OBSERVATION OF NEON IR EMISSION LINES INDUCED BY X-RAY IRRADIATION OF THE CIRCUMSTELLAR DISK.

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Young Stellar Objects are intense sources of X-ray emission. Theoretical calculations indicate that X-rays are likely to be the dominant ionization agent of circumstellar disks, with profound implications for the disk structure, angular momentum transport, and planet formation. Empirical signatures of the interaction between X-rays and disk material are difficult to observe. The 6.4 keV Kα fluorescence line from neutral to low-ionization iron is one of such signatures and has recently been observed in about 10 young stellar objects. Glassgold et al. (2007) have recently predicted the fluxes of the Ne II (12.8 μm) and Ne III (15.55 μm) fine-structure lines due to the X-ray ionization of warm disk atmospheres. Two papers have since reported the observation of the lines with *SPITZER* IRS spectra in 19 PMS stars (Pascucci et al. 2007; Lahius et al. 2007).

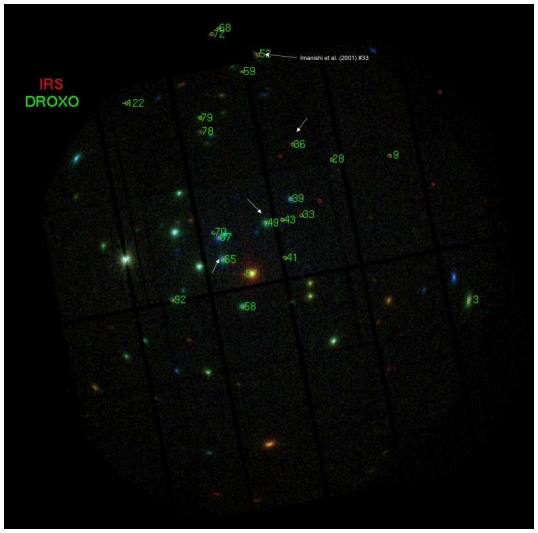

Figure 1: True color EPIC (PN+MOS1+MOS2) image of the DROXO observation. Red circles indicate stars with available IRS spectra in the SPITZER archive; green circles stars associated with DROXO sources (numbers are DROXO source identifiers). The four stars with Ne II line detection are marked by arrows. Note that one of the sources is not detected by DROXO because it falls close to a bright source (#62), and in a region of low effective exposure time. It is however detected by Imanishi et al. (2001) with Chandra-ACIS.

In the context of the Deep Rho Ophiuchi *XMM-Newton* Observation (DROXO), a $\sim$500 ksec *XMM-Newton* exposure of core F of the ρ Ophiuchi molecular cloud, we have searched the *SPITZER* archive for IRS observations of stars in our FOV. We find that 30 stars have been observed in the IRS high resolution mode, 23 of which are counterparts of detected X-ray sources. Figure 1 shows the positions of these sources within the DROXO field of view. We clearly detect the Ne II line in four stars (see Fig. 2), three class II and one class I, all of which are X-ray sources, three detected with DROXO and one by Imanishi et al. (2001) with *Chandra* ACIS data. Figure 3 shows the 0.3-10 keV X-ray spectra of the three DROXO sources, along with an enlargment of the 5-10 keV region for one of the sources, showing the likely detection of the 6.4 keV fluorescence Fe line. We investigate the relation between luminosity of the Ne II emission and L_X (cf. Fig. 4).

1 Conclusions

Using archival *SPITER*-IRS spectra, we have detected the Ne II fine structure line in four X-ray sources within the FOV of the DROXO observation. The data seem to suggest a correlation between X-ray and NeII luminosities, but more data points are needed in order to draw firm conclusions. The line fluxes are $\sim$1 dex larger than those observed by Pascucci et al. (2007) for somewhat older/more evolved stars, and within the range of those found by Lahuis et al. (2007).

