



Halo Streams in the 7th SDSS Data Release

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ABSTRACT

We searched for and detected stellar halo streams in the Solar neighborhood using the data provided by the 7th SDSS data release. Our sample consists of 22,321 nearby ($d \leq 2$ kpc), metal-poor ($[Fe/H] \leq -0.5$) main sequence stars, with 6D estimates of (r, v) . We characterize the orbits of these stars through suitable kinematic proxies for their “effective” integrals angular momentum, eccentricity and orbital inclination and compare the observed distribution to the expectations from a smooth distribution in four $[Fe/H]$ -bins. The metallicities provide an additional “dimension” in parameter space that is suited well to distinguish tidal streams from those of dynamical origin. On this basis we identify at least seven significant “phase-space overdensities” of stars on very similar orbits in the Solar neighborhood to which we can assign unambiguously peaked $[Fe/H]$ -distributions. Three of them have been identified previously, thereunder the stream discovered by Helmi et al. (1999). In addition, we find at least four new genuine halo streams, judged by their kinematics and $[Fe/H]$. This demonstrates the practical power of our search method to detect substructure in the phase-space distribution of nearby stars without making a priori assumptions about the form of the gravitational potential.

THE SAMPLE

Our sample consists of 22,321 nearby (2 kpc), metal-poor ($[Fe/H] \leq -0.5$) main sequence ($\log g \geq 3.5$) stars from the 7th SDSS data release. Distances have been estimated using the photometric parallax relation from Ivezić et al. (2008), which includes a correction for metallicity. This relation systematically under-estimates distances by a factor below 5% (derived from a comparison to 15 cluster fiducial sequences from An et al. 2008, see Figure 1).

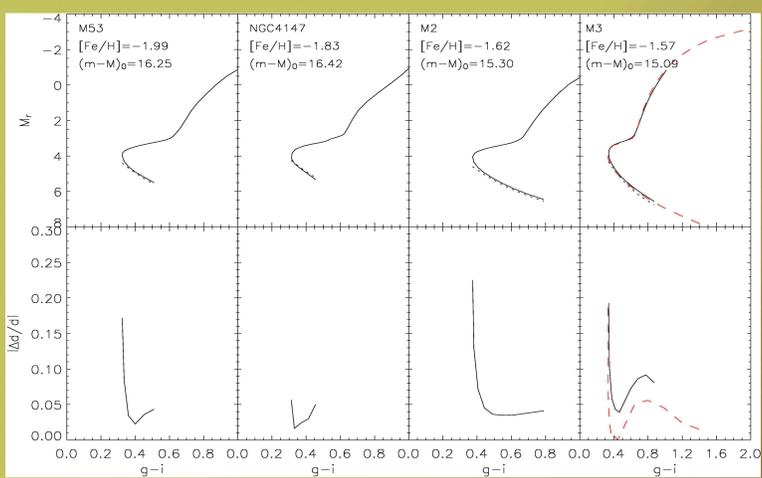


Fig.1: Comparison of the photometric parallax relation from Ivezić et al. (2008) with four of the 15 cluster fiducials from An et al. (2008).

SEARCH STRATEGY

We assume a spherical potential and use the space spanned by $v = \arctan((V + V_{LSR})/W)$, $V_{az} = (V^2 + W^2)^{1/2}$ and $V_{\Delta E} = (U^2 + 2(V_{az} - V_{LSR})^2)^{1/2}$. These quantities are measures of orbital inclination with respect to the z-axis, total angular momentum and eccentricity. Overdensities in this space presumably correspond to stellar streams (Figure 2).

