Open Clusters and Galactic Disk Observations with LAMOST

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LAMOST Survey
for the Milky Way Galaxy

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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)

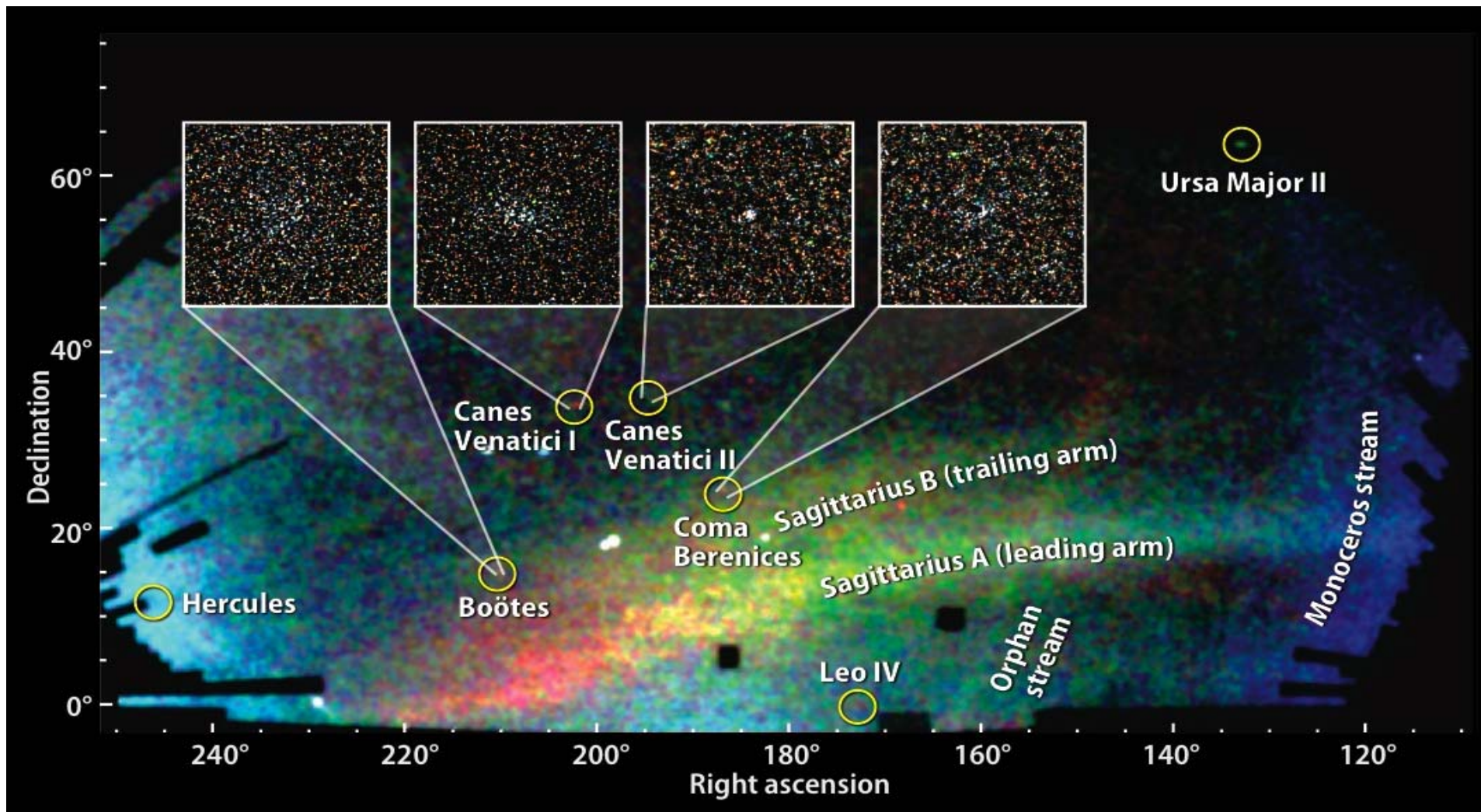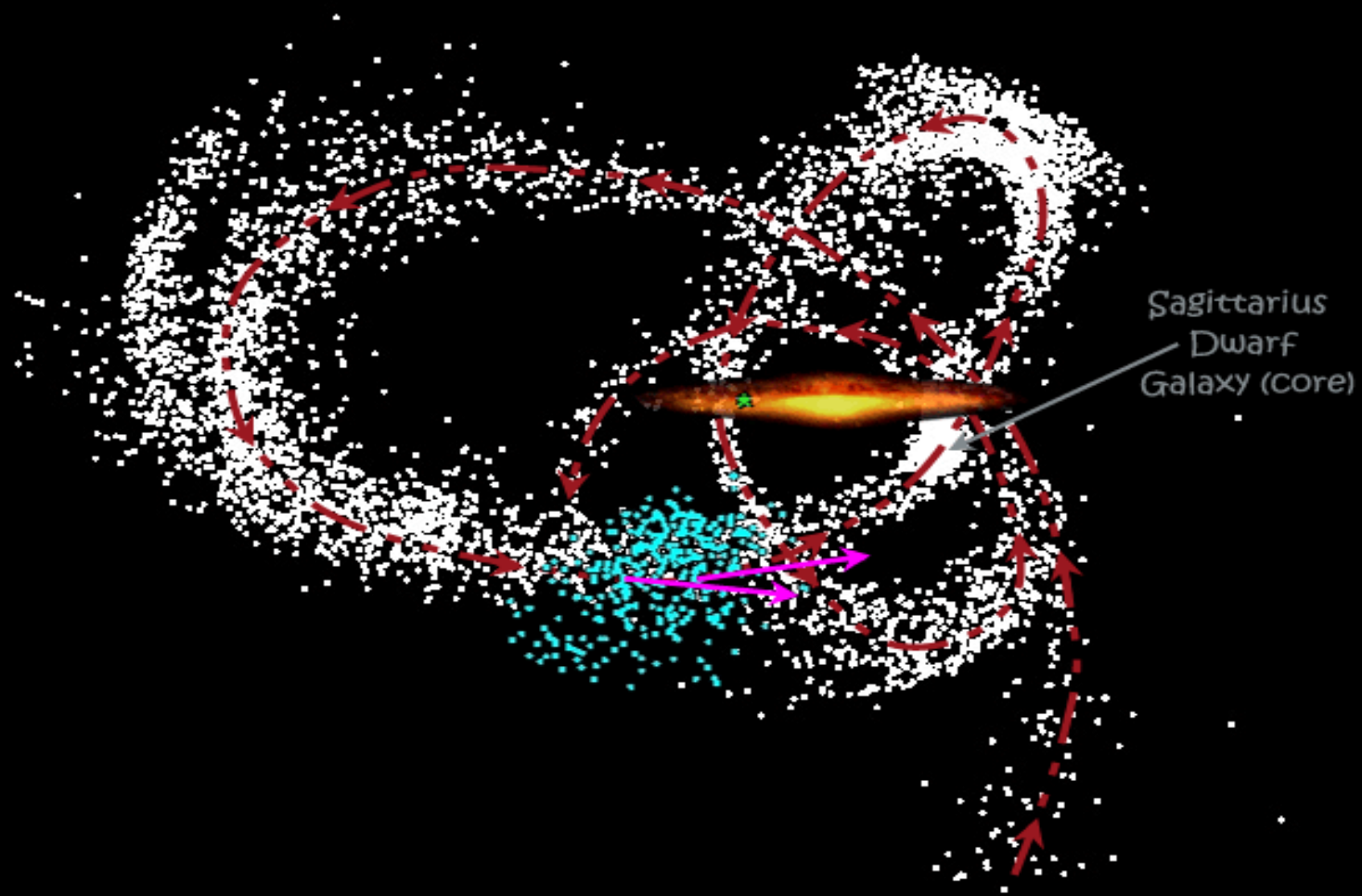 - Using about 1/3 of the grey and all bright nights for bright stars (V=18m) in the 'green' fields

