Outflows and jets from low mass protostars in Bok globules: the case of CB230

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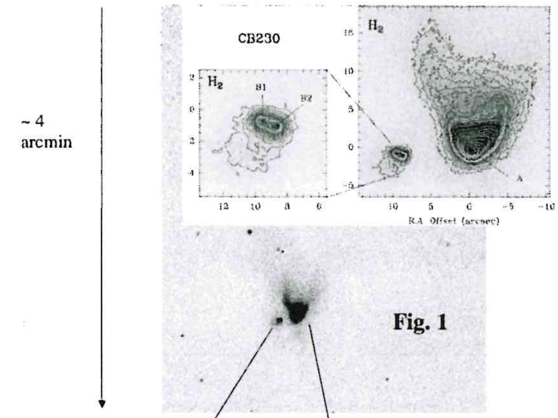


Fig. 1

The project: Outflow and infall are inextricably associated with the very earliest stages of star formation. The emission at mm wavelengths allows one to study the large-scale swept up gas, but the present flow activity is represented by a fast, hot component traced by H_2 and/or FeII NIR lines.The Bok globules are a very good place to study this jet component (Clemens & Barvainis 1988 and references therein): cold (10 K), nearby (~a few 100 pc), small (~ 0.7 pc) and relatively isolated molecular clouds, often with dense cores and embedded (NIR) protostars. Globules form low-mass stars in small numbers and are therefore without the observational confusion found in regions like Orion or Ophichus.
We are using the NIR camera NICS at the TNG telescope (La Palma) to survey a sample of Bok globules through the narrow-band filters centred on the 2.12 μm and the 1.64 μm lines of H_2 and FeII, searching for jet signatures. When these are found, follow-up spectral observations both in the NIR and in the mm are carried out to study the interaction between the jet-component and the outflow. See Massi, Codella & Brand (2004) for the first results.

CB230 has proved ideal to perform such a multiwavelength approach. It is a relatively nearby Bok globule (450 pc) hosting a NIR protostar classified as a Class 0/Class I source. Froebrich (2004) quotes a bolometric luminosity of 7.7 L_{sun} and an envelope mass of 0.56 M_{sun}. Applying a few models, the same author conclude that its age is ~$2x10^4$- $2x10^5$ yrs and the predicted final mass ranges between 0.3 and 0.9 M_{sun}. It is definitely a low-mass star precursor. The K-band image on the left shows that the protostar is embedded in a bright nebula, probably a cavity swept out by the jet. Two more NIR infrared sources are visible a few arcsec south-east (see the zoom in Fig. 1), suggesting that multiple star formation is in progress.

