CHANDRA/HETGS **OBSERVATIONS OF YOUNG STELLAR OBJECTS IN THE HD 104237 FIELD.**

Paola Testa, David P. Huenemoerder, Norbert S. Schulz, Claude R. Canizares, Kazunori Ishibashi, *MIT, Kavli Institute for Astrophysics and Space Research, 70 Vassar street, Cambridge, MA 02139, USA (testa@space.mit.edu).*

We present 150 ks *Chandra*/HETGS observations of a group of young stars comprising a Herbig Ae star (HD 102437), three T Tauri stars (with at least one classical T Tauri star), and a supposed brown dwarf. The HETG spectrum of the Herbig Ae star shows strong emission lines corresponding to a wide range of plasma temperatures. Spectral diagnostics and temporal variability provide clues to the yet unestablished X-ray production mechanisms in young intermediate mass stars. We also present 0th order spectra, obtained for all group members.

The recently discovered young stellar group (Figure 1) associated with the Herbig Ae star HD 104237 allows to study the X-ray properties of several young stars, presumably coeval, with wide range of stellar masses (0.15-2.3 $M_\star$). The Herbig Ae star HD 104237 with its proximity, high X-ray luminosity and low line-of-sight extinction is one of the few Herbig Ae stars accessible to high resolution spectroscopy, providing detailed diagnostics of the X-ray emission mechanisms that for young intermediate mass stars are still a mistery.

Zero-order Spectra

Figure 2 shows the zero-order spectra for source A, C, D, E.

A: L_X varies within a factor ~ 2 during our observations, but the other parameters (T, N_H, abundances) do not significantly change. At least two temperature components are needed to fit the spectrum. $T_1 = 4.5 \times 10^6$ K, $T_2 = 3 \times 10^7$ K, $N_H = 10^{21}$ cm^{-2}, $L_X = 2.5 \times 10^{30}$ erg/s; abundances are about solar except Ne (~ 1.3 solar) and Fe and O (~ 0.6 solar)

C: $T_1 = 10^7$ K, $N_H = 7 \times 10^{21}$ cm^{-2}, $L_X = 7 \times 10^{28}$ erg/s

D: very soft, TW Hydrae-like X-ray spectrum, with $T_1 = 3 \times 10^6$ K, $N_H = 4.5 \times 10^{21}$ cm^{-2}, $L_X = 10^{30}$ erg/s

E: hard, highly absorbed spectrum with $T_1 = 2 \times 10^7$ K, $N_H = 3.4 \times 10^{22}$ cm^{-2}, $L_X = 10^{30}$ erg/s

HETGS spectrum of A

The HETGS spectrum of HD 104237 is show in Figure 3. He-like O VII (~ 22Å) and Ne IX (~ 13.5Å) triplets (in particular the ratio of the forbidden to the intercombination line, f/i) provide a powerful diagnostic of accretion related X-ray emission in pre-main sequence stars (see e.g. Kastner et al. 2002, ApJ, 567, 434). In the spectrum of HD 104237 O VII is barely detected. The Ne IX triplet has f/i ratio somewhat lower than typical coronal sources at the same activity level (but significantly larger than for accretion powered sources). The thermal distribution presents a wide range of plasma temperatures with a soft component somewhat larger than in coronal sources with similar activity level (e.g. L_X)

