

Letter to the Editor

Accretion properties of Class 0 protostars studied with near-infrared spectroscopy

Oral presentation abstract

Valentin Le Gouellec[1], Thomas P. Greene[1], Lynne A. Hillenbrand[2], and Zoe Yates[1]

[1] NASA Ames Research Center Space Science and Astrobiology Division M.S. 245-6 Moffett Field, CA 94035, USA
[2] Department of Astronomy, MC 249-17, California Institute of Technology, Pasadena, CA 91125, USA

ABSTRACT

Sun-like stars are thought to accrete most of their final mass during the protostellar phase, where the protostellar embryo is surrounded by an infalling dense envelope. The so-called Class 0 phase designates the youngest protostellar stage, where the accretion is the most vigorous. Because these objects are highly embedded, it is difficult to retrieve direct diagnostics from the accretion, whose observational imprint lie at small wavelengths, in the near-infrared and below. Therefore, little is known about the accretion mechanisms occurring in the Class 0 phase because of high extinction. However, in rare cases the blueshifted cavity created by the outflow is sufficiently close to pole-on to liberate enough near-infrared scattered light for us to probe the immediate surroundings of the central object. We present a new set of K-band spectra of 18 Class 0 protostars recently observed with Keck MOSFIRE. Br_{γ}, several H_2 and $\Delta \nu = 2$ CO lines are detected and analyzed. We detect Br_{γ} in 9 sources, which suggests a good fraction but not all of Class 0s accrete via magnetospheric accretion. The H_2 lines are consistent with shock excitation indicating jets/outflows. Stella CO lines are seen in absorption in 2 sources suggesting recent vigorous accretion episodes. CO is seen in emission in 10 sources, tracing the heated inner accretion disk. We find that a significant higher fraction of Class 0 objects tend to exhibit CO in emission than in archival K-band spectra of later-evolved, Class I protostars. We also perform and discuss statistical tests comparing the near-IR line parameters of Class 0 and I objects. Our results suggest that the near-IR accretion properties of Class 0s tend to be different that of Class I objects. Studying the infalling structures of the Class 0 sub-millimeter envelopes alongside their near-IR Spectra, we find that one source presenting a large accretion streamer and disorganized density structures could have recently undergone an accretion burst. Upcoming JWST observations shall constrain further the accretion mechanisms of Class 0 protostars.

Key words. ISM: jets and outflows – ISM: magnetic fields – polarization – stars: formation – stars: magnetic field – stars: protostars

