From: ae@ras.org.uk Subject: MNRAS: MN-16-0473-MJ Date: Mon, March 14, 2016 1:00 pm To: trick@mpia.de Cc: trick@mpia.de,glenn@mpia.de,dutton@nyu.edu

Dear Ms Trick

Copied below are the reviewer's comments on your manuscript entitled "A spiral galaxy's mass distribution uncovered through lensing and dynamics", ref. MN-16-0473-MJ, which you submitted to Monthly Notices of the Royal Astronomical Society.

Minor revision of your manuscript is requested before it is reconsidered for publication.

You should submit your revised version, together with your response to the reviewer's comments via the Monthly Notices ScholarOne Manuscripts site https://mc.manuscriptcentral.com/mnras. Enter your Author Centre, where you will find your manuscript title listed under "Manuscripts with Decisions." Under "Actions," click on "Create a Revision." Your manuscript reference will be appended to denote a revision.

IMPORTANT: do not submit your revised manuscript as a new paper!

You will not be able to make your revisions to the originally submitted files of the manuscript held on ScholarOne Manuscripts. Instead, you must delete the original files and abstract and replace them with your revised files. Check that any requests for colour publication or online-only publication are correct. Carefully proof read the resulting PDF and HTML files that are generated. If you have used a .bib file to generate your bibliography in Latex, please include this in your .tar archive along with the .bbl and .tex files; this will aid the editing and typesetting process.

When submitting your revised manuscript, you will be able to respond to the comments made by the reviewer in the space provided. You should also use this space to document any changes you make to the original manuscript. In order to expedite the processing of the revised manuscript, please be as specific as possible in your response to the reviewer. Changes to the manuscript should be highlighted (e.g. in bold or colour), to assist the referee and editor. Along with the highlighted manuscript you should also upload clean files (remove any bold font/track changes) for our publishers, as accepted manuscripts are now immediately published online ahead of the proof-corrected version.

Because we are trying to facilitate timely publication of manuscripts submitted to MNRAS, your revised manuscript should be uploaded promptly. If you do not submit your revision within six months, we may consider it withdrawn and request it be resubmitted as a new submission.

Please note that, due to the tight schedule, any post-acceptance changes notified after the paper has gone into production (i.e. the day after the acceptance email is sent) cannot be incorporated into the paper before it is typeset. Such changes will therefore need to be made as part of the proof corrections. To avoid excessive proof corrections and the delay that these can cause, you are strongly encouraged to ensure that each version of your paper submitted to MNRAS is completely ready for publication!

I look forward to receiving your revised manuscript.

Regards,

Anna

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cc: all listed co-authors.

Reviewer's Comments: Reviewer: 1

Comments to the Author

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- This is an interesting paper which makes neat use of the combination of stellar kinematics and strong lensing to investigate the mass structure of the spiral galaxy J1331. $\Longrightarrow$ *Thanks. It is a very exiting galaxy that's definitely worth exploring.*

- The introduction could be re-written slightly to emphasise the points that the study wants to investigate; for instance, the opening paragraph talks about the methods used rather than the astrophysics that the study is hoping to probe. This could probably be removed altogether, and the second paragraph promoted to the beginning. $\Longrightarrow$ *That is a good point. We changed the opening paragraph to a general sentence why determining the matter distribution of galaxies is important. We mention the different methods now in the third paragraph.*

- It would also be nice to include some more discussion of the possibility of a recent merger in the galaxy's past in the introduction, as this is a really interesting feature of the galaxy in question and is also a very active topic of research. $\Longrightarrow$ *Good point. 1.) We added a sentence mentioning the important role of mergers in modifying the matter distribution and added some recent references. 2.) We added a short paragraph later in the introduction that points out that J1331 is a special and very interesting galaxy for researching mergers. We also explain better that this merger is one of the reasons why we especially focus on the inner regions of J1331 in our study.*

- The manuscript in its current form is also slightly longer than necessary at certain points: for instance, in section 3.2.1, it is not really necessary to present all the lensing equations (e.g. the time delay, equation 7), and similarly, section 3.3.1 contains a lot of material that is implicit in Cappellari's JAM code, and therefore does not need to be explained equation by equation here. Section 3.3.4 also rather throws the book at the NFW profile relations – it probably isn't necessary to include equation 22. $\Longrightarrow$ *We made an effort to remove unnecessary equations in Section 3.2.1, tighten the explanation of the derivation of the Jeans equations in Section 3.3.1 and 3.3.3 and removed big and clumsy mathematical expressions by referring to the explicit equations in the literature instead. In 3.3.2 we refer stronger to the changes we made to Capellari's JAM code and kept the corresponding equations. In Section 3.3.4 we moved equations that are definitions and therefore needed inline to make it shorter; we kept the Maccio concentration vs. halo mass relation and explicitely mention that*

we will use this later as a prior in our modelling. In general we include a lot of equations and a big theory introduction because it is a paper that is potentially interesting for two communities, the lensing and the dynamics community. We wanted to make the paper understandable for both.

