

# APEX Champ<sup>+</sup> high-J CO observations of low mass star forming regions: L483 and L1527

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## Abstract

Observations of warm ( $T \approx 50\text{--}200$  K) CO gas are essential for understanding various heating mechanisms in young stellar objects, where interactions between a collapsing envelope, a bipolar outflow and a central star-disk system take place. The CHAMP<sup>+</sup> heterodyne  $2 \times 7$  pixel 650/850 GHz array receiver mounted on the Atacama Pathfinder EXperiment telescope in Chile is a pioneering instrument which allows arcmin scale maps of CO in J=6–5, 7–6 and 8–7 transitions. Observations of two deeply embedded YSOs, probably in transition between Class 0 and I, are presented. The edge-on orientation of L483 ( $d=200$  pc) and L1527 ( $d=140$  pc) on the sky provides a great opportunity to view the outflow cavities and to test the feedback on the cloud by UV photons and by shocks.

## CO 6-5 maps of L483 and L1527

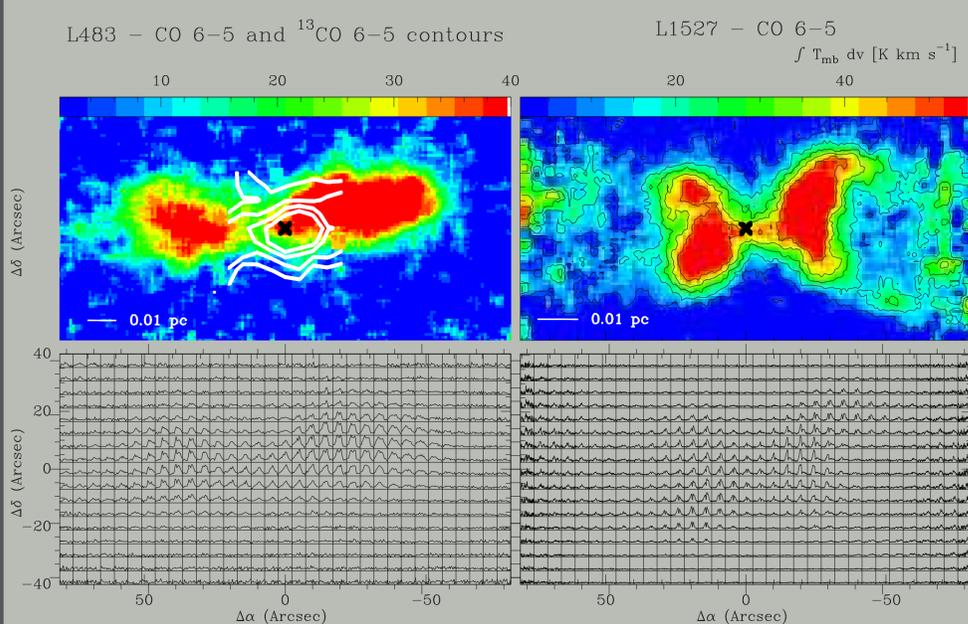


Figure: Contour and spectral maps of L483 and L1527 in CO 6-5. In addition, <sup>13</sup>CO 6-5 contours are added to L483 integrated map.

## Outflow maps of L483 and L1527

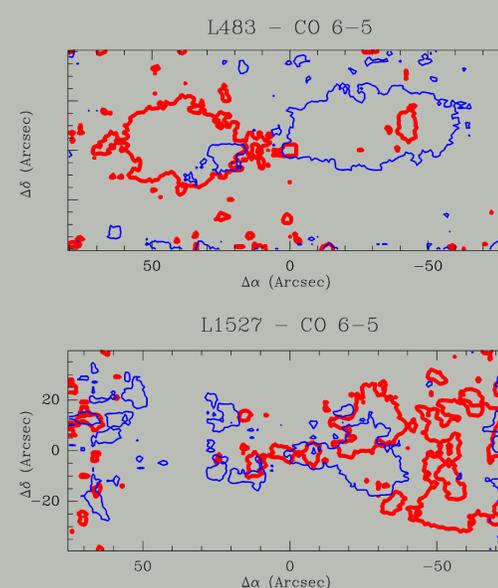


Figure: Maps of L483 and L1527 outflows in CO 6-5 transitions.

## Cartoon model

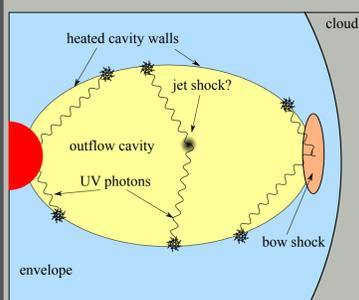


Figure: Cartoon model of L483 and L1527, which illustrates the photon heating of cavity walls. Such heating results in enhanced CO J=7–6 and 6–5 emission.

## Profiles

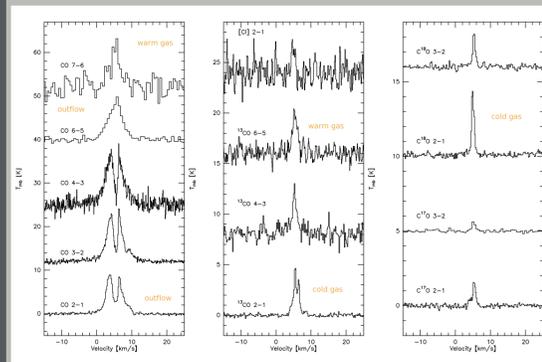


Figure: Single spectra taken at central position of L483 using APEX CHAMP<sup>+</sup> and JCMT.

## Conclusions

The <sup>12</sup>CO 6–5 maps of L483 and L1527 probe optically thick material in extended bipolar outflows, with clear enhancements around the outflow walls. The corresponding narrow profiles in spectral maps suggest that UV photon heating of cavity walls is substantial in both objects, similar to HH46 (Class I object, van Kempen et al. 2009) and NGC 1333 4A and 4B (Class 0s, Yildiz et al. 2010) observed with CHAMP<sup>+</sup>. UV heating is expected to cause photodissociation of e.g. H<sub>2</sub>O into OH and HCN into CN, which is currently tested with Herschel/PACS as part of the WISH key program. WISH will also observe higher-J CO lines up to J=35–34. On the other hand, <sup>13</sup>CO 6–5 emission (in L483) peaks in the central part of the map, close to the central object, probing the dense part of the envelope. ALMA will be able to image these CO lines, as well as photoproducts such as CN, with unprecedented detail to test this scenario.

- ▶ T.A. van Kempen, E.F. van Dishoeck, et al. 2009, A&A 501, 633
- ▶ U. Yildiz, L.E. Kristensen, E.F. van Dishoeck, et al. 2010, in preparation