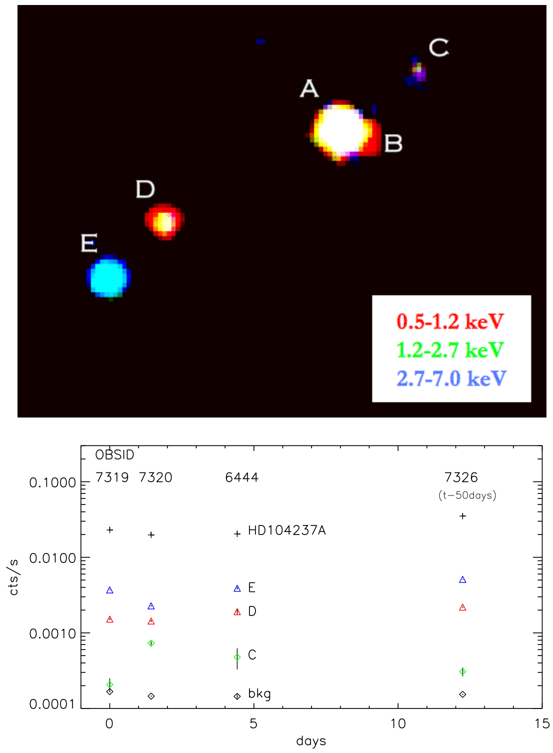

Figure 1: *Top* Color coded image from our 150 ks *Chandra*HETG observation. The X-ray sources: A is a spectroscopic binary with the Herbig Ae star HD 104237 (A4-A7, M$\sim$2.3 $M_\odot$)+K-type companion within $\sim$ 0.2 AU (K3, $\sim$ 1.7 $M_\odot$; Bohm et al. 2004, A&A, 427, 907); B is an M3-M4 T Tauri star (Grady et al. 2004, ApJ, 608, 809); C is a supposed brown dwarf (Feigelson et al. 2003, ApJ, 599, 1207); D is a borderline weak line/classical T Tauri star (M2-3.5); E is a classical T Tauri star (K2-5.5). *Bottom* Lightcurves from zero-order counts. All sources show significant variability.

Conclusions

The *Chandra* observations presented here were aimed at studying the X-ray characteristics of young stars in their pre-main sequence phase (either still accreting or not), and in particular to investigate the X-ray emission mechanism in young intermediate mass stars that are not expected to have strong X-ray emission. A stars in fact are not expected to sustain internally generated magnetic fields (and therefore X-ray emission through solar-like magnetic processes) nor are their winds powerful enough to produce X-rays through radiative wind shocks as in early-type stars.

Is the Herbig Ae star HD 104237 an X-ray source? if so, what is the possible X-ray emission mechanism? or is it the K-type companion responsible for all the X-ray emission? The

