

GREAT - Kickoff meeting
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Open Clusters and Galactic Disk Observations with LAMOST

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LAMOST Survey for the Milky Way Galaxy

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LAMOST dome at Xinlong Station, Northeast of Beijing, 110km



LAMOST Spectroscopic Surveys

- ◆ Key projects include
 - Extra-Galactic Survey
 - **Milky Way Galaxy**
 - Cross-identification

- 1. WG for the Milky Way study
- 2. WG for extragalactic survey
 - Survey plan shall be fixed in 2009

The Milky Way Survey plan:

- Consider a 5 year survey plan
- Spectra of 2.5m stars are expected
 - Using about 1/2 of the total dark observing time for halo (down to $V=20m$)
 - Using about 1/3 of the grey and all bright nights for bright stars ($V=18m$) in the 'green' fields

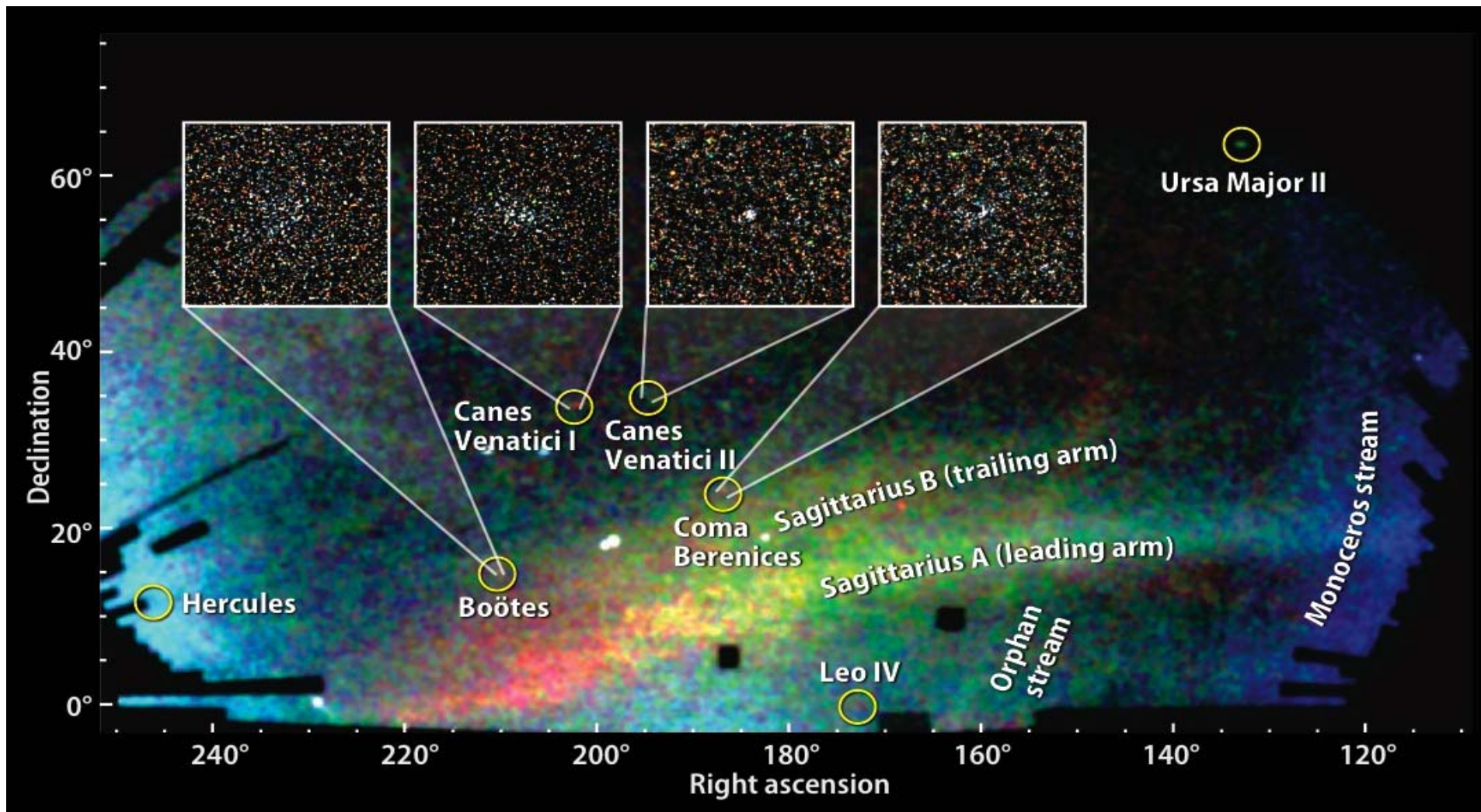


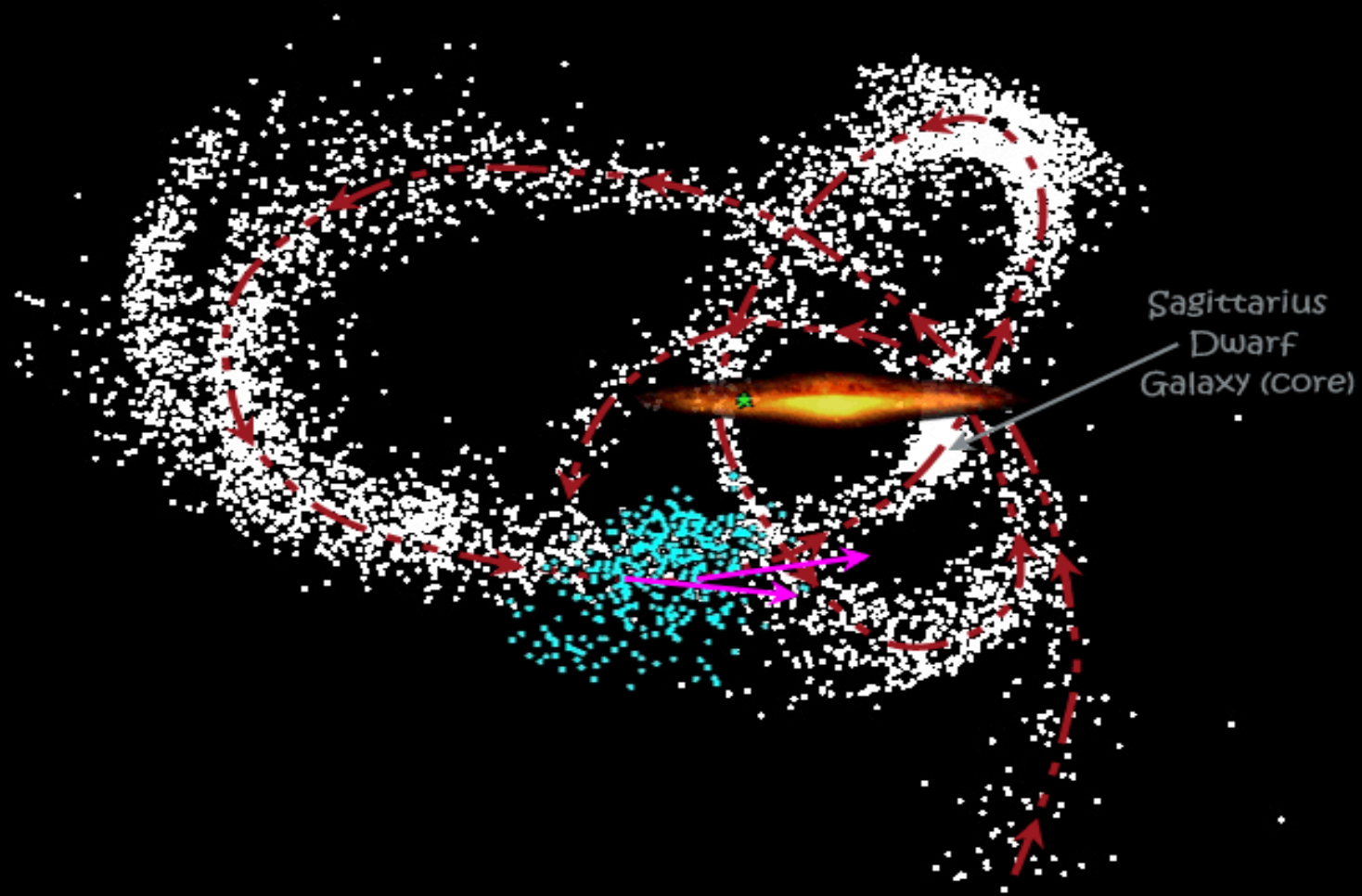
Scientific Objectives for the MWG

1. **Halo** -- almost well defined
2. **Disk** -- should be defined next month

(1) Dwarf galaxies and stellar moving groups

Licai DENG, Heidi Newberg et al.



