Galactic Structure from SEGUE and LAMOST

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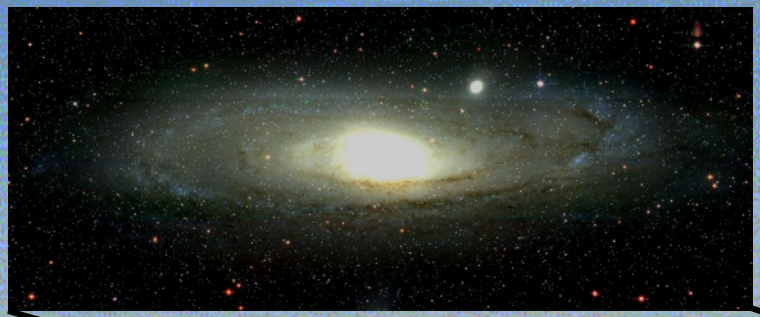
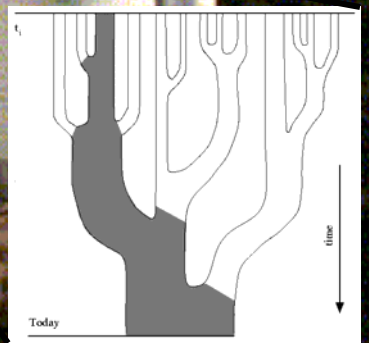
Rensselaer Polytechnic Institute





Overview

(1) The Sgr stream does not go through the Solar neighborhood.

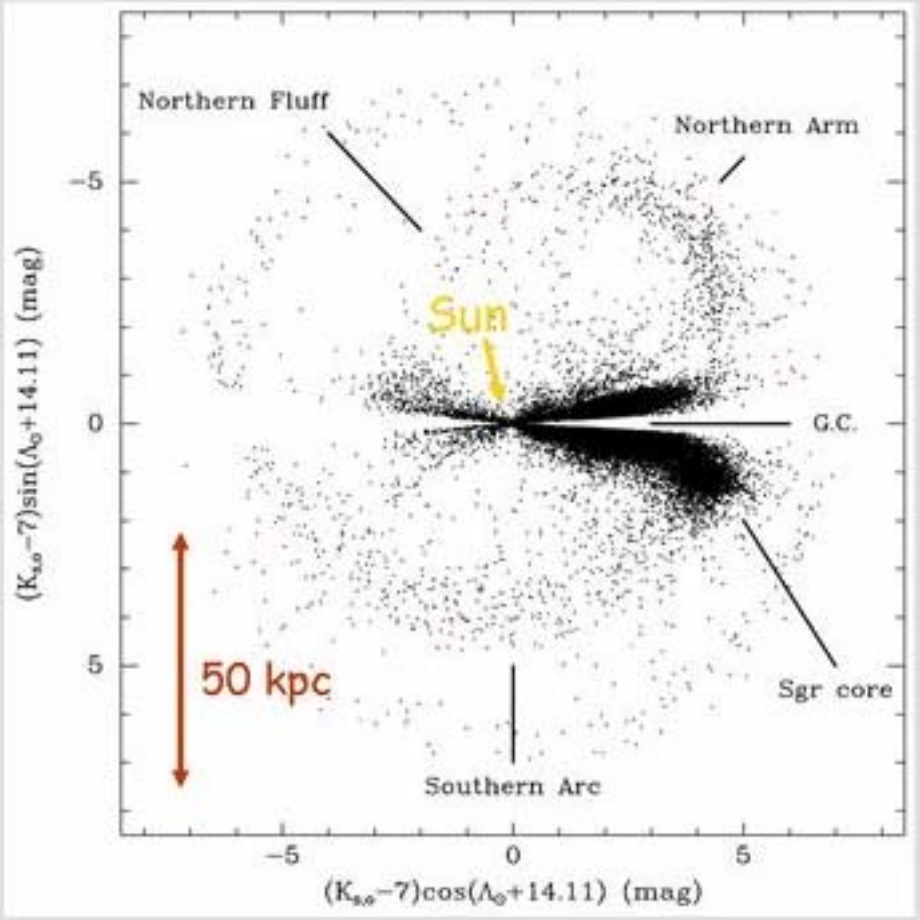
(2) We can photometrically select Sgr M giants, and the SDSS/SEGUE velocities of Sgr stars seem to match those of Law, Johnston & Majewski 2005

(2) Photometric separation of Sgr dwarf tidal debris

(3) A Galactic structure survey in collaboration with the Chinese LAMOST project

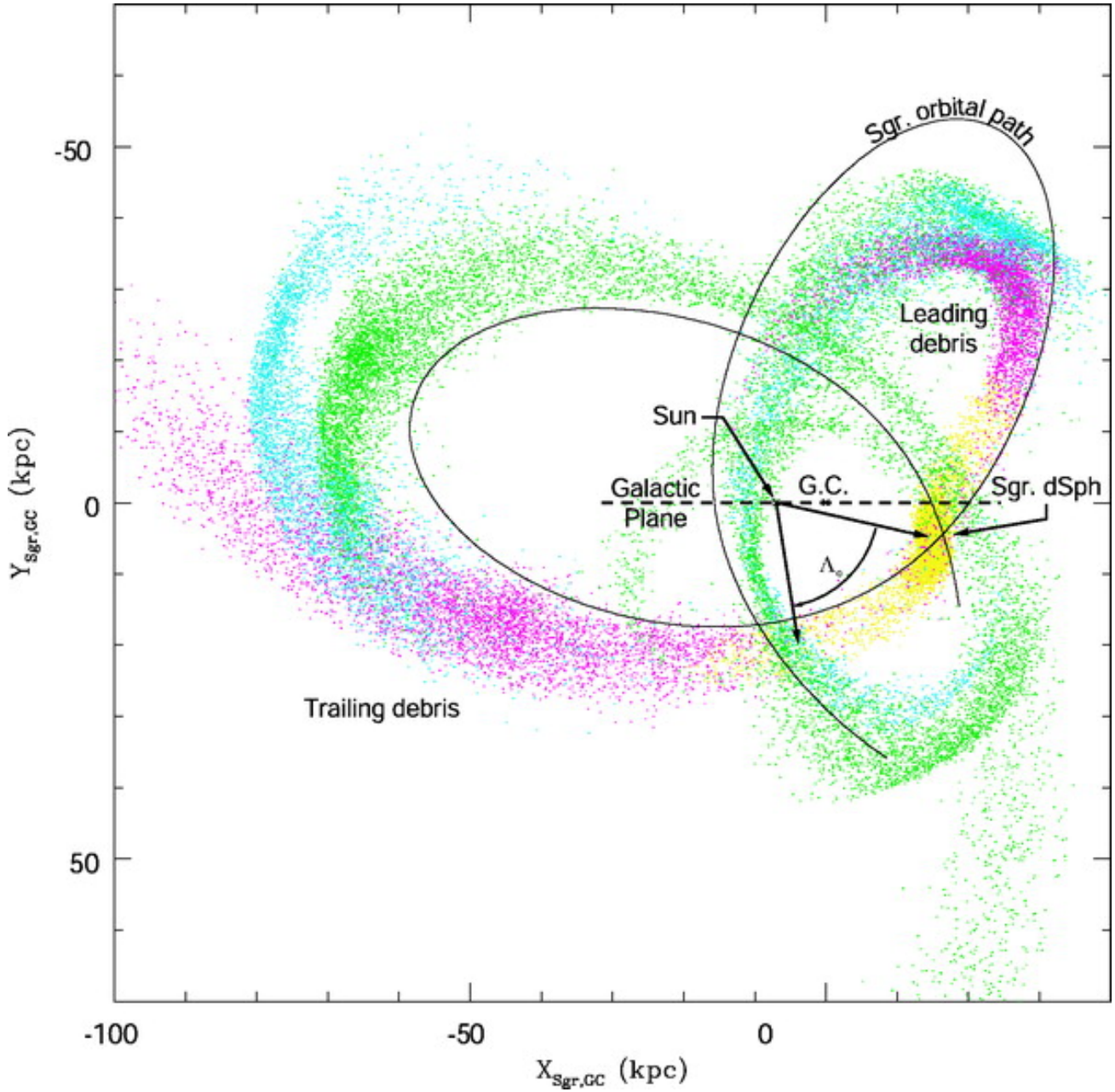
Substructure in the stellar halo

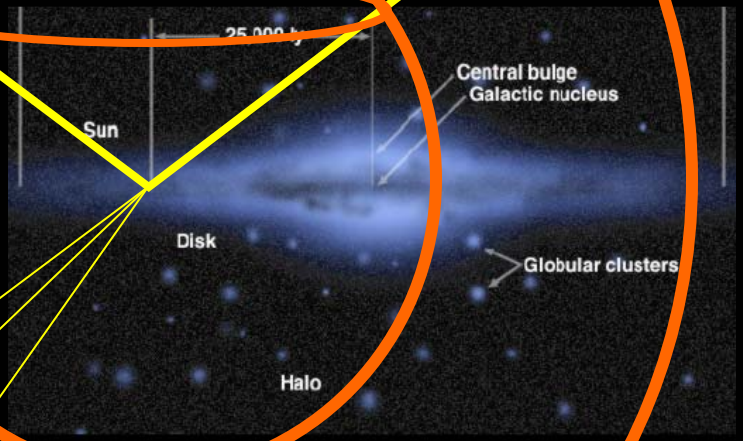
- in the past decade many lumps, tails and other features have been discovered in the stellar halo of the Galaxy
  - Sagittarius stream
    - associated with Sagittarius dwarf galaxy
    - has been detected around 1-2 complete orbits
    - passes over Galactic poles and close to the Sun
    - provides a significant fraction of all halo stars at ~ 50 kpc

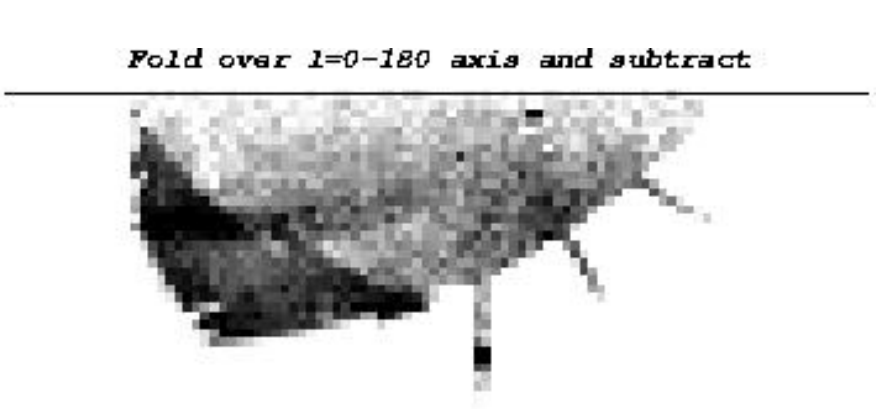


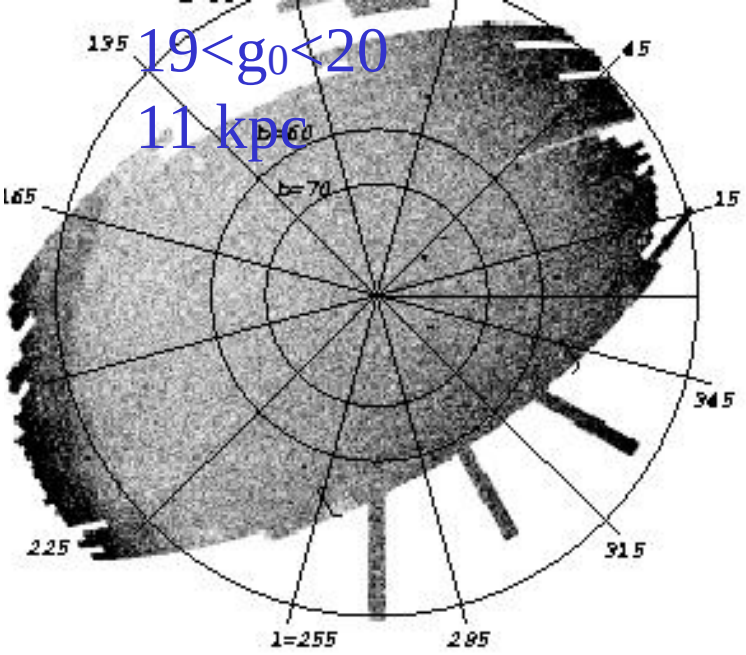
Majewski et al. (2003)

Law, Johnston & Majewski 2005

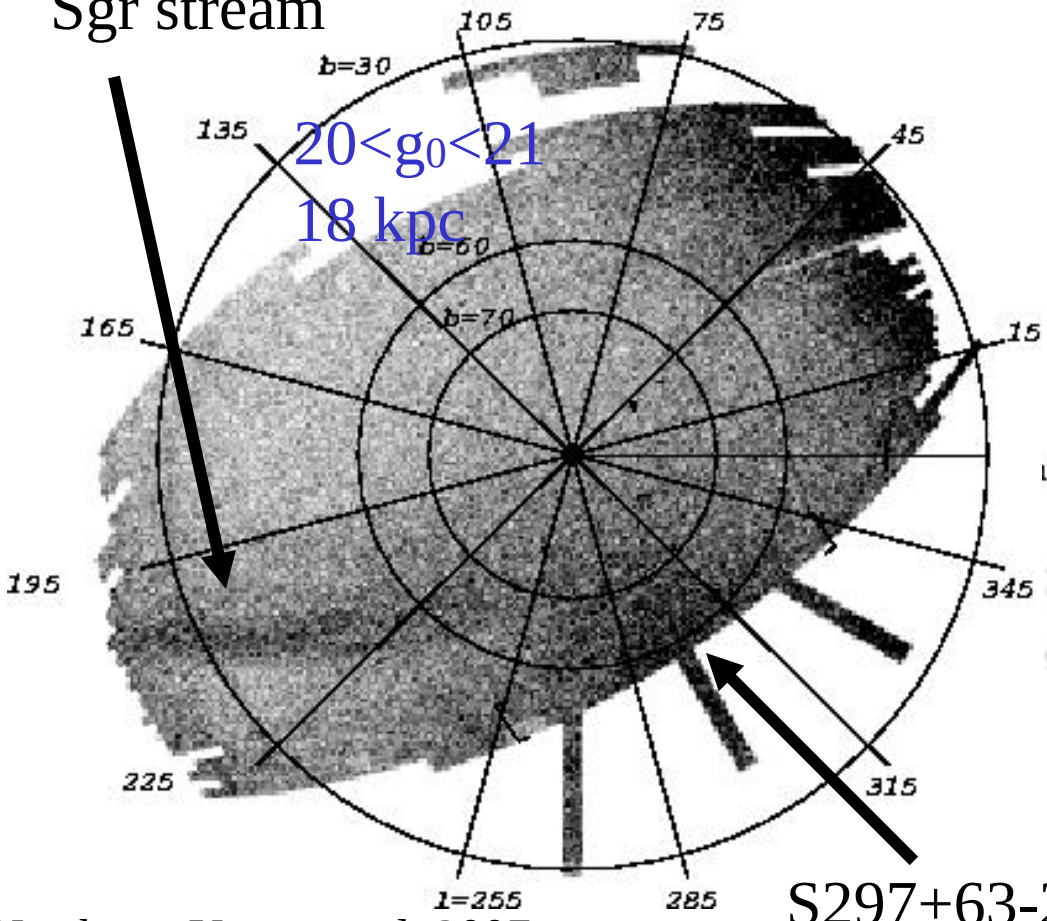


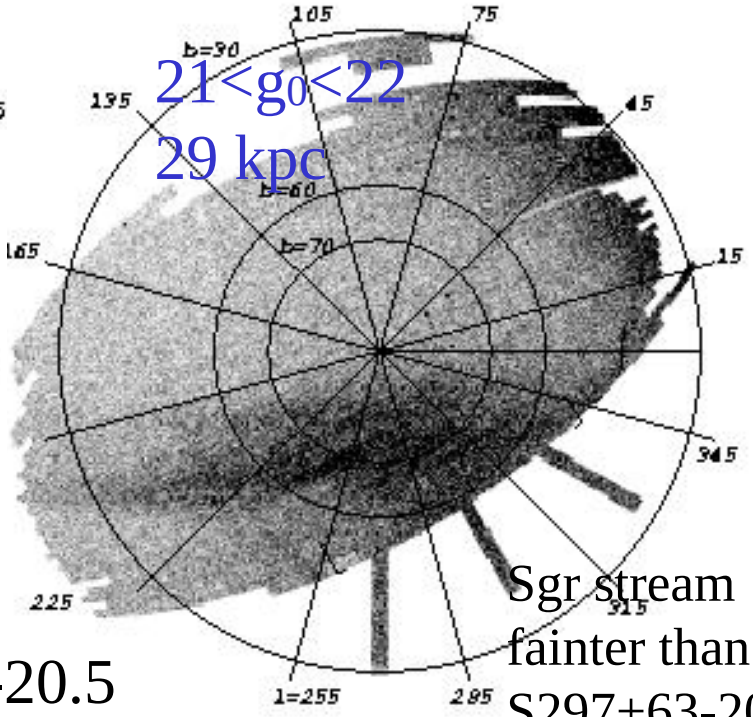

Central bulge
Galactic nucleus
Sun
Disk
Globular clusters
Halo





Sgr stream



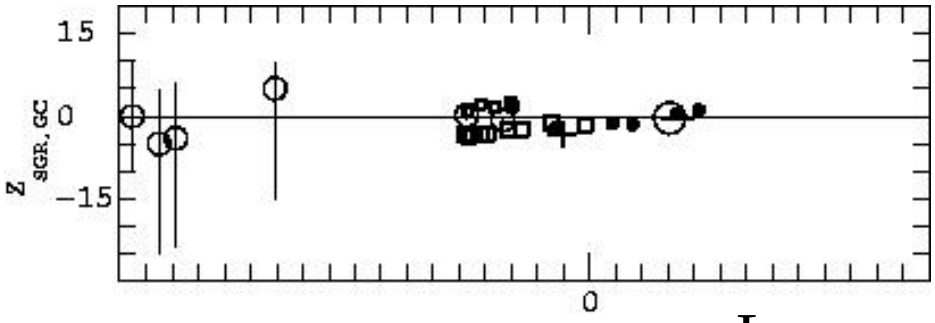


S297+63-20.5

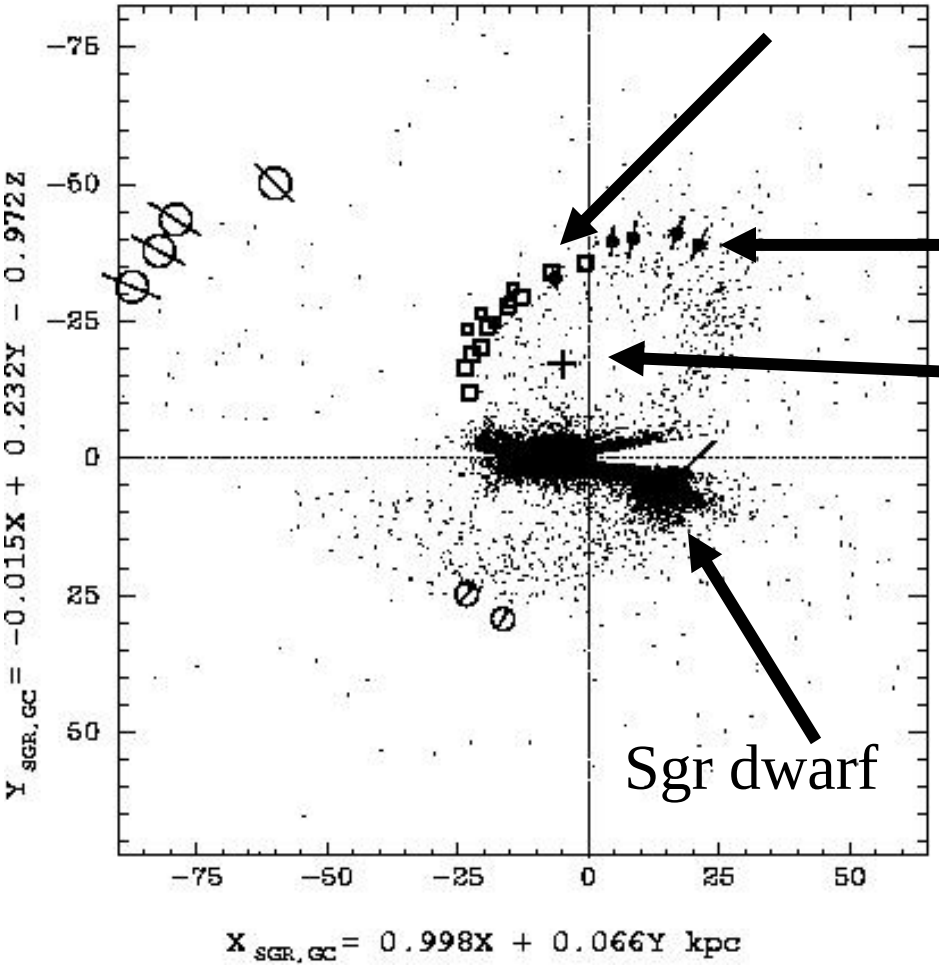
Sgr stream fainter than S297+63-20.5

Newberg, Yanny et al. 2007

Newberg, Yanny et al., 2007



Lower density bifurcation?



