P119a A compact outflow in a low-mass protostar with age of $\lesssim$2500 yrs

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In order to shed light on the earliest stage of low-mass star formation processes, we conducted interferometric observations towards an exceptionally young low-mass protostar GF 9-2 with CARMA and SMA. Our observations were carried out in the dust continuum emission at $\lambda = 3.3\,\mathrm{mm}$, 1.1 mm and 840 μm and the ^{12}CO $J = 3-2$ line. The continuum imaging detected a single source with a deconvolved effective radius of $250 \pm 30\,\mathrm{AU}$ at the center of the cloud core. A total mass of $M_{\rm tot} = 0.06 \pm 0.02\,M_\odot$ was derived through an analysis on spectral energy distribution of the the central source. Comparing a mean column density deduced over the radius and the previously derived radial density profile, we concluded that a profile of $\rho(r) \propto r^{-2}$ holds in $r \gtrsim 250\,\mathrm{AU}$. Namely an inner free-fall region, $\rho(r) \propto r^{-3/2}$, has not grown up to the $\sim$250 AU radius, yielding the protostar's age of $\tau_{\rm protostar} \lesssim 2 \times 10^3$ yrs. Furthermore the mass estimate in conjunction with the previously derived mass accretion rate ($\dot{M}_{\rm acc}$) gave us the duration of the accretion, $\tau_{\rm acc} \sim M_{\rm tot}/\dot{M}_{\rm acc} = (2.6 \pm 0.8) \times 10^3$ yrs. Spectroscopic imaging of the CO line revealed that the continuum source is driving a molecular outflow whose lobe lengths range between 1300 AU and 1600 AU. The outflow lobes are found to be one of the youngest (dynamical timescale; $\tau_{\rm dyn} \sim 360-1600$ yrs), the least massive ($M_{\rm lobe} \sim 10^{-5} - 10^{-4}\ M_\odot$), and the least powerful (momentum rate; $F_{\rm CO} \sim 10^{-7} - 10^{-5}\ M_\odot$ km s^{-1} yr^{-1}) ones known to date. All the results reinforce our assertion that the putative protostar would be at the *first core* phase.