Observational studies of gas in protoplanetary disks with high-resolution infrared spectroscopy

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and

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Searching for H2 emission at 17 and 28 micron in HAEBES with VISIR at ESO-VLT

Motivation:

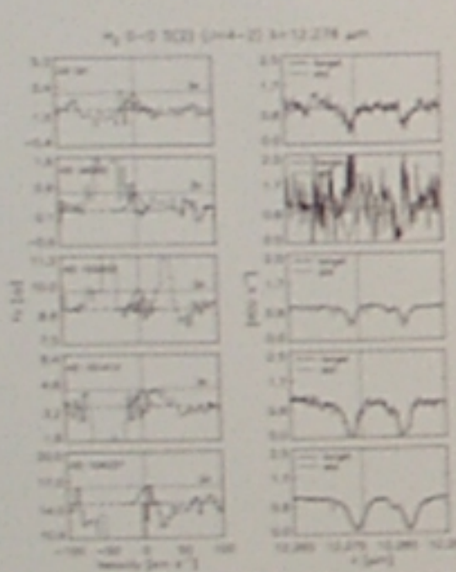
- To probe the gas in the giant planet forming region.

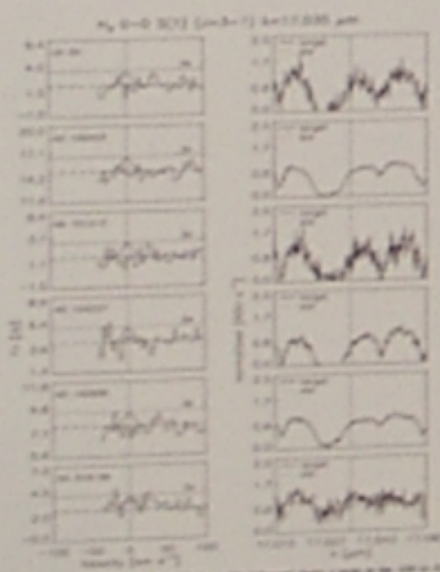
Observations

- VISIR: ESO-VLT high resolution MIR spectrograph R~ 20000 (15 km/s).
- nearby Herbig Ae/Be stars with evidence for large gas reservoirs (e.g. with CO in the sub-mm).
- 44h (40% completed) P76 + 4h P78.

Results

- None of the targets exhibit MIR H2 emission .
- The disks contain :
  less than a few tenths of Jupiter Mass at 150K .
  less than a few Earth masses at 300 K and higher.

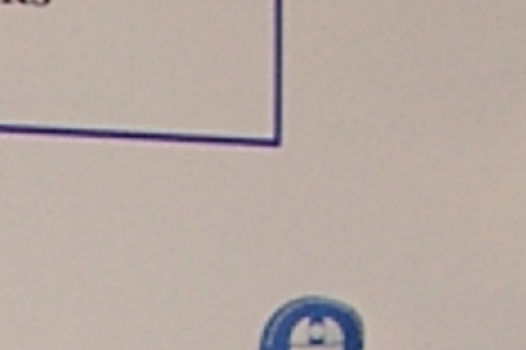




Searching for H2 2.12, 2.22 micron emission in the CTTS LkHa 264 and the debris disk 49 Cet with CRIRES at ESO-VLT

Motivation:

- To probe the gas in the terrestrial planets region of the disk.

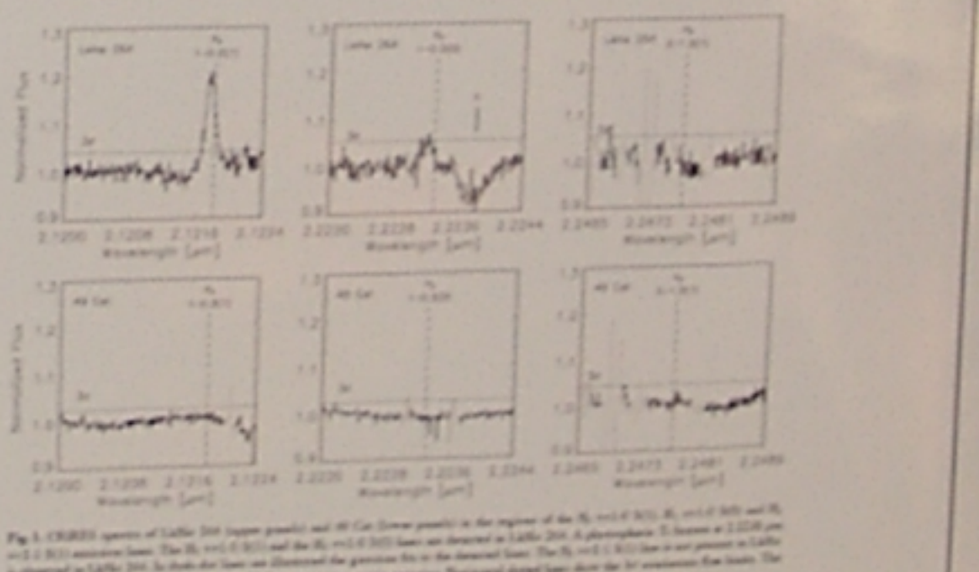


Observations

- CRIRES: ESO's new VLT high resolution NIR spectrograph R~ 45000 (6.6 km/s).
- LkHa 264 : a classical T Tauri star.
- 49 Cet : debris disk with CO detections in the sub-mm.