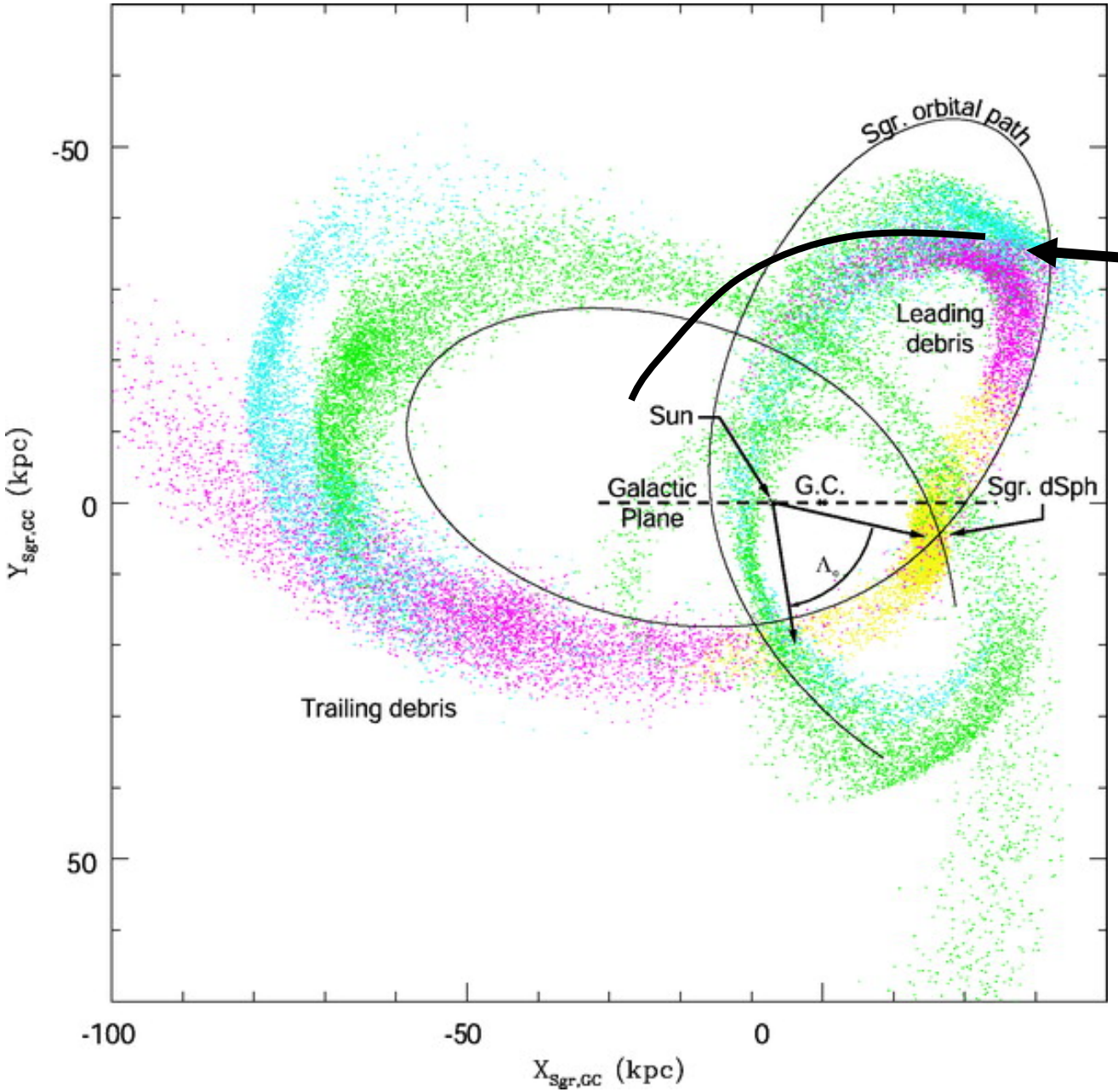
Sgr leading tidal tail

Virgo Overdensity

Sgr dwarf

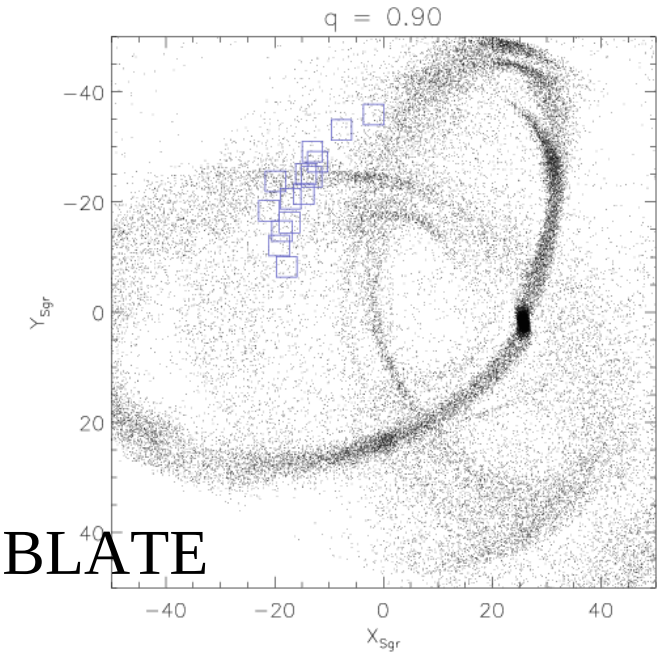
Cross section through the Galaxy in the plane of the Sgr dwarf orbit. The 2MASS M giant stars from Majewski et al. (2003) are points. The symbols are positions measured from SDSS BHB or F turnoff stars.

Law, Johnston & Majewski 2005

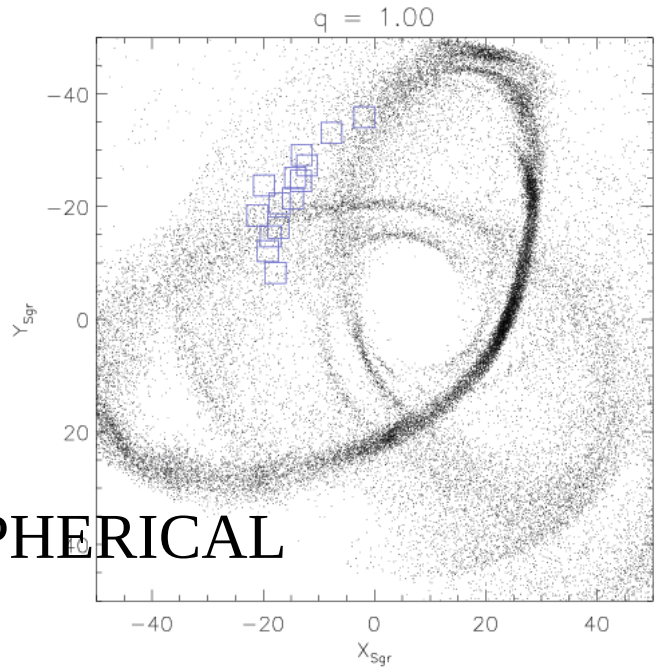


Leading tidal tail in A/F stars

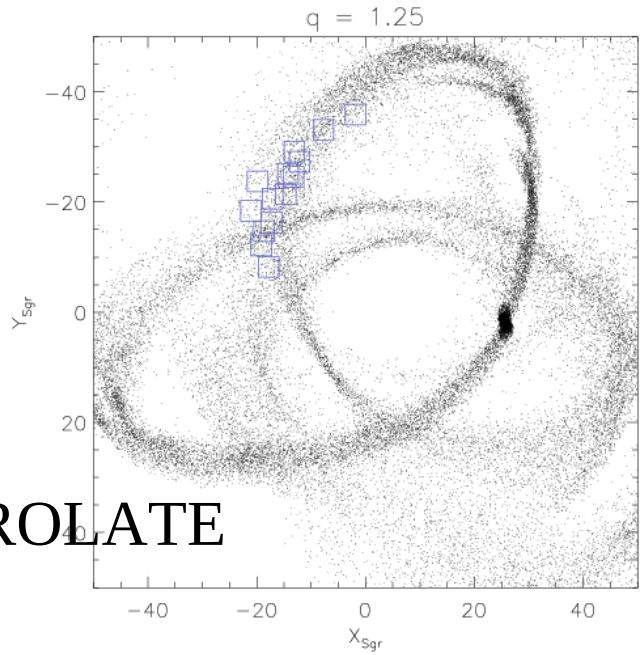
Notice that the position we find for the leading tidal tail of Sgr (black curve) does not follow the LJM 2005 model.



OBLATE



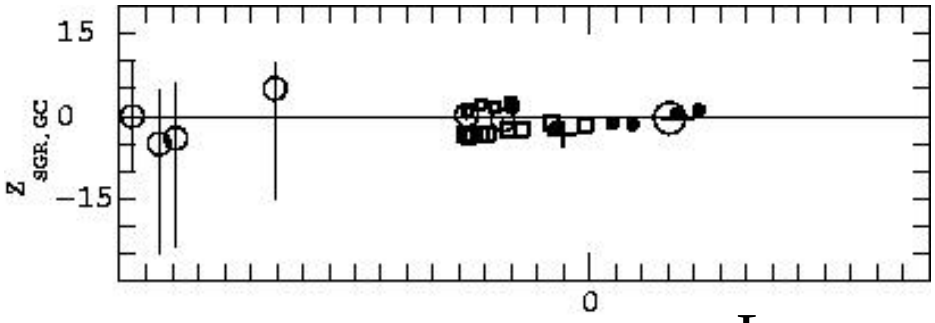
SPHERICAL



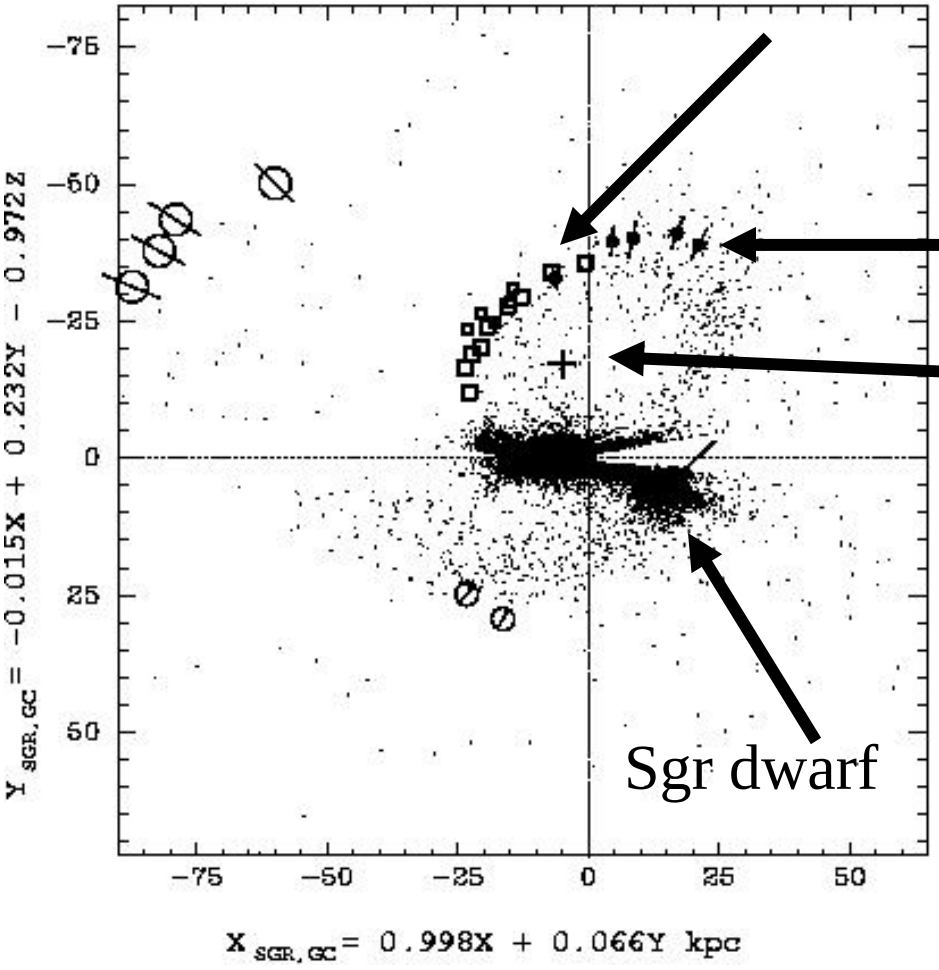
PROLATE

Models of the Sgr dwarf tidal stream compared to new data (Helmi, private communication). The prolate model fits better, but there is an inconistency with the tilt of the tidal tails.

Newberg, Yanny et al., 2007



Lower density bifurcation?



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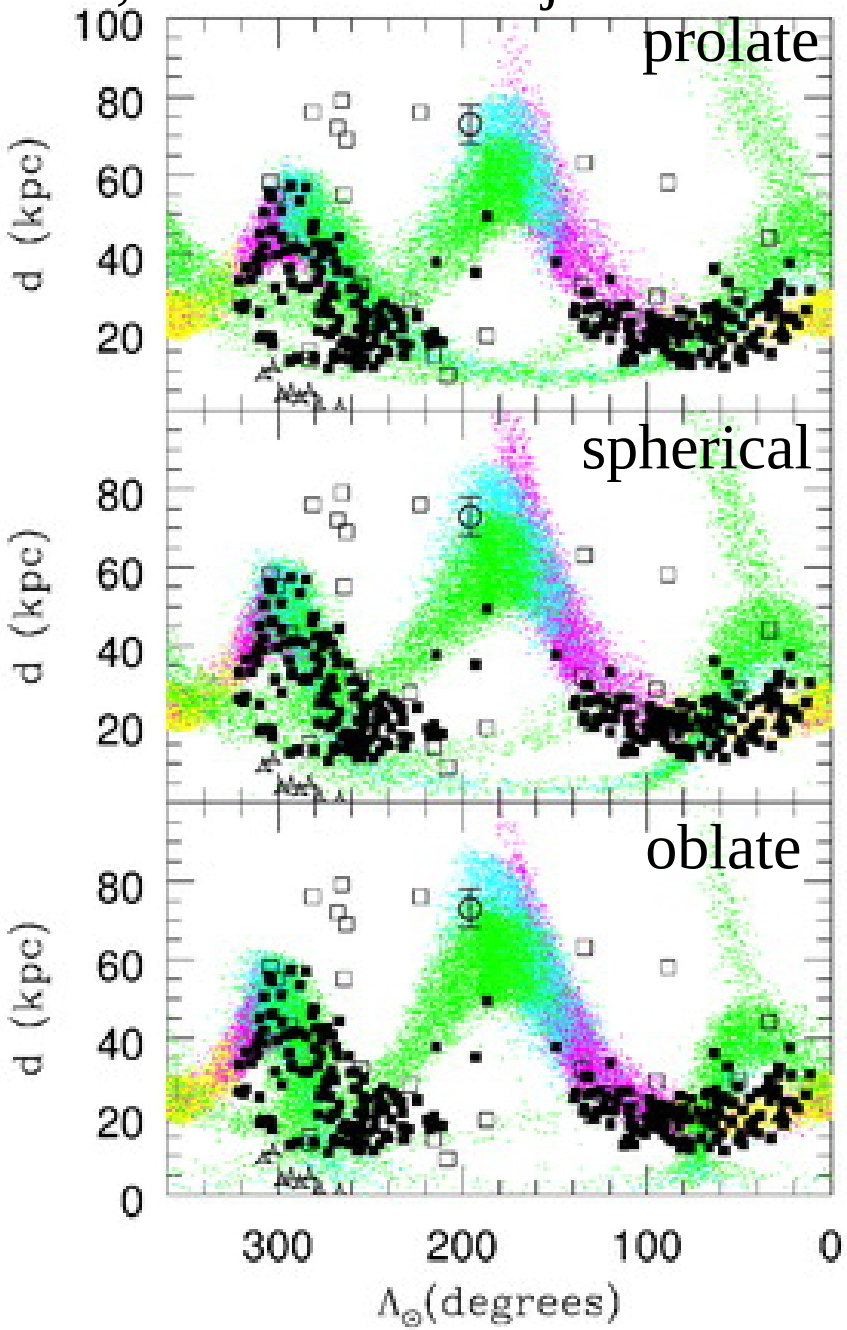
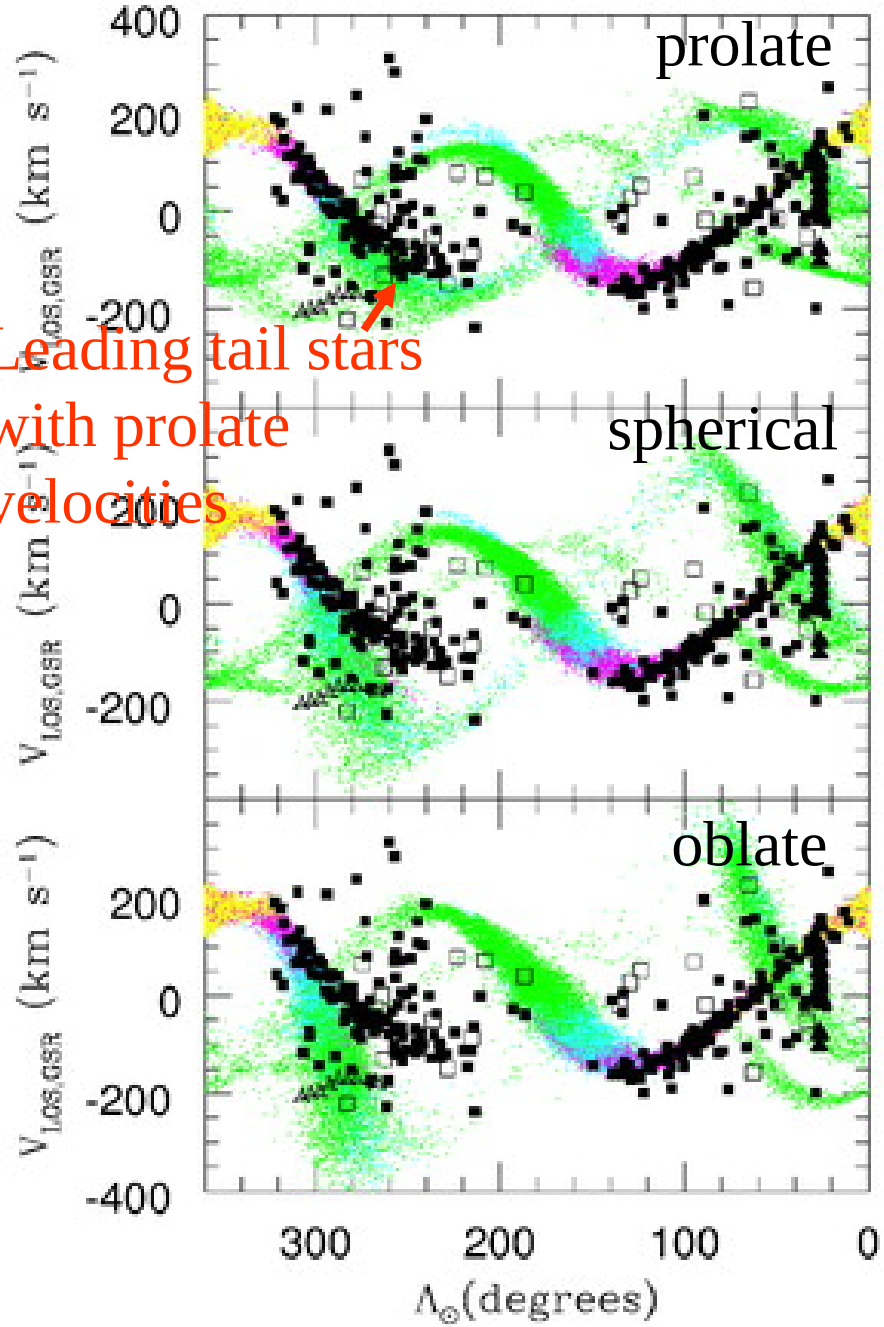
Cross section through the Galaxy in the plane of the Sgr dwarf orbit. The 2MASS M giant stars from Majewski et al. (2003) are points. The symbols are positions measured from SDSS BHB or F turnoff stars.

