expected. For this sightline:

1)Normally weak absorption lines of neutral species appear stronger than in other reddened stars.
2)The CO abundance is greater than of some of our GTO stars, consistent with ground-based molecular abundances.
3)Concerning the cloud morphology, the high-resolution mm-wave CO emission band shows three velocity components which will have to be taken into account in analyzing the COS spectra.

The complete data set for HD 204827 has not yet been fully processed. However, when all of the data is combined, a S/N ratio of approximately 50 is expected. Taking advantage of this high S/N, future work will involve:

1)Deriving depletions and comparing them to other COS stars
2)Searching for very weak lines that could improve knowledge of atomic abundances and depletions
3)Searching for weak lines or bands of interstellar molecules
4)Exploring the spectrum looking for broad interstellar bands that might be UV DIBs
5)Deriving physical conditions such as the electron density (using neutral to ionic ratios) and calculating the kinetic temperature and the radiation field intensity using C2 rotational excitation
6)Combining data from all spectral regions (UV, visible, and IR) to obtain a complete picture of the cloud
7)Modeling the cloud

This research was funded by NASA/HST grant HST-GO-12542.