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.

Sagittarius
Dwarf
Galaxy (core)

(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.
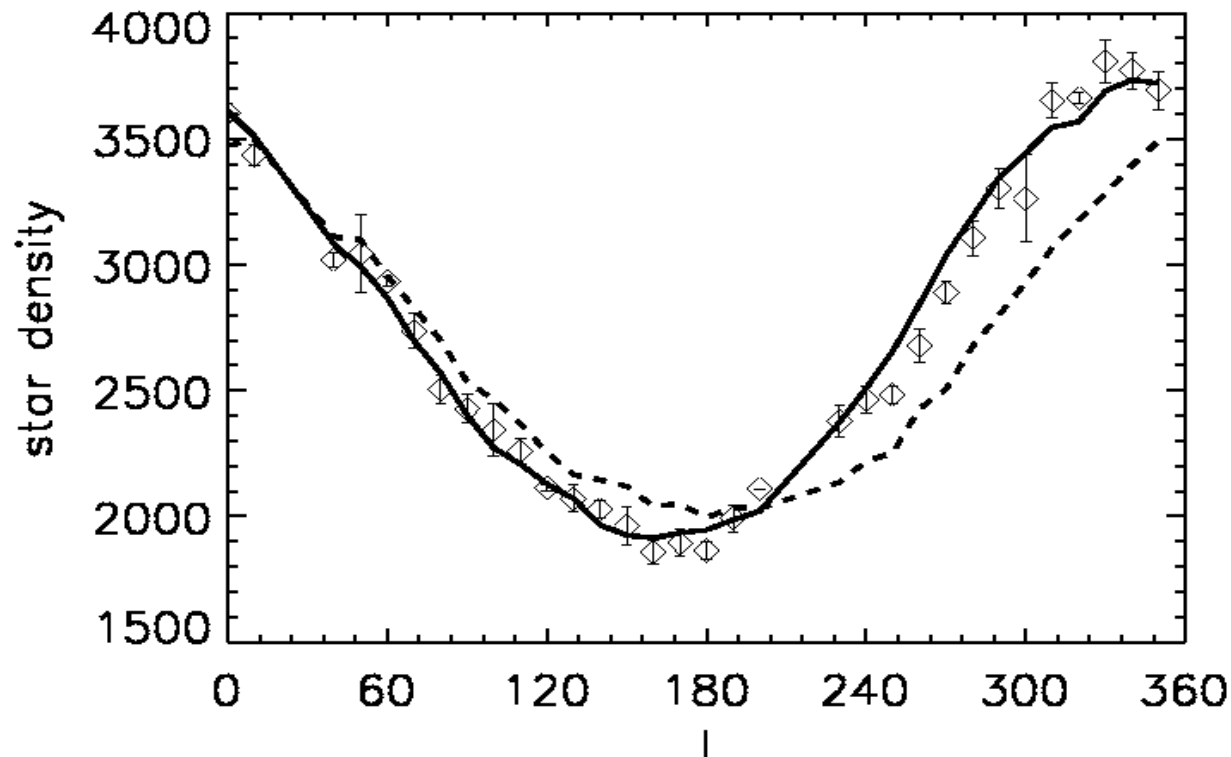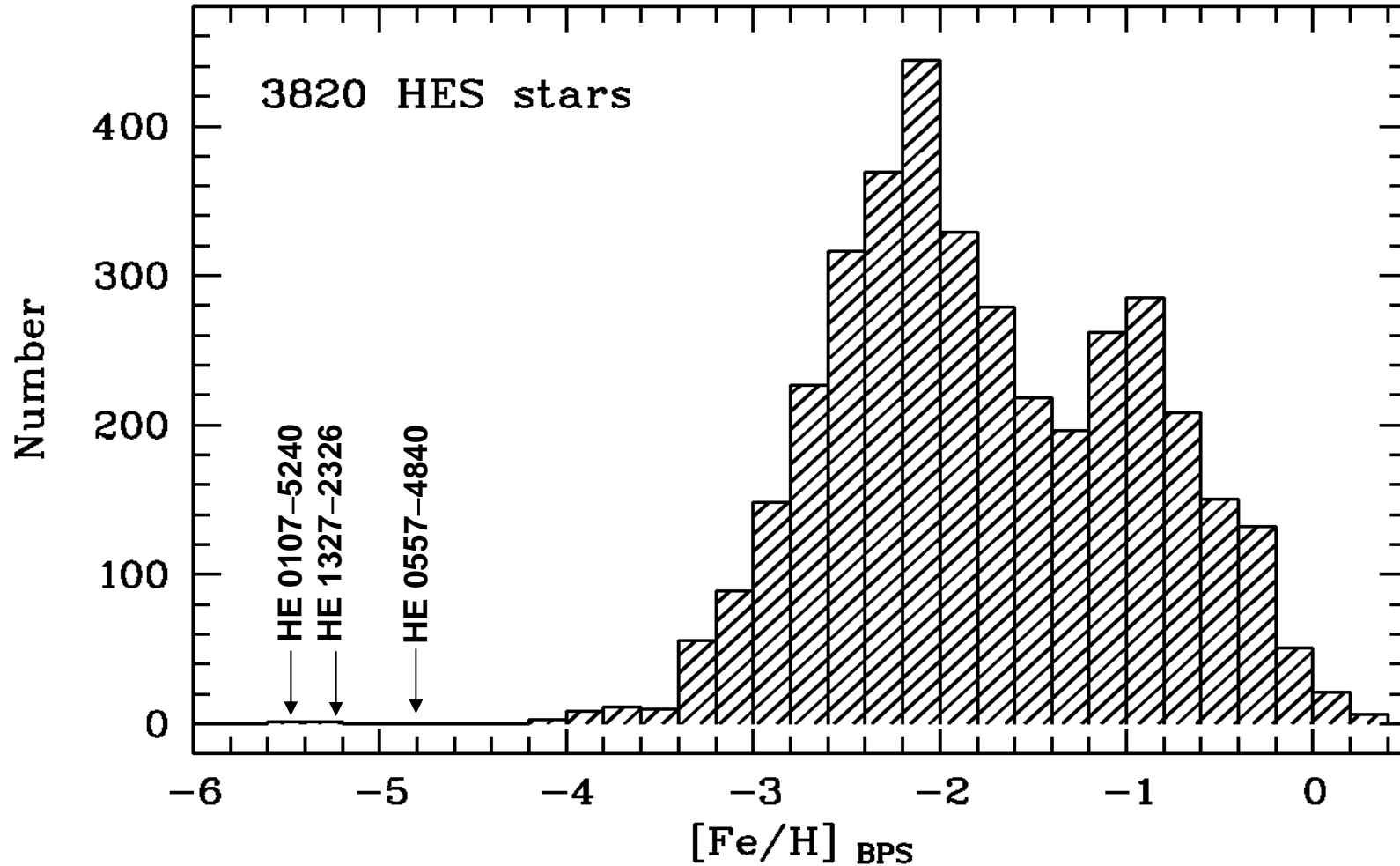

