Anyone out there? Post-AGB stars in the Galactic halo

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To date, only a limited number of post-AGB stars are known throughout the Milky Way. If we look at possible members of the old Galactic populations - halo and thick disc - numbers get even smaller with only a handful of candidates known plus a small number of PNe. Most known post-AGB stars were selected from IR surveys, and thus a bias against slowly evolving low mass post-AGB stars could play a role. Simple back-of-the-envelope calculations and more-detailed simulations of the populations indicate that sizable samples of thick disc and Population II post-AGBs should exist and be detected in colour surveys like Palomar-Green and SDSS. If this discrepancy is real and not caused by selection effects, this would indicate that only a minority of thick disc/halo stars are evolving along the post-AGB channel. We report from an ongoing project to systematically identify post-AGB stars at high Galactic latitude. We compare results from a study by Saffer et al. (1997) of a complete sample selected from the Palomar Green survey with predicted numbers. We also performed a systematic search of the SDSS database (DR7) for possible post-AGB candidates. Only one(!) possible post-AGB candidate was found in an analysis of 21,031 blue SDSS spectra. We discuss and explore observational biases which may cause the result. If found to be truly representative of the halo and thick disc population this would indicate that the vast majority of Population II stars do not follow a standard evolution path. One possible alternative would be evolution through the blue/extreme horizontal branch bypassing the AGB.
Anyone out there? Post-AGB stars in the Galactic halo
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Abstract
To date, only a limited number of post-AGB stars are known throughout the Milky Way. If we look at possible members of the old galactic populations - halo and thick disc - numbers get even smaller with only a handful of candidates known plus a small number of PNe. We report from an ongoing project to systematically identify post-AGB stars at high galactic latitude. We compare results from a study by Saffer et al. (1997) of a complete sample selected from the PG survey with predicted numbers. We also perform a systematic search of the SDSS spectroscopic database (DR7) for possible post-AGB candidates. Only one (!) possible post-AGB candidate was found in an analysis of 21,031 blue SDSS spectra. We discuss and explore observational biases which may cause the result. It found to be truly representative of the halo and thick disc population this would indicate that the vast majority of pop. II stars do not follow a standard evolution path. One possible alternative would be evolution through the blue/extreme horizontal branch bypassing the AGB straight to the white dwarf (WD) cooling tracks.

Introduction
Most known post-AGB stars were selected from IR surveys, and thus a bias against slowly evolving low mass post-AGB stars could play a role. Simple band magnitude based envelope calculations and more detailed simulations of the populations indicate that sizable samples of thick disc and pop. II post-AGBs should exist and be identified in colour surveys like Palomar Green (PG) and Sloan Digital Sky Survey (SDSS). If this discrepancy is not and not caused by selection effects this would indicate that only a minority of thick discolate stars are evolving along the post-AGB channel. Drilling & Schönberner (1985) observe that only 0.2-3% of stars which evolve off the main sequence will not become post-AGBs. As this may be biased to the local sample we have used a model population synthesis model to determine whether we expect to find post-AGB stars at high galactic latitudes.

Simulated Populations
Adapting Napiwotzki's (2009) Monte Carlo WD simulated population using a standard structure of our galaxy and calibrated using observations of the local WD sample we produce a synthetic post-AGB population. For each star a location, metallicity, radial velocity (therefore, population group) and mass using a bijective initial mass function is simulated. The stars evolve individually to the tip of AGB using the Padova group evolutionary tracks. Finally, post-AGB tracks of various masses (Schönberner, 1981 and Drilling & Schönberner) and PG survey evolutionary tracks are fitted to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4).

Observed Population
PG. - In the Saffer et al. (1997) sample there are ten post-AGB candidates (Fig. 2). High resolution, follow-up spectroscopy had been carried out on all of the objects in the complete sample. PG 2222-369 was ruled out as a candidate due to a likely close binary interaction in its earlier evolution. This left PG 1407-252 and PG 2120-062 as the only possible candidates. Moreover, the Teff-l diagram (Fig. 3) suggests that all the candidate objects are low mass as they lie below the 0.55 M☉ track. This is consistent with one might expect for an older population but the simulated numbers increase for lower mass post-AGBs.

SDSS - With the depth of the SDSS and the large number of spectra taken we expected to find some post-AGB stars particularly with our large predicted number. We selected only SDSS spectra with a ‘blueish’ photometry. Balmer lines are used to select AGB stars but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4). The poorer fit to all of the spectra but found only one strong candidate, SDSS J145817.52+022806.6 (fit shown in Fig. 4).

Conclusion
The massive discrepancy between the observed and predicted post-AGB populations suggest the simulated evolution is not a good representation of halo post-AGBs. The PG complete sample is well studied and the initial SDSS spectra agree that these objects appear to be rare. Why do the simulations produce so many post-AGBs, what is an alternative evolutionary channel and less has been observed before? Broves et al. (2008) find a dearth of post-AGBs in M22 and elliptical which has a similar environment as our galactic halo. Possible solutions are that the progenitor envelope mass is too low for the star to ascend the AGB cooling through the horizontal branch. This implies a significant decrease in the galactic percentage of stars which evolve through the AGB phase. Alternatively, they could evolve quicker across the post-AGB track, however, this solution is unlikely as this would be more likely to produce a PN.

References
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Table. Predicted post-AGB populations for a given mass.

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<th>Mass (M☉)</th>
<th>Thin Disc</th>
<th>Thick Disc</th>
<th>Halo</th>
<th>Halo pAGBs</th>
<th>Total pAGBs</th>
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