Measuring Organic Molecules in Disks with Low Resolution *Spitzer* Spectra

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Motivation

High resolution spectroscopy of a small sample of T Tauri disks has shown that organic molecules are present in the planet forming disks surrounding young stars (Carr & Najita 2008, e.g. Fig. 1). Are such features common in disks, and what influences their detection? In this poster, we explore the extent to which low resolution IRS spectra can be used to measure the strength of HCN (14 μm) and C_2H_2 (13.7 μm) bands. If this is feasible, the larger number of low resolution IRS spectra obtained to date could be used to search for organic molecules in a broader range of disks.

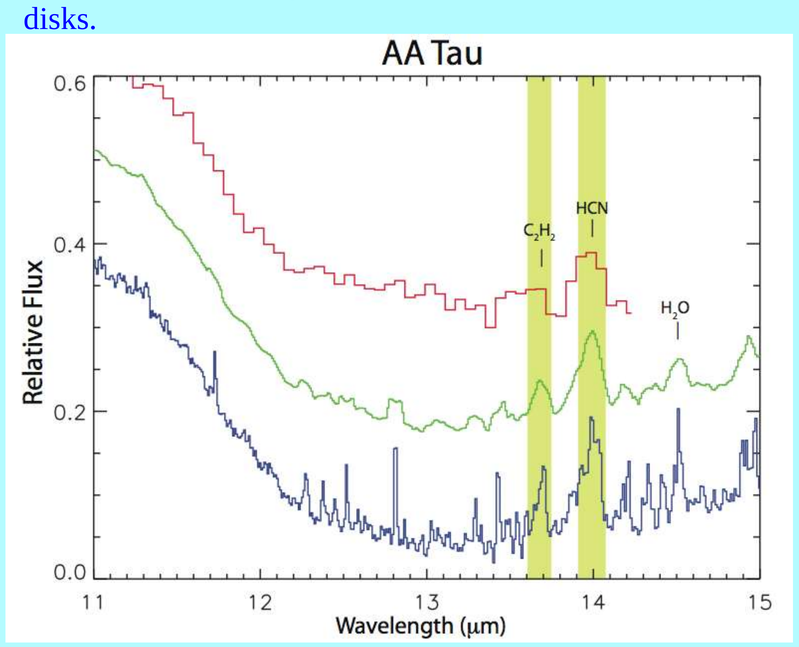

Fig. 1 - The spectrum of AA Tau is shown from 11-15 μm in high resolution (R~600, bottom, blue), smoothed high resolution (R ~155, middle, green), and low resolution (R~90, top, red). The only manipulation is a constant offset added so the spectra would not overlap in the plot. Prominent molecular emission features are labeled with vertical ticks, and regions measured in this poster are shaded in yellow-green.

Analysis

Our study finds:

• The HCN equivalent width measurements in the HR and LR spectra are strongly correlated. While the LR equivalent widths are systematically lower than in the HR spectra, they are comparable to the equivalent width measurements from the smoothed high resolution data. (Fig. 4)

• The C_2H_2 equivalent widths measured in the HR and LR spectra show more scatter. This could be in part because the C_2H_2 is weaker than the HCN. As in the HCN case, the LR measurements are systematically lower than in the HR spectra. (Fig. 5)

• The scatter in the equivalent width measurements could be due to time variability in the spectral features, the impact of neighboring molecular features, and data reduction issues.

Data

We attempted to measure molecular spectral features in the following data sets (Figs. 2 & 3):

• High resolution (HR) spectra from Carr & Najita (2008, Sci, 319, 1504; also in preparation).

• Low resolution (LR) spectra from the IRS GTO study of Taurus, originally published in Furlan et al. (2006, ApJS, 165, 568) and re-reduced by Pascucci et al. (2008, ApJ, 673, 477) using the techniques described in Bouwman et al. (2008, ApJ, 683, 479) and Pascucci et al. (2008).

• High resolution spectra boxcar smoothed to R ~155 to compare to the LR data.

