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First disk-mediated accretion burst from a massive protostar

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Abstract. We report on the discovery and follow-up of the first disk-mediated accretion burst in a high-mass young stellar object (HMYSO), S255IR NIRS 3. Our results strengthen the idea that massive stars form through disks via episodic accretion, pointing to a common formation mechanism across the entire stellar mass spectrum. Moreover, our data reveal a tight correlation between the burst, the onset of a methanol maser flare and boosting of pre-existent radio jet emission.

1. S255IR NIRS 3 accretion burst

The latest picture of low-mass YSO evolution suggests that most of the accreted material is gathered during outbursts (FUor and EXor bursts; see Audard et al. 2014, for a review). The mass accretion rate increases by several orders of magnitude (up to $10^{-4}\,M_\odot\,yr^{-1}$) and, as a consequence, in a few months the YSO brightness also increases by several magnitudes at optical and near-infrared (NIR) wavelengths. Moreover, augmented mass ejection rates are also expected. Such bursts take place through a broad range of stellar masses and during the whole low-mass YSO evolution (see Contreras Peña et al. 2017). Evidence of bursts was so far missing in HMYSOs ($M>8\,M_\odot$, L_{bol} $>5\times10^3\,L_\odot$), as the very nature of their formation process is still unclear. Nevertheless, accretion bursts should develop if massive stars gain mass through disk-mediated accretion, as their low-mass counterparts. During the NIR imaging follow-up of a 6.7 GHz methanol maser flare (Fujisawa et al. 2015) in the star forming region S255 IR, our group discovered the accretion burst of S255IR NIRS 3 (Stecklum et al. 2016; Caratti o Garatti et al. 2017), a $\sim$20 $M_\odot$ HMYSO (Zinchenko et al. 2015). Our NIR images show the brightening of the central source and its outflow cavities. NIR spectroscopy reveals emission lines typically observed in EXor bursts (see Fig.1), but orders of magnitude more luminous. By comparing pre- and outburst spectral energy

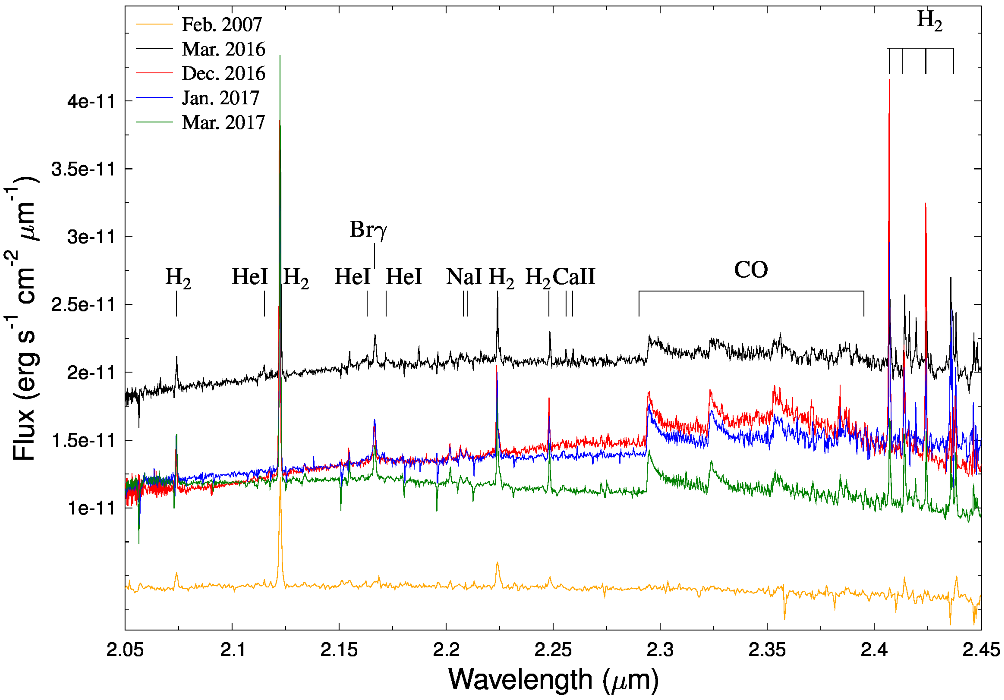

Fig. 1. Pre-outburst (orange) and outburst SINFONI K-band spectra of the red-shifted outflow cavity of S255IR NIRS 3. The cavity acts as a mirror allowing to detect the disk emission. The pre-outburst spectrum only displays H_2 lines in emission, whereas the outburst spectra show emission lines typical of EXor bursts.

distributions, we were able to derive the burst energetics. The HMYSO luminosity increased by $1.3\times10^5\,L_\odot$ corresponding to a mass accretion rate increment of $5\times10^{-3}\,M_\odot\,yr^{-1}$ (see Caratti o Garatti et al. 2017). Notably, the accretion burst triggered Class II methanol maser flares (at 6.7 GHz), excited through IR pumping (see Moscadelli et al. 2017). Finally, about 14 months after the beginning of the accretion burst, we also detected a burst from the pre-existing radio jet emission with our JVLA monitoring (Cesaroni et al. in prep.). Indeed, the radio jet emission has been boosted by a sudden increase in the mass loss rate, which is, in turn, a consequence of the accretion burst.

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