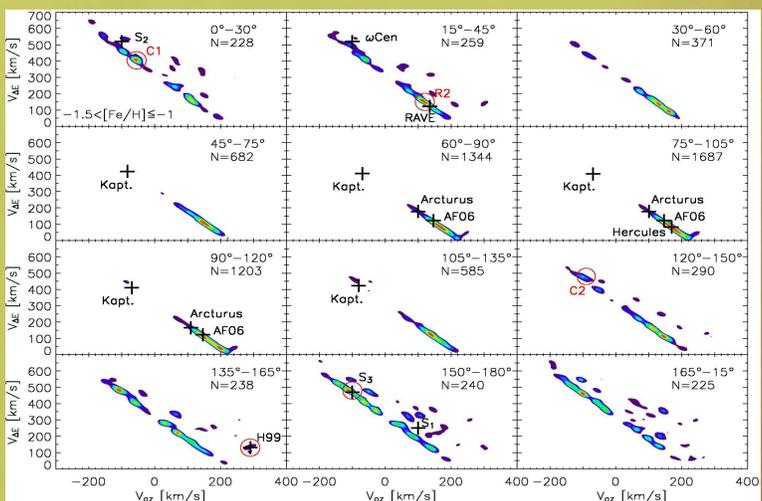


Fig.2: Contours of the wavelet transform of the distributions of stars with $-1.5 < [Fe/H] \leq -1.0$ in V_{az} vs. $V_{\Delta E}$ in 12 overlapping v -slices.

SIGNIFICANCE OF THE STREAMS

To test the statistical significance of the overdensities like those shown in Figure 2, we randomly draw 30 Monte Carlo samples from a two-component Schwarzschild distribution. The mean value of the wavelet transforms of all Monte Carlo samples represents a smooth reference model and - together with the standard deviation - is used to derive the significance of structure (Figure 3).

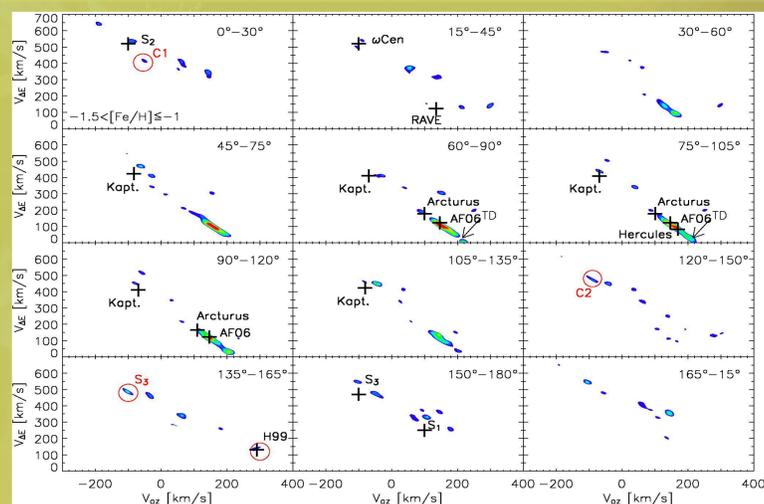


Fig.3: Significance map of the overdensities from Figure 2

RESULTS

In total, we detect at least seven significant halo streams, of which three are already known and four are new candidates. Analyzing the (U, V, W) -, $[Fe/H]$ - and (L_z, L_{perp}) -distributions, we confirm the tidal origin of the streams (exemplarily shown in Figure 4 for the stream candidate 'C2').

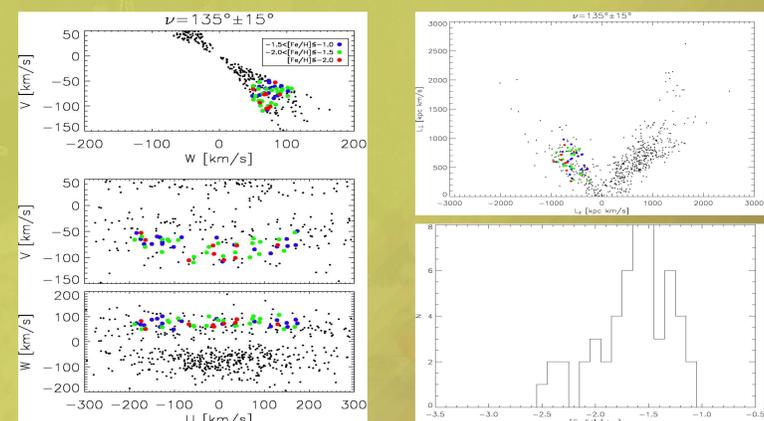


Fig.4: (U, V, W) -, $[Fe/H]$ - and (L_z, L_{perp}) -distribution for members of the stream 'C2'

REFERENCES

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