Astrochemistry: Recent Successes and Current Challenges
Poster Book IAU Symposium No. 231, 2005
A. J. Markwick-Kemper, ed.

DOI: 00.0000/X000000000000000X

The massive disk around the young B-star AFGL 490

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Abstract. The AFGL 490 is a key target in the class of deeply embedded young stellar objects with masses of 8–10 $M_\odot$ being in a transition stage to the pre-main-sequence Herbig Be stars. We observe this system at sub-arcsecond resolution with the Plateau de Bure Interferometer (PdBI) in the $C^{17}O$(2-1) transition in order to confirm the presence of a rotating disk. The $C^{17}O$(2-1) data show clear evidence for a rotating $\sim 1\,500$ AU disk centered at the the 1 mm continuum point source. We model these data iteratively. First, the physical structure of the disk is obtained using a two-dimensional radiative transfer code. Second, with this model in hand, we calculate time-dependent abundances in the disk using a gas-grain chemical network. Finally, the beam-convolved $C^{17}O$(2-1) interferometric map is synthesized by a 2D line transfer code, and these results are compared with the observations in the step-by-step way (Semenov et al. 2005). We estimate that (1) the disk inclination angle is $30 \pm 5^\circ$, (2) its positional angle is $150 \pm 10^\circ$, (3) the disk is in Keplerian rotation, (4) it has a radius of about 1 400 AU, and (5) the disk mass is about 0.2–0.4 $M_\odot$ (depending on the assumed surface density gradient $p \sim -1$). This is in contrast to the value of 4 ± 2 $M_\odot$ estimated from the intensity of the PdBI 1 mm continuum emission within 1000 AU around the star, and ~ 8 $M_\odot$ for the mass of the gas located within about 4 000 AU around the star, as it has been found using our CS(2-1) PdBI data (Schreyer et al. 2002). It is interesting that the geometry of the detected $C^{17}O$ emission map speaks in favor of a larger inclination angle, $\geqslant 60^\circ$. Thus, the $C^{17}O$ interferometric map traces the densest part of a more extended and likely asymmetric disklike structure. Moreover, we find clear indication for on-going accretion in this object, since the detected PdBI CH_3OH J=$2_{(0,2)}$-$1_{(0,1)}$ A^+ emission lines show characteristic inverse P Cygni profiles. Given the large mass of the circumstellar gas, comparable to the mass of the central star, we suggest that accretion in AFGL 490 is globally regulated by gravitational instabilities, inevitably leading to the formation of several spiral arms (as predicted by Fromang et al. 2004), while the detected $C^{17}O$ emission arises in a small inner region that is already fully relaxed to the Keplerian state.

Keywords. Stars: formation; ISM: individual objects: AFGL 490; disks; ISM molecules

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