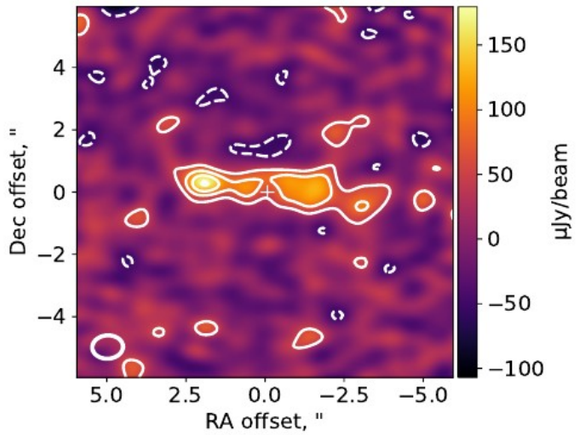
Resolving the Outer Ring of HD 38206 using ALMA

Mark Booth
Friedrich Schiller Universität, Jena
Michael Schulz, Alexander Krivov, Sebastián Marino, Ralf Launhardt & Tim Pearce

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

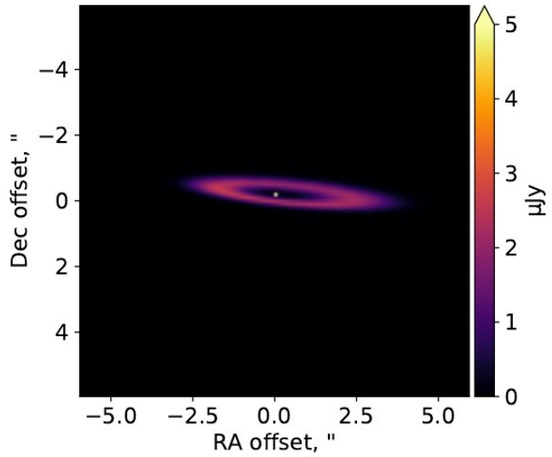
The observation of HD 38206 was carried out by ALMA in band 6 (1.35mm) during cycle 1 as part of the project 2012.1.00437.S (PI: David Rodriguez). The above image shows the data after processing with the CLEAN algorithm. The contours show the ±2, 4, 6 and 8σ levels. The white cross marks the position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

a_0, au	Δa, au	$M_{\rm dust}$, $M_\oplus$	I, °	Ω, °	e	ω, °
184^{+19}_{-17}	143^{+46}_{-36}	$0.105^{+0.016}_{-0.015}$	$83.3^{+1.3}_{-1.3}$	$84.3^{+1.2}_{-1.2}$	$0.25^{+0.10}_{-0.09}$	49^{+22}_{-25}

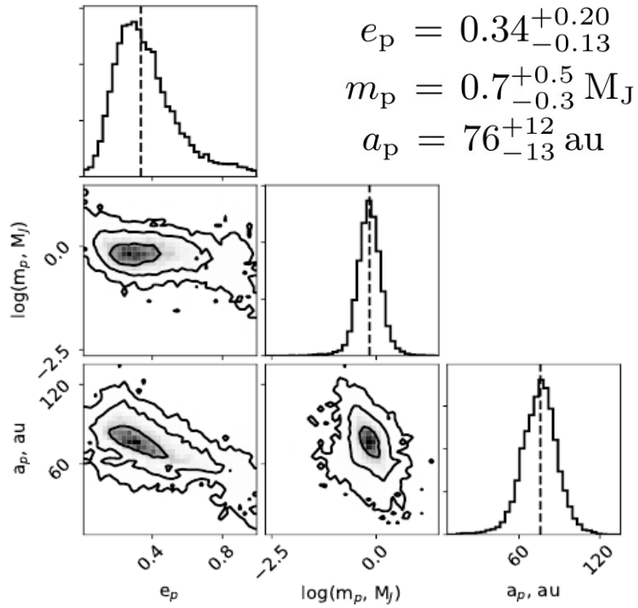
Modelling

We model the disc using a Gaussian distribution in semi-major axis with mean a_0 and FWHM Δa. The disc is allowed to be eccentric with eccentricity, e, and argument of pericentre, ω. The disc is inclined from the sky plane by I, with a position angle east of north given by Ω. The total dust mass is defined by M_{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.



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.



Accepted for publication in MNRAS: https://ui.adsabs.harvard.edu/abs/2020MNRAS.tmp.3165B

This research was supported by the DFG, grants Kr 2164/13-2, Kr 2164/14-2 and Kr 2164/15-2 as part of the FOR 2285 research unit "Debris Disks in Planetary Systems".