Space Motions of Stars in Tidal Streams: Survey Description & Results

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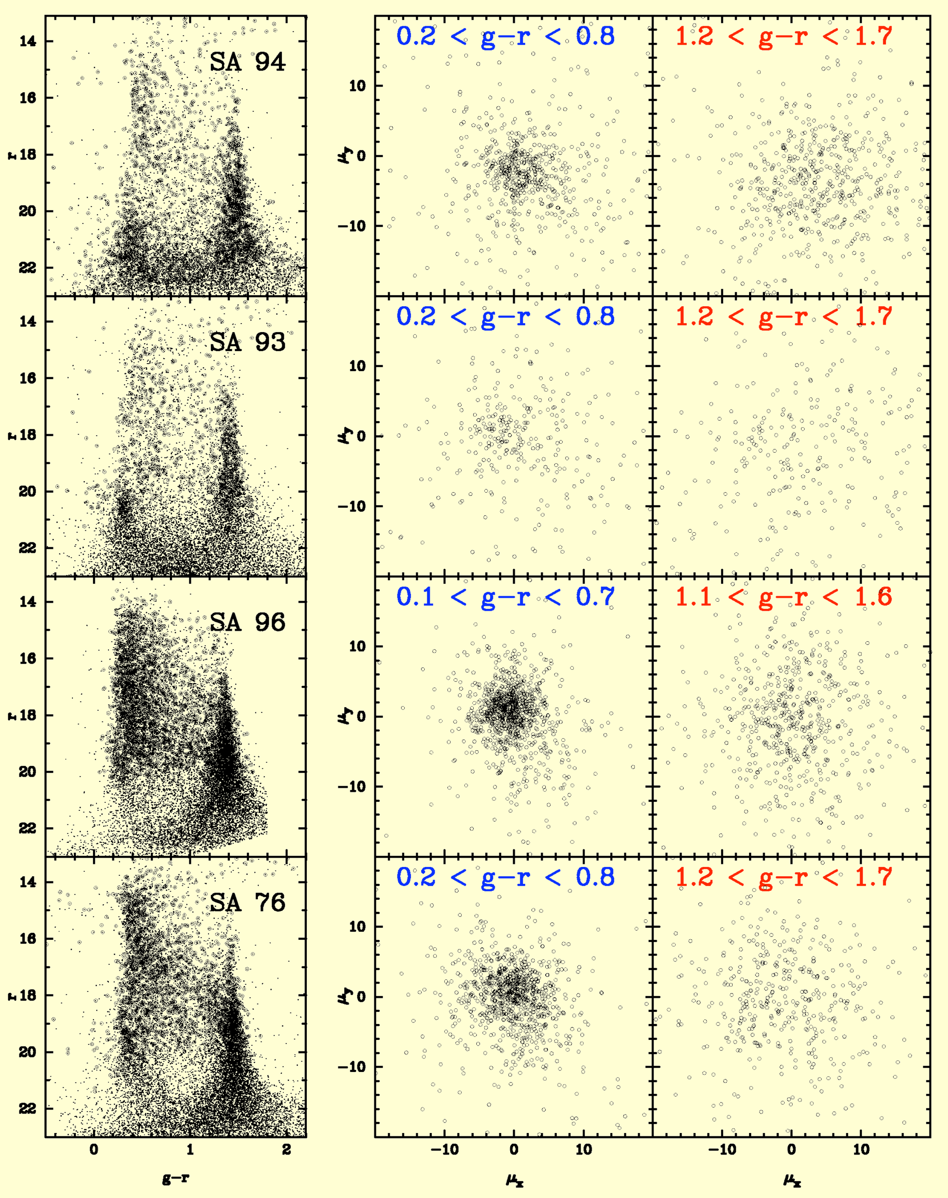
Summary:

A high-precision, relatively deep (down to V ~ 19-21) absolute proper-motion survey is underway consisting of about 50 lines of sight that correspond to the Kapteyn selected area (SA) fields along declination zones -15º, 0º and +15º. We obtain a proper-motion uncertainty between 1 and 2 mas/yr per star between V = 14 and 18 for the majority of fields. For a smaller number of fields that have complementary 4-m photographic plates, this precision is achieved down to V = 20. The absolute reference system is established by numerous extragalactic sources found in each field; the precision of the correction to absolute proper motion is between 0.2 and 0.7 mas/yr, with the most common value being 0.4 mas/yr.