- From a scientific perspective, in section 4.3.3, the authors comment that the varying M/L JAM model is unable to reproduce the dynamics when M/L is forced to be always rising as a function of radius, but it would be interesting to see if the model could be improved by removing this constraint. Perhaps the authors could add such a model to this section, or else comment on why they do not attempt it. $\Longrightarrow$ *We have indeed tried a "mass-follows-light" JAM model with constant anisotropy and free M/L profile early on in our investigations of J1331. This was unsuccessful to a degree that showing the result in the paper would not be reasonable. The way how we can generate variable M/L profiles with our MGE mass model is restricted. We have 6 data points and 5 fit M/L parameter within 5 arcsec. This lead to an over-fitting in the inner regions where most of the Gaussians are, while not having enough flexibility at larger radii. (We added a sentence mentioning that in the paper.) The resulting profile was very wiggly, difficult to interpret and most likely unphysical. As we lay out in the discussion, constraints on a varying stellar M/L ratio should be motivated by stellar population analysis in the future.*

- In section 4.4.1, the NFW profile is fitted only to the inner data, and then is shown to not provide a good model for the data beyond that point. This is not entirely surprising, given that the outer data were not used to constrain the model! What happens if the NFW profile is fitted to both small- and large- radius data at once? (Perhaps it is impossible to find a good NFW model across the whole radius range, but if this is the case, then it should be stated.) $\Longrightarrow$ *Yes, you are completely right. Our initial tests tried of course to fit the whole range of data, but failed. The problem is that we were never able to fit both the central v_{rms} dip and the dip around $R' \sim 6''$ with any of the models we tried. If you think this is frustrating, we definitely feel the same way. Our best explanation was, that the spiral arms do weird things to the kinematics around $R' \sim 5 - 7''$ that cannot be captured by the axisymmtric Jeans models. In this region our MGE models also were not a good fit to the galaxy anymore. Considering also that there are other studies focussing on the outer regions and the counter-rotating core is the most interesting feature, we decided to focus our efforts on the inner regions and to try to explain the central kinematics only. We added however a small new section 4.4.4 that discusses that and why modelling attempts to the whole data range fail and what possible next modelling steps should be.*

- The discussion section is too non-committal and speculative in parts. For instance, in section 5.1, the M/Ls inferred from a number of the different models are compared with M/Ls from the literature, but the authors do not make any value judgement between the different models to come to any firmer conclusions about what they believe the most convincing description of the IMF to be. At the moment, this section seems to just be trying to show that their various models can be made to agree with pre-

vious models from the literature, but it would be much more interesting if some attempt could be made to resolve all the different models (both in this paper and in previous works) or at least present them in a more coherent framework, to try to come up with a better picture of the nature of J1331's IMF. $\Longrightarrow$ *This is a valid point of criticism. We thought again about the different models and indications for different IMFs that we collected and came to the conclusion that an IMF slightly less bottom-beavy than the Salpeter IMF is the most likely model for J1331's bulge. We tried to give Section 5.1 (now 5.2) more structure and tweaked the discussion to present arguments for* $\Upsilon_{I,*} \sim 4.2$ *and and to argue against the alternative models.*
We also moved the section that discusses J1331's merger history to the beginning to the discussion section, focussed more on the what the merger could have done to J1331's mass distribution and less on modelling failures. All following sections use the background information about mergers to discuss our models.
Our scientific honesty is however, that without further data, we cannot be more commital and some of our statements have to stay in the "speculation regime".

- In Section 5.2, the authors could make suggestions for what might be causing the two v_{rms} dips. Currently, they just state what cannot be the cause, but do not make any more convincing suggestions – e.g. could it be associated with the possible recent merger that is explored in Section 5.3? It would be more satisfying if some suggestions like this could be put forward. $\Longrightarrow$ *Good point. We admit that the text was formulated a bit too negative, and that we can do better in explaining J1331 based on our models than just ruling out things. Also, some of the effects that mergers can have on galaxies* could, *if they occured in J1331, actually explain some of the peculiar kinematic features of J1331. We tried to re-formulate section 5.2 (now 5.3) and discuss several aspects of the kinematics with respect to the merger history.*

- While the use of English is impressive given that it is not the main author's mother tongue, I would also recommend giving the manuscript to a native speaker to correct the number of grammatical errors that remain. Aaron, could you have another look at the paper, specifically for grammar errors? Or should I try to find a student who is willing to read the paper?