Law, Johnston & Majewski 2005

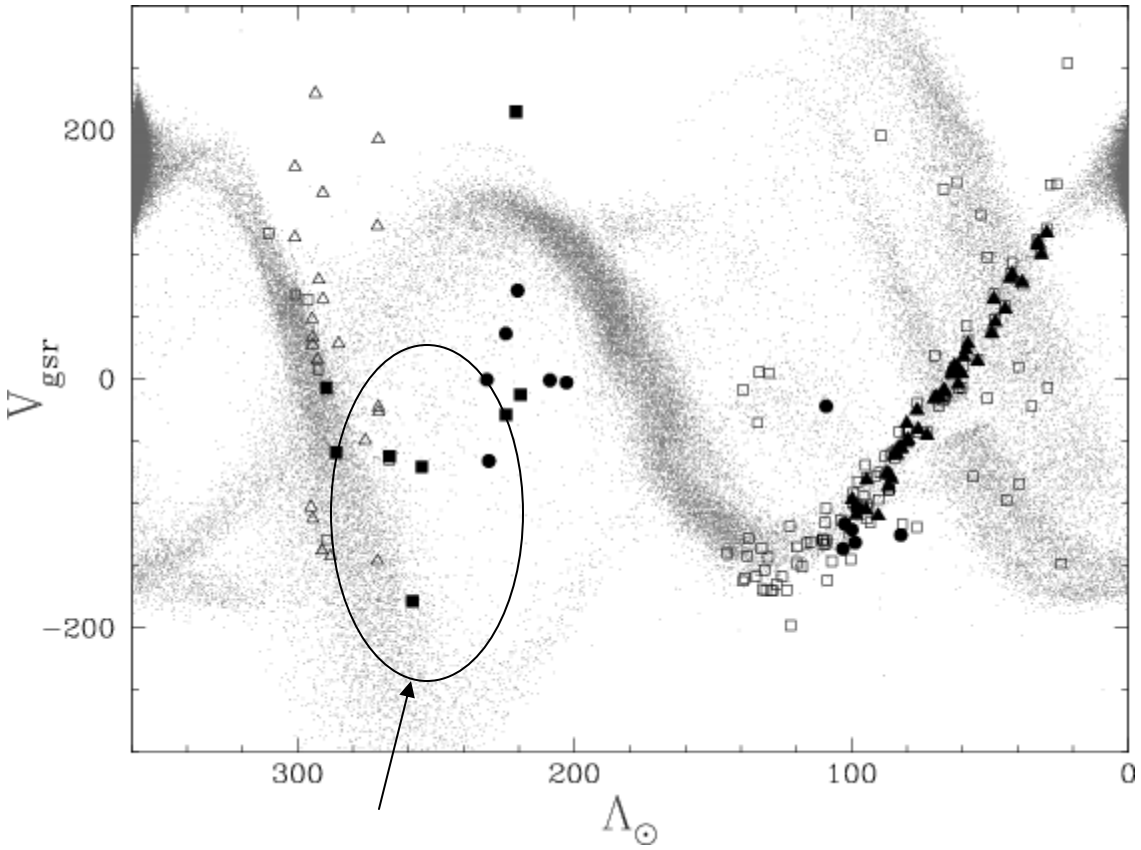




Leading tail stars with prolate velocities

Monaco et al. 2006

New data (filled symbols) overlaid on
Law et al. oblate halo disruption model



Virgo region

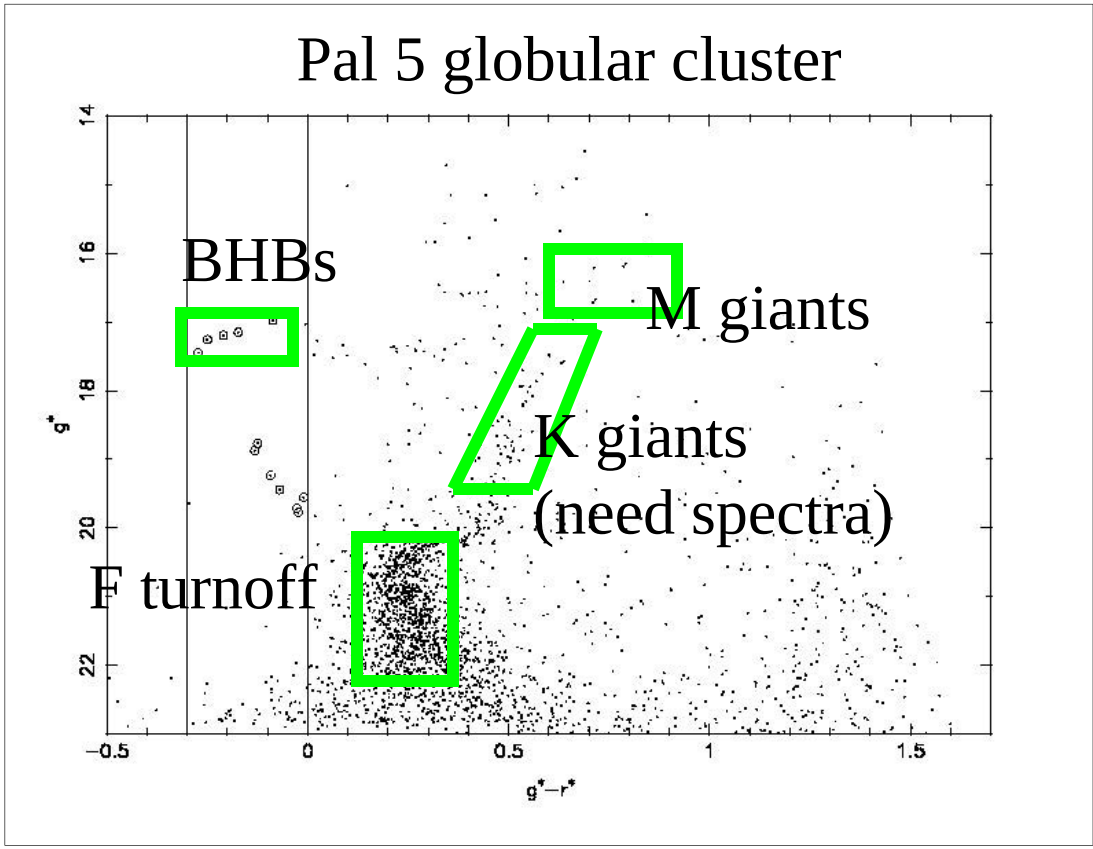
Note that Monaco et al. 2006 identify Sgr stars at substantially lower Vgsr than LJM (2005) in the Virgo region, along with some stars that are about the same Vgsr, but do not fit the model.

Techniques for finding spatial substructures

(1) Select a tracer of known luminosity to use as a distance indicator.

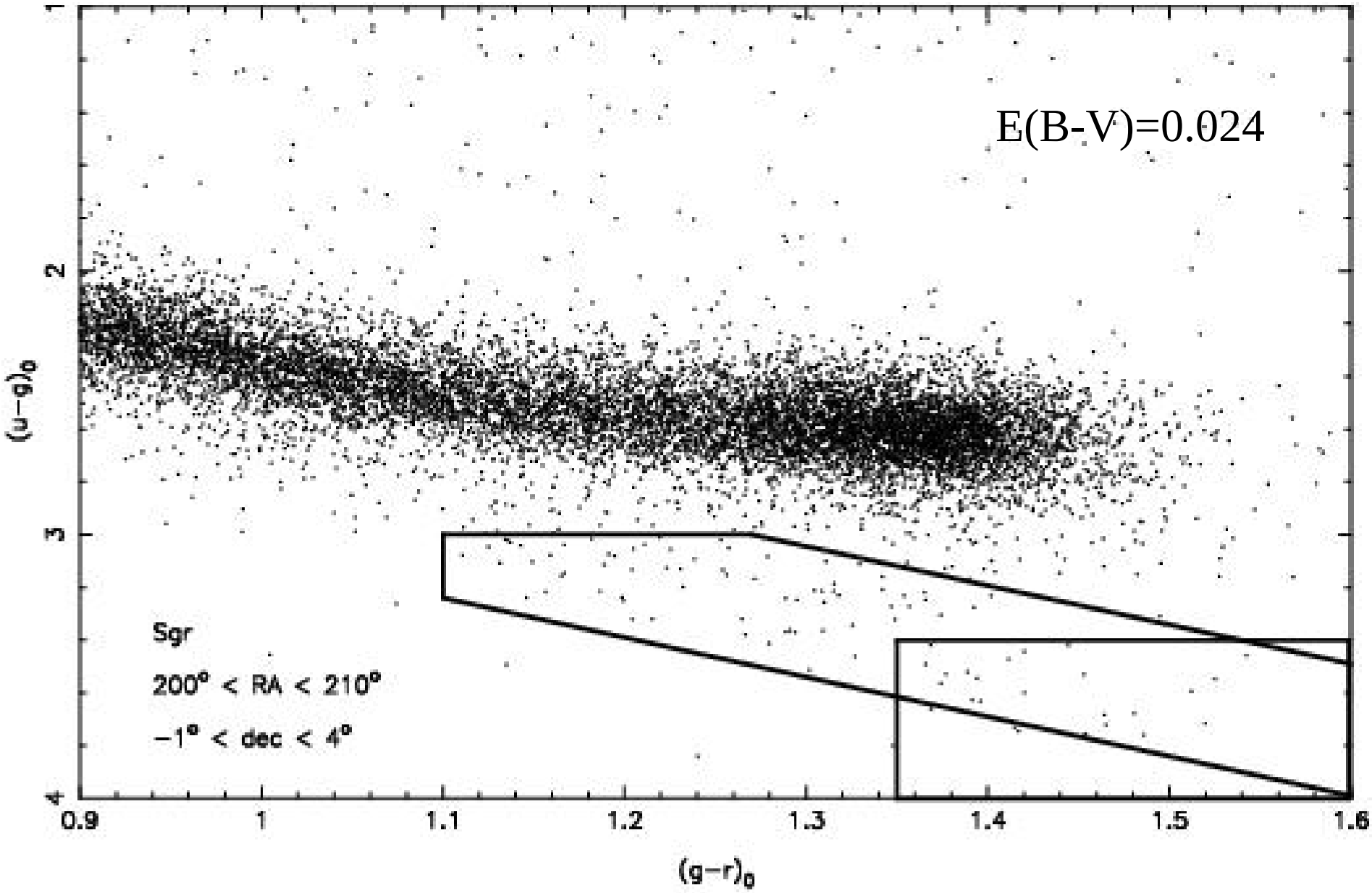
(2) Select a tracer that can be used statistically to measure distance to a structure