We have thus far identified kinematical substructure in proper-motion space in most areas where SDSS and QUEST have found stellar overdensities. The proper motions are complemented with radial velocities obtained at WIYN and CTIO, and with photometry in arareas of interest..

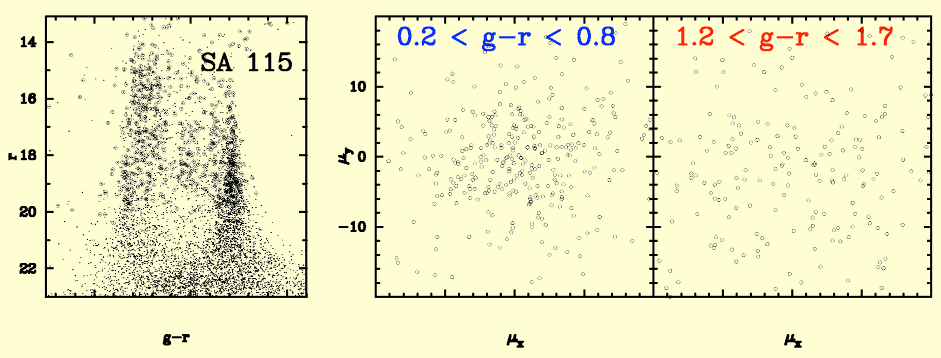
With these data we aim to:
- disentangle multiple, superposed substructure in complex areas,
- characterize the progenitors by modeling their disruption process,
- determine the shape of the Galactic potential.

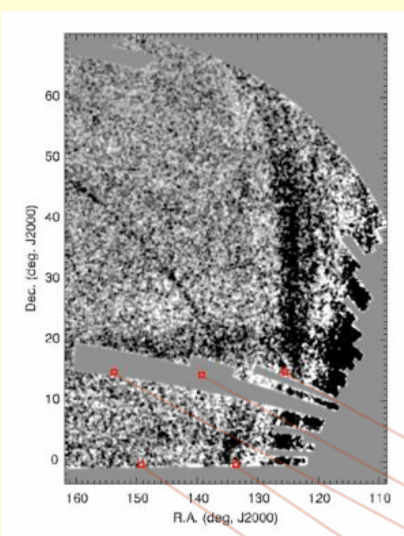


Proper-Motion results: The presence of kinematically cold substructure is discernible in the proper-motion vector point diagram (VPD). The leftmost panels in the figure to the left show the SDSS r vs. g-r CMDs for four SA fields in which overdensities have been previously found. The large symbols correspond to stars for which we have measured proper motions. The middle and right panels show the resulting VPD for these stars, divided into blue and red samples. Each row represents a different SA field. (See the "Survey coverage" map below for the positions of these fields.)