Stellar projected number density distribution in a ring at b=+6o

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

Gang ZHAO, Norbert Christlieb

Christlieb 2009

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 planed scientific goals

5 year plan's DARK and GREY (sky level legend on the right)
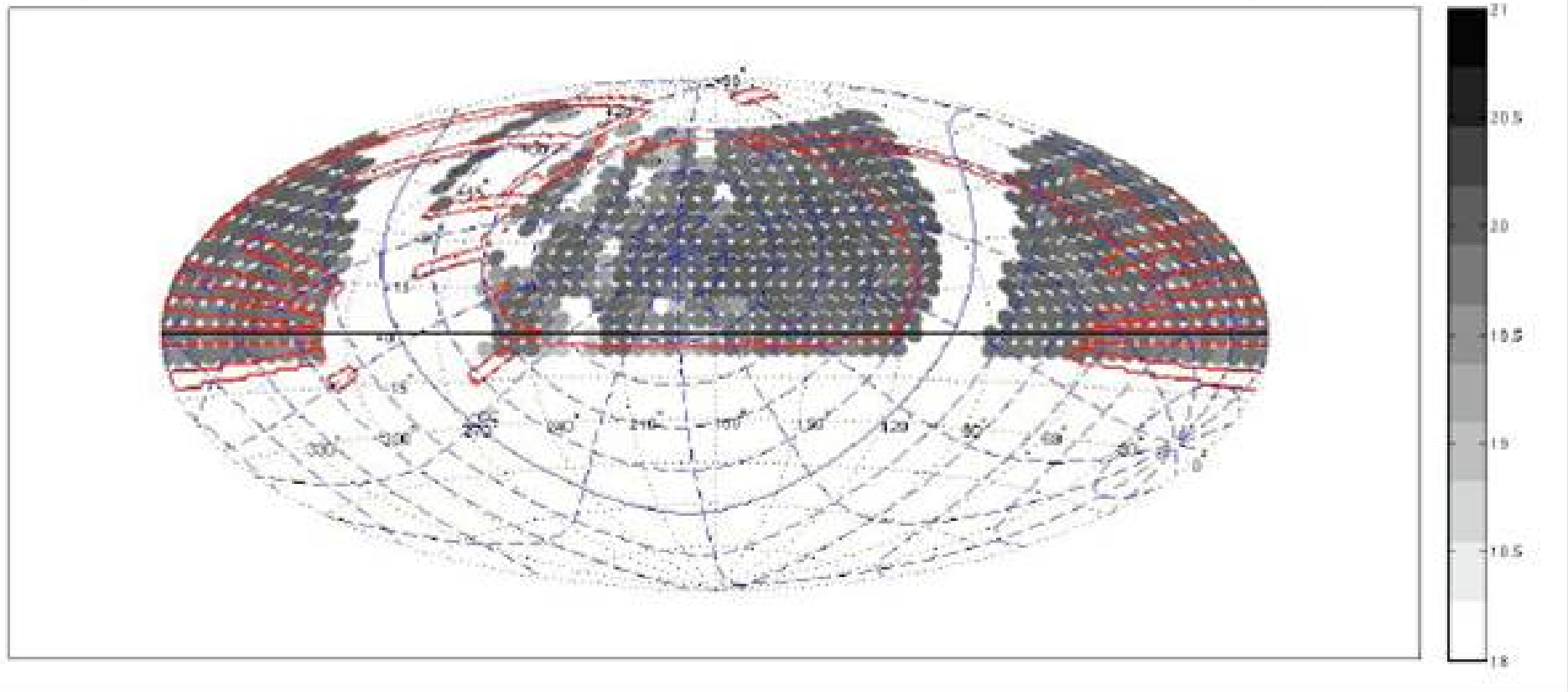
16000d2, