Confirmation of the proto-brown dwarf SSTB213-J041757B and discovery of a nearby new candidate with ALMA and CARMA

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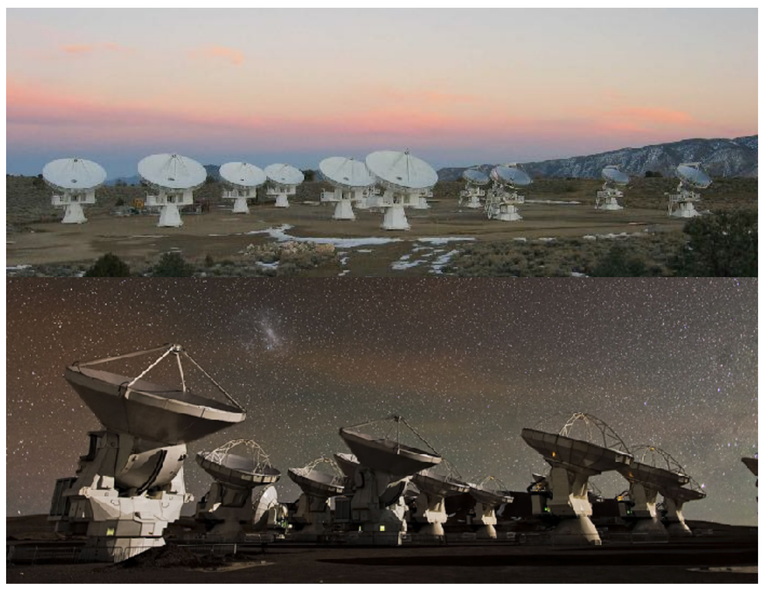
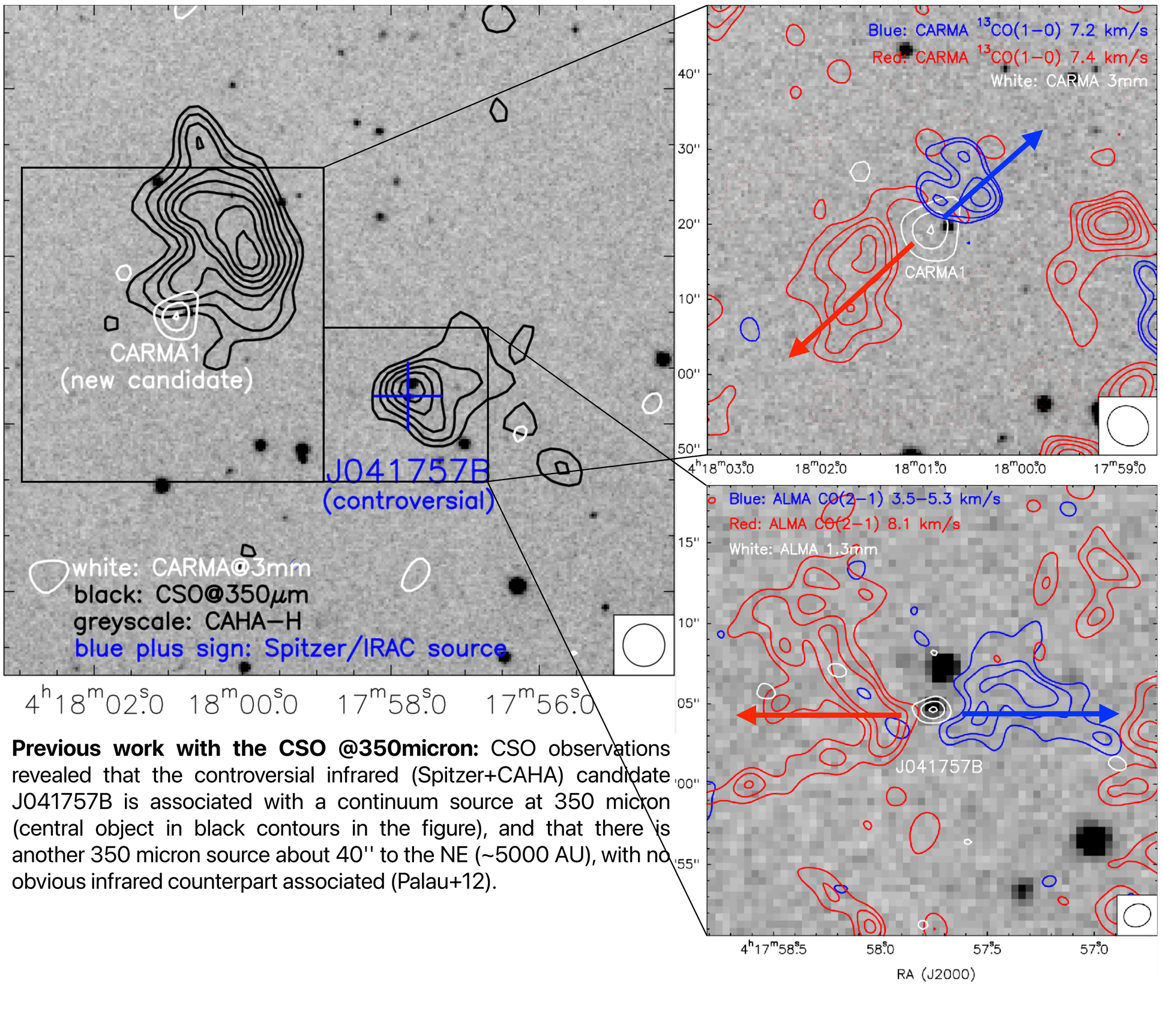
Introduction: The **formation mechanism of brown dwarfs** (BDs) is still poorly understood, with **two big competing scenarios** nowadays: BDs could be formed as a **scaled-down** version of low-mass stars, or they could be formed in **protostellar disks** and subsequently ejected. A possible way to distinguish among both scenarios is to observe BDs at their **earliest stages of formation, the so-called proto-BDs**, equivalent to Class 0 or Class I low-mass protostars.