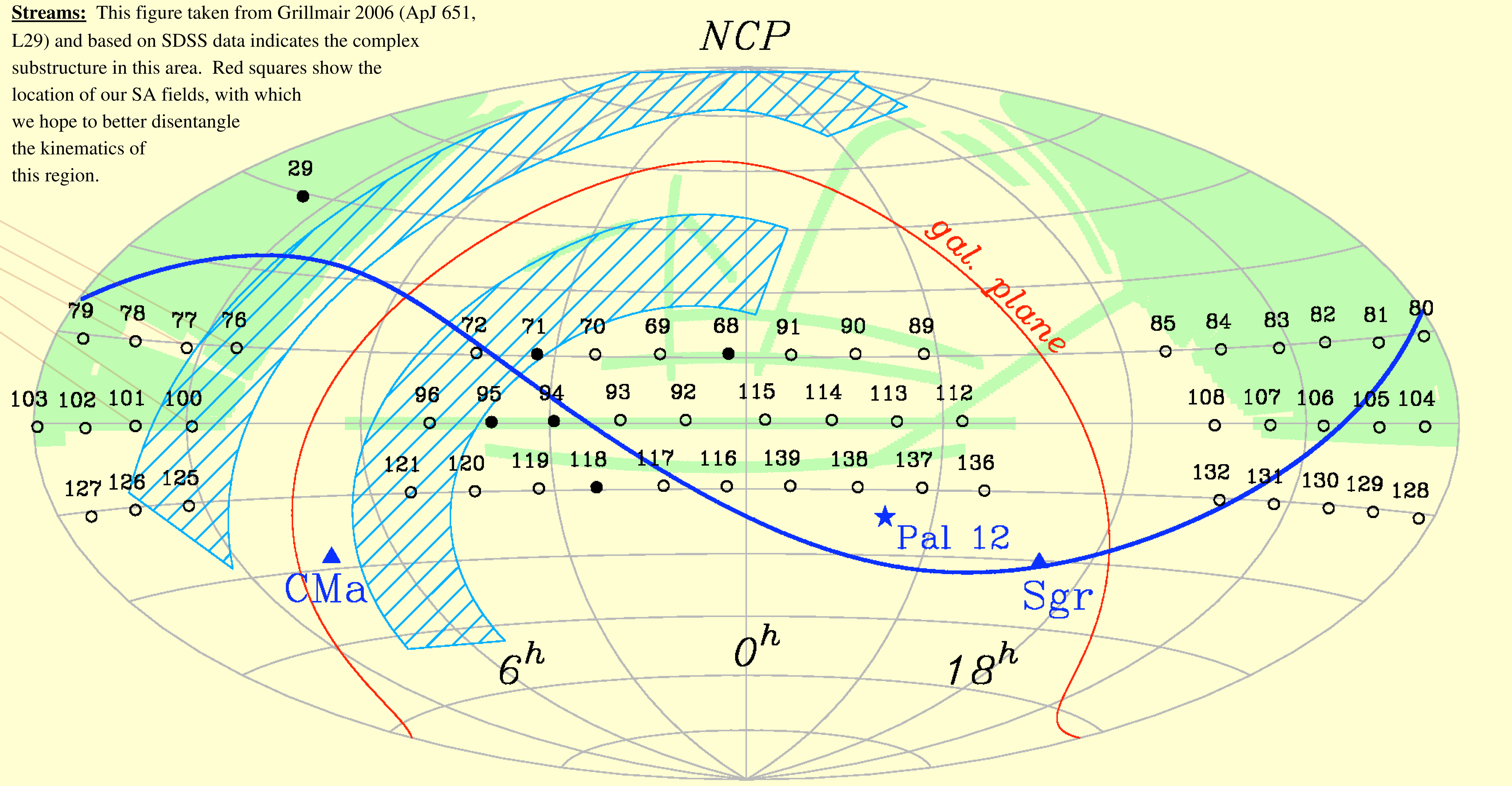
The Sgr stream is clearly visible in fields 93 and 94. The blue-star sample, containing the Sgr turnoff, allows us to measure the absolute proper motion of Sgr debris in these areas. In fields 76 and 96 it is the Monoceros substructure that is detected, above and below the Galactic plane.

For comparison, similar plots for SA field 115 are shown immediately below. There is no indication of substructure in either the CMD or proper-motion VPD.