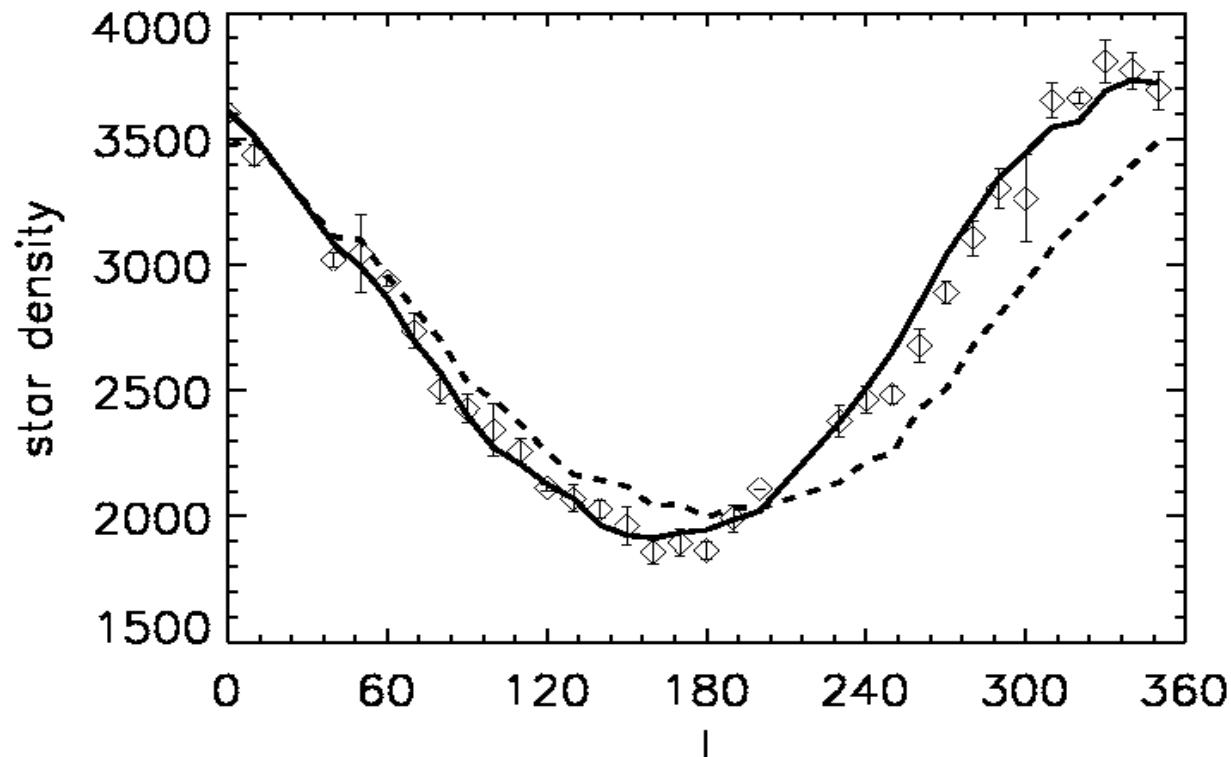


(2) Constraining the gravitational potential

- The kinematical information carried by stars can be used to constrain the mass distribution in the Galaxy. Radial + tangential velocities + (α , δ , d)
- Large area survey and homogeneous high precision data set is needed. Radial velocity measurement by LAMOST beyond GAIA limit ($< 17m$) will be important in this issue.

(3) Probing the Spheroid, is it triaxial?

- There is a apparent deviation from rotational symmetry as shown by star counts.