Target and observations: We present an ALMA+CARMA follow-up study of the **controversial candidate SSTB213-J041757B** (Barrado+09, Palau+12) discovered in the Taurus Molecular Cloud line of sight. Since only continuum data were reported in these works, it was not clear whether the proto-BD candidate belonged to the Taurus Molecular Cloud or is a background object. We conducted **CARMA** observations at 1 and 3 mm including the ^{13}CO(1-0), C^{18}O(1-0), CS(2-1), CO(2-1), ^{13}CO(2-1), C^{18}O(2-1) transitions, along with **ALMA** Band 6 observations at 1.3 mm and CO (2–1). The CARMA beam was 5-7 arcsec, and the ALMA beam was ~1.5 arcsec.



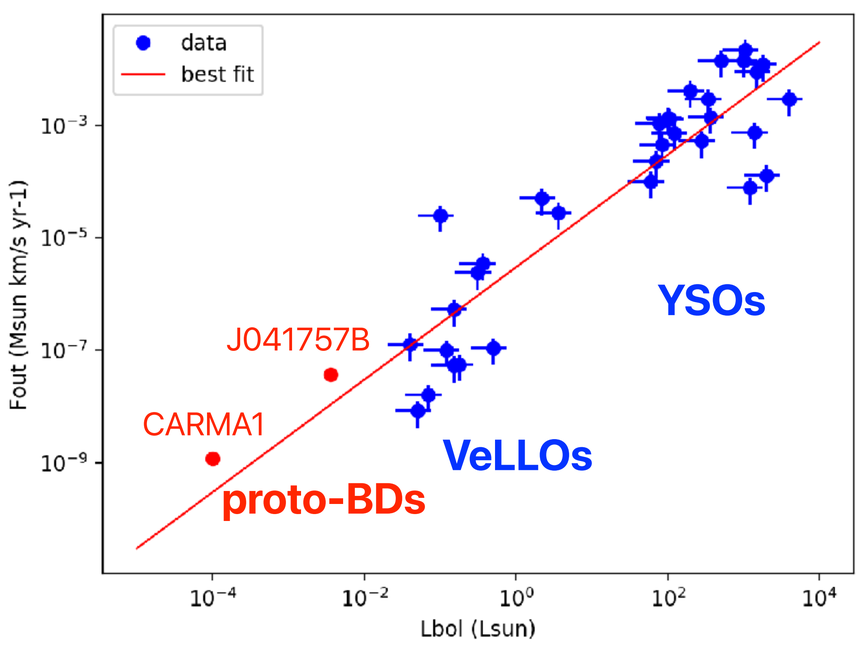
Previous work with the CSO @350micron: CSO observations revealed that the controversial infrared (Spitzer+CAHA) candidate J041757B is associated with a continuum source at 350 micron (central object in black contours in the figure), and that there is another 350 micron source about 40'' to the NE (~5000 AU), with no obvious infrared counterpart associated (Palau+12).

New CARMA data: CARMA revealed one continuum source at 5sigma at 3mm (CARMA1) with a faint counterpart at 1mm. The source is unresolved at both wavelengths. The total mass of gas and dust of CARMA1 is **~13 M_{jup}**. CARMA1 has associated a ^{13}CO(1-0) and (2-1) **bipolar structure** elongated in the SE-NW direction, possibly tracing a **molecular outflow**.

New ALMA data: ALMA observations were centered on J041757B, and revealed a continuum 1.3mm source at 10sigma, of **0.5 M_{jup}**. In addition, CO(2-1) was found associated with the proto-BD, including a bipolar structure most likely tracing a molecular outflow. This confirms its association with the Taurus Molecular Cloud and therefore its BD nature.

Outflow parameters: t (dynamical time), M_{rate} (mass outflow rate), P (momentum), F_{out} (outflow force)

	t (yr)	M_{rate} (M_{sun}/yr)	P (M_{sun} km/s)	F_{out} (M_{sun} km/s yr^{-1})
J041757B	6000	4x10^{-8}	2x10^{-4}	4x10^{-8}
CARMA1	21000	9x10^{-9}	2x10^{-5}	1x10^{-9}



Conclusions: A preliminary diagram plotting the outflow momentum force vs the bolometric luminosity suggests that the parameters determined for the **two proto-BD candidates studied here are a scaled-down version** of low-mass protostars, suggesting that at least these two proto-BDs in Taurus could have formed as low-mass stars form. Further candidates need to be found to set this result in a broader context.

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