(3) Convolve with a presumed color-magnitude distribution

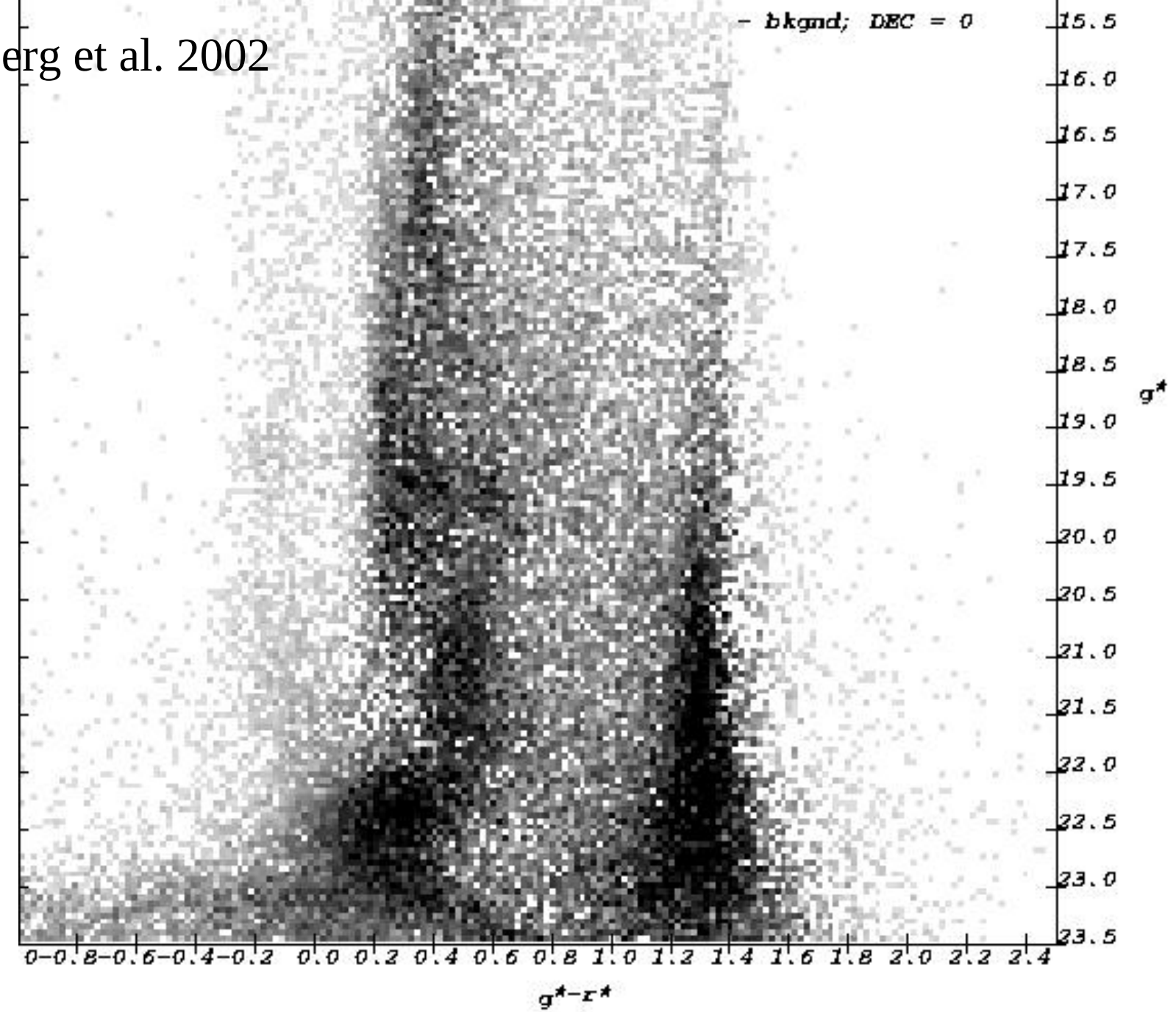


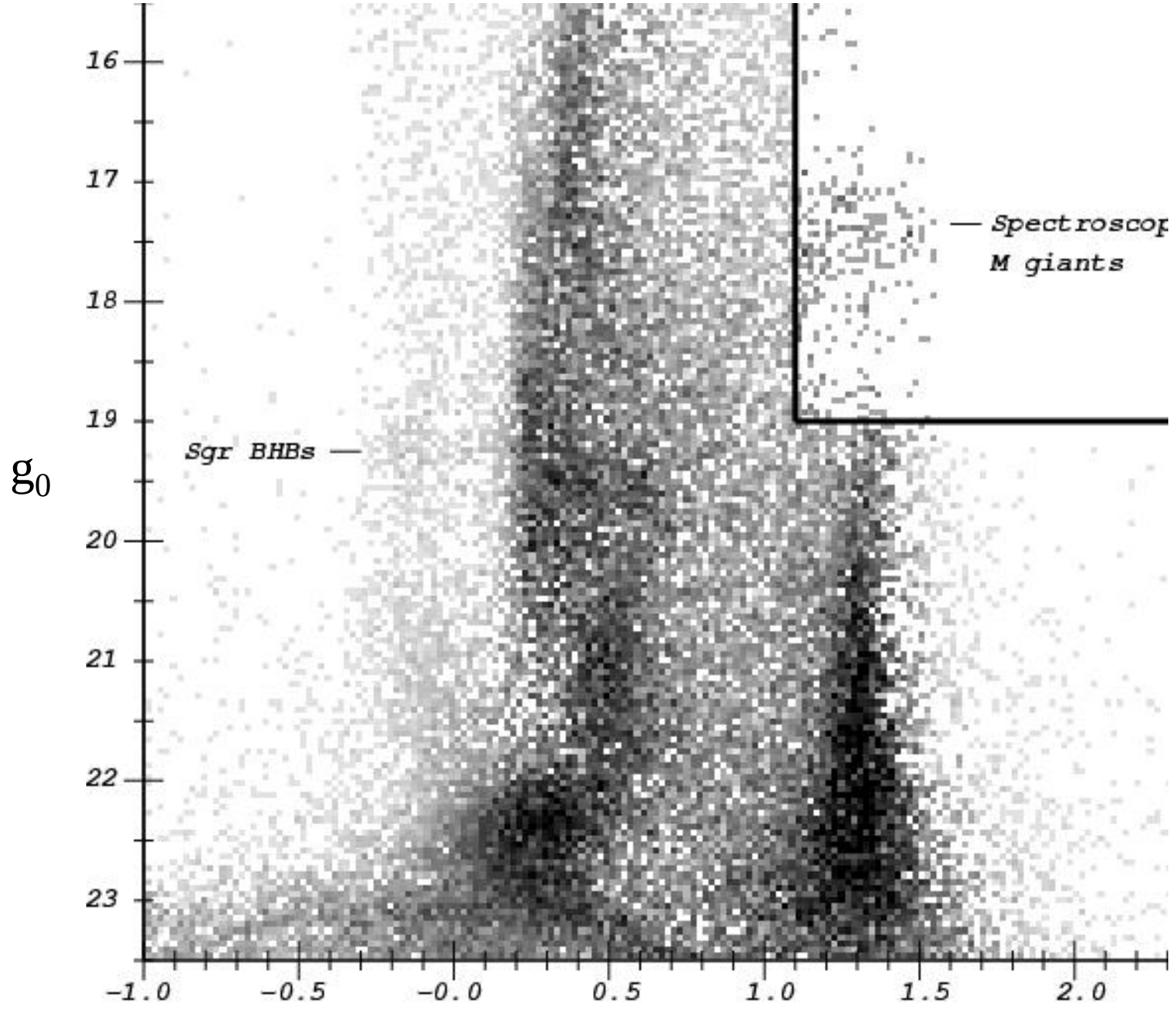
Yanny et al. 2000

Yanny et al., in preparation

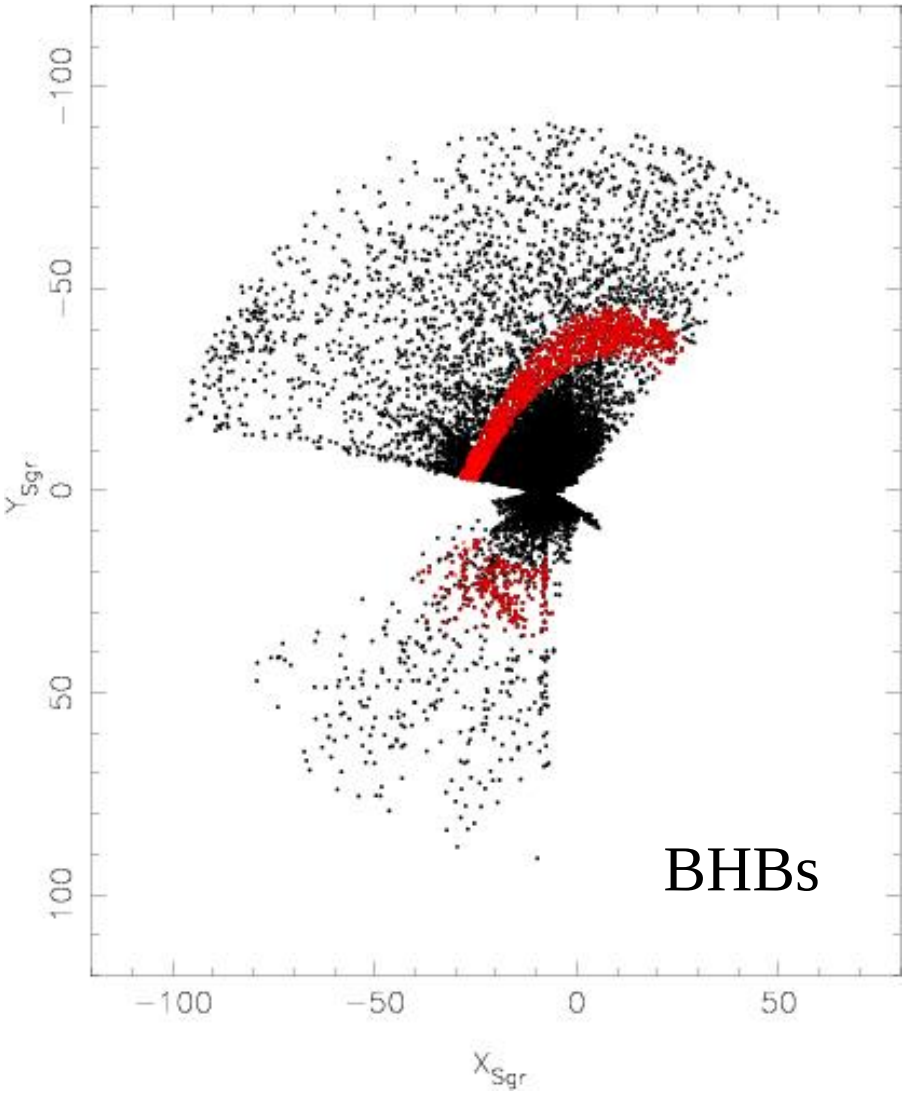


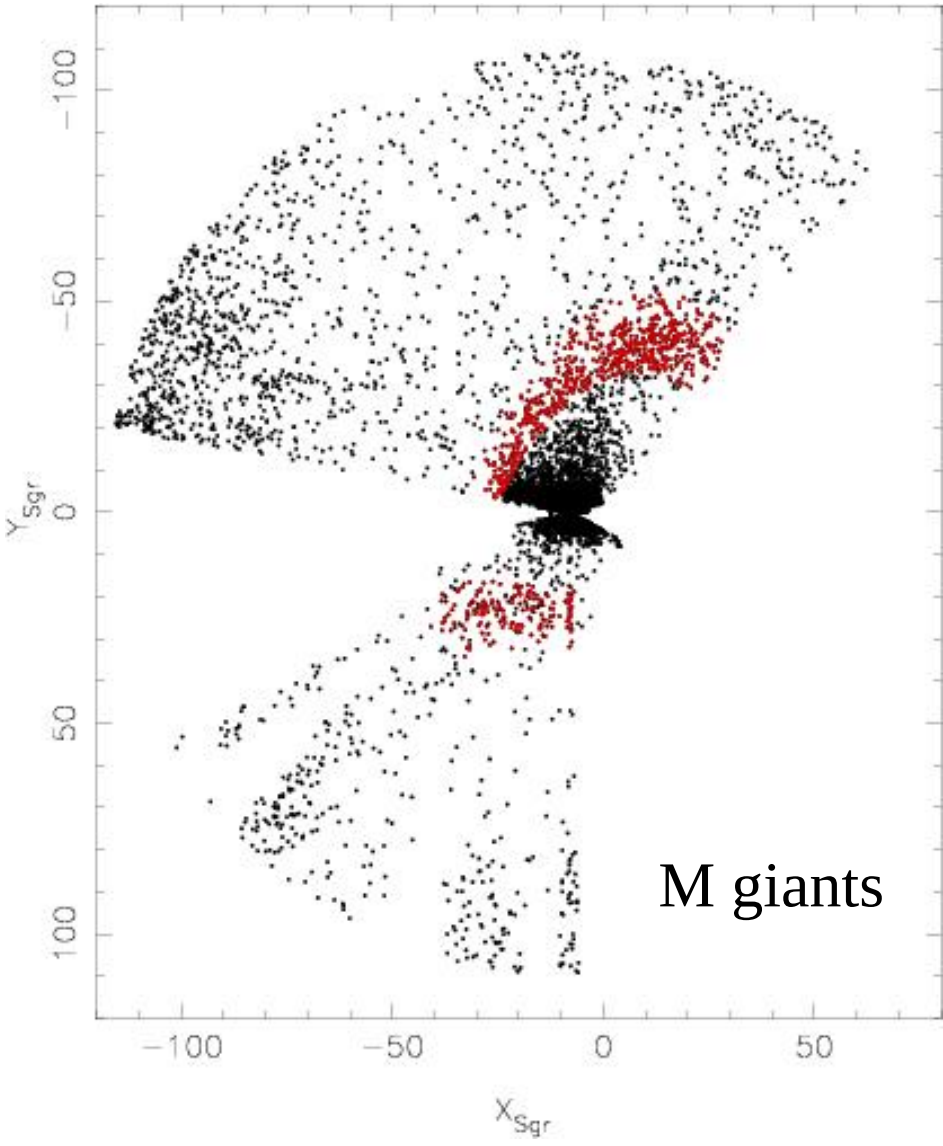
Newberg et al. 2002





Yanny et al., in preparation

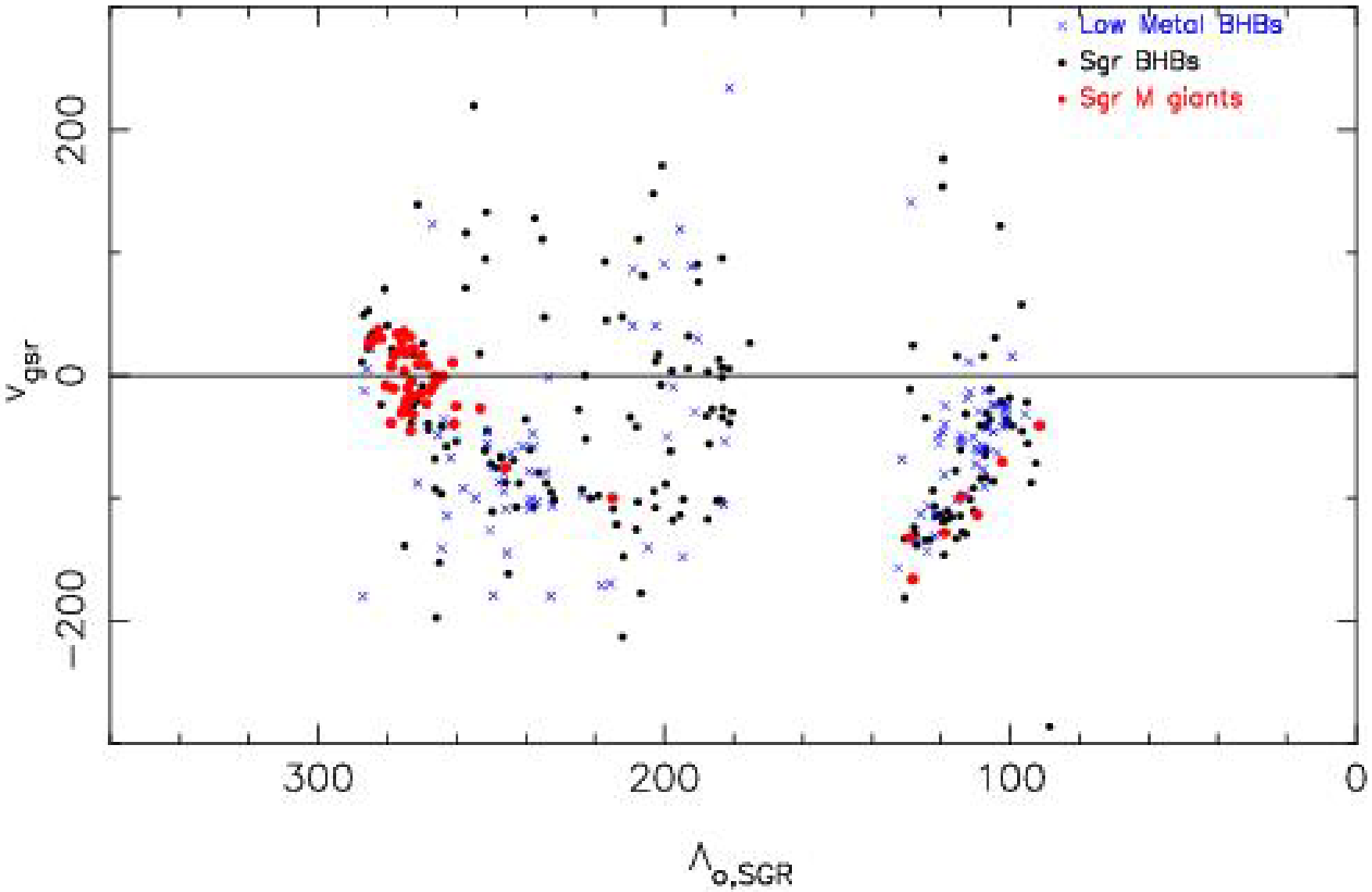




Yanny et al., in preparation

Velocity trend in Sgr tidal stream

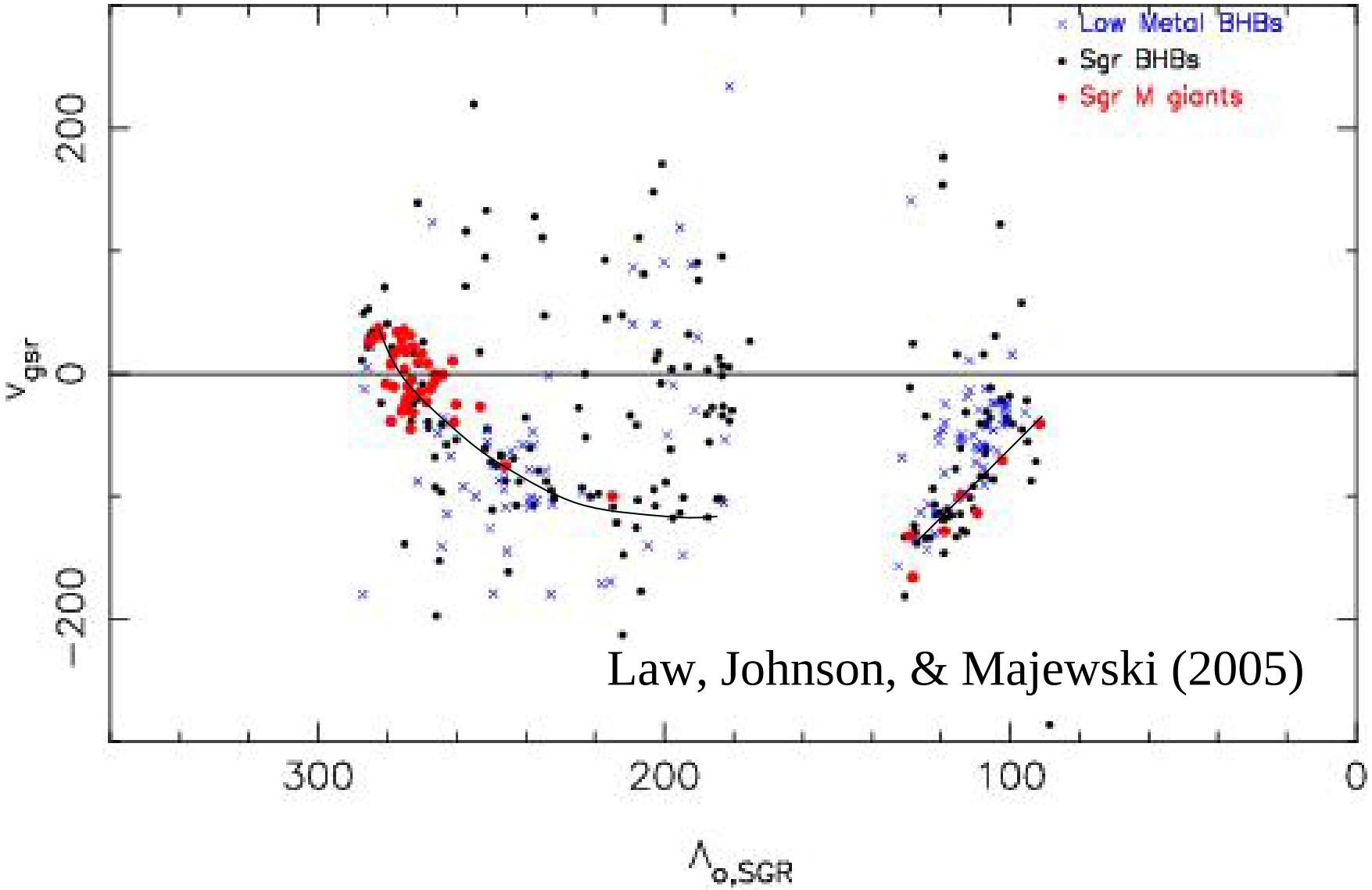
Yanny et al., in preparation



SDSS spectroscopy of stars that are spatially in the Sgr tidal stream.

Velocity trend in Sgr tidal stream

Yanny et al., in preparation

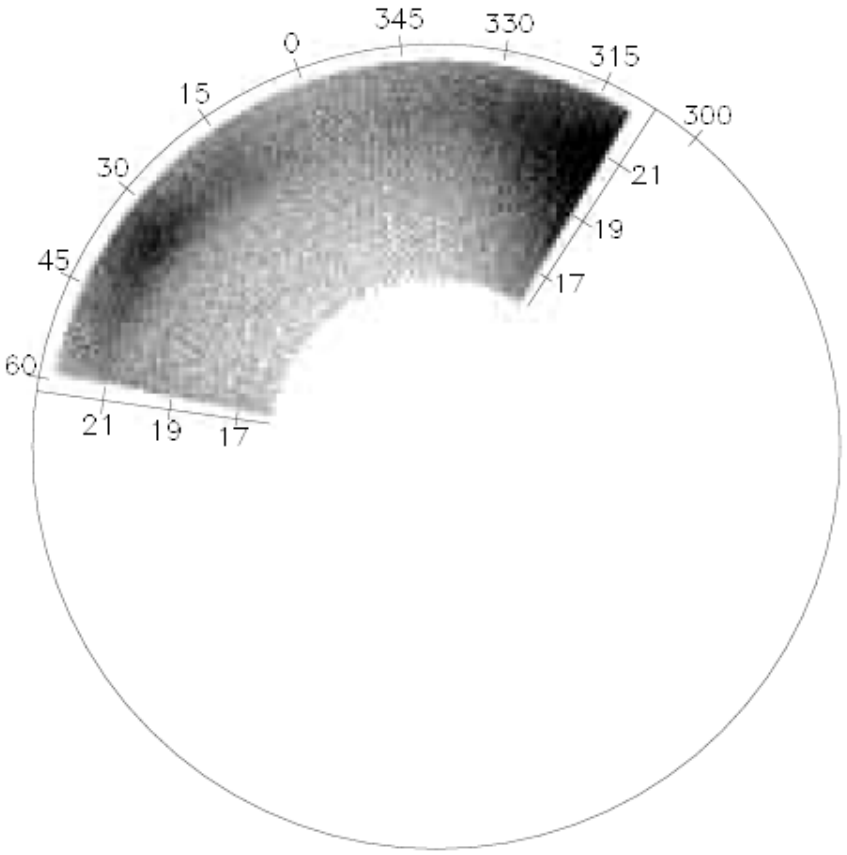


SDSS spectroscopy of stars that are spatially in the Sgr tidal stream.

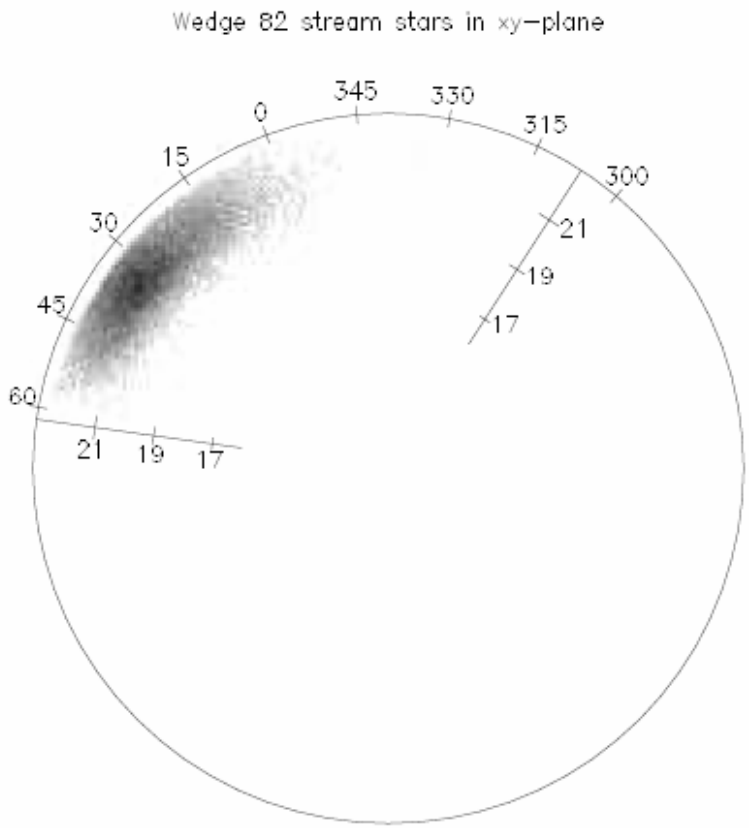
Maximum Likelihood fit to the Sagittarius dwarf

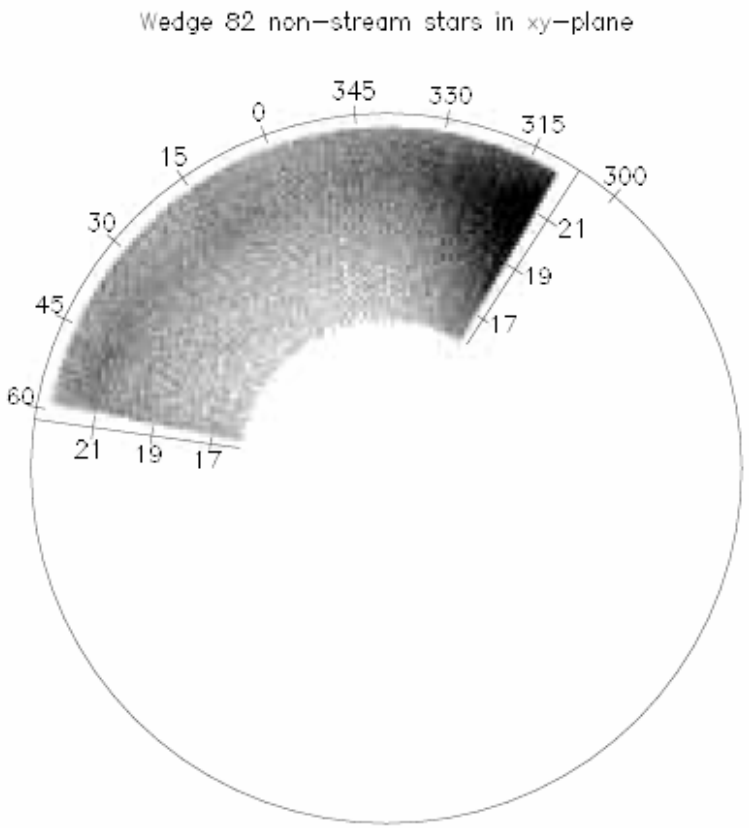
Nate Cole's thesis

- F-turnoff stars
  - $0.1 < (g\text{-}r)_0 < .3$
  - $16 < g_0 < 22.5$
  - $(u\text{-}g)_0 > 0.4$
  - $310^o < ra < 59^o$
  - 115,907 stars
- Gaussian magnitude distribution with std. deviation of 0.6 and median 4.2



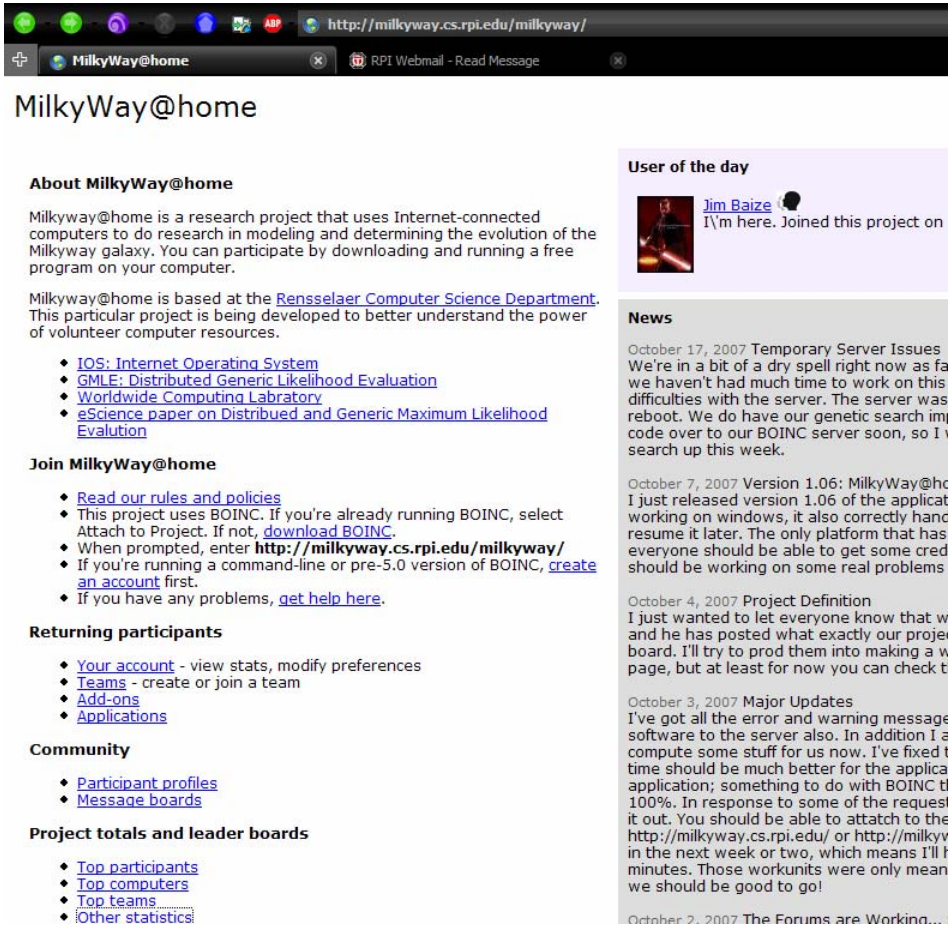
Stripe 82 Separation





Milkyway@home

http://milkyway.cs.rpi.edu



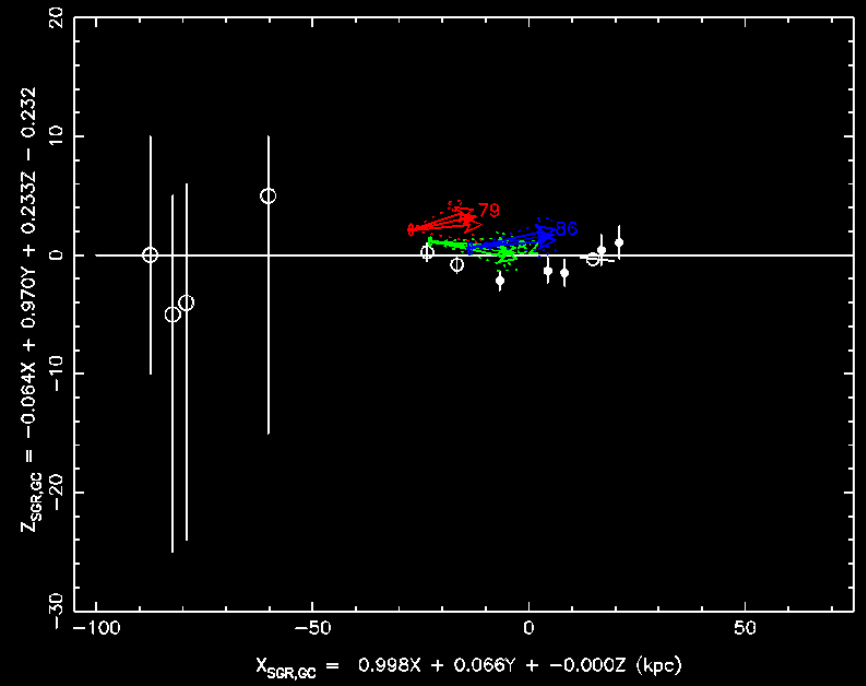
- BOINC
  - Einstein@home, SETI@home, etc
- Donate your idle computer time to help perform our calculations.
- 6322 users; 21,992 CPUs; 594 teams; from 99 countries; distributed 401,728,782 BOINC credits

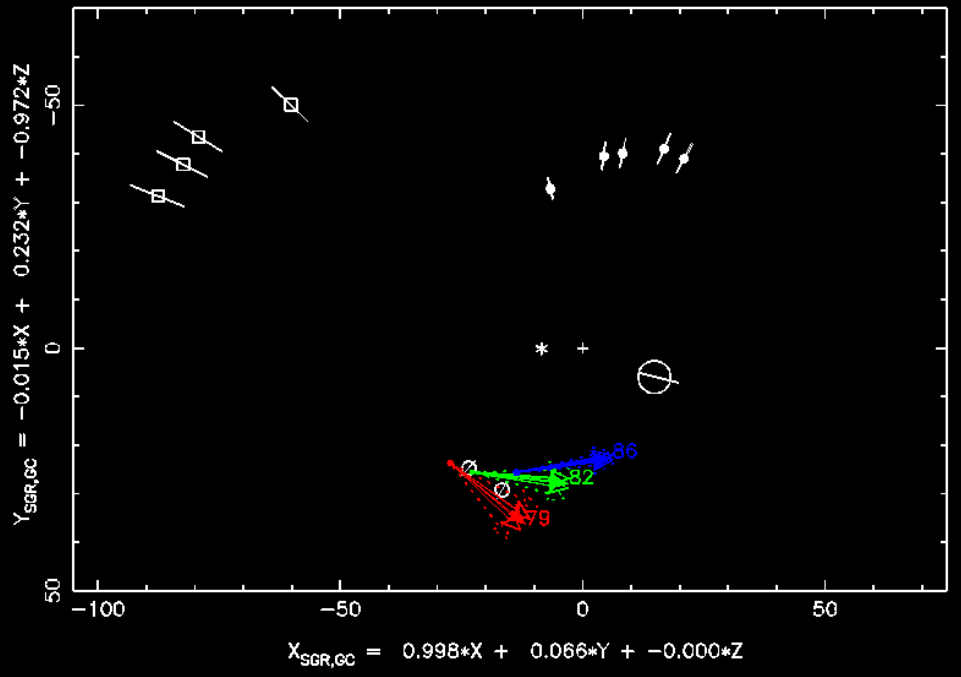
TABLE 1. The results of the fits for SDSS stripe 79 and 86. The results for the debris center, direction, and size are given. The center is presented in Galactic coordinates (l,b,r) with corresponding magnitude (g), direction is presented in Galactic Cartesian unit vector ($\hat{x}$,$\hat{y}$,$\hat{z}$). The results for stripe 82 found in [1] are also given for reference.

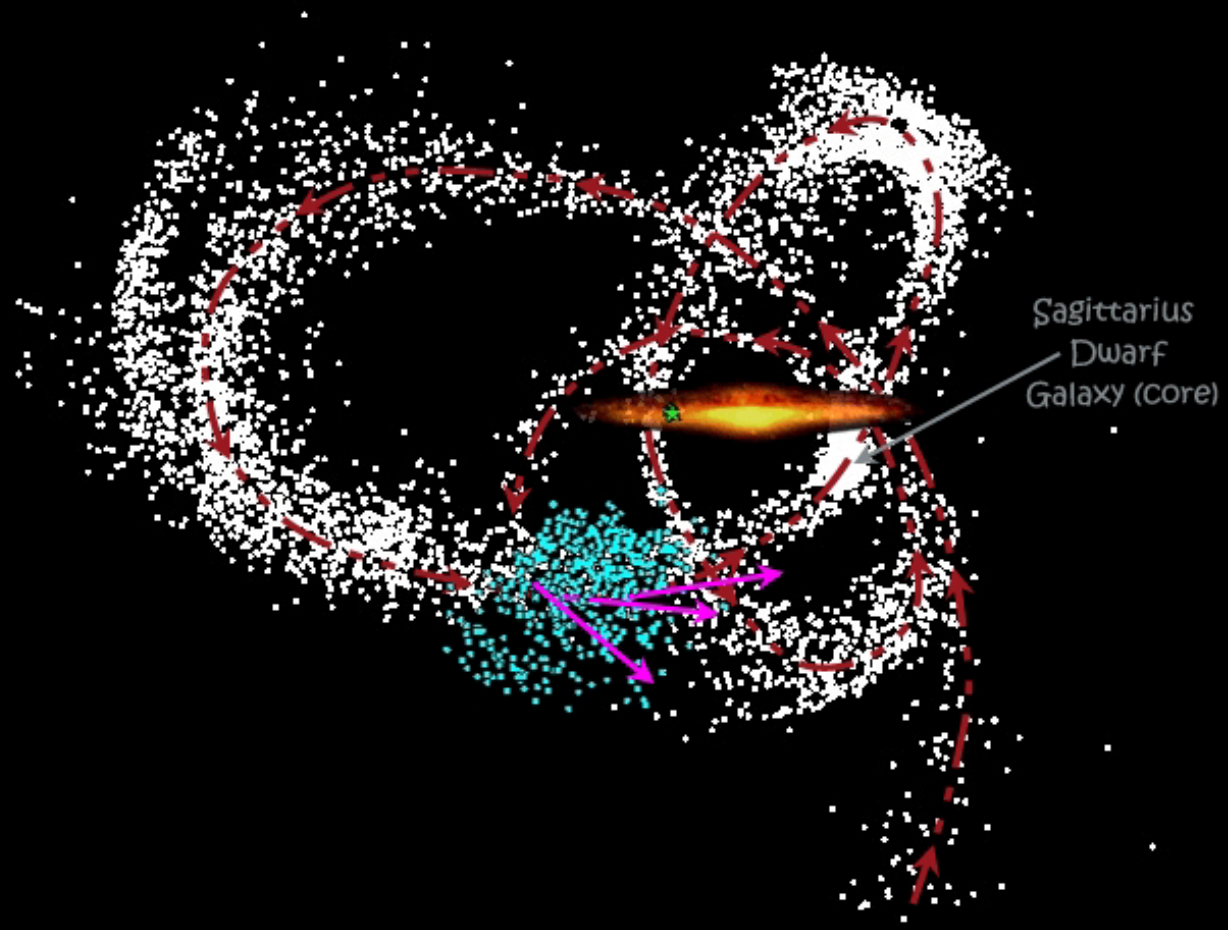
	l (deg)	b (deg)	R* (kpc)	g	$\hat{x}$ (kpc)	$\hat{y}$ (kpc)	$\hat{z}$ (kpc)	FWHM (kpc)	# stars
Stripe 79	163.311	-48.400	30.23	21.60	0.758	0.254	-0.600	6.53	9,500
Stripe 82	159.223	-57.558	29.22	21.53	0.991	0.042	-0.127	6.74	16,000
Stripe 86	134.775	-72.342	26.08	21.28	0.982	0.945	0.167	5.71	16,700

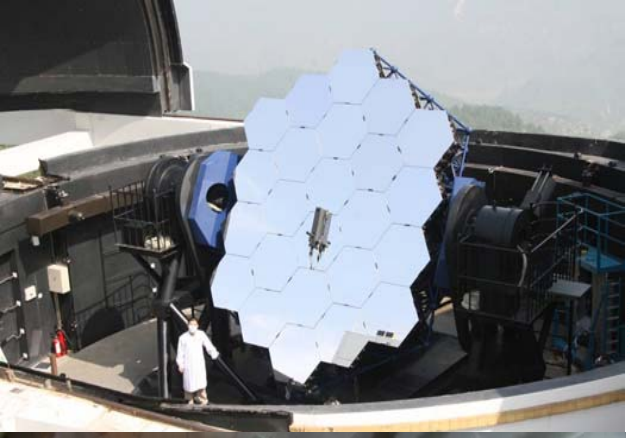
* Assuming $M_g = 4.2$

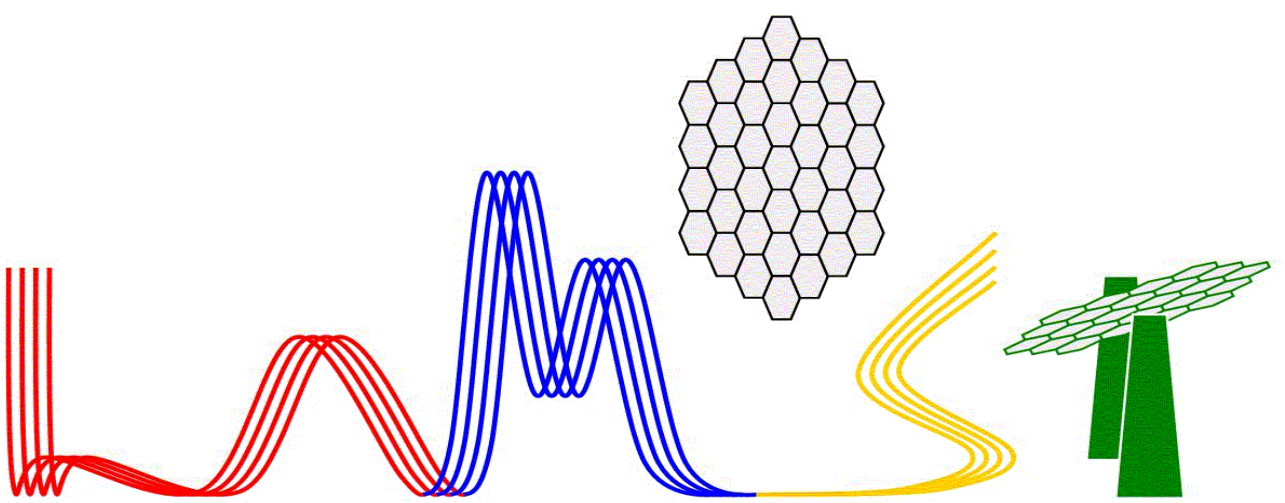
1,800,000 F turnoff stars in the surviving Sgr dwarf






Sagittarius
Dwarf
Galaxy (core)





4 meter telescope
4000 fiber spectrograph

Operations in 2009/2010

2

www.astronomy.com

Xinglong Observing Station, 3hr north of Beijing

LAMOST facts

Aperture: ~4 m
Type: Schmidt, Alt-Az
Focal length: 20m
Relative aperture: f/5
Field of view: 5 degree diameter
Size of focal plane: 1.75 m
Sky coverage: Dec>-10 degrees, 1.5 hours around meridian
Wavelength range: 370 nm to 900 nm, R=1000/2000
Number of fibers: 4000, 16 spectrographs with 250 fibers each
>10,000 spectra per night, 2-3 gigabytes/night

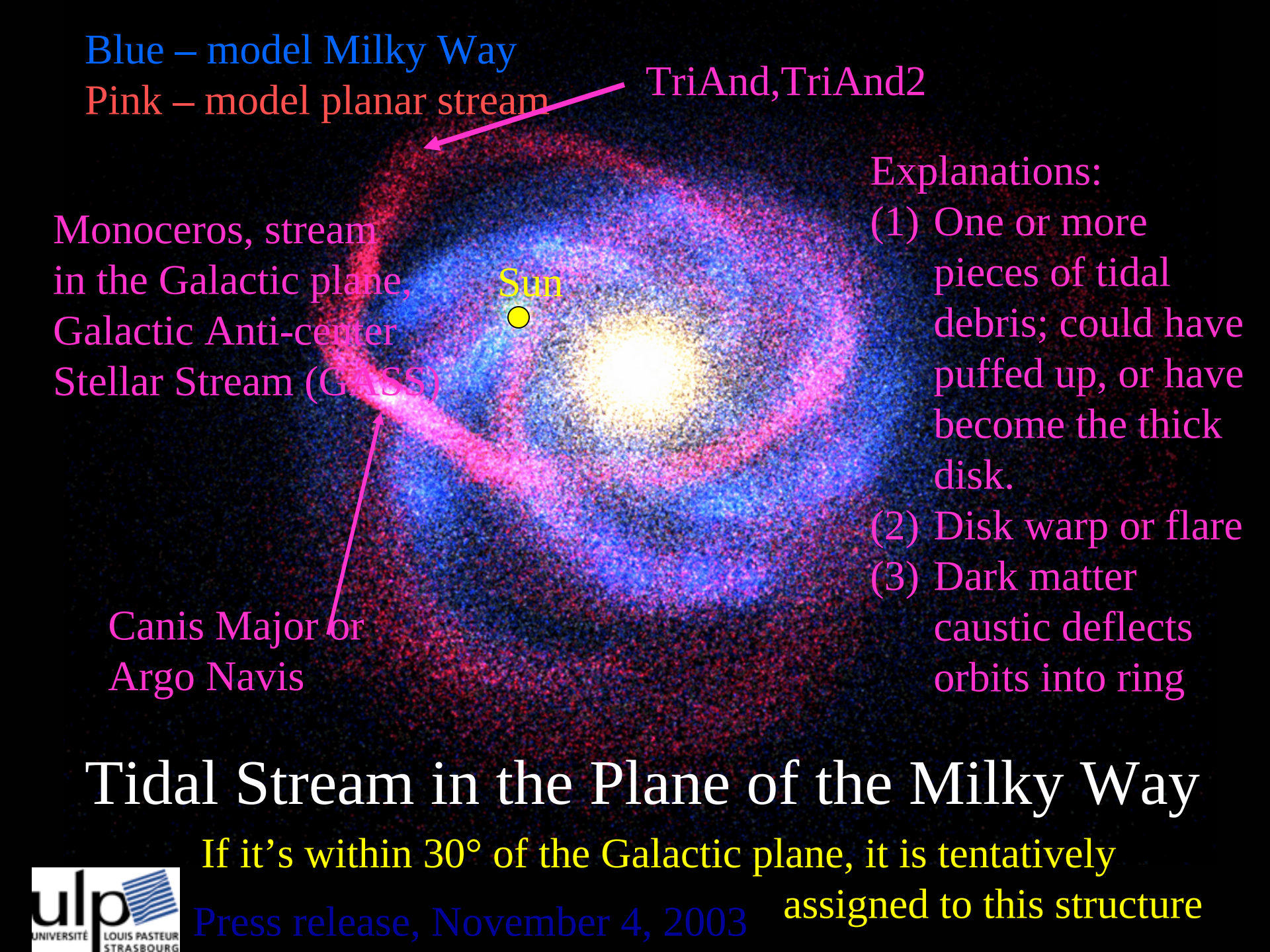
GAIA Astrometric Satellite

Magnitude limit: 20
1 billion Galactic stars
Astrometry and radial velocities
2011-2020

Will only get radial velocities for stars brighter than 17th magnitude!

With LAMOST, radial velocities can be obtained for the most interesting magnitude range of 17<V<20

Other large spectroscopic surveys of stars include RAVE (brighter), SDSS III/ SEGUE II (250,000 stars), and WFMOS (in planning stages).

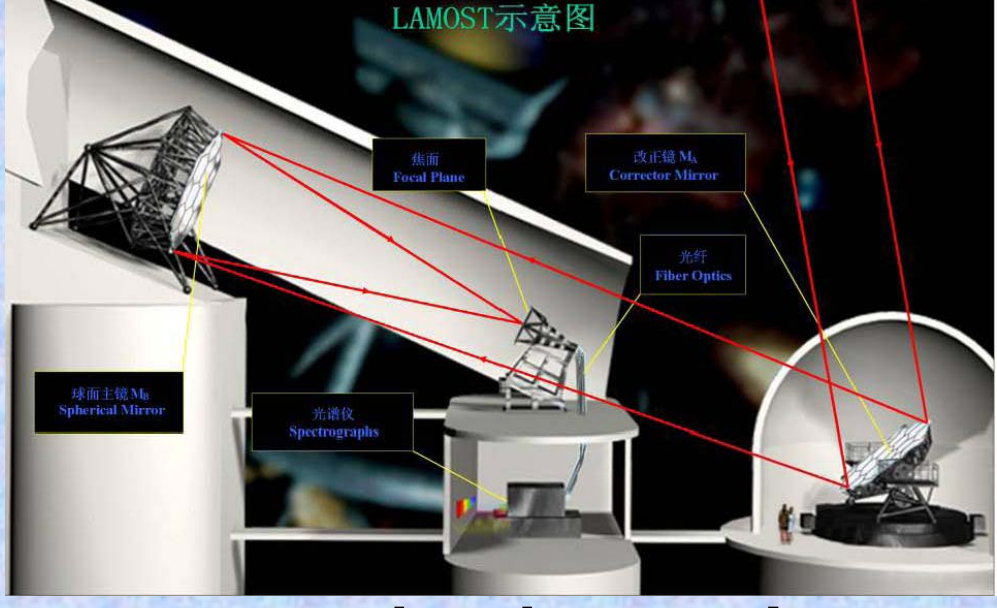


Tidal Stream in the Plane of the Milky Way

If it's within 30° of the Galactic plane, it is tentatively assigned to this structure

Press release, November 4, 2003

Optical System



M_A is the Schmidt corrector, 5.72m x 4.40m, with 24 hexagonal plane sub-mirrors, each with 1.1m diagonal and 2.5 cm thickness.

M_B is the spherical primary, 6.67m x 6.05m, with a radius of curvature of 40m, 37 hexagonal spherical sub-mirrors, each with 1.1m diagonal and 7.4 cm thickness.

Active control for aspheric shape of corrector (34 force actuators plus 3 mount points per submirror). Optimal shape changes with declination and hour angle.

Active control for M_B is just 3 mount points plus three actuators per submirror.

Optical axis is 25° from horizontal.

The focal plane has a radius of curvature of 20m.

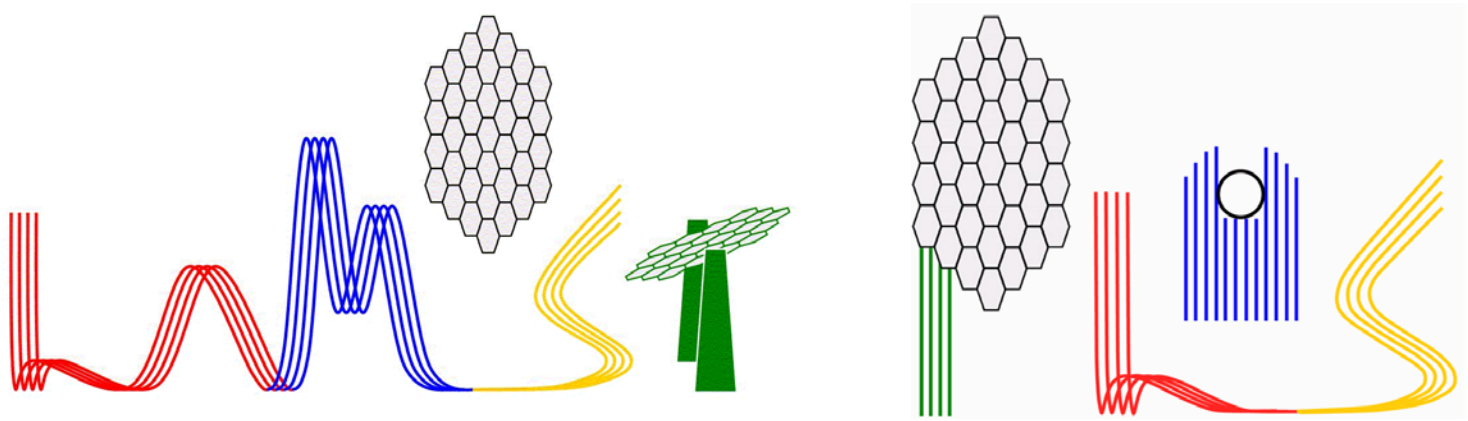

The LAMOST telescope, July 2007

The Promise of LAMOST

4000 fibers, 4 meter telescope, first light expected December 8, 2008. R=1000/2000, maybe 5000/10,000 gratings in the future.

Two million spectra per year.

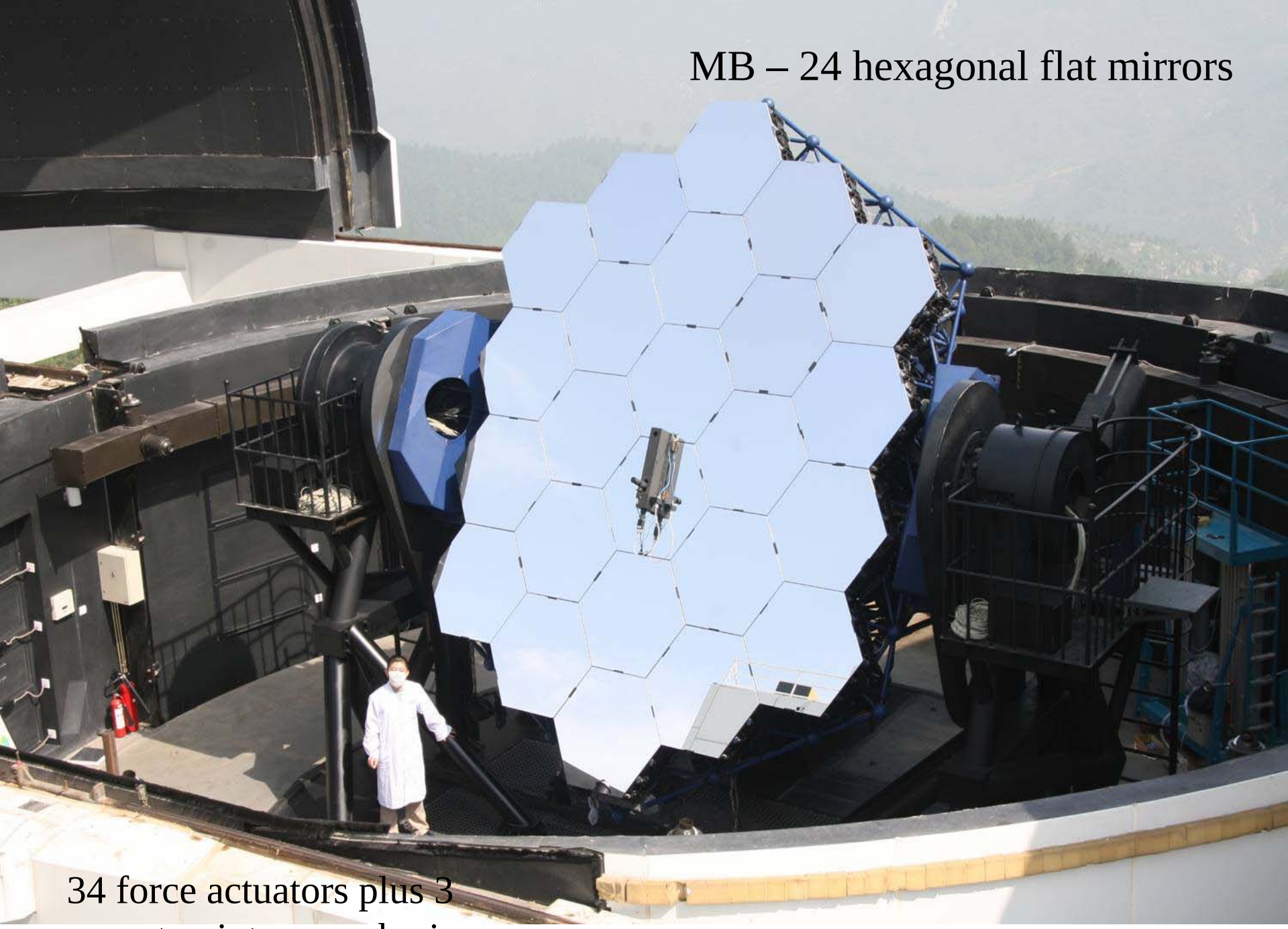
Because I believe that LAMOST has the best potential for unraveling the formation history and dark matter potential of the Milky Way galaxy, I will travel 12 time zones more than 8 times in two years, have committed my sabbatical this year to LAMOST survey planning and design, and started learning Chinese.

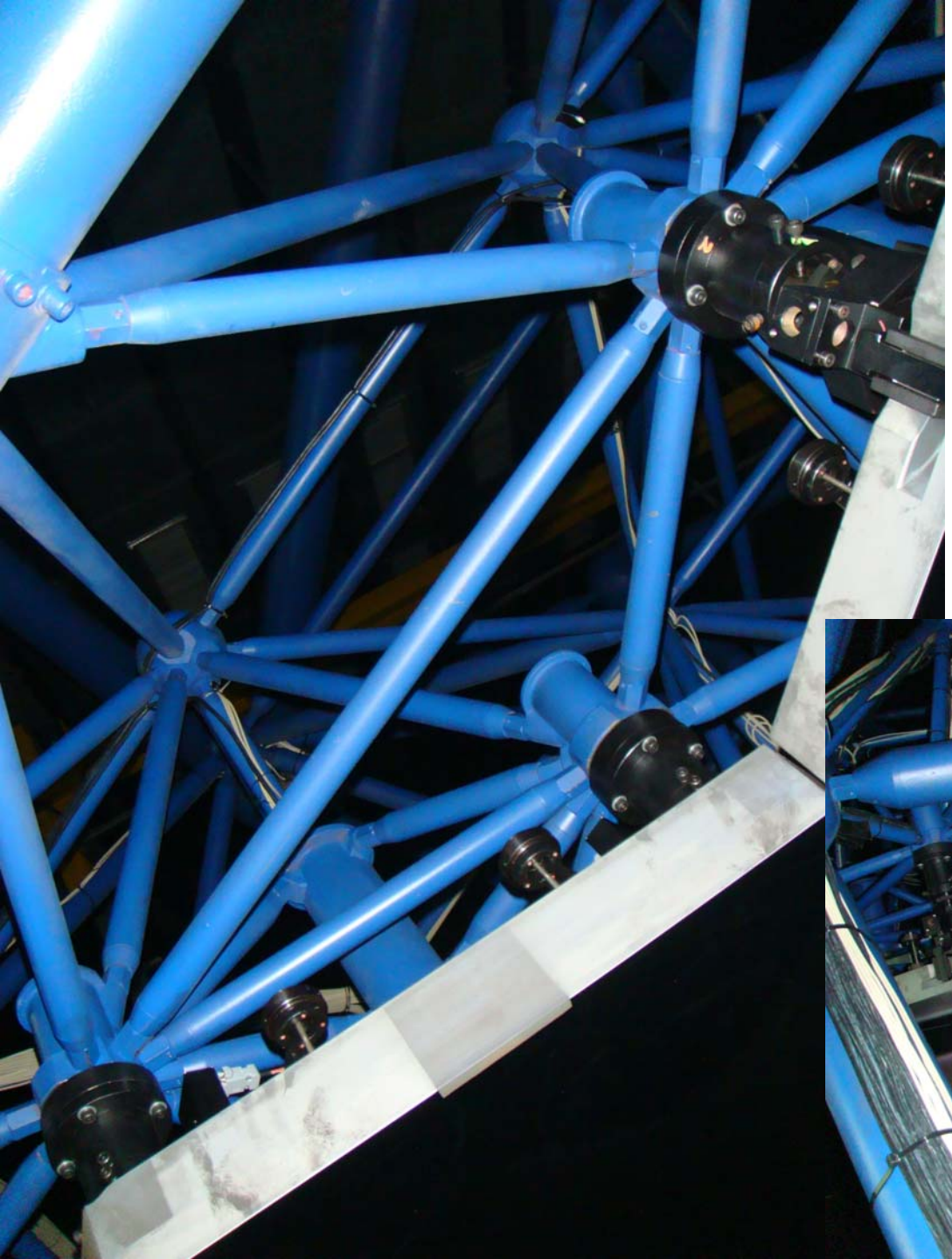


Participants in LAMOST, US (PLUS)

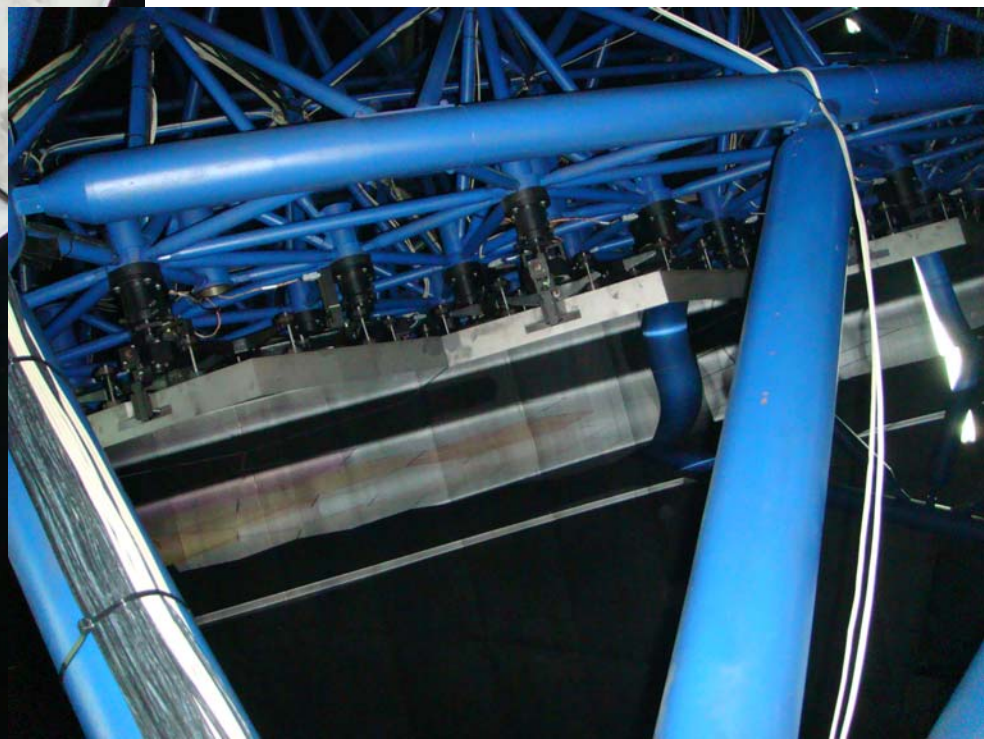
Heidi Newberg (Rensselaer), Timothy Beers (Michigan State), Xiaohui Fan (Arizona), Carl Grillmair (IPAC), Raja Guhathakurta (Santa Cruz), Sebastien Lepine (AMNH), Jeff Munn (USNO), Brian O'Shea (MSU), Jordan Raddick (education, Johns Hopkins), Jerry Sellwood (Rutgers), Jason Tumlinson (STSci), Beth Willman (CfA), Rosie Wyse (JHU), Brian Yanny (FNAL), and Zheng Zheng (IAS).

The collaborating group of Chinese astronomers, under the leadership of Licai Deng(NAOC), includes: Yuqin Chen, Jingyao Hu, Huoming Shi, Yan Xu, Haotong Zhang, Gang Zhao, Xu Zhou (NAOC); Zhanwen Han, Shengbang Qian (Yunnan, NAOC); Yaoquan Chu (USTC); Li Chen, Jinliang Hou (SHAO); Xiaowei Liu, Huawei Zhang (PKU); and Biwei Jiang (BNU).


MB – 24 hexagonal flat mirrors
34 force actuators plus 3 mount points per submirror

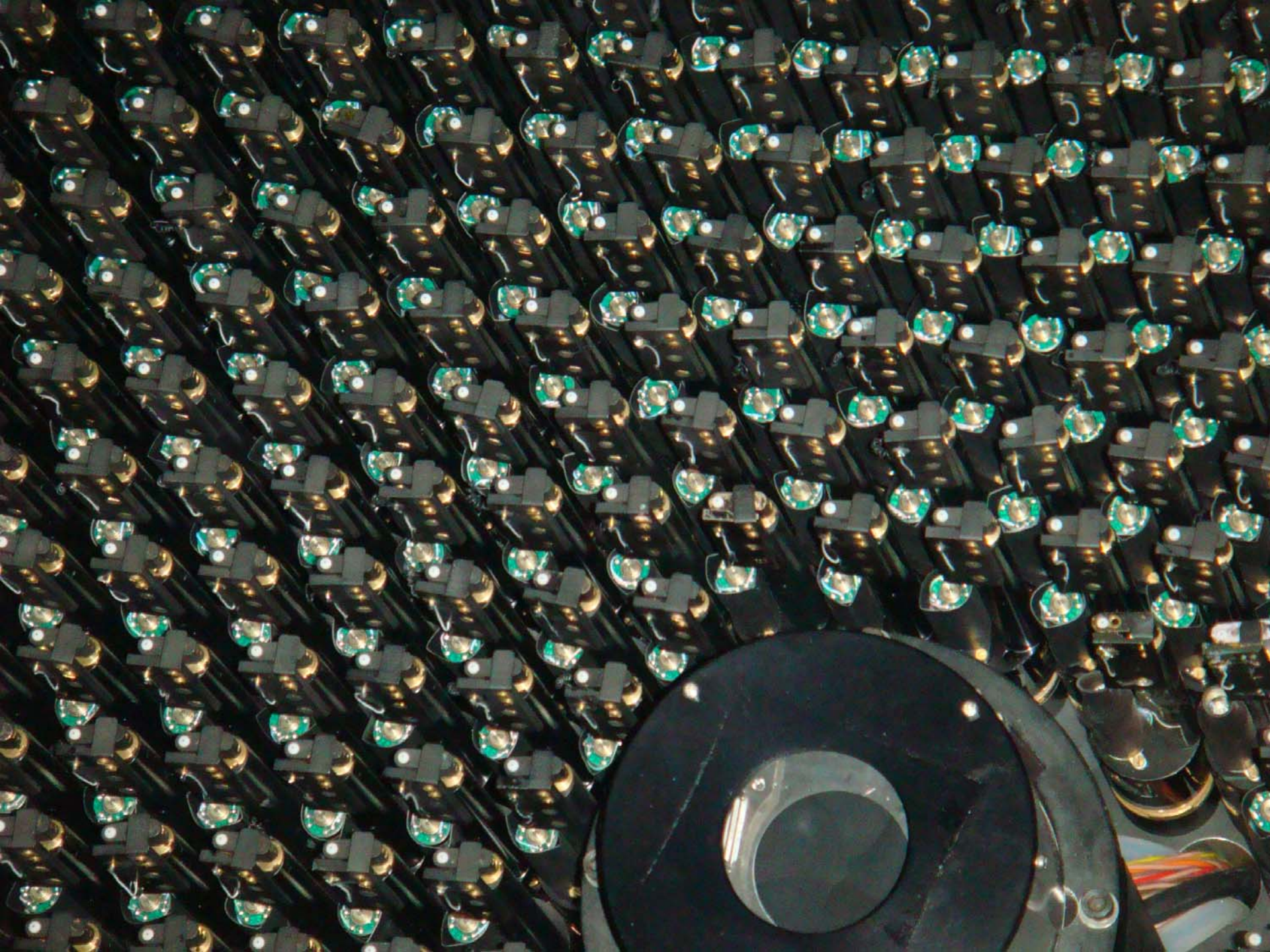


Downward facing spherical primary, 6.67m x 6.05m, 37 hexagonal spherical sub-mirrors, 3 mount points and three actuators per sub-mirror



The telescope tube is concrete on the outside, aluminum on the inside, and between is an extensive temperature control system.

The field of view is 5 degrees diamter. Atmospheric refraction can move an object up to 1.7” during an observation.



