Highlights of Astronomy, Volume 15
XXVIIth IAU General Assembly, August 2009
Ian F. Corbett, ed.

doi:10.1017/S1743921310011397

Classical T Tauri-like Outflow Activity in the Brown Dwarf Mass Regime

E. T. Whelan[1], T. P. Ray[2], F. Bacciotti[3], L. Podio[2] and S. Randich[3]

[1]Laboratoire d'Astrophysique de l'Observatoire de Grenoble , [2]Dublin Institute for Advanced Studies, [3]INAF/Osservatorio Astrofisico di Arcetri

Since 2005 we have been analysing the spectra of brown dwarfs (BDs) using the technique of spectro-astrometry and to date have found 5 outflows driven by BDs. Our aim is to obtain an understanding of outflow activity in the BD mass regime and make a comprehensive comparison with low mass protostars, in particular the classical T Tauri stars (CTTSs). Table 1 summarises some results for the sources in our sample. Also see Whelan *et al.* (2009b) for a complete discussion and comparison with CTTSs. Some noteworthy results include the asymmetry in the ISO-217 bipolar outflow which is revealed in the relative brightness of the two lobes (red-shifted lobe is brighter) and the factor of two difference in radial velocity (the red-shifted lobe is faster). Asymmetries are common in jets from low mass protostars (0.1 Msun to 2 Msun) and the observation of a strong asymmetry at such a low mass supports the idea that BD outflow activity is scaled down from CTTSs. In addition, Whelan *et al.* (2009a) find a strong contribution to the Hα line emitted by LS-RCrA 1 and evidence of a dust hole in its disk. Using methods previously applied to CTTS Whelan *et al.* (2009b) estimate the mass outflow rate ($\dot{M}_{out}$) for LS-RCrA 1, ISO and ISO-Oph 102 $\dot{M}_{out}$ to be in the range 10^{-10} to 10^{-9} Msun yr^{-1} which is comparable to measured mass accretion rates.

Source	Mass (M_{JUP})	V_{rad} (kms^{-1})	Outflow PA (°)	Publication
ISO-217	80[1]	-20/30	202 (±) 8	Whelan *et al.* (2009b)
2MASS1207A	24[2]	-8/4		Whelan *et al.* (2007)
ISO-Oph 32	40[4]	-10-20	240 (±7)	Whelan *et al.* (2009b)
ISO-Oph 102	60[4]	-45	0	Whelan *et al.* (2005)
LS-RCrA 1	35-72[5]		15	Whelan *et al.* (2009a)

Table 1. BD candidates found to date to be driving outflows. In all cases the [OI]λ6300 line is the dominant line and V_{rad} is given here. For all sources where an outflow position angle (PA) is known (except ISO-Oph 102) this has been estimated from the spectro-astrometric analysis. 1-5 refer to the papers giving the mass estimates, 1=Muzerolle *et al.* (2005), 2=Mohanty *et al.* (2007), 3=Mohanty *et al.* (2004), 4=Natta *et al.* (2002) and 5=Barrado y Navascués *et al.* (2004).

References

Barrado y Navascués, D., Mohanty, S., & Jayawardhana, R. 2004, *ApJ*, 604, 284
Muzerolle, J. *et al.* 2005, *ApJ*, 625, 906
Mohanty, S., Jayawardhana, R., Huélamo, N., & Mamajek, E. 2007, *ApJ*, 657, 1064
Mohanty, S., Jayawardhana, R., & Basri, G. 2004, *ApJ*, 609, 885
Natta, A. *et al.* 2002, *A&A*, 393, 597
Whelan, E. T. *et al.* 2005, *NATURE*, 435, 652
Whelan, E. T. *et al.* 2007, *ApJL*, 659, L45
Whelan, E. T., Ray, T. P., & Bacciotti, F. 2009(a), *ApJL*, 691, L106
Whelan, E. T., Ray, T. P., Podio, L, Bacciotti, F., & Randich, S 2009(b), *ApJ*, submitted