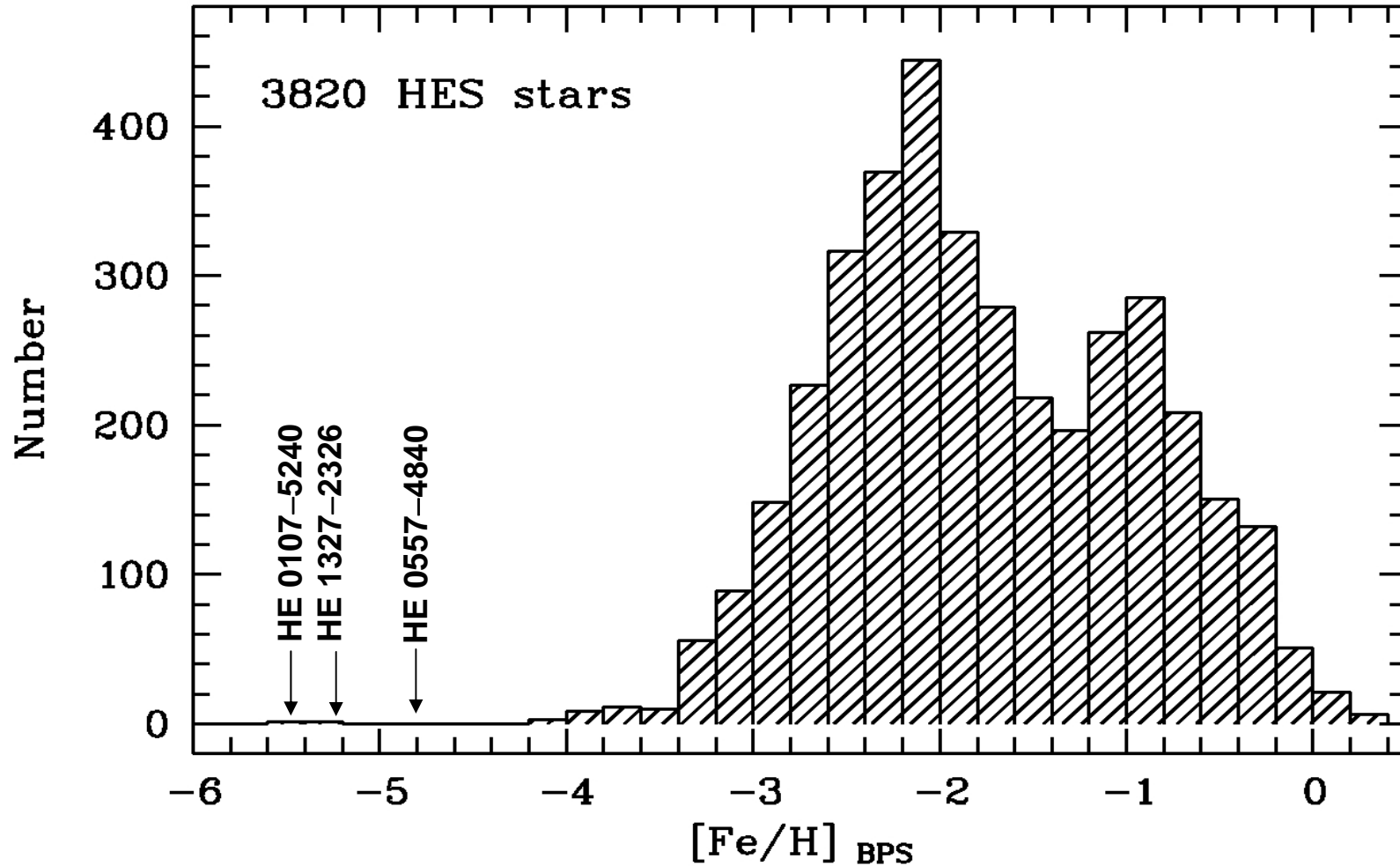
Stellar projected
number density
distribution in a ring
at $b=+60$

Xu et al. (2007)

What are those substructures?

- Possibly
 - Dwarf galaxies
 - Globular clusters
 - Tidal debris of accreted dwarfs
- Tidal radius estimation: bound or unbound?
 - Need LAMOST survey data to confirm