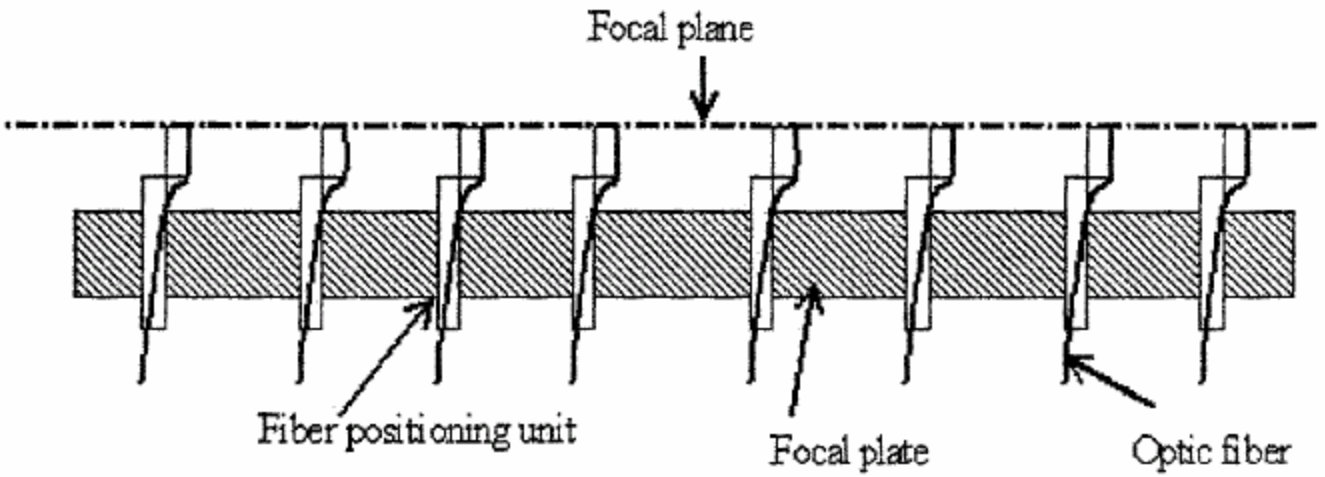
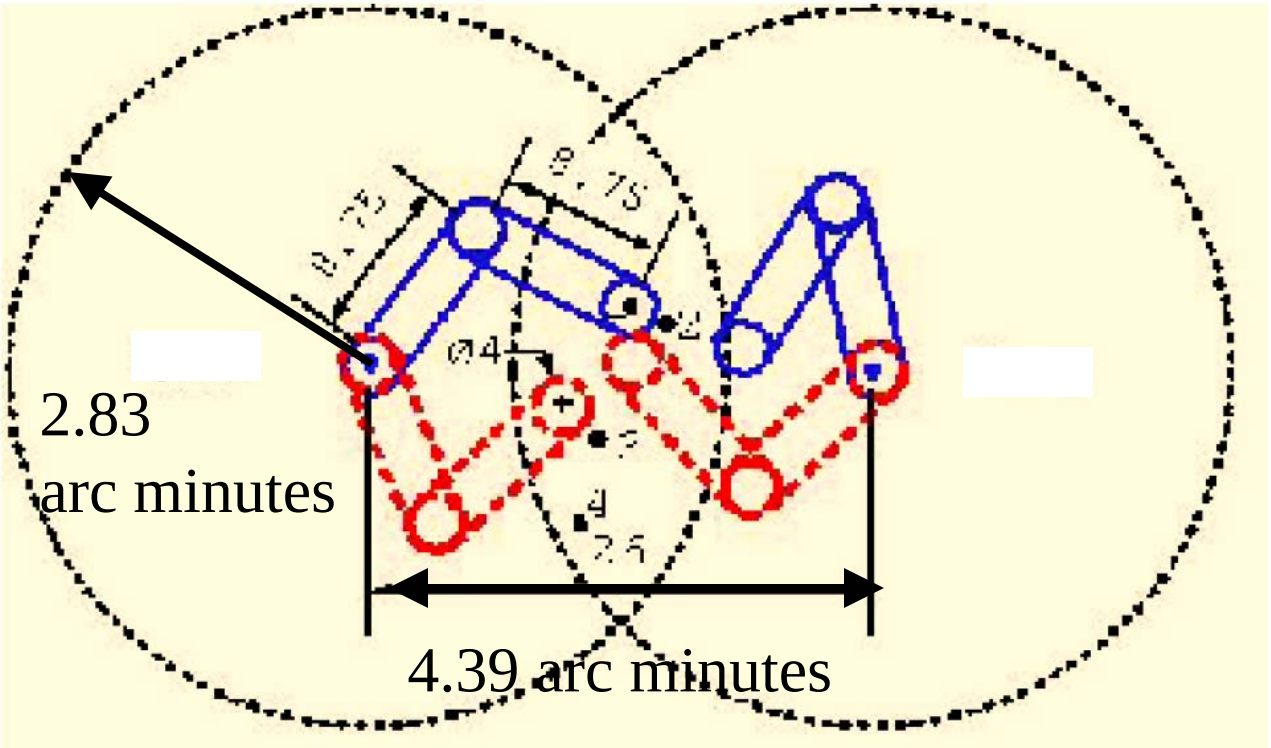
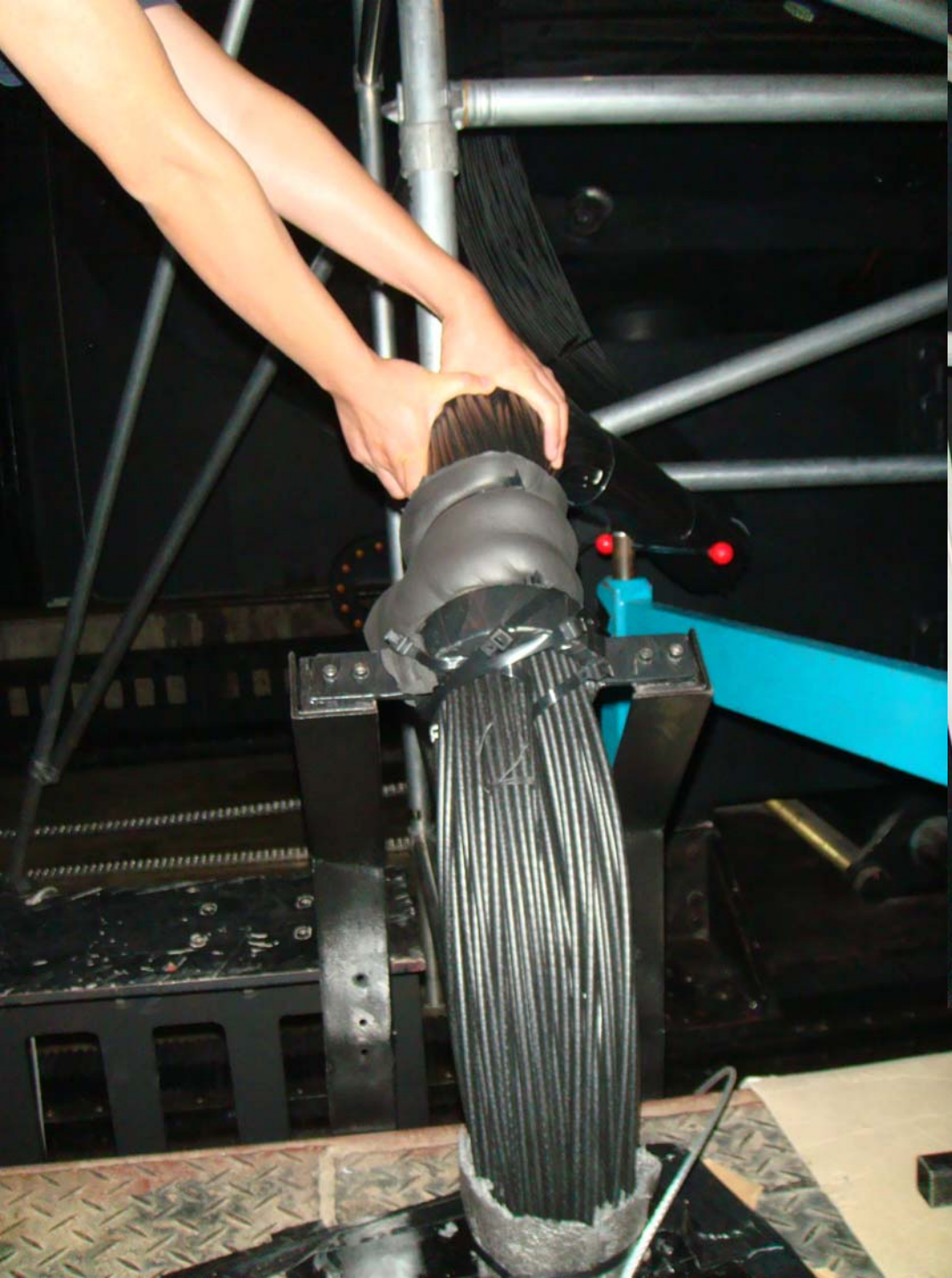


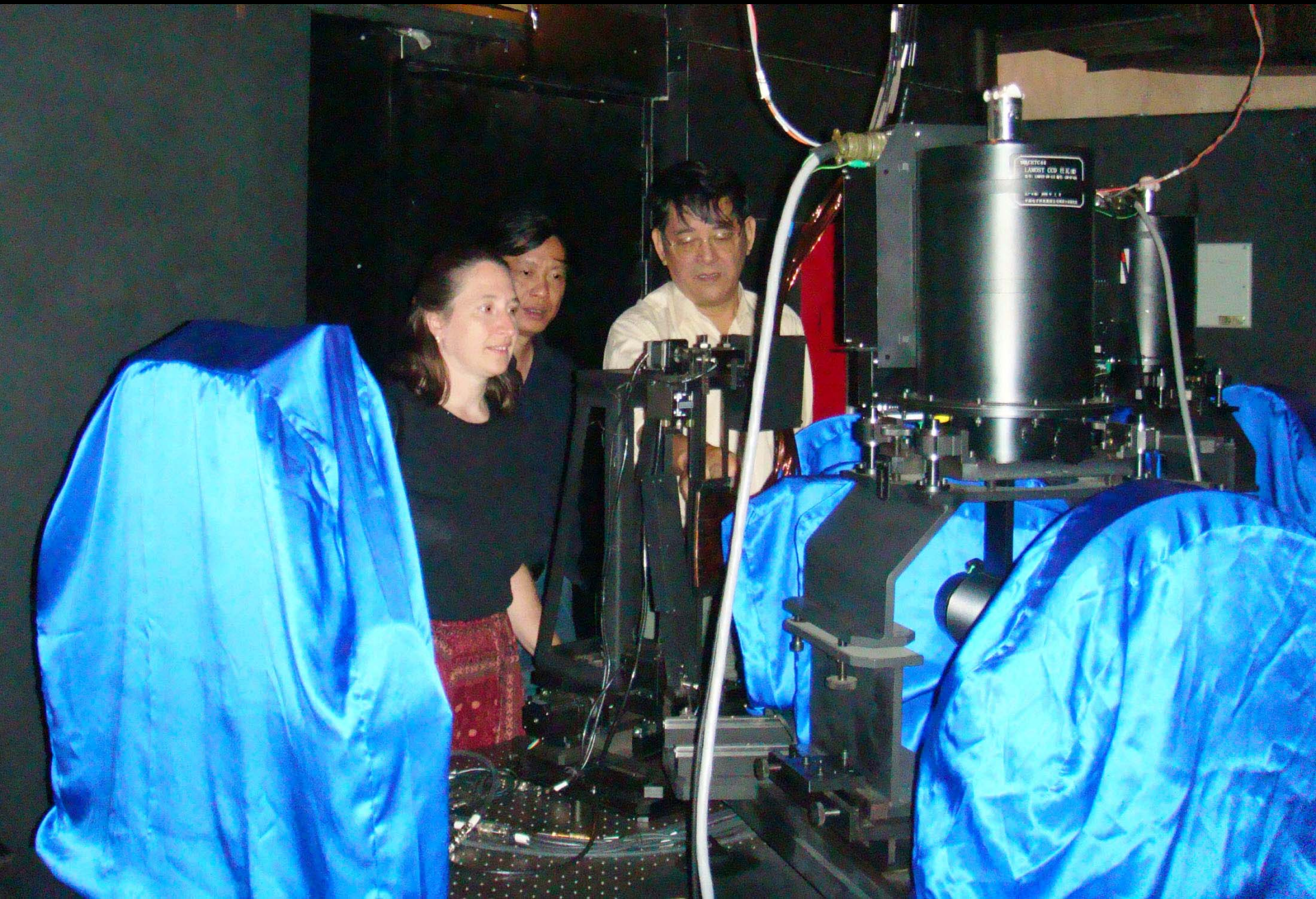
Fig. 4 Fiber positioning units mounted on focal plate

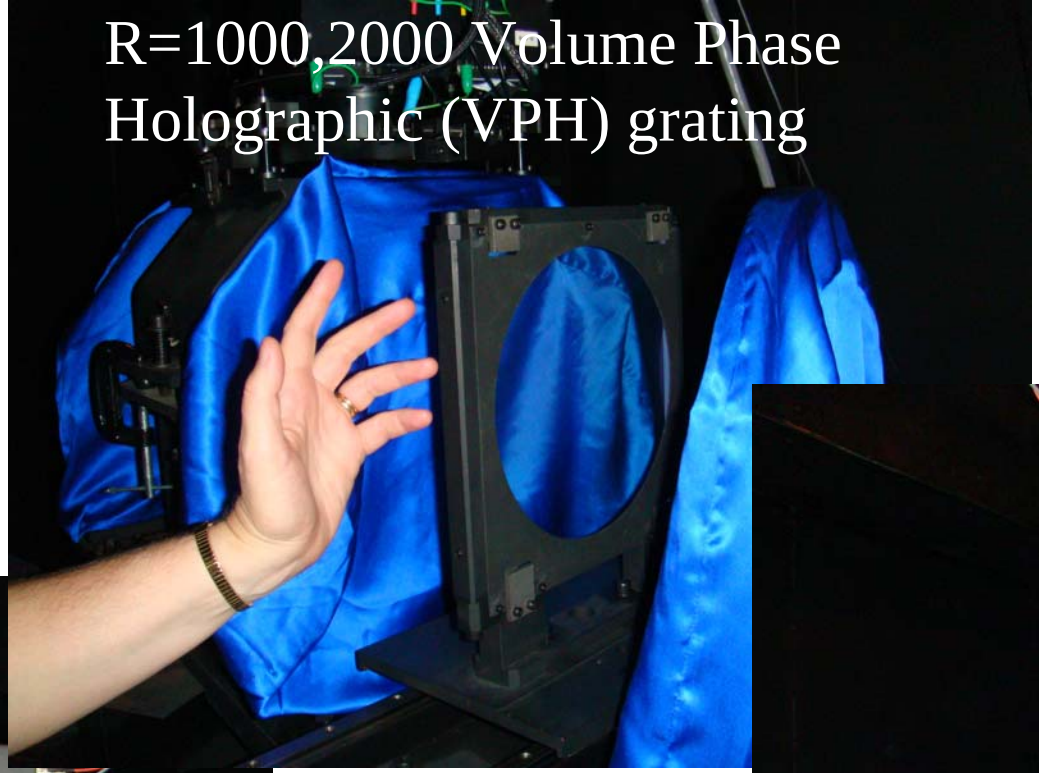




4000 fibers going from the focal plane to the spectrograph rooms below.

16 double spectrographs, 250 fibers each, 8 per floor.

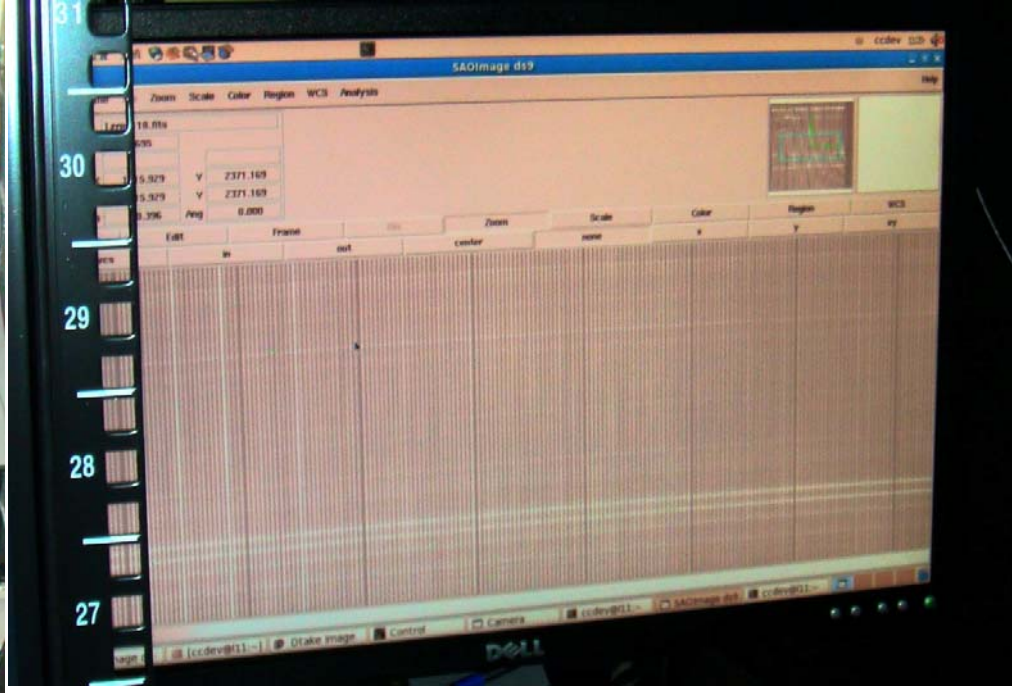




R=1000,2000 Volume Phase Holographic (VPH) grating

250 fibers

Two CCDs per spectrograph


SAOImage ds9
Zoom
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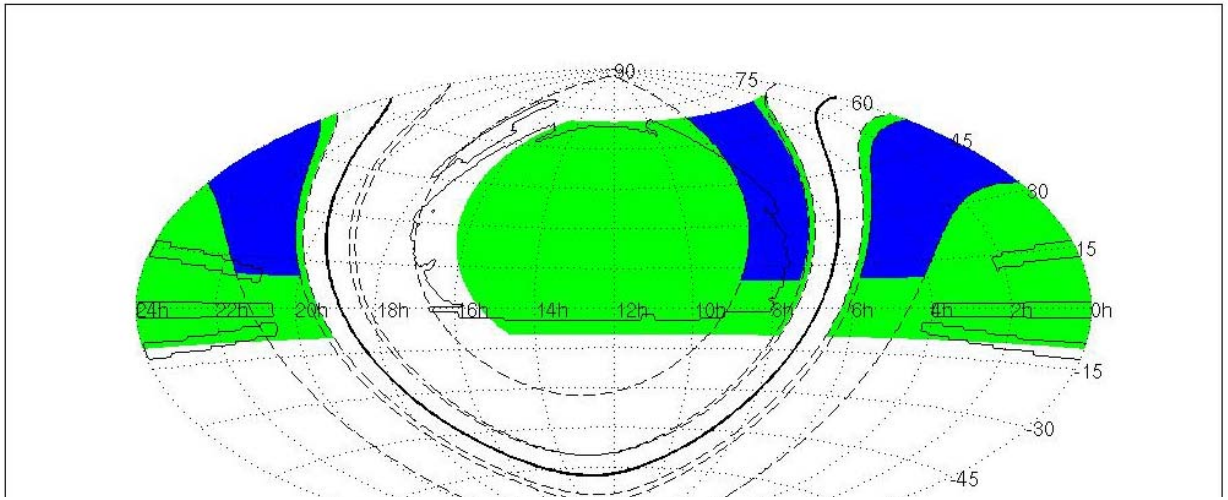
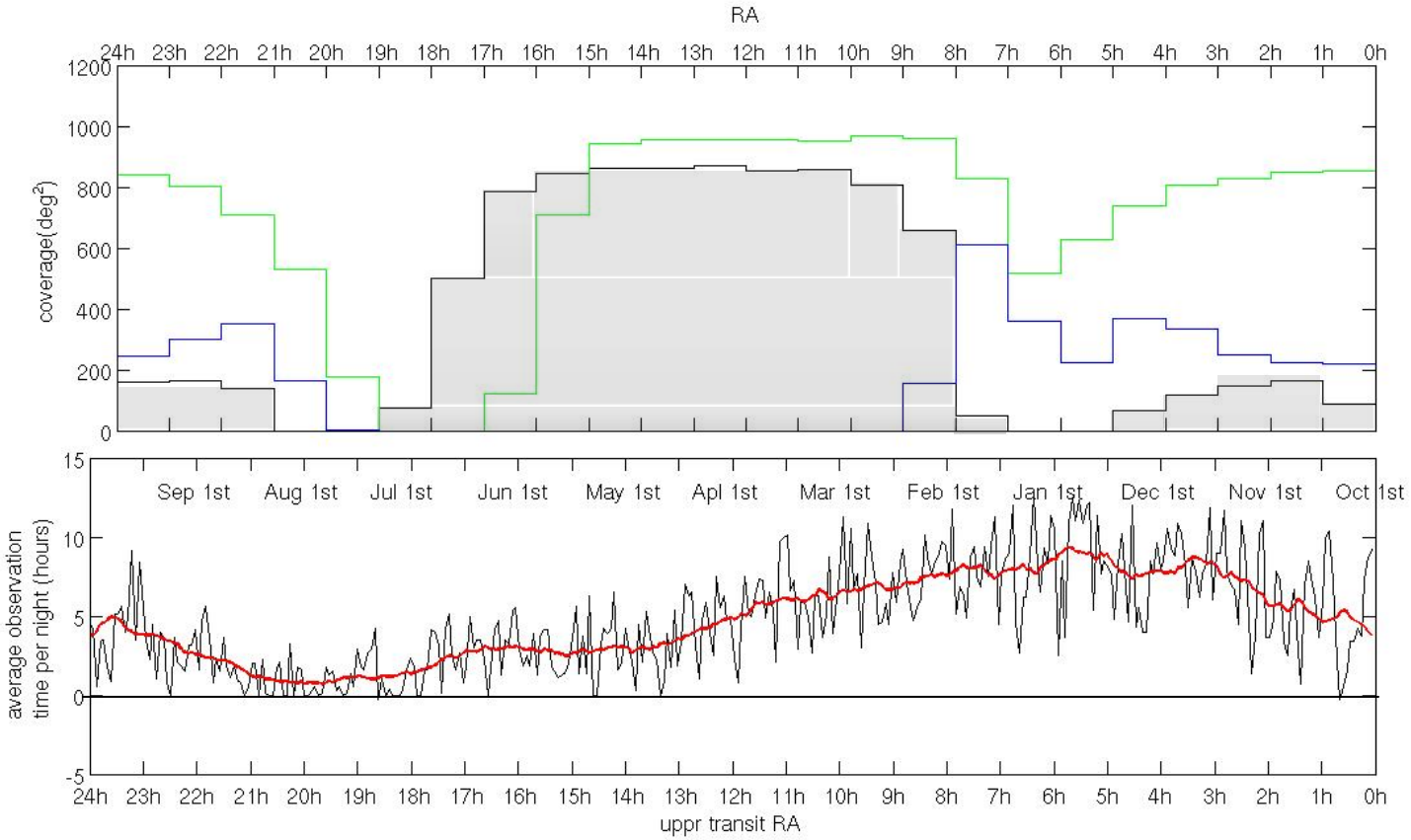
DELL