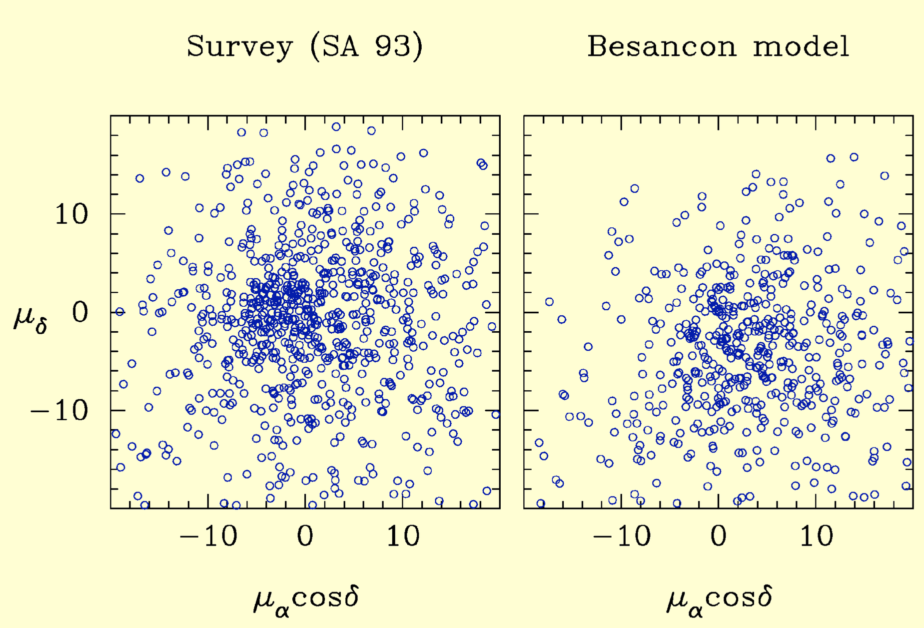




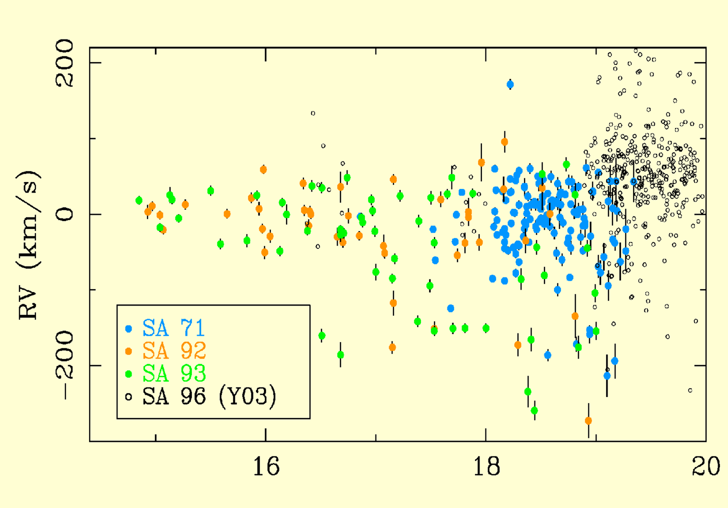
Streams: This figure taken from Grillmair 2006 (ApJ 651, L29) and based on SDSS data indicates the complex substructure in this area. Red squares show the location of our SA fields, with which we hope to better disentangle the kinematics of this region.



Survey coverage: The fields for which we have astrometric plate material are shown above, labeled by their SA field number. Solid circles indicate those fields for which we have additional 4-m plates, providing precise proper motions to fainter limits. The core of the Sgr dwarf spheroidal is shown along with its most recent orbit. The blue hatched areas roughly indicate the regions over which the Monoceros ring structure has been seen. Green areas correspond to the SDSS data release #5, providing precise photometry to complement our kinematic data.