(4) Searching for the metal poor stars



EMP and HMP stars expected to be found

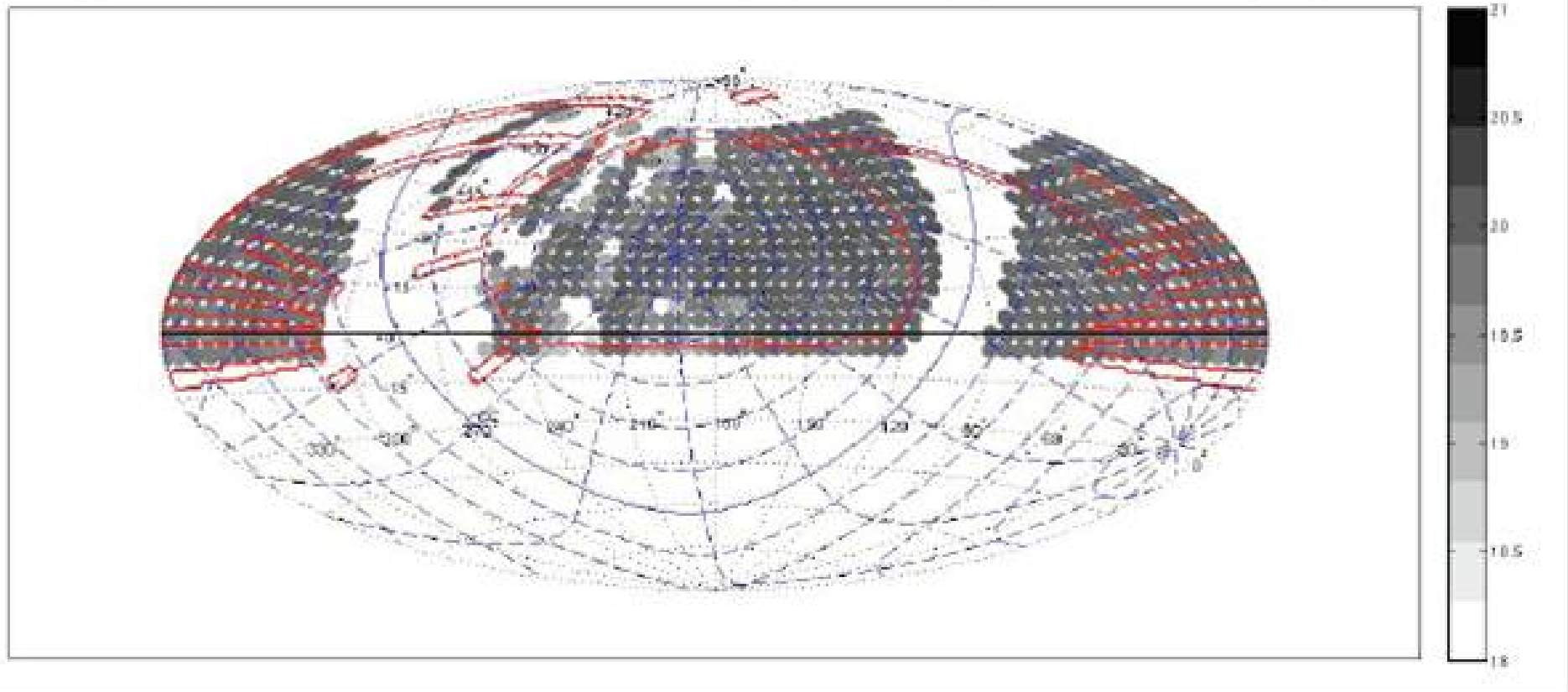
Survey	Effective sky coverage	Effective mag limit	$N < -3.0$ (EMP)	$N < -5.0$ (HMP)
HES	6400 deg ²	$B < 16.5$	200	2
SEGUE	1000 deg ²	$B < 19$	1000	10
LAMOST	12,200 deg ²	$B < 18.5$	6000	60
SSS	20,000 deg ²	$B < 18$	5000	50

- **These estimates are accurate only to within a factor of ~2!**
- Number of stars to be found in SEGUE will mainly be limited by number of fibers allocated for follow-up. Only about 10% of all candidates down to $B = 19$ can be observed.



Making a survey for planned scientific goals

5 year plan's DARK and GREY (sky level legend on the right)



16000d2, 2.5M spectra

(5) Scientific Objectives for the MW Disk

Disk, thin/thick

1. The structure of the **thin/thick disks** of the Galaxy, including the chemical abundance as a function of position within the disk and extinction in the disk;
2. Probing the center of the Milky Way with **hypervelocity stars**, including a survey for OB stars in the Galaxy;
3. A survey of the properties of **Galactic open clusters**, including the structure, dynamics and evolution of the disk as probed by open clusters;

Disk survey: several proposals

- Lamost Open Cluster dominated Survey (LOCS)
 - (CHEN LI et al.)
- Thin disk survey (with $|b| < 5d$)
 - (LI Jinzeng et al.)
- Galactic anticenter survey (with $|b| < 30d$)
 - (LIU Xiaowei et al.)
- Some specific programs:
 - Star forming regions (WANG Hongchi et al.)
 - Gould Belt

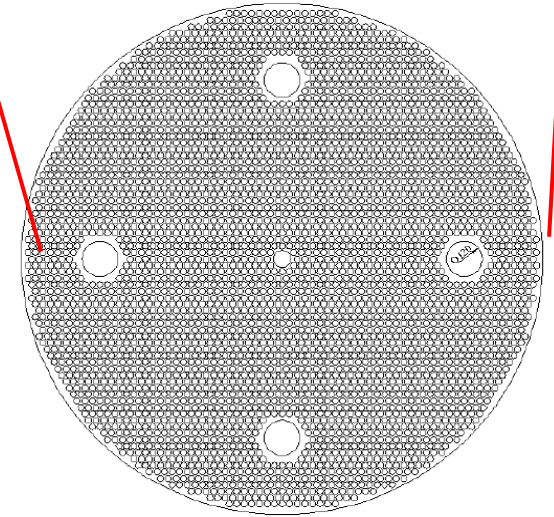
Disk Survey problems

LAMOST Field Of View = $20d^2$
(PLATE)