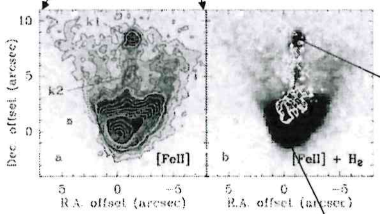


Fig. 2

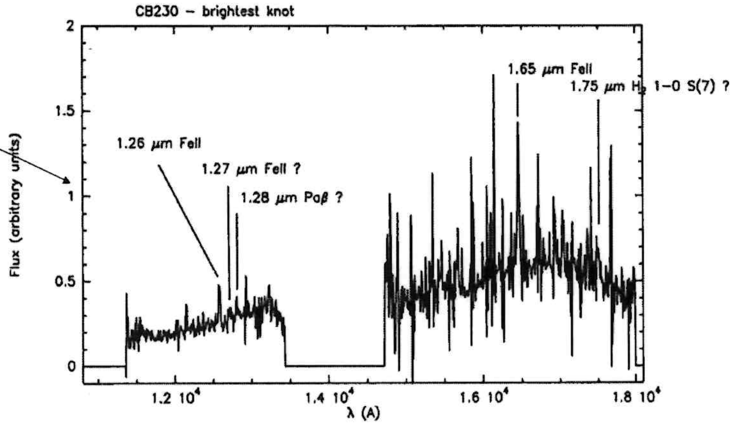


Fig. 2 shows a zoom on the embedded protostar. To the left, the continuum-subtracted image through FeII is shown, to the right, the continuum-subtracted image through H_2 (contours) is overlaid with the former. A bright knot of FeII emission is visible ~8 arcsec north of the source and a faint H_2 emission appears to connect the two. Low resolution (R~500) NIR spectra towards the source and the knot confirm the intense FeII line emission from the knot, but also intense FeII emission from the source itself, along with H_2 emission from the source. Also, the continuum emission is characterized by a rising flux with wavelength, typical of embedded objects. Using the ratio of the FeII lines at 1.25 and 1.64 □m it is possible to estimate the extinction, which ranges from Av~16 mag towards the source to Av~14 mag towards the knot.

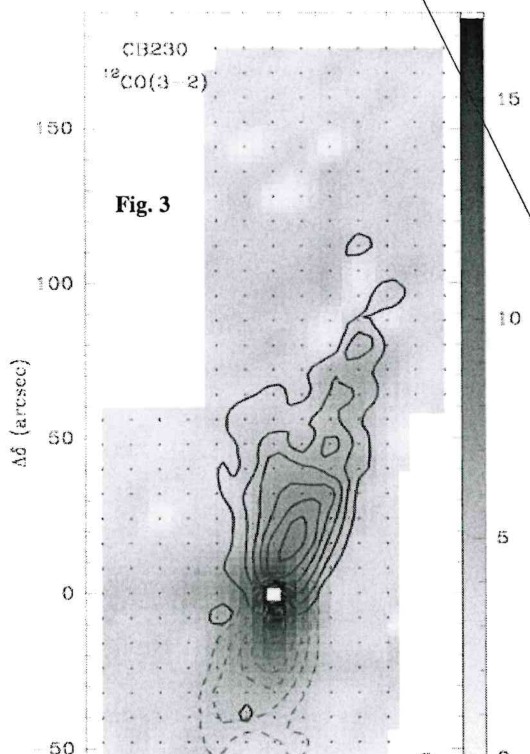
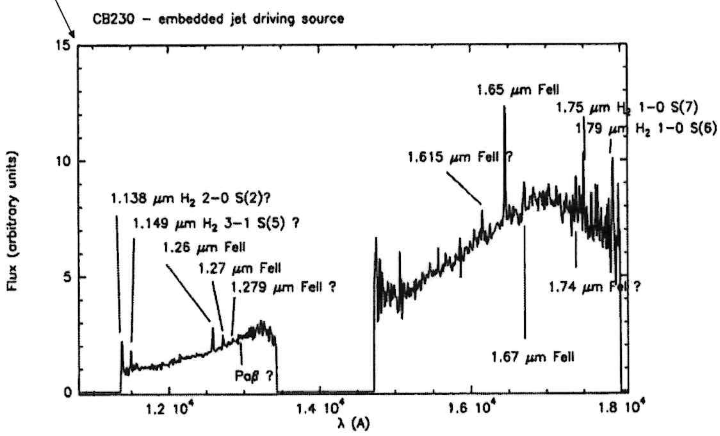


Fig. 3



In **Fig. 3**, the molecular outflow is evidenced in the CO(3-2) line observed with the JCMT (Brand et al. 2004, in preparation) . The blue lobe (solid blue contours) and red lobe (dashed red contours) are overlaid with the ambient emission (grey scale). The white square marks the location of the 850 μm peak (roughly coinciding with the NIR source). The north-south morphology indicates that outflow and jet are aligned, highlighting different manifestation of a same phenomenon.We carried out mm observations in many transitions of different molecules, using the JCMT and the IRAM 30m telescopes. These data will allow us to derive the physical properties of the outflow and the environment where it is embedded.

REFERENCES

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