ON LLOYD’S THE MASS DISTRIBUTION OF SUBGIANT PLANET HOSTS (arXiv:1306.6627v1)

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ABSTRACT

We provide an informal response to James P. Lloyd’s recent arXiv preprint (arXiv:1306.6627v1) “The Mass Distribution of Subgiant Planet Hosts” accepted for publication by Astrophysical Journal Letters.

1. CONTEXT

Recently, James P. Lloyd posted a preprint on the arXiv (arXiv:1306.6627v1, Lloyd 2013) of The Mass Distribution of Subgiant Planet Hosts accepted for publication by Astrophysical Journal Letters. Lloyd’s preprint is a surrebuttal to our paper Retired A Stars: The Effect of Stellar Evolution on the Mass Estimates of Subgiants (Johnson et al. 2013, hereafter JMW13), which in turn is a rebuttal to Lloyd’s manuscript “Retired Planet Hosts: Not So Massive, Maybe Just Portly After Lunch” (Lloyd 2011, hereafter L11).

Exploring (and, hopefully, settling) this issue of the true masses of subgiant stars deserves careful analysis and peer review, and this is best undertaken in a thorough discussion in the refereed literature. In addition to Lloyd’s work, the recent work by Schlaufman & Winn (2013), suggesting that the kinematics of the subgiant planet hosts are inconsistent with having evolved from an A-star main sequence population, deserves close attention. We are undertaking observations and preparing work for future publication on these topics, including interferometric radii and asteroseismological masses of bright subgiants.

That said, since Lloyd’s paper has generated immediate interest, as well as calls for us to quickly respond, we are making this post to the arXiv to share our considered thoughts on it, for the benefit of the astronomical community.

To be clear, the comments below do not speak directly to the resolution of the many outstanding questions regarding of the true masses of subgiant planet host stars, but pertain specifically to our thoughts on Lloyd’s recent paper per se.

2. RESPONSE

In L11, Lloyd argued that the spectroscopically derived masses from our subgiant planet search were systematically high, largely because the number of retired A stars in our sample appeared inconsistent with his models of stellar evolution. L11 attributed this difference to shape of the IMF and the differing rates of evolution across the subgiant branch for stars of different masses. Both effects should reduce the number of observable, massive subgiants. This inspired us to check our spectroscopically-derived masses for consistency with expectations from state-of-the-art galactic population synthesis models, which we described in JMW13.

We showed results from one such model, TRILEGAL (Girardi et al. 2002), which accurately reproduces the Hipparcos color-magnitude diagram, as well as star counts from many different surveys such as 2MASS. Figure 1 shows a simulated color-magnitude diagram of a 200 pc sample of stars (red) compared to the Hipparcos sample (green) (L. Girardi private communication). In JMW13, we selected stars from the subgiant branch of this simulated sample using the color and apparent/absolute magnitude cuts described by Johnson et al. The resulting distribution of stellar masses agrees well with the stellar masses in the planet search sample of Johnson et al. (2010) and allows for a fraction of those subgiants to have masses in excess of 1.5 Msun.

Given this, we feel that there is now a significant burden on Lloyd to demonstrate not just that spectroscopically-derived masses are problematic, but to directly address the demonstrations in JMW13 and argue why we should not trust the TRILEGAL simulations. He has not done this in his newest manuscript. Instead, he uses his own galactic population model, the details of which have not been described in the refereed literature nor tested on actual data.

Lloyd uses his galactic population model to argue, contra JMW13, that the Malmquist bias is not the real difference for the mass distributions of L11 and JMW13. Instead, he argues that the difference among stars with M<1.3 solar is actually a difference in the scale heights chosen by us and him. This is possible, indeed perhaps likely, but Lloyd does not actually demonstrate this to be the case.

More problematically, Lloyd does not argue that the TRILEGAL scale height is wrong, just that the answer is sensitive to it. Given the success of TRILEGAL in reproducing the Hipparcos color-magnitude diagram and 2MASS star counts (among other stellar catalogs), we feel that this argument implicates Lloyd’s models, not
TRILEGAL’s, as having the wrong scale height.

We note that Lloyd could address both of these issues using TRILEGAL itself by changing the scale height parameter and rerunning our simulations. We have provided Lloyd with the scripts we used to call TRILEGAL, so he could easily make a direct comparison with JMW13; with these he can also easily check whether a different scale height reproduces the L11 results, and whether it is consistent with the Hipparcos star counts and color-magnitude diagram.

In Section 2.4, Lloyd argues heuristically why high-mass subgiants are rare, but all of the physics he invokes are already accounted for in TRILEGAL, so this does not actually support his contention that our mass distribution is wrong. He addresses the analytic scaling arguments we used in JMW13, but our conclusions never rested on those simple calculations and JMW13 is clear on this point. Again, the burden is on Lloyd to show not only that the output of TRILEGAL is sensitive to certain model parameters (which we do not dispute) but that the star formation rates and the age-metallicity relations used by TRILEGAL are wrong, which he does not do.

Why should the reader trust the L11 models over TRILEGAL? Lloyd’s sole argument appears to be that the planet-occurrence rate as a function of mass implied by our mass estimates has an implausible shape.

Johnson & Wright

Fig. 1.— Comparison of TRILEGAL galactic synthesis to data from Hipparcos in color-magnitude, distance, and absolute magnitude spaces (L. Girardi, private communication). TRILEGAL incorporates all of the physics Lloyd invokes to explain why subgiants with the masses we ascribe to them in our previous works should be very rare, but TRILEGAL predicts that they should be in our sample, nonetheless. Despite the good match between TRILEGAL’s model outputs and observations, Lloyd prefers his models, which have not been tested in this manner and which give different results.
We acknowledge our co-author Tim Morton for his significant contribution both to our work on the subject and this document. We would also like to use this informal forum to note Dr. Lloyd’s transparent and professional approach to this controversy, including his solicitation of our input before submission and frank discussions on other occasions. He has repeatedly identified ways to make our mass estimates and manuscripts better, and we thank him for his care and dedication to this important topic. Although our disagreement on this scientific topic is profound, the dispute is not personal, and we remain friends and colleagues.

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