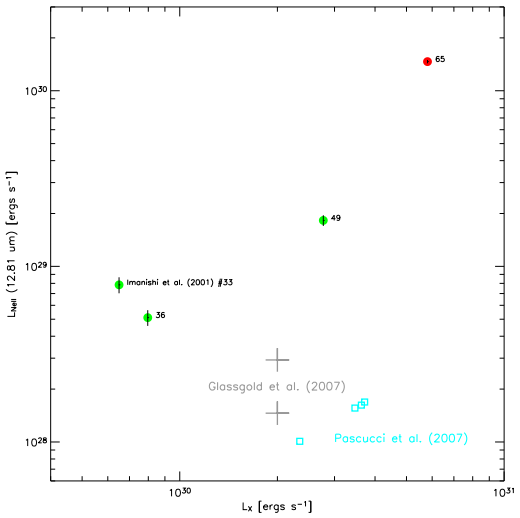

Figure 4: Luminosity of the Ne II (12.8 μm) line vs. L_X. Filled circles: X-ray sources in the DROXO FOV. Identifiers are given to the side of the symbols. The red circle indicate the class I source while the other stars are all class II. The model prediction for two assumptions on disk heating are indicated by the large grey crosses. Data points indicated by empty squares are reported from Pascucci et al. (2007) and refer to a sample of somewhat older stars ($\sim$5Myr) with respect to our ρ Ophiuchi sample.

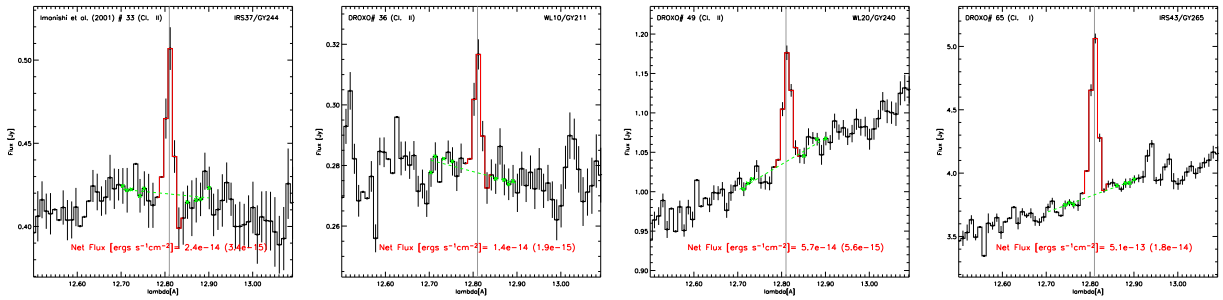

Figure 2: IRS spectra of four stars with a clear detection of the Ne II line. X-ray and optical identifiers are given in the upper part of the panels along with the ISO spectral class (Bontemps et al, 2001). Measured line fluxes are given toward the bottom.

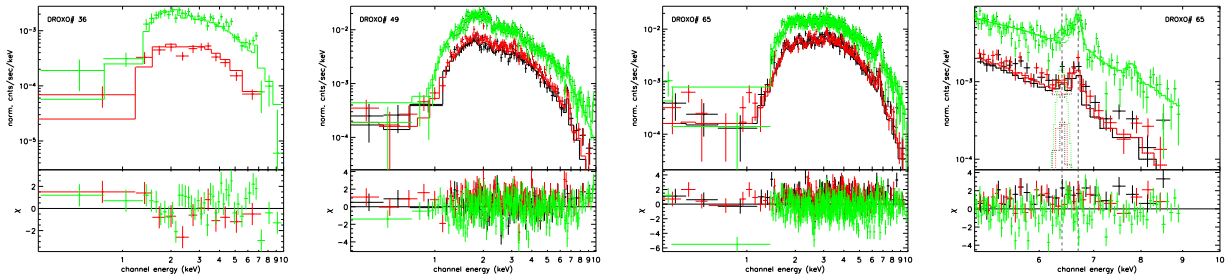

Figure 3: First three panels from the left: EPIC X-ray spectra of the three Ne II sources detected with DROXO, fitted with isothermal models. Best fit kT and N_H values are given within each plot. The class I source #65 is the brightest both in X-rays and in the Ne II line. The panel on the right shows, for this star, an enlargement of the Fe 6.4/6.7 keV line region. The Fe 6.4 keV fluorescent line is seen in emission, consistent with the relatively large and hard X-ray flux of the source.

2 References

Bontemps, S., André,P., Kaas, A. A., et al. (2001) A&A. 372, 173

Glassgold, A. E., Najita, J. R., Igea J., 2007, ApJ, 656, 515

Pascucci, I, Hollenbach, D., Najita, J. R. et al. , 2007, ApJ, 663, 383

Lahuis F., van Dishoeck, E. F., Blaek, G. A., et al. 2007, ApJ. In press (arXiv:0704.2305)

3 Acknowledgments

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