Nature of the Dusty S-cluster Object (DSO/G2): Pre-main-sequence star with non-spherical dusty envelope

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Abstract. Near-infrared observations reveal several infrared-excess sources near the Galactic Centre with emission lines present in their spectra. One of these objects, DSO/G2, which moves around the supermassive black hole (Sgr A*) on a highly eccentric orbit, passed the pericentre at approximately 160 AU in 2014. It remained compact, which implies that at least in this case it is a star embedded in a dusty envelope. The spectral energy distribution and the detection of polarized continuum emission indicate that it is probably a pre-main-sequence star surrounded by a dense envelope with bipolar cavities. In addition, the star associated with DSO/G2 plausibly develops a bow shock due to its supersonic motion. The model of the star surrounded by the non-spherical dusty envelope can reproduce the main characteristics of the DSO/G2 source: 1. spectral energy distribution in near-infrared bands; 2. linear polarization in \(K_s\) band; and 3. the overall compact behaviour.

Keywords. Galaxy: center, radiative transfer, polarization, stars: pre–main-sequence

1. Summary

Based on the observed compactness of the DSO/G2, which is difficult to reconcile with the scenario of the core-less cloud (Witzel \textit{et al.} 2014; Valencia-S. \textit{et al.} 2015; Peissker \textit{et al.} 2016), a dust-enshrouded young star was proposed to explain the observed phenomena (Eckart \textit{et al.} 2013; Zajaček \textit{et al.} 2014; Zajaček \textit{et al.} 2015). Based on the measured near-infrared excess of \(K_s – L’ > 3\) (Eckart \textit{et al.} 2013) and the total linear polarization degree in \(K_s\) band of \(\sim 30\%\) for at least three epochs (Shahzamanian \textit{et al.} 2016; , this volume), we propose the model of a young star embedded in a non-spherical dusty envelope to explain the main characteristics of DSO. We performed a set of Monte Carlo radiative transfer simulations using the code Hyperion (Robitaille T. P. 2011) to assess which geometry of circumstellar dusty envelope can explain the significant near-infrared polarized emission – see Fig. 1 for the illustration how the polarization degree varies for different geometries.

The model that fits the observed properties best consists of a star, dusty envelope, bipolar cavities and a bow shock. See Fig. 2 for the simulated SED (left panel) and the RGB image of the source model (right panel). The geometry and densities applied are standard for pre-main-sequence stars of Class 1. The bow shock is expected to form because of the supersonic motion of the star associated with DSO/G2 close to the pericentre (Zajaček \textit{et al.} 2016). The details of the model are described in Shahzamanian \textit{et al.} (2016).
Figure 1. Increasing the total polarization degree by breaking the spherical symmetry.

Figure 2. Left: Modelled SED with inferred flux densities in $H$ (upper limit), $K_s$, $L'$, and $M$ bands. Right: RGB image of the source model of DSO/G2 ($K_s$, $L'$, and $M$ bands) with the inclined bipolar outflow with respect to the bow-shock symmetry axis by 45°.

References

Peissker F. et al., 2016, in preparation
Zajaček M., Eckart A., Peissker F. et al., 2015, Proceedings of 24th WDS, ArXiv 1507.00237