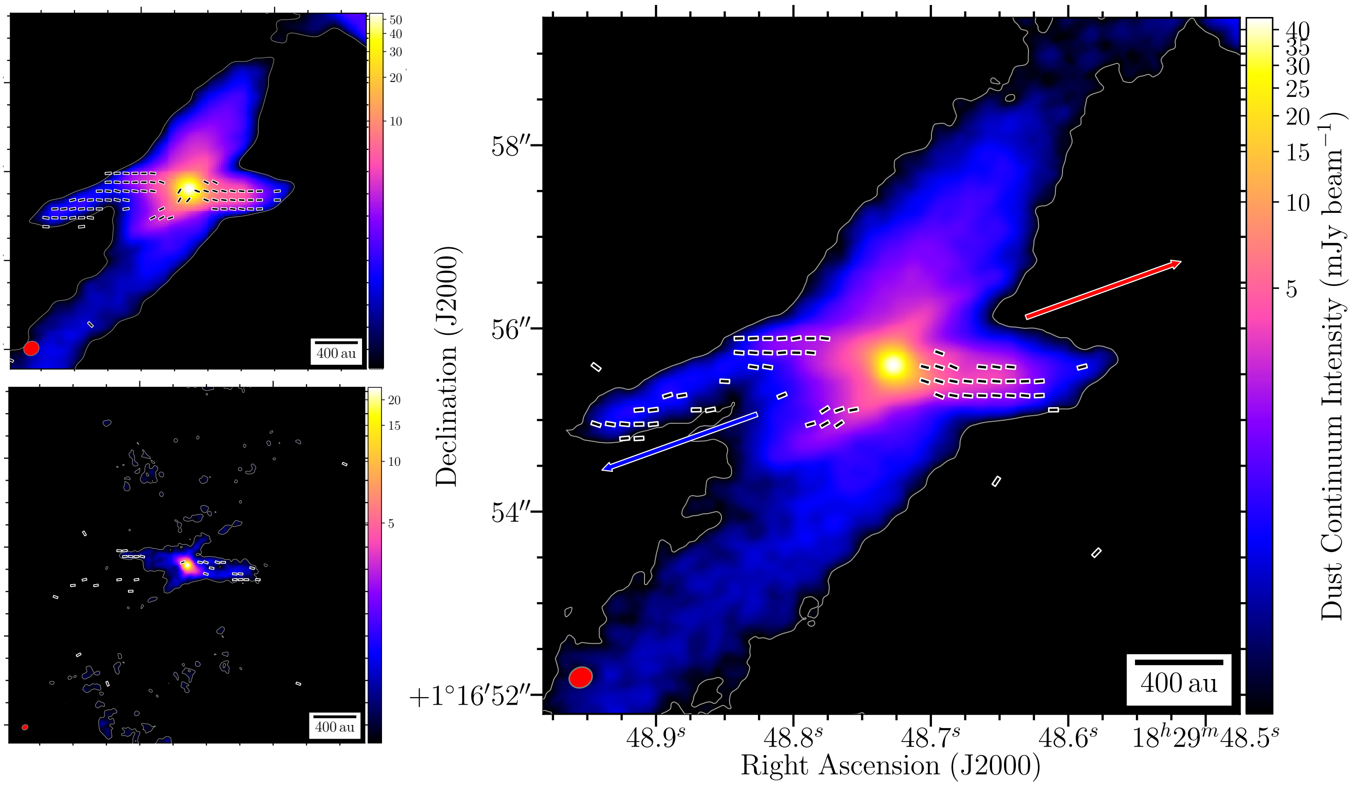

Fig. 1. Magnetic field around Serpens Emb 8(N) from Le Gouellec et al. 2020. The three panels correspond to three different angular resolution, from the lowest in the top-left panel, to the highest in the bottom-left panel. Line segments represent the magnetic field orientation. The color scale is the total intensity (Stokes I) of the thermal dust emission. The blue and red arrows represent the directions of the blueshifted and redshifted lobes of the bipolar outflow, respectively. The polarized emission is clearly enhanced along the outflow cavity walls visible in the dust thermal emission.

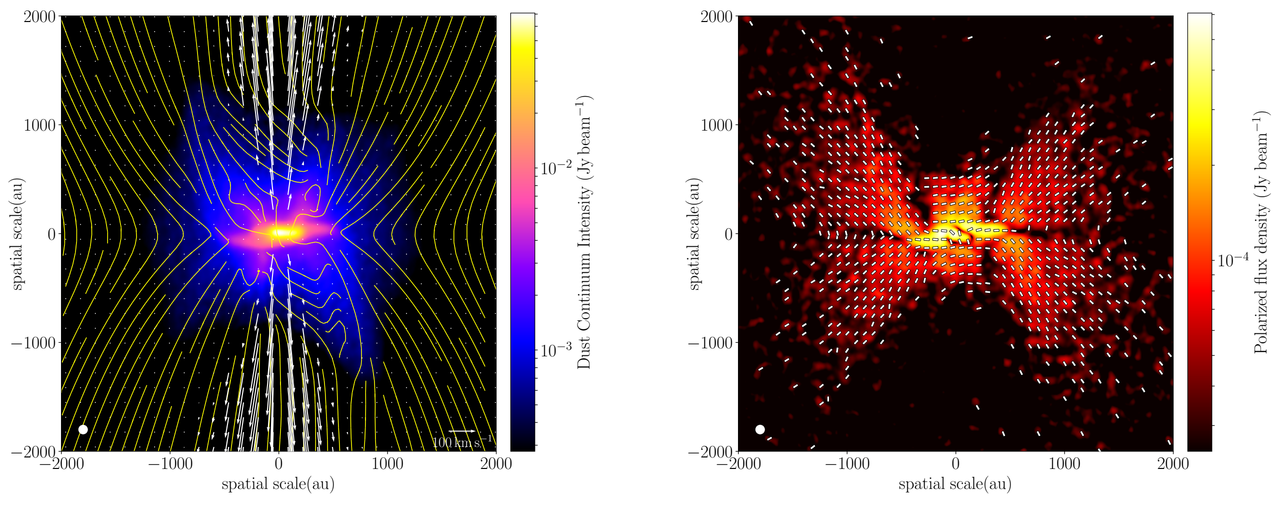

Fig. 2. Model of a protostellar core synthetically observed by POLARIS, filtered with ALMA. *Left:* Dust continuum total intensity, overlaid with the magnetic field lines and velocity field at the center of the core. *Right:* The colorscale is the polarized intensity, and segments are magnetic field lines.