LAMOST observable area: $\Delta Gl \approx 240^\circ, \Delta Gb \approx 20^\circ$

→ Total $\sim 5000d^2$ → 250 plates as **LOWER LIMIT**

Density ~ 2500 stars/ d^2 for $V < 16$



• one plate $\sim 20 d^2 \times 2500 \sim 5 \times 10^4$ stars

→ need 3600 fibres $\times 14$ exp $\times (0.5+0.5)$ hour → ~ 3.5 obs-nights

250 plates $\times 3.5 = 750$ nights ($\sim 10^7$ spectra)

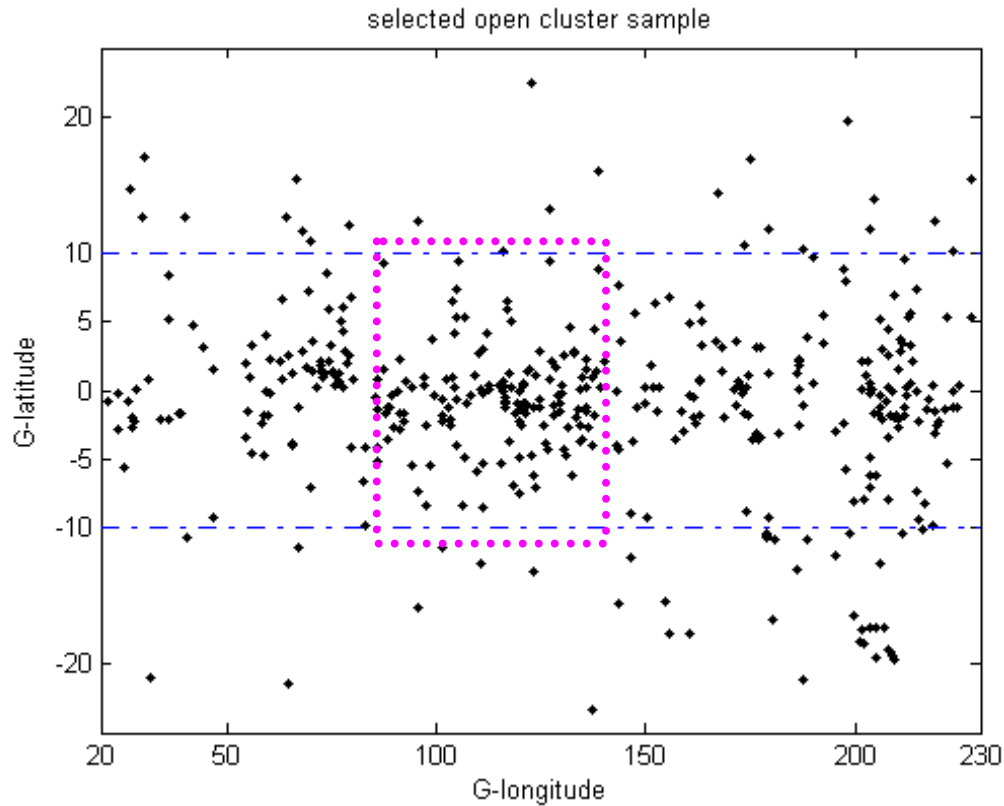
• Observable nights (spectra) for LAMOST: ~ 200 /yr

• If 1/3 assigned to Galactic survey ~ 65 /yr → totally $(750/65) > 12$ yrs
(assume: 1/3 of total are **bright nights**)

"OC dominated survey" - LOCS project

Aim: probe both OCS in Milky Way
& statistical properties of the Disk

$V_{\text{lim}} \sim 16$;
30 min. obs.
 $R_V \sim 5 \text{ km/s}$
 $[\text{Fe}/\text{H}] \sim 0.2 \text{ dex}$



