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THE AQUARIUS STREAM PROGENITOR WAS NOT A GLOBULAR CLUSTER

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ABSTRACT

Subject headings: Galaxy: halo, structure — Individual: Aquarius Stream — Stars: FGK-giants

1. INTRODUCTION

Stellar streams in the halo are relics of mergers in the Milky Way. The positions and kinematics of stars within these substructures are sensitive to the galactic potential. As such they can constrain the shape and extent of dark matter in the Milky Way, and piece together the chemodynamic evolution of the galaxy.

Wide field digital image catalogues have proved excellent sources for finding streams in the stellar halo. However, as **?** point out, this method is only successful for identifying substructure that are sufficiently distant from the solar neighbourhood. A nearby stream within 10 kpc will not appear as an on-sky overdensity, and would only be detectable by utilising both position and kinematic information.

2. OBSERVATIONS & DATA REDUCTION

3. ANALYSIS

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3.1. *Radial Velocities*

?? The radial velocity for each star was accurately determined in a two step method. Initially each normalised, stitched spectrum was cross-correlated with a synthetic spectrum of a K0 giant with $T_{eff} = 4500\,\mathrm{K}$, $\log g = 1.5$, and $[\mathrm{M/H}] = -1.0$ across the wavelength range $8450 - 8700$ Å. Velocities found during our cross-correlation are typically within $1\,\mathrm{km\ s^{-1}}$, and this measurement is used to place each spectrum at its rest wavelength. The rest spectrum was used to measure equivalent widths of approximately N absorption lines in each spectrum (§**??**). In addition to an equivalent width and the FWHM of a Gaussian profile which best fits the absorption shape, a measured central wavelength is found for every line. The ratio between the measured central wavelength and the known rest wavelength of the given transition is primarily determined by the stellar radial velocity. Thus, we have N measurements of the stellar radial velocity.

The second step of our radial velocity determination is to find the mean offset and standard deviation from this distribution of line velocity measurements. Figure **??** shows the line velocities for HD440077 after initially being placed at rest using our cross-correlation velocity of X.XX km s^{-1}. As expected, the mean offset is small ($-1.1\,\mathrm{km\ s^{-1}}$), and our standard deviation is X.XX km s^{-1} from N line measurements. This provides us with a final measured radial velocity of $X.XX \pm X.XX\,\mathrm{km\ s^{-1}}$. All of our published radial velocities in Table 1 have been determined in this two-step process.

3.2. *Line Measurements*

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For the measurement of atomic absorption lines, we employed the line list of **?** with additional transitions of Cr, Sc, Zn, and Sr from **?**. Molecular line data for CH was taken from **??**. We supplemented the list with hyperfine-structure data for Sc and Mn from the Kurucz compilation **?**.

We list the atomic data and measured equivalent widths for lines used during this analysis in Table **??**. In order to exclude saturated lines we only used lines with a reduced equivalent widths $\log_{10}(\mathrm{EW}/\lambda) < -4.5$ in our chemical abundance analysis. A minimum detectable equivalent width was measured as a function of wavelength, and only lines that exceeded a 3σ detection significance were included. We have verified our equivalent width measurement techniques by measuring equivalent widths for N lines in HD122563 and comparing our measurements with the study of **?**. Excellent agreement is found between the two studies, which is illustrated in Figure **??**. The mean difference between this study and that of **?** is a negligible $X.X \pm X.X$ mÅ, and no systematic trend is present.

For lines with hyperfine structure, blended transitions or molecular features, we used a spectral synthesis approach. The abundance of a given species was obtained by matching a synthetic spectrum of known abundance to the observed spectrum.

3.3. *Stellar Parameters*

3.4. *Model Atmospheres*

3.5. *Abundances*

4. DISCUSSION

4.1. *Observations*

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TABLE 1
OBSERVATIONS

Object	α (J2000)	δ (J2000)	Observed Date	Airmass	Slit Size (")	t_{exp} (secs)	S/N[a] (px^{-1})	V_{rad} (km s^{-1})	V_{err} (km s^{-1})
C2225316-14437	22:25:31.7	−14:54:39.6	2011-07-30	1.033	0.7	...	...	−169.0	0.7
C2306265-085103	23:06:26.6	−08:51:04.8	2011-07-30	1.096	0.7	...	...	−239.3	0.6
HD41667	06:05:03.7	−32:59:36.8	2011-03-13	1.005	1.0	...	...	314.4	0.8
HD142948	16:00:01.6	−53:51:04.1	2011-03-14	1.107	1.0	...	...	6.8	0.4
J221821-183424	22:18:21.2	−18:34:28.3	2011-07-30	1.026	0.7	...	...	−170.5	0.5
J223504-152834	22:35:04.5	−15:28:34.9	2011-07-30	1.047	0.7	...	...	−180.9	0.7
J223811-104126	22:38:11.6	−10:41:29.4	2011-07-30	1.218	0.7	...	...	−248.4	0.7

[a] S/N measured at 6000 Å for each target.

TABLE 2
OBSERVED TARGETS

ID	α (J2000)	δ (J2000)	Air mass	S/N[a] (px^{-1})	V_{helio} (km s^{-1})
HD130694	14:50:17.1	–27:57:41.6	1.289	···	···
HD170642	18:32:21.0	–39:42:12.8	1.464	···	···
HD180928	19:18:59.6	–15:32:11.5	1.934	···	···
HD181342	19:21:03.9	–23:37:09.7	1.203	···	···
HD187111	19:48:39.3	–12:07:17.8	1.281	···	···
HD210049	22:08:22.8	–32:59:14.6	1.006	···	···
C2225316-145437	22:25:31.7	–14:54:39.6	1.033	···	···
J221821-183424	22:18:21.2	–18:34:28.3	1.026	···	···
J223504-152834	22:35:04.5	–15:28:34.9	1.047	···	···
J223811-104126	22:38:11.6	–10:41:29.4	1.218	···	···
C2306265-085103	23:06:26.6	–08:51:04.8	1.096	···	···
HD219615	23:17:10.7	+03:16:51.9	1.412	···	···

[a] S/N measured at 6000 Å for each target.

TABLE 3
OBSERVED TARGETS

Star	α (J2000)	δ (J2000)	Observed	Air mass	Seeing (")	S/N[a] (px^{-1})	V_{helio} (km s^{-1})	Comment
AQS 1	12 43 42.9	-44 40 35.8	April 2011	?	?	260	?	?
AQS 2	12 51 24.8	-13 29 31.3	April 2011	?	?	232	?	?

[a] S/N measured at 600 nm for each target.