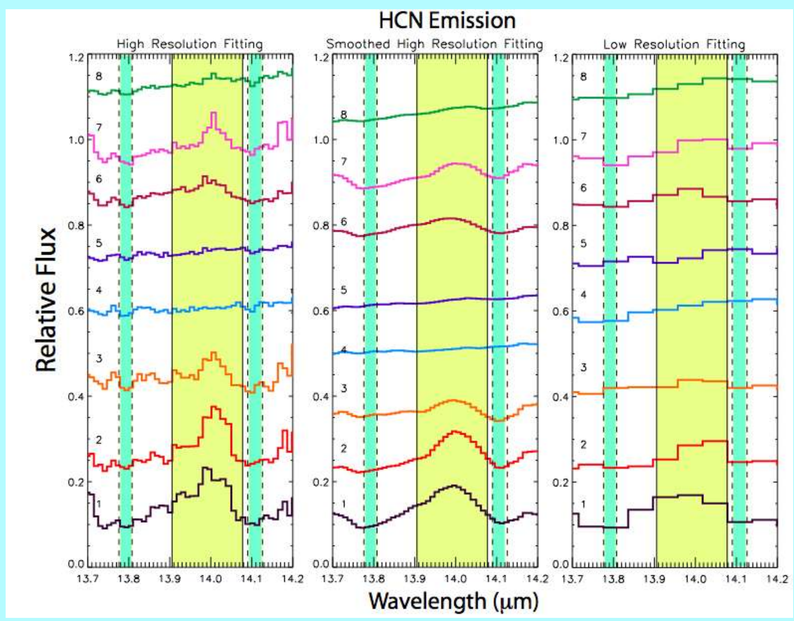

Fig. 2 - The HCN molecular feature is shown in our eight objects in the high resolution, smoothed high resolution, and low resolution spectra (left to right). Each color corresponds to a different object. The continuum (dashed lines, aqua shading) and equivalent width regions (solid lines, yellow-green shading) used to measure HCN in all the spectra are marked. Each spectrum was normalized by the average flux in the continuum regions, and a constant offset was added to prevent the spectra from overlapping in the plot.

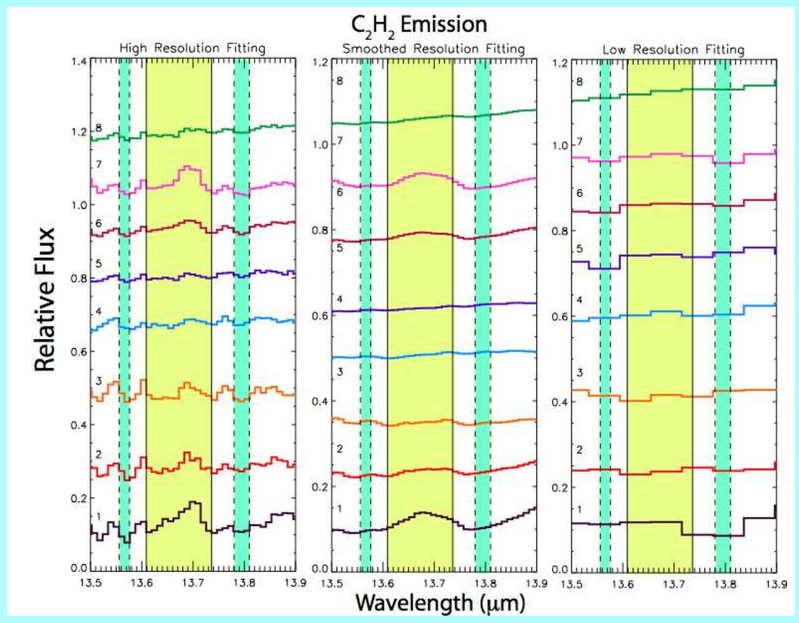

Fig. 3 - As in Fig. 2, but for the C_2H_2 molecular feature. Note that the C_2H_2 bands in these T Tauri stars are weaker than their HCN bands shown in Fig. 2.

Method

The equivalent widths were measured using the following procedure:

• Spectral regions defining the continuum (Figs. 2 & 3, dashed lines, shaded aqua) and molecular features (Figs. 2 & 3, solid lines, shaded yellow-green) were chosen based on existing HR spectra and synthetic disk emission models (e.g. Carr & Najita 2008).

• A linear fit to two continuum regions bracketing the feature was used to obtain standard equivalent width measurements.

Conclusions

• We can detect and recover trends in the relative strength of strong molecular features (such as HCN) in low resolution IRS spectra. (See poster #35 by Pascucci et al.[2008 arXiv0810.255], which takes this approach.)

• Distinguishing and studying intrinsically weaker features (like C_2H_2 in T Tauri stars) is more challenging.

• Equivalent width measurements from low resolution data tend to underestimate the true equivalent width.

• Our study indicates that we can broaden the range of systems that can be searched for organic molecules using low resolution *Spitzer* spectra.

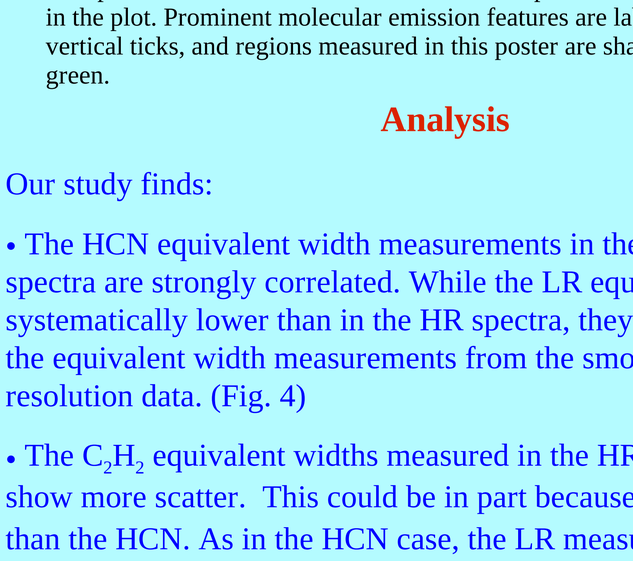

Fig. 4a - Equivalent width measurements of HCN from the high resolution spectra are plotted against analogous measurements from the low resolution spectra, with numbered points corresponding to the same sources as in Figs. 2 & 3. A solid unity line is overlaid.

