Investigating the gas-to-dust ratio in the protoplanetary disk of HD 142527

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We present the ALMA observations of the 98.5 GHz dust continuum and the $^{13}$CO $J = 1 \rightarrow 0$ and C$^{18}$O $J = 1 \rightarrow 0$ line emission towards the protoplanetary disk of HD 142527. The 98.5 GHz continuum shows a strong azimuthal-asymmetric distribution similar to the previously reported 336 GHz continuum, and its peak emission at the dust concentrated northern region is optically thin at approximately 8 K. In every position angle, the peak brightness temperature of C$^{18}$O $J = 1 \rightarrow 0$ emission ($\lesssim 25$ K) is lower than that of the optically thick $^{13}$CO $J = 3 \rightarrow 2$ ($\approx 36$ K), indicating that the C$^{18}$O is optically thin. We derive the gas and dust surface densities, $\Sigma_g$ and $\Sigma_d$, of the disk of HD 142527 by using the ALMA Band 3 and Band 7 observations. In the analyses we assume the local thermodynamic equilibrium and the disk temperature to be the same as the peak brightness temperature of $^{13}$CO $J = 3 \rightarrow 2$ with continuum emission. We successfully derived the gas-to-dust ratio $G/D$, defined as $\Sigma_g/\Sigma_d$, distribution across the disk. The ratio varies azimuthally, where it is $\sim 3$ and $\sim 20$ in the disk northern and southern regions, respectively. We also found that $\Sigma_g$ varies approximately as $\propto \Sigma_d^{-0.5}$, or equivalently $G/D \propto \Sigma_d^{-0.5}$. In addition, our results show that the peak $\Sigma_d$ is located ahead of the peak $\Sigma_g$; if the latter correspond to a vortex of high gas pressure, the results indicate that the dust are trapped ahead of the vortex, which is predicted by theoretical studies.

Keywords: HD 142527, protoplanetary disk, gas-to-dust ratio