Accretion outbursts in massive star formation

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Using the HPC resources of the state of Baden-Württemberg, we modelled for the first time the luminous burst from a young massive star by accretion of material from its close environment. We found that the surroundings of young massive stars are shaped as a clumpy disk whose fragments provoke outbursts once they fall onto the protostar and concluded that similar strong luminous events observed in high-mass star forming regions may be a signature of the presence of such disks.

1 An FU-Orionis-like burst from a high-mass protostar

Accretion-driven luminosity outbursts are a vivid manifestation of variable mass accretion onto protostars. They are known as the so-called FU Orionis phenomenon in the context of low-mass protostars (Vorobyov & Basu 2006). More recently, this process has been found in models of primordial star formation (Hosokawa et al. 2016). In Meyer et al. (2017), using numerical radiation hydrodynamics simulations of a collapsing 100 $M_\odot$ pre-stellar cores rotating with a ratio of kinetic by gravitational energy of 4% that produces a central massive protostar (cf. Kuiper et al. 2011), we stress that present-day forming massive stars also experience variable accretion (Fig. 1) and show that this process is accompanied by luminous outbursts induced by the episodic accretion of gaseous clumps migrating from the circumstellar disk onto the protostar (Fig. 2).

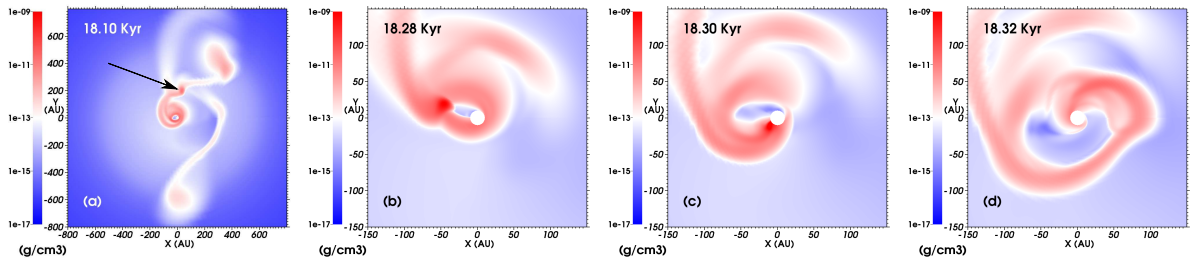

Figure 1: Midplane density in the center of the computational domain around the time of the outburst. (a) The region when a clump forms in a spiral arm. Panel (b-c) display zooms to illustrate the migration and accretion of a part of the clump.

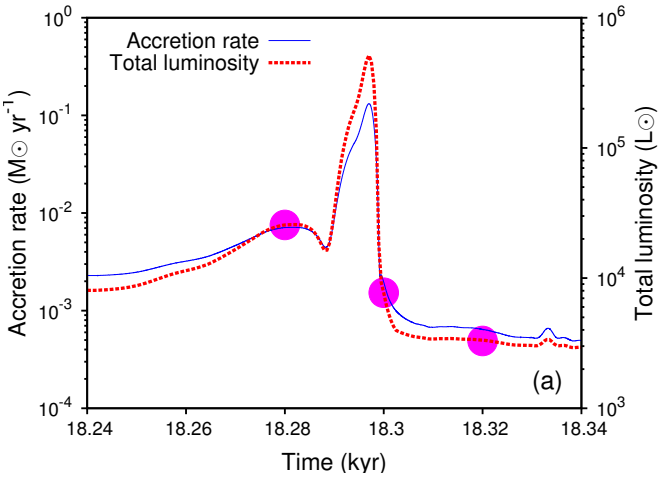

Figure 2: Accretion rate onto the protostar (in $M_\odot\,yr^{-1}$) and total luminosity of the protostar (in $L_\odot$) during the burst. Magenta dots mark the times of Fig. 1b-d.

2 Observational implications

We conjecture that luminous flares from regions hosting forming high-mass star may be an observational implication of the fragmentation of their accretion disks, i.e. that those flares constitute a possible tracer of the fragmentation of their accretion disks. This may apply to the young star S255IR-NIRS3 that has recently been associated to a 6.7 GHz methanol maser outburst (Fujisawa et al. 2015, Stecklum et al. 2016) but also to the other regions of high-mass star formation from which originated similar flares (Menten et al. 1991) and which are showing evidences of accretion flow associated to massive protostars, see e.g. in W3(OH), W51 and W75.

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