Resolving the Outer Ring of HD 38206 using ALMA

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Introduction
HD 38206 is an A0V star in the Columba association, hosting a debris disc first discovered by IRAS. Further observations by Spitzer and Herschel showed that the disc photometry is best modelled using two components, likely analogous to the asteroid and Kuiper belts of the Solar System.

Observations
The observation of HD 38206 was carried out by ALMA in band 6 (1.35mm) during cycle 1 as part of the project 2012.1.00437.S (PI: David Rodriguez). The above image shows the data after processing with the CLEAN algorithm. The contours show the ±2, 4, 6 and 8σ levels. The white cross marks the position of the star based on the Gaia DR2 position and accounting for proper motion.

The disc is seen to be edge-on. There are some signs of asymmetry with a peak in the emission of 0.18±0.02 mJy at 2.1" east of the star, whilst to the west the emission peaks at 2.9" from the star, but with a lower flux density of 0.09±0.02 mJy.

Prediction for the Outermost Planet
The geometry of the disc enables us to make predictions about possible planets in the system under various assumptions. For instance, if we make the assumption that the outermost planet is simultaneously responsible for the stirring of the disc, the clearing of the inner edge and the eccentricity of the disc, then three simultaneous equations can be derived that allow us to determine the eccentricity, mass and semi-major axis of the planet. Due to the large uncertainty in our knowledge of the disc parameters, we make use of all of the samples from our MCMC run, solving the simultaneous equations for each set of disc parameters. The full posterior distribution for the planet properties is shown in the figure below along with the best fit values.

Modelling
We model the disc using a Gaussian distribution in semi-major axis with mean $a_0$ and FWHM $\Delta a$. The disc is allowed to be eccentric with eccentricity, $e$, and argument of pericentre, $\omega$. The disc is inclined from the sky plane by $i$, with a position angle east of north given by $\Omega$. The total dust mass is defined by $M_{\text{dust}}$. We determine the best fit model using an MCMC algorithm.

The best fit parameters and their uncertainties are shown in the table above and the best fit model is shown in the image below. The disc is found to be very wide and slightly eccentric, although a circular disc cannot be completely ruled out at this sensitivity.

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| $a_0$, au | $\Delta a$, au | $M_{\text{dust}}$, $M_\odot$ | $i$, $^\circ$ | $\Omega$, $^\circ$ | $e$ | $\omega$, $^\circ$ |
|---|---|---|---|---|---|---|
| 184±19 | 143±46 | 0.105±0.016 | 83.3±1.3 | 84.3±1.2 | 0.25±0.10 | 49±22 |

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