Response to peer reviews

Thinh Nguyen

Personal changes: a major change of this version compared to the previous version of the paper is the use modulus instead of parallax. A reason for this change is that the parallax of the cluster is very small (in the order of 10^-4) in the unit of arc-second (the unit used in BASE-9). Because the values are smaller than the accuracy of the computer, this make the posterior distribution of the parallax not evenly distributed. Also, the author realizes that the step size used in the previous paper is too large, and therefore the MCMC runs can skip the correct values while sampling. The step size in the updated version is decreased accordingly. As a result, the two changes alter the final results compared to the previous version of the paper.

thinh_1 review

- Major point 1: resolved.
- Major point 2: even though Sujatha & Babu (2003) and Ahumada (2000) both used CCD photometry to collect data, their personal telescopes and reduction methods can be different, thus resulting in different results. Therefore, I disagree with the reviewer that studies using CCD photometry should have a similar result. For the latter point, I updated the paper with the explicit age (1.9 billion years) to make it easier for comparison, as the reviewer pointed out.
- Major point 3: These correlations are specific to the MCMC run itself. More explanations have been provided.
- Minor point 1: The author uses “we” and “us” because supervisors are included and there will be co-author in the future version of the paper.
- Minor point 2: resolved.
- Minor point 3: the author disagrees with the reviewer, as these numbers are important and can affect the final results.
- Minor point 4: resolved.
- Minor point 5: resolved.
- Minor point 6: disagree, because isochrones represent stellar population or stellar evolution track, not the age.
- Minor point 7: resolved.
- Minor point 8: because we assume all stars in the cluster are at the same distance, it is not really important to use absolute magnitude or apparent magnitude. Using the absolute magnitude only shifts the plot upward, but the plot’s appearance will remain the same.
- Minor point 9: the G is the apparent magnitude (*Gaia* notation). In Figure 1, we add 5*log(parallax/1000) + 5 to convert the apparent magnitude to absolute magnitude. The author thinks “contamination removed” is good enough.
- Minor point 10: the code like format is used to signify that those are *Gaia* parameters. Also, the author thinks it is better to put those equations separately rather than in the text. The author thinks it is clearer to list the equations that way.
- Minor point 11: resolved.

- Minor point 12: the author thinks it is unnecessary to discuss the information in great details. The reader can see the original paper for reference.
- Minor point 13: resolved.
- Minor point 14: resolved.
- Minor point 15: resolved.
- Minor point 16: explaining “Mini-batch k-means for the clustering method” will distract the readers from the text. The author already provides reference for the method.
- Minor point 17: the author mentions “Red giants do appear in the plot”. The fact that no white dwarfs or blue stragglers is in the final cluster data is an observation. A cluster can or may not contains white dwarfs and/or blue stragglers.
- Minor point 18: resolved.
- Minor point 19: disagrees, the prior sigma is not 0.1 for all free parameters.
- Minor point 20: resolved.
- Minor point 21: resolved.
- Minor point 22: resolved.
- Minor point 23: disagrees, because G_BP and G_RP are the filters named used for *Gaia*.
- Minor point 24: the isochrones are made from points (it appears as line because there are a lot of points).
- Minor point 25: this is just a pure comparison. The author thinks a detail analysis for the difference between two data sets is not necessary.
- Minor point 26: the contours are pre-determined by the code.
- Minor point 27: resolved.
- Minor point 28: resolved.
- Minor point 29: resolved. The results are different between this paper and the results of other studies because we use different data set and different fitting methods. However, the author does not think it is necessary to put in the conclusion.

thinh_3 review

- Major point 1: resolved.
- Major point 2: resolved with the additional of log posterior probability plot.
- Major point 3: we know that metallicity for open clusters are generally between -0.3 to 0.3. Therefore, we provide the prior mean metallicity of 0.0 with the standard deviation of 0.1 to cover that range.
- Minor point 1: resolved. This discrepancy can be caused by the differences between their data or isochrones models with ours.
- Minor point 2: resolved.
- Minor point 3: resolved.
- Minor point 4: resolved.