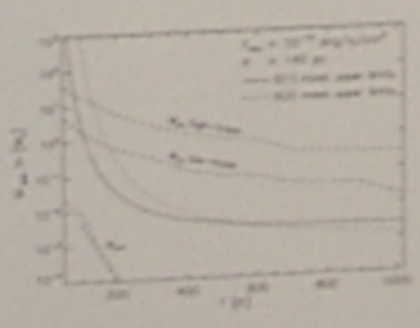
Results

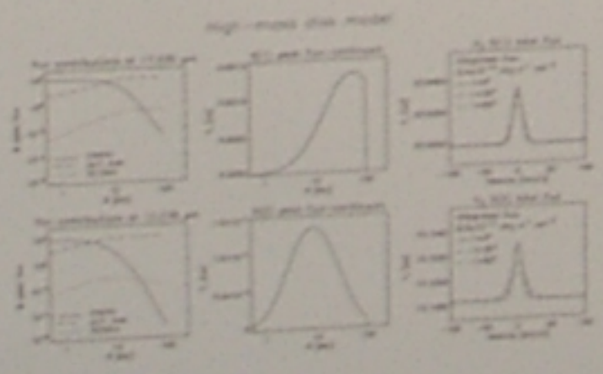
- 1-0 H2 S(1) emission at 2.1218 micron confirmed in LkHa 264.
- first detection of the 1-0 H2 S(0) line from a protoplanetary disk.
- non detection of 2-1 H2 S(1) emission at 2.2477 micron in LkHa 264.
- Any of the three lines is detected in 49 Cet.



Analysis & Interpretation

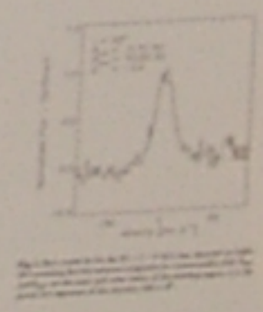
- The upper limits to the disk's warm gas mass are smaller than the amount of warm gas in the interior layer of the disk, but they are much larger than the amount of mass expected to be in the surface layer.
- We calculated the H2 emission at 12 and 17 micron from a Chiang & Goldreich (1997) two-layer optically thick disk model of a Herbig Ae/Be disk.
- The predicted line fluxes of the two-layer disk model are of the order of $10^{-26} - 10^{-27}$ erg s^{-1} cm^{-2}, much smaller than the detection limits of our observations (0.4×10^{-24} erg s^{-1} cm^{-2}).
- If the two-layer approximation to the structure of the disk is correct, we are essentially blind to most of the warm H2 in the disk because it is located in the optically thick interior layer of the disk.
- Our non-detections are explained because of the intrinsically low thermal H2 emission flux levels from the surface layer.

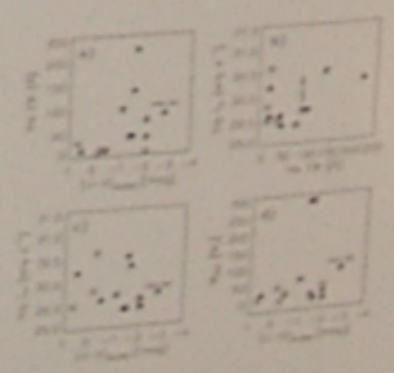




Analysis & Interpretation

- The detected lines are coincident with the rest velocity LkHa 264. They have a FWHM of 20 km s^{-1}. This is strongly suggestive of a disk origin for the lines.
- The measured 1-0 S(0)/1-0 S(1) (0.33 ± 0.1) and the 2-1 S(1)/1-0 S(1) (<0.2) line ratios indicate that the emitting H2 is at a T < 2000 K and that the H2 is most likely thermally excited by UV photons.
- Modeling of the shape of the line suggest that the disk of LkHa 264 should be inclined at less than 35°.
- The emission is spatially unresolved. The H2 emitting region to is located in the inner 50 AU of the disk.
- There is a few lunar masses of emitting H2 in the inner 1 AU of LkHa 264, and less than a tenth of a lunar mass in the inner disk of 49 Cet.
- The lack of H2 emission in the NIR spectra of 49 Cet and the absence of Hα emission suggest that the gas in the inner disk of 49 Cet has dissipated. These results combined with previous detections of ^{12}CO emission at sub-mm wavelengths indicate that the disk surrounding 49 Cet should have an inner hole.
- A comparative analysis of the physical properties of CTTS in which the H2 v = 1 – 0 S(1) line has been detected and non-detected indicates that the presence of H2 emission is correlated with the magnitude of the UV excess and the strength of the Hα line.





References

- Carmona, A., van den Ancker,M. E., Henning, T., Ya. Pavlyuchenkov, C.P. Dullemond, M.Goto, W.F-.Thi, J.Bouwman, & L.B.F.M. Waters. 2007, submitted to A&A.
- Chiang, E. I., & Goldreich, P. 1997, ApJ, 490, 368

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- Carmona, A., van den Ancker, M.E., Henning, T., Goto, M., Fedele, D., & B.Stecklum. 2007, submitted to A&A.