OC dominated sky area

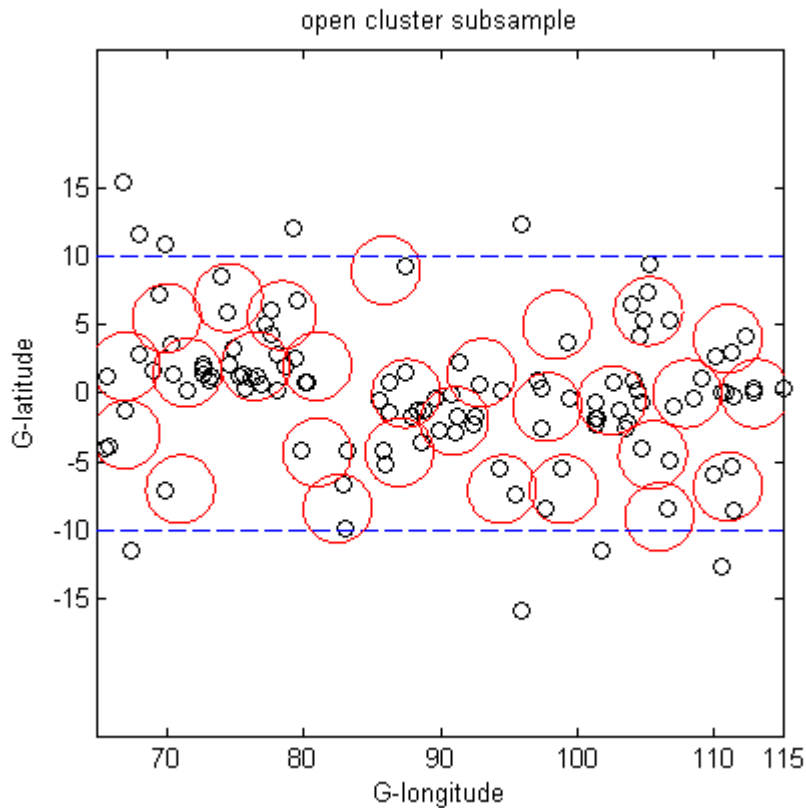
$$\Delta Gl \approx 230^\circ - 20^\circ = 210^\circ$$

$$\Delta Gb = 20^\circ$$

OCs observable with LAMOST: total $N \sim 720$
With distance ($> 200 \text{ pc}$) information $N \sim 400$

A 1/4 subsample of LOCS:113OCs

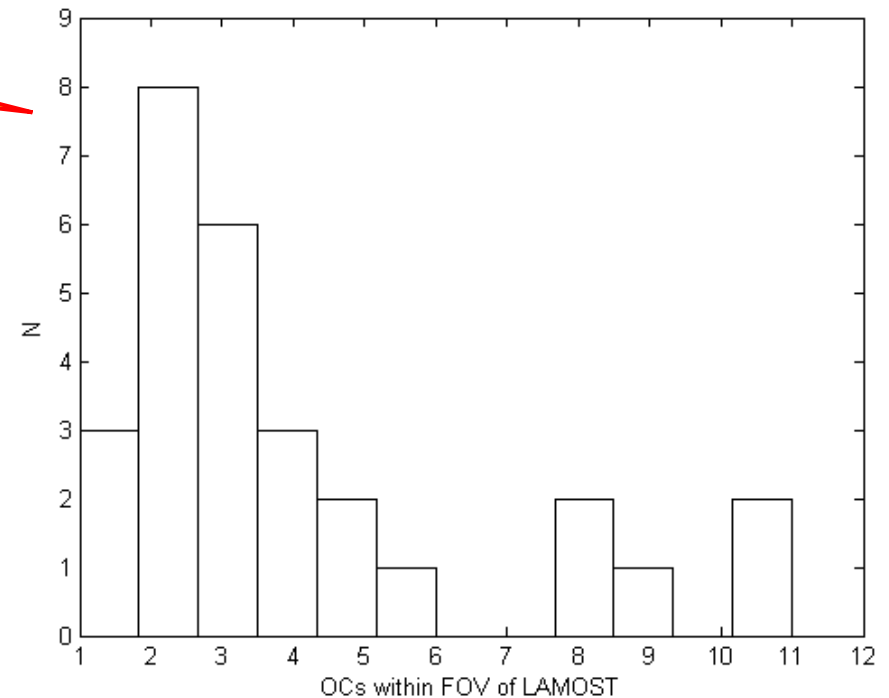
$$\Delta Gl \approx 115^\circ - 65^\circ = 50^\circ, \Delta Gb = 20^\circ$$



Total of ~28 plates ~98 nights

-- about 1.5 year of observation

→ 113 OCs & 560d² (~1 × 10⁶ stars)



Chen et al. 2008

LAMOST OC dominated Disk Survey:

- 400 OCs (spectroscopic database) to probe disk properties;
- a **representative** sample of the disk stars:

$$\Delta Gl \approx 210^\circ, \Delta Gb = 20^\circ$$

→ spectra for 5×10^6 stars distributed in this 2-D sky area
(Rv & [Fe/H])

Within 6 years !