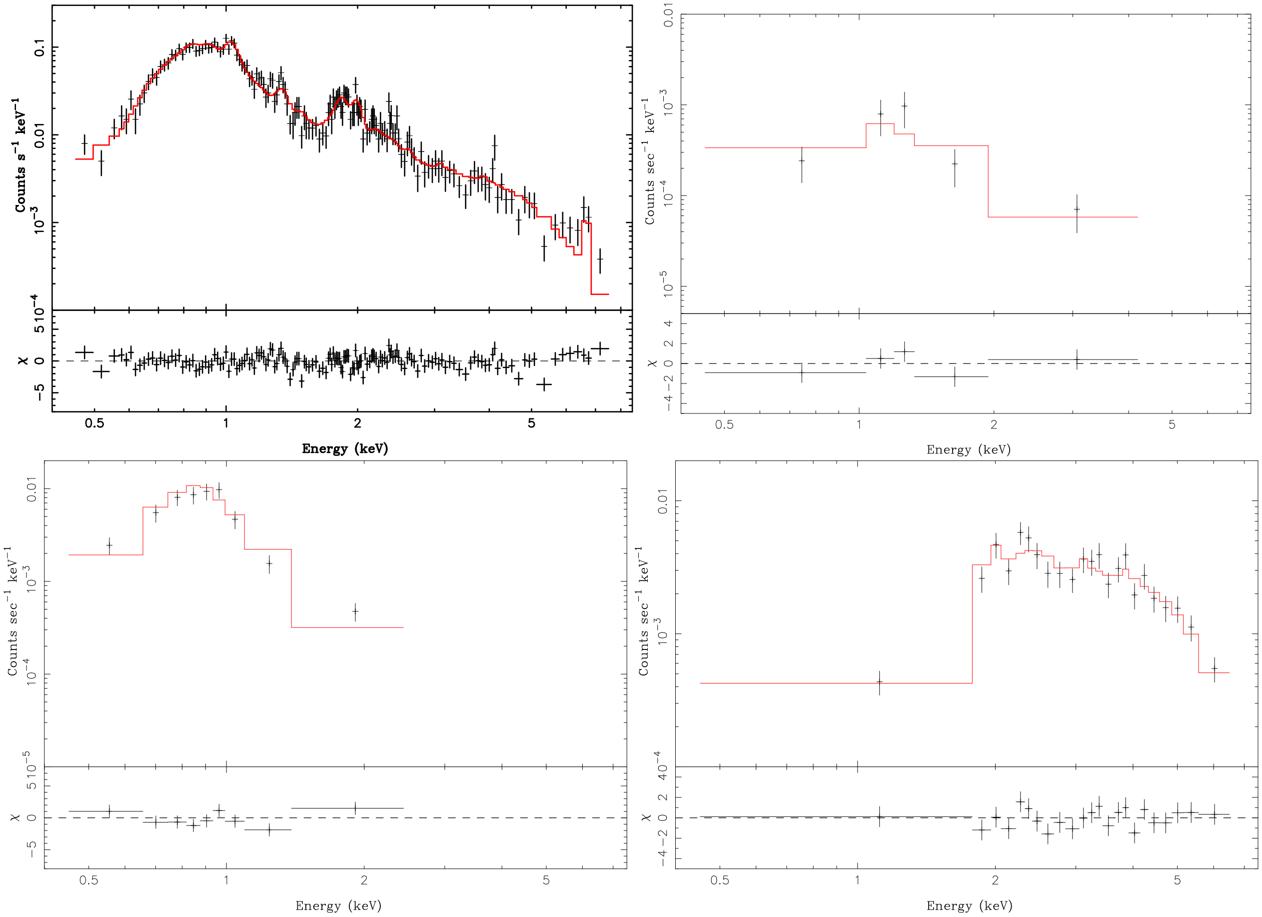

Figure 2: Zero-order spectra of source A (*top left*), C (*top right*), D (*bottom left*), E (*bottom right*). The best fit model is superimposed to the data as a red solid line.

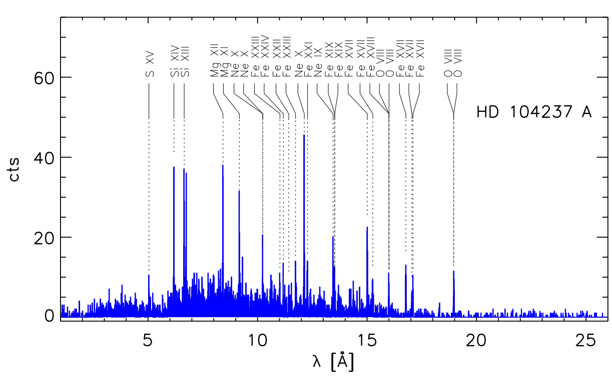

Figure 3: *Chandra*HETGS X-ray spectrum of HD 104237. Most of the prominent lines are labeled.

presence of hot plasma and of significant variability suggests magnetic origin for the X-ray emission. Also, K-type pre-main sequence stars are strong X-ray emitters, therefore we expect that at least part of the observed X-ray emission is produced by the spectroscopic companion. We can compare the characteristics of the X-ray emission of HD 104237 with the typical characteristics of other T Tauri stars similar to the K-type companion to investigate how likely is that the the X-ray emission in entirely produced by the spectroscopic companion. Comparing our findings with the results from the *Chandra* Orion Ultradeep Project (COUP; Preibisch et al. 2005, ApJS ,160, 401) we find that A shows a soft excess with respect to the typical emission of K-type T Tauri stars. Considering that the likely single Herbig Ae stars HD 163296 (Swartz et al. 2005, ApJ, 628) and AB Aur (Telleschi et al. 2007, A&A in press) are characterized by very soft emission very similar to the soft component we find for A, we speculate that the soft emission might be partially produced by the Herbig Ae star while the hard emission is likely produced by the K-type companion exclusively.

Another very interesting finding is the extremely soft emission of the T Tauri star D that is characterized by very cool plasma for its moderately high X-ray luminosity, possibly indicating that it originates in shocked accreting plasma as for some classical T Tauri stars (Kastner et al. 2002; Schmitt et al. 2005, A&A, 432, L35; Gunther et al. 2006, A&A, 459, L29; Argiroffi et al. 2007, A&A, 465, L5).