STAR-DISK INTERACTIONS IN OUTBURSTING STARS.

M. Audard, *Integral Science Data Centre & Observatoire de Genève, Université de Genève, Ch. d'Ecogia 16, 1290 Versoix, Switzerland, (Marc.Audard@obs.unige.ch),* M. Güdel, K. R. Briggs, *Paul Scherrer Institut, 5232 Villigen PSI, Switzerland*, S. L. Skinner, G. Stringfellow, *CASA, University of Colorado, 389 UCB, Boulder, CO 80309-0389, USA,* F. M. Walter, *Department of Physics and Astronomy, State University of New York at Stony Brook, Stony Brook, NY 11794-3800, USA*, E. F. Guinan, *Department of Astronomy and Astrophysics, Villanova University, Villanova, PA 19085, USA*, R. T. Hamilton, *Department of Astronomy, New Mexico State University, Las Cruces, New Mexico 88003-8001, USA.*

The origin of the X-ray emission in young, accreting stars remains unclear. Kastner et al. (2002) obtained the first X-ray grating spectrum of TW Hya, a moderately accreting classical T Tauri star (CTTS), and observed unexpected new spectral features: the O VII and Ne IX He-like triplets showed very low forbidden-to-intercombination line ratios and indicated high electron densities of the order of $10^{12} - 10^{13}$ cm^{-3}. The effect of UV photoexcitation on the observed line ratio was deemed negligible. In addition, the X-ray spectrum was consistent with a quasi-isothermal plasma of about 3 MK. Taken together, Kastner et al. (2002) concluded that the X-ray emission in TW Hya was due to accretion, a result further supported by Stelzer & Schmitt (2004) with *XMM-Newton*. Additional high-resolution X-ray spectra of CTTS also indicated that accretion may play a significant role in accreting stars (e.g., Schmitt et al. 2005; Robrade & Schmitt 2006). Telleschi et al. (2007) showed that CTTS display a soft X-ray excess from plasma at low temperature. The soft X-ray excess can co-exist with the hot plasma observed in the vast majority of young stars, which is due to scaled-up solar-like magnetic activity (e.g., Preibisch et al. 2005; Telleschi et al. 2007). The origin of such an excess is unclear, but it could be due in part to accretion onto the stellar photosphere. Therefore, it is important to understand how the X-ray emission in young stars, in particular those accreting matter actively, can be influenced by the accretion process.

A handful of accreting young stars display powerful eruptive events with flux increases in the optical regime of a few magnitudes. Two classes have emerged: FUors, which display outbursts of 4 magnitudes and more, last several decades and, therefore, show a low recurrence rate. EXors (named after the prototype EX Lup), in contrast, show somewhat smaller outbursts ($\Delta V = 2 - 3$ mag) on a much shorter timescale, from a few months to a few years, and may occur repeatedly (see review by Hartmann & Kenyon 1996). Such outbursts are believed to originate during a rapid increase of the disk accretion rate over a short period of time, from values of 10^{-7} $M_\odot$ yr^{-1} to 10^{-4} $M_\odot$ yr^{-1}. The limited number of eruptive young stars and the long recurrence time (especially for FUor-type objects) make it difficult to test models. It is, therefore, crucial to study in as much detail as possible the evolution of outbursts.

In late 2003, V1647 Ori, a young low-mass star erupted and illuminated a nebula, McNeill's nebula (e.g., Reipurth & Aspin 2004). An international, multi-wavelength campaign started to monitor the high state of the outburst and to follow it through its decay (e.g., Kastner et al. 2004; Reipurth & Aspin 92004; Briceño et al. 2004; Vacca et al. 2004; Andrews et al. 2004; Walter et al. 2004; McGehee et al. 2004; Ábrahám et al. 2004; Grosso et al. 2005; Kastner et al. 2006). Kastner et al. (2004) and Grosso et al. (2005) reported increases up to a factor of 200 in the X-ray flux of V1647 Ori from its pre-outburst flux, in line with the flux increase in the infrared. The X-ray flux then followed the optical outburst flux and returned to its pre-outburst level after the outburst ended (Kastner et al. 2006). This behavior indicated that the X-ray emission in young stars can increase dramatically as a consequence of the rapid increase of accretion rate in outbursts.

In January 2005, Williams et al. (2005) reported the outburst of V1118 Ori, a low-mass M1e young EXor star (Hillenbrand 1997; Stassun et al. 1999). V1118 Ori has been known for its outbursts in the past (see Garcia Garcia & Parsamian 2000 for details). For this 2005 outburst, we have monitored V1118 Ori in X-rays, optical, near-IR, and mid-IR (Audard et al. 2005; 2007). We obtained DDT and TOO time with *Chandra* and *XMM-Newton* in 2005 and GO time with *Chandra* to follow the outburst in 2006. A deep *XMM-Newton* observation was also granted to study the X-ray spectrum in outburst.

In contrast to V1647 Ori, which displayed a strong X-ray flux increase coincident with the optical/near-IR outburst (Kastner et al. 2004), the X-ray flux in V1118 Ori did not increase very much, and while it returned to the quiescent level at the end of the outburst in V1647 Ori, there is evidence that the X-ray flux decreased below the level observed in a serendipitous quiescent 2002 observation (Audard et al. 2005). A cool component was detected together with the hot component in V1647 Ori, and Grosso et al. (2005) interpreted the former component as accretion shocks onto the stellar photosphere. In contrast, a spectral change occurred in V1118 Ori from a dominant hot plasma (~ 25 MK) in 2002 and in January 2005 to a cooler plasma (~ 8 MK) in February 2005 and probably in March 2005. The 2006 observations all indicate that the X-ray spectrum returns to a dominating hot plasma (Audard et al. 2007). Audard et al. (2005) hypothesized that the hot magnetic loops high in the corona were disrupted by the closing in of the accretion disk due to the increased accretion rate during the outburst, whereas the lower cooler loops were probably less affected and became the dominant coronal component. Such a hardening is interesting because it suggests that the hot coronal loops dominate again the X-ray emission; however, their emission measures appears to be small (compared to pre-outburst levels) since the X-ray flux decreases with the optical flux and is *lower* than the pre-outburst level.

The V1118 Ori and V1647 Ori results provide clear indications that the X-ray emission in young stars can be significantly influenced by the mass accretion rate during outbursts and that star-disk interactions exist in young outbursting stars.