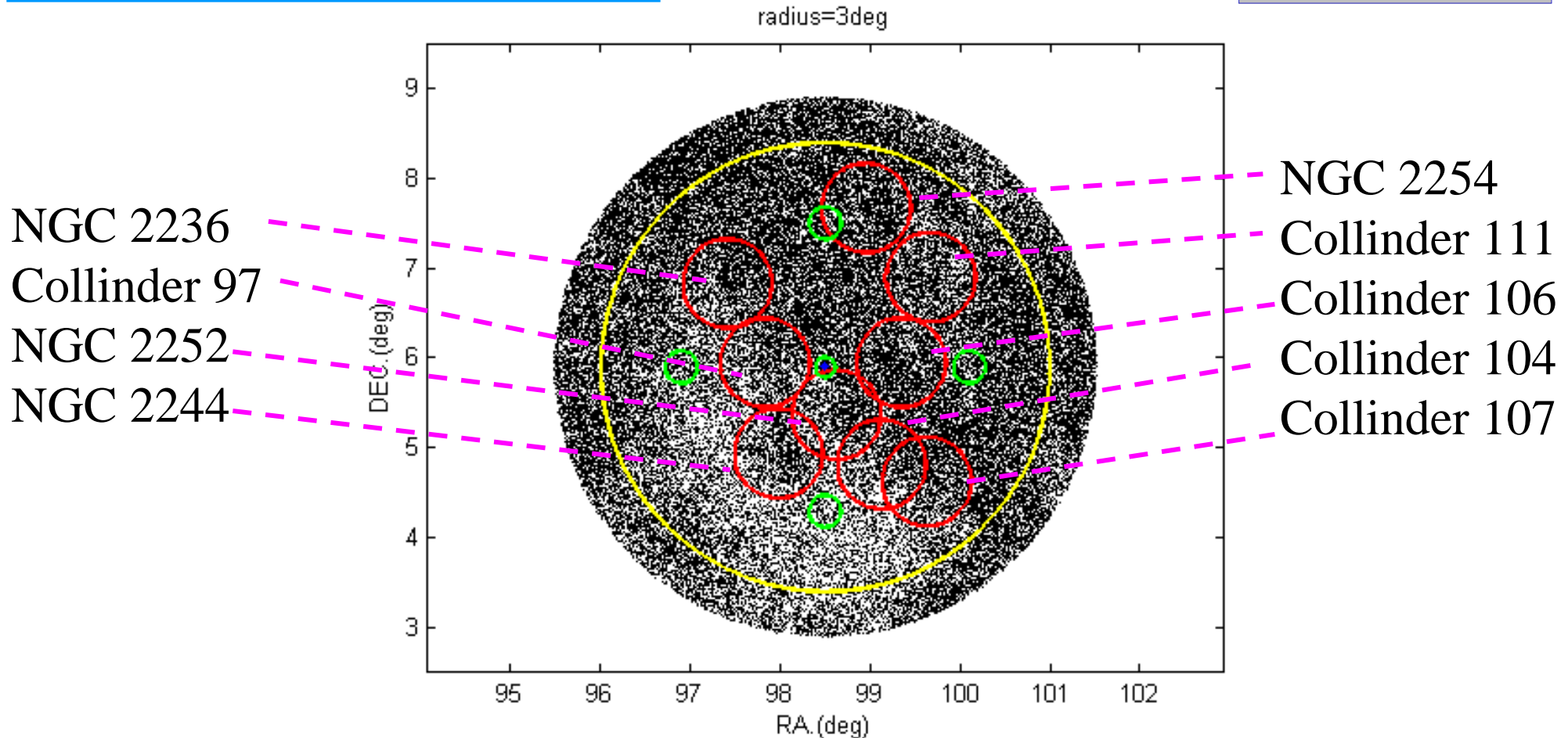
And, for ~ 150 first priority OC subsample (statistically significant)
→ LAMOST may output an important obs. dataset for disk study
within 2 yrs

- Science for open cluster is significant, but OC is only about **1 square degree**.
- How about the other fields in the plate? What kind of sciences could be done needs to be defined!

A sample of **plate field**
one of the most crowded
OCs field (9 Ocs)

Yellow circle: rad=2.5d, 9 OCs covered
L=205d, B=-1.2d

Density~2600/d²



Thanks