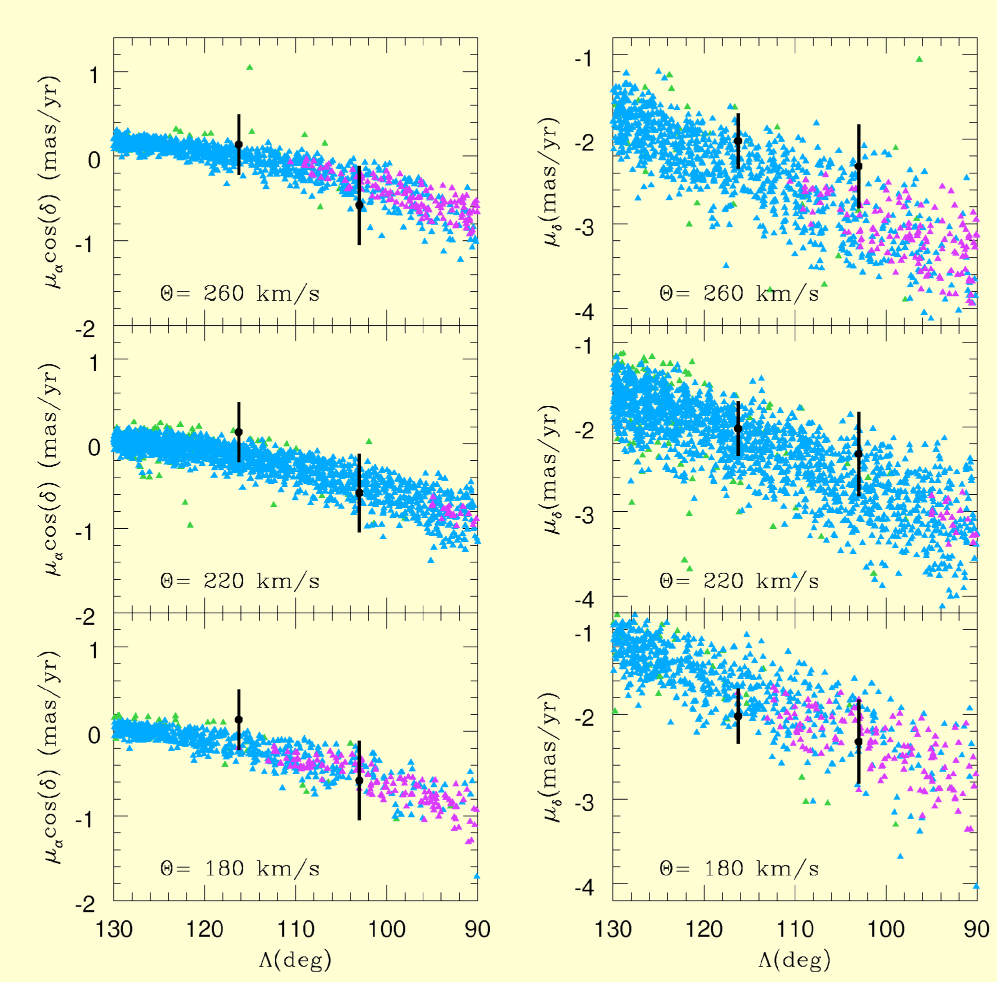


Sgr in SA 93: At left is a comparison between the relative proper-motion VPD for stars in SA 93 with a predicted absolute VPD from the Besançon synthetic Galactic model (Robin et al. 2003, A&A 409, 523) for the same pointing. The empirical data show an obvious extra component that is kinematically cold.



Radial-velocity structure: For some of our survey fields we have obtained WIYN/HYDRA radial velocities of probable "cold component" stars. Three such fields are shown (in color) together with measures from Yanny et al. 2003 (ApJ 588, 824) for an area near SA 96 that contains Mon ring stars. SA 71 shows similar clumping while all three HYDRA-measured fields show the presence of Sgr stars at RV ≈ -150 km/s.

Constraining the Galactic potential: In theory both the velocity of the LSR (Θ) and the flattening of the Galactic potential (q) can be deduced from precise measurement of the absolute proper motion of stars along the Sgr debris stream. Shown are three models (Law *et al.* 2005, ApJ 619, 807) of the expected stream motion for different values of Θ as a function of angular distance (Λ) from the core of the Sgr dSph. The different colors denote various wrappings of the tidal stream. Superposed are our absolute proper-motion measures and their errors of Sgr stars in fields 93 and 94. While these two fields alone cannot differentiate between the models, it is expected that additional measures in fields at varying Λ will provide a useful constraint.



Further details and discussion can be found in Casetti-Dinescu *et al.* 2006 (AJ 132, 2082).

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