thinh_4 review

- Minor point 1: the limit on the ruwe value of 1.4 will help remove stars with bad astrometric solutions. While this can accidentally remove some binary stars (but not all), the author does not mean to look only for single stars. I updated the text with some clarifications.
- Minor point 2: Similar kernels are rejected from being members because we are comparing our data kernel with the random, uniform kernel. If the two kernels are adequately similar, this means that the stars in the corresponding subset are distributed uniformly, and thus those stars are field stars rather than cluster stars.
- Minor point 3: I believe that the absence of those stars do not affect the results. Clarification is added to the text.
- Minor point 4: resolved.
- Minor point 5: there is currently no explanation for this. Since our analysis is data-driven, combined with the consistence of the robustness analysis, we believe that our absorption value is unique to this data set. However, I added some clarifications, saying that I will try to constrain the absorption in MCMC runs to see what affect the absorption has on other parameters.

thinh_5 review

- Minor point 1: more explanations are given in the text.
- Minor point 2: more explanations are given to explain Bayesian analysis and MCMC method.
- Minor point 3: when looking at the whole range, we are more interested in the 3-sigma value because it covers 99% of the distribution. For the range of -0.3 to 0.3, 3-sigma corresponds to 0.3. Therefore, 1-sigma value is 0.1. We chose a Gaussian distribution when choosing a parallax prior because the distribution of the parallax does look like a Gaussian distribution.
- Minor point 4: resolved.
- Minor point 5: resolved by adding a footnote when the burn-in stage is mentioned. There are a maximum of 2000 iterations in the burn-in stage.

thinh_6 review

- Major point 1: I leave the UPMASK's default configuration because it is believed that the default configuration will results in the best efficiency for the classification. Also, the cut-off value of 0.5 for cluster members is chosen by personal preference and it is also a common practice when determining cluster members.
- Major point 2: we cross-match with Cantat-Gaudin et al 2018 list because they use *Gaia* DR2 data, and we are using *Gaia* EDR3 data. We want to see how two data releases within one mission compares to each other. A short clarification is added to the text to make it clearer.

- Minor point 1: I disagree with the author. I think the bars sufficiently tell the readers that they are error bars.
- Minor point 2: resolved.
- Minor point 3: resolved.
- Minor point 4: disagrees, caption should be on top of the table. Also, the position of Table 2 is different after the modifications, therefore it is easier to read through the text now.

thinh_7 reivew

- Minor point 1: the study results will be provided at the same time with the publication of the paper.
- Minor point 2: resolved. The future work of the project is added in the discussion and conclusion.
- Minor point 3: resolved by adding more clarifications.

thinh_8 review

- Major point 1: resolved. The introduction is re-written to be more concise, and more explanations are now given in the methodology and discussion parts.
- Major point 2: resolved.
- Major point 3: disagree, I think the absence of white dwarfs or blue stragglers will not significantly affect the isochrones fitting, as long as the turn-off point is visible. Also, I think a legend showing each type of stars is unnecessary within the scope of the paper.
- Minor point 1: HR should also has a main-sequence turn-off point. However, I changed all the phrase “HR diagram” to “color-magnitude diagram” for consistency.
- Minor point 2: I think isochrones is considered a common knowledge in the field, and thus we don’t need too many citations.
- Minor point 3: resolved. I think citation can be at the beginning of the sentence in some cases.
- Minor point 4: resolved.
- Minor point 5: this can be an over-estimation, and I expect that. All those overestimated stars will be removed with the cut on the membership probability.
- Minor point 6: disagree. I think the contamination removal is one way to reduce and select good data, and thus it should be in the methodology section.
- Minor point 7: I change the word “equation” to “criteria” to make it more appropriate.
- Minor point 8: from the data, all ruwe values are larger than 0.8. Therefore, we do not need a lower limit for ruwe.
- Minor point 9: the cut-off value of 0.5 for cluster members is chosen by personal preference and it is also a common practice when determining cluster members.
- Minor point 10: initially, the color absolute magnitude is used because our data contain both field stars and cluster stars. After our selection, the cluster stars are assumed to be at

the same distance, and thus using color apparent magnitude is enough (even if we use the color absolute magnitude diagram at this point, the plot will shift upward but the shape of the plot will remain the same).

- Minor point 11: disagree, that paragraph is also used to justify the author's choice of prior.
- Minor point 12: resolved by rephrasing the sentence.
- Minor point 13: the top right of the plot are the giant branches of the isochrones. To make the data points easier to see, I need to limit the ranges of the x and y axis. Also, this figure is more of a confirmation than a culmination of the project as the reviewer points out.
- Minor point 14: resolved by including further direction for the project.