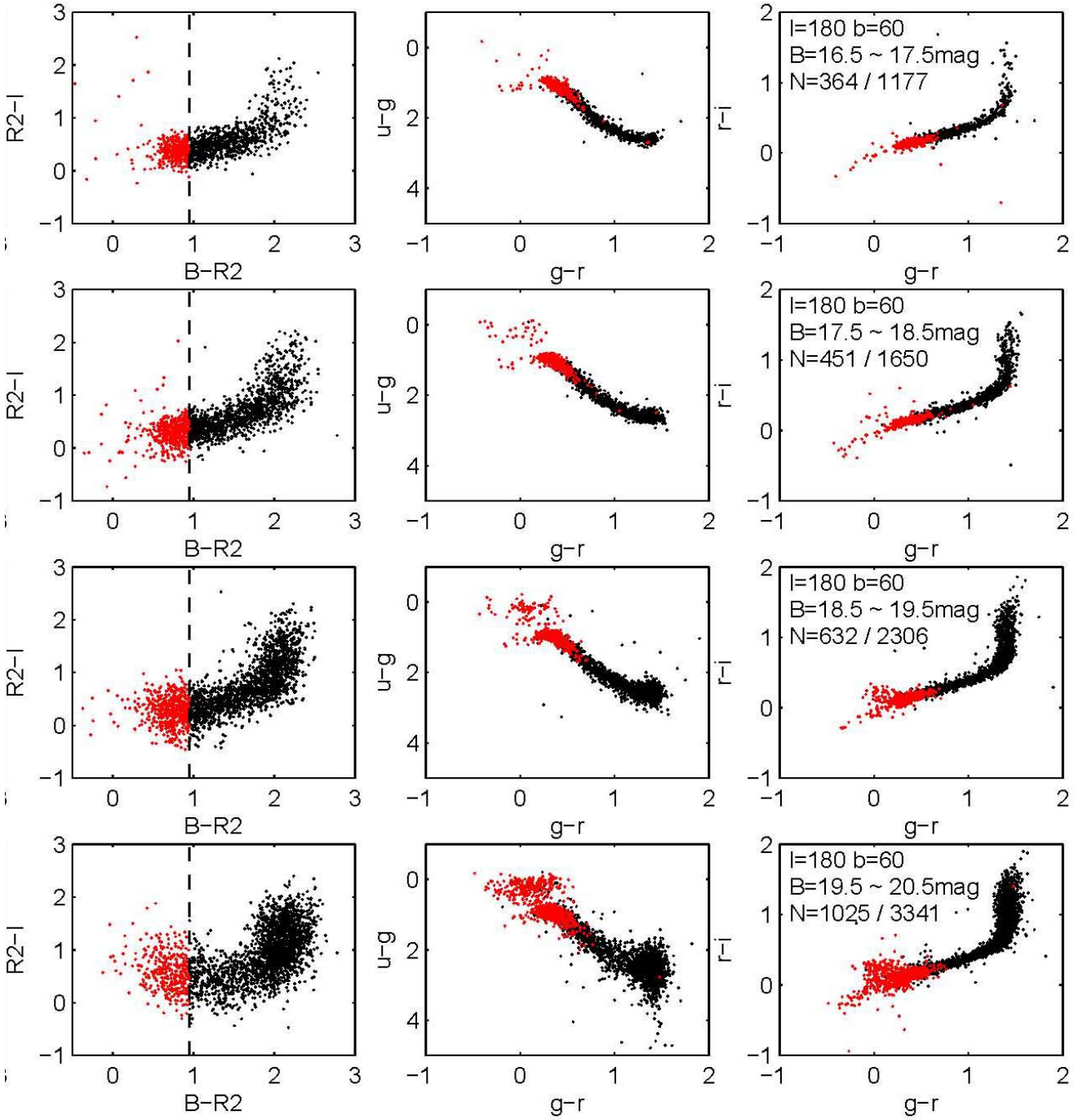

MPC



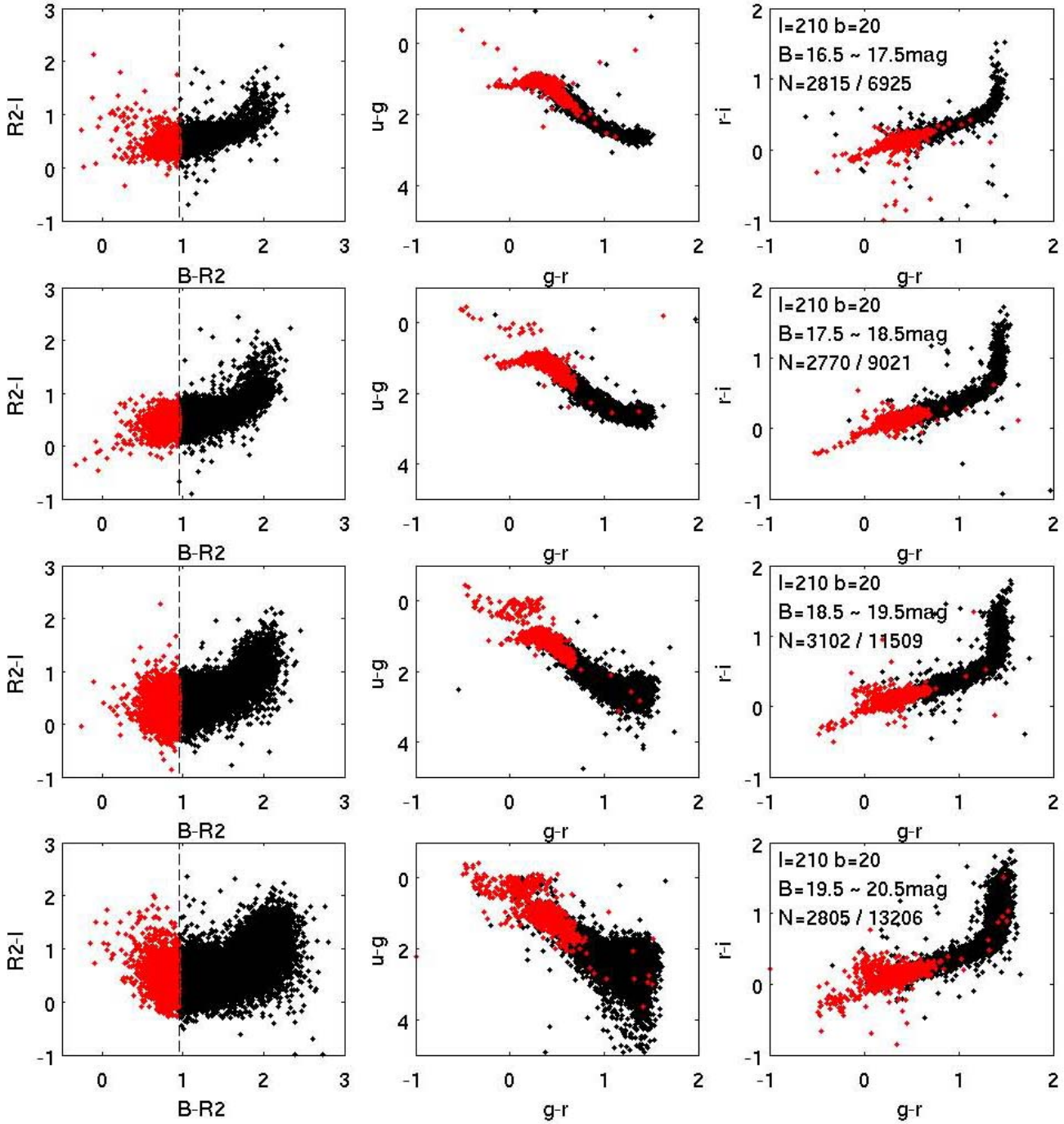
The Challenge of LAMOST



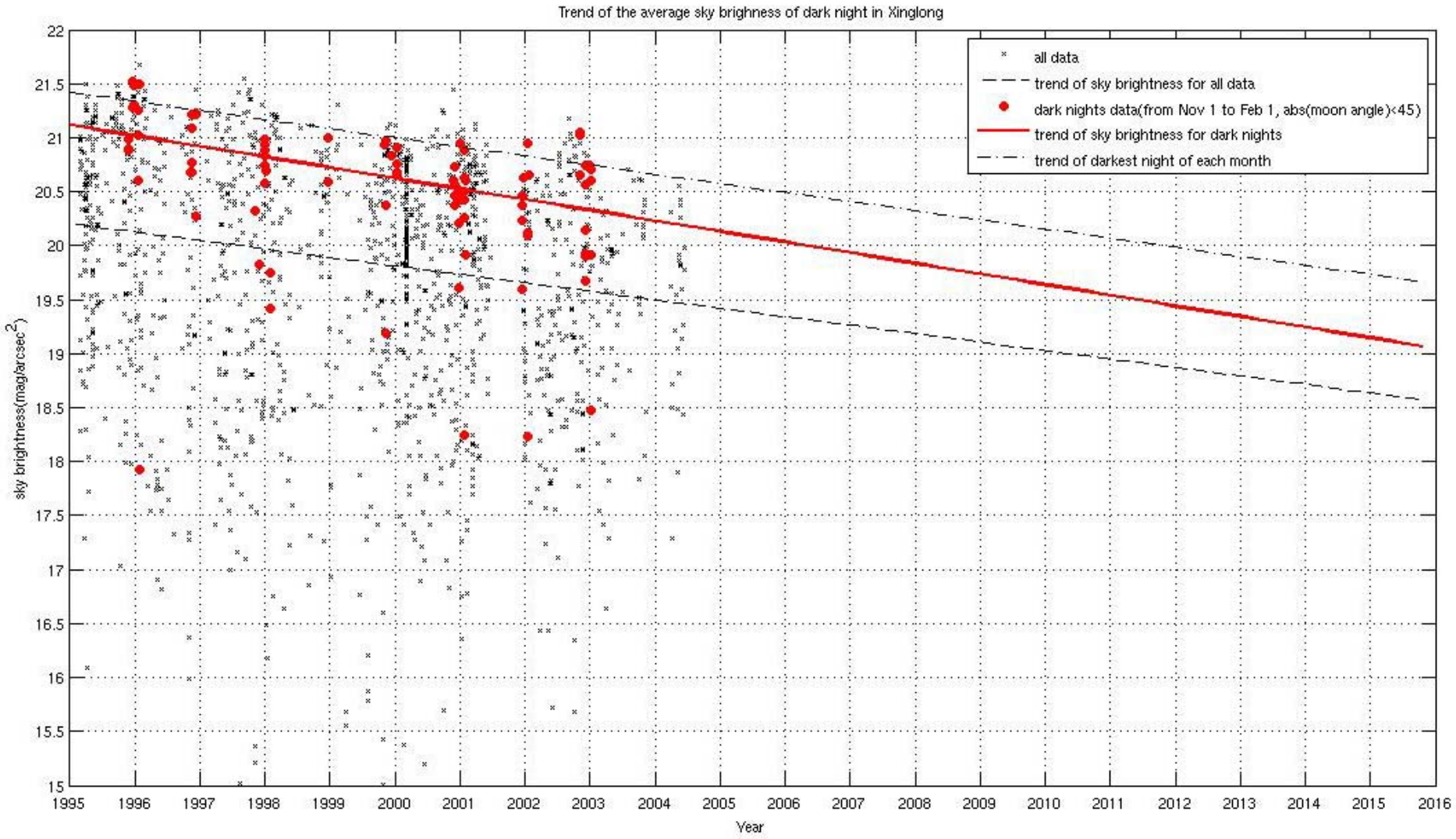
LAMOST has strong constraints in declination, angle from the meridian, spacing of the fibers, and weather.



SuperCOSMOS vs. SDSS



SuperCOSMOS vs. SDSS


Trend of the average sky brighness of dark night in Xinglong
all data
trend of sky brightness for all data
dark nights data(from Nov 1 to Feb 1, abs(moon angle)<45)
trend of sky brightness for dark nights
trend of darkest night of each month
sky brightness(mag/arcsec^2)
Year
22
21.5
21
20.5
20
19.5
19
18.5
18
17.5
17
16.5
16
15.5
15
1995
1996
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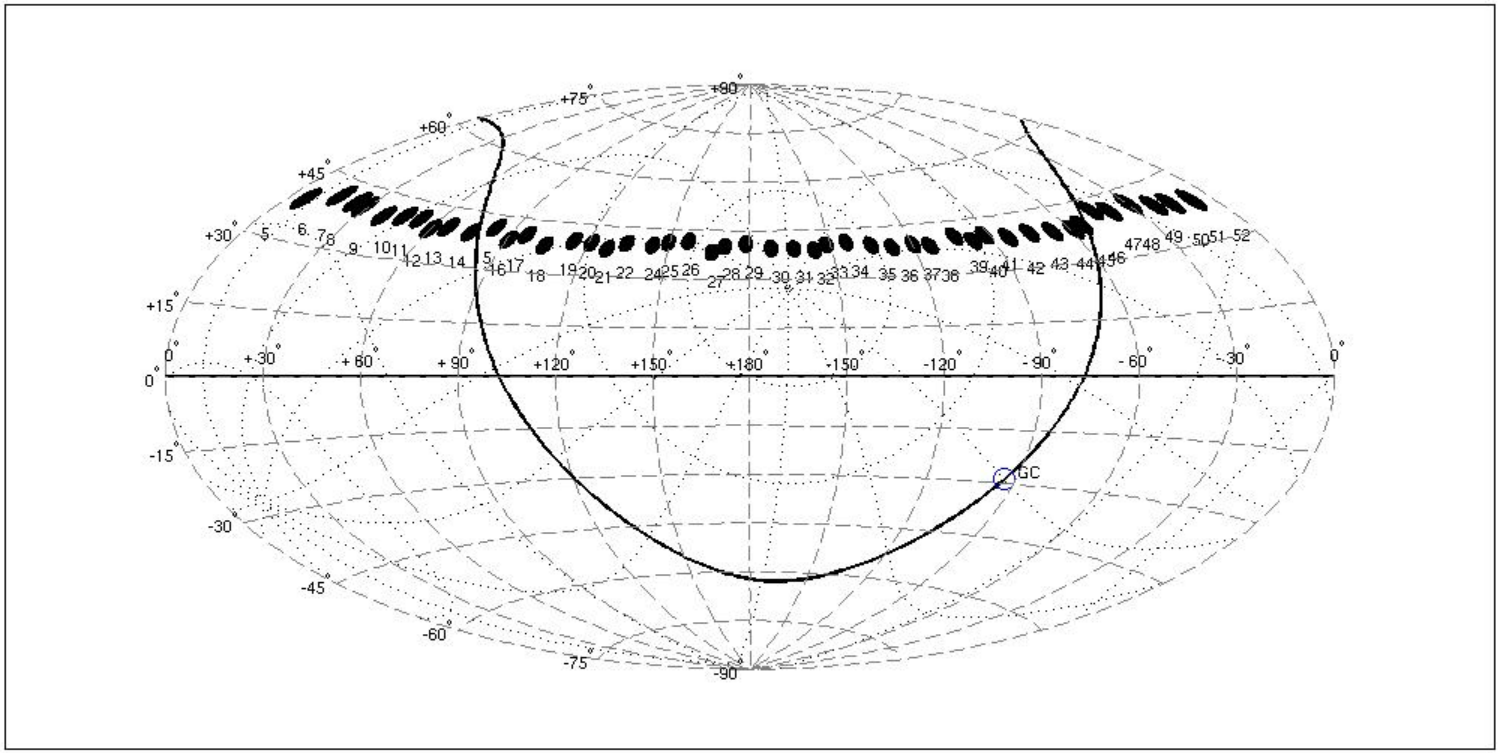

I asked the head technician at the site when he would be ready for us to send him targets, and he said, “now.” So Xu Yan has designed the plates above (plot by LIU Chao). Maybe soon they will try putting the fibers on stellar targets.

LAMOST Timeline

Original proposal: November 1996

Approved: April 1997

Preliminary design approved: June 1999

Detailed design competed, construction begins: September 2001

“First Light” with partial mirrors, weird focal plane instrument: May 2007

All parts on mountaintop: August 2008

Real first light & start of commisioning: around now

Dedication: October 2008

Survey operations: beginning of 2010

Prospects for Galactic structure survey are very good

- Galactic structure working group has been formed, chaired by Licai DENG and Jinliang HOU (as has an extragalactic structure working group)
- Competition for the NGC region may be tough, but in other directions, there is little competition for time.
- Looking at 5 yrs, 2.5 million spectra, starting Jan. 2010, but could be in excess of 5 million spectra.

File Edit View History Bookmarks Tools Help

http://lamost.us/legue/

vanguard bond fund

Getting Started

LAMOST Experiment for Galactic ... | Vanguard Mutual Fund Offerings | Let Risk-Taking Financial Institutions F...

About the project LAMOST PLUS Gallary

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- S/N Calculator

Useful links

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LAMOST Progress: All the hardware components have been in place

Monday, 08 September 2008 13:26

By the end of August 2008, all the hardware components of the LAMOST telescope had been in place, and initial test was executed. It is another important milestone for the project.

LAMOST Progress : The Small LAMOST System Acquired Stellar Spectra Successfully

Wednesday, 23 July 2008 02:25

After finishing mechanical, electric and electronic subsystems, LAMOST passed it preliminary test on its partially segmented mirrors (small system)
The small LAMOST system features a clear aperture of about 2-meters, 250 fibers mounted on the small focal plane, 1 spectrograph
with 2 CCD cameras, all other hardwares are the standard ones of LAMOST at full configuration.

Last Updated (Wednesday, 27 August 2008 21:33)

Read more...

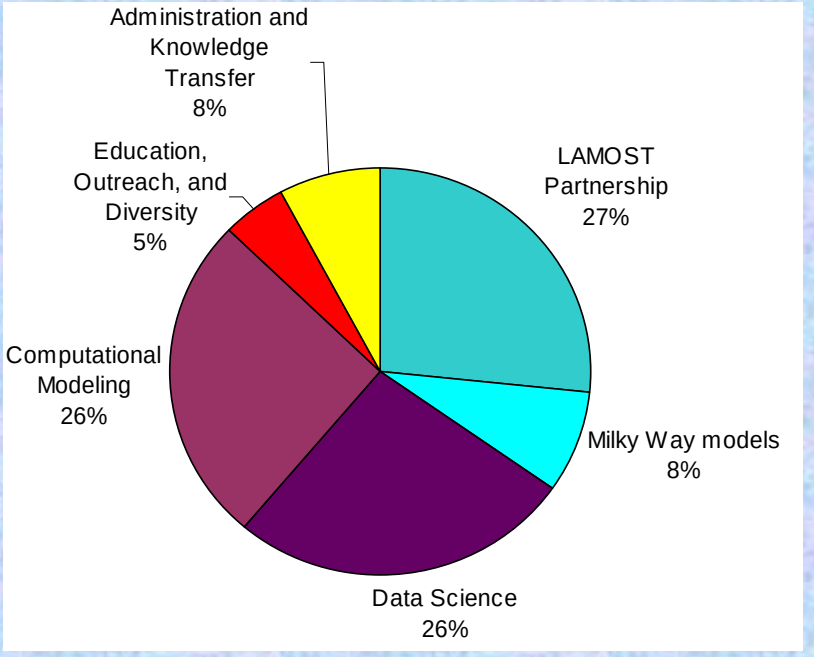
LAMOST Progress : MA mosaic finished on June 21, 2008

Wednesday, 23 July 2008 02:13

Done

The Center for Galactic eScience

- Cutting edge Galactic structure, generalized eScience tools, labor pipeline and diversity
- $20M over five years
- And **none** of the money comes from the NSF astronomy budget!!!!!



If center proposal is not successful, the project will be downsized, broken in pieces, and submitted as separate proposals.

Overview

(1) The Sgr stream does not go through the Solar neighborhood.

(2) We can photometrically select Sgr M giants, and the SDSS/SEGUE velocities of Sgr stars seem to match those of Law, Johnston & Majewski 2005

(2) Photometric separation of Sgr dwarf tidal debris

(3) A Galactic structure survey in collaboration with the Chinese LAMOST project