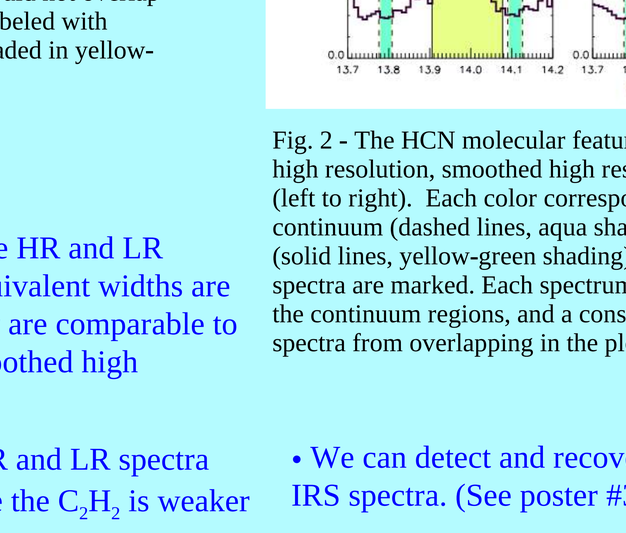

Fig. 4b - Equivalent width measurements of HCN from the smoothed high resolution spectra are plotted against analogous measurements from the low resolution spectra, with numbered points corresponding to the same sources as in Figs. 2 & 3. A solid unity line is overlaid.

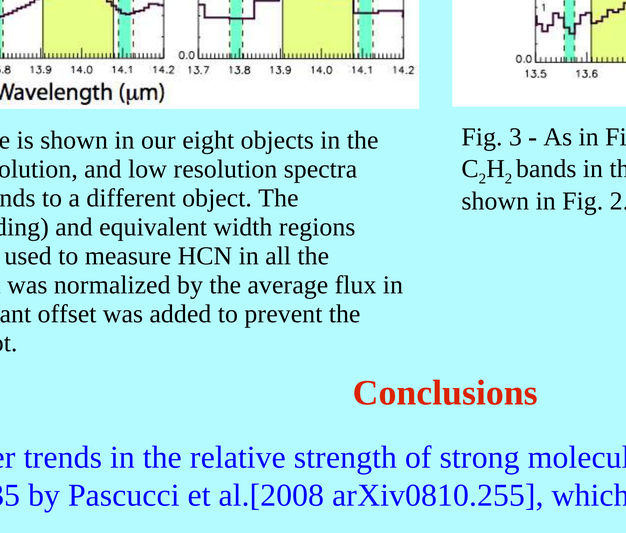

Fig. 5a - Equivalent width measurements of C_2H_2 from the high resolution spectra are plotted against analogous measurements from the low resolution spectra, with numbered points corresponding to the same sources as in Figs. 2 & 3. A solid unity line is overlaid.

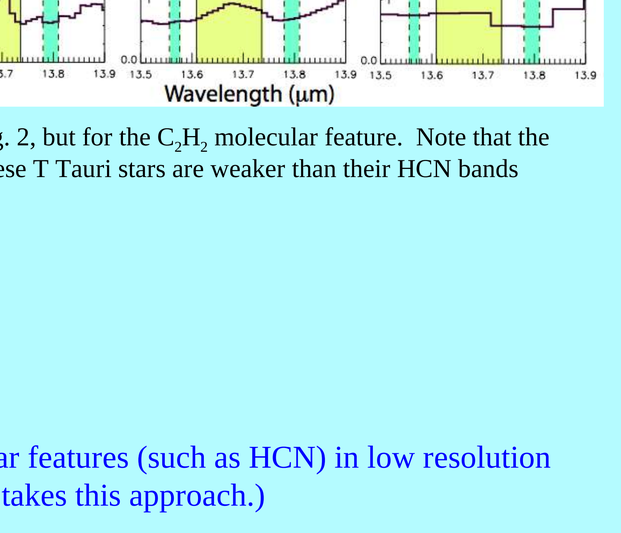

Fig. 5b - Equivalent width measurements of C_2H_2 from the smoothed high resolution spectra are plotted against analogous measurements from the low resolution spectra, with numbered points corresponding to the same sources as in Figs. 2 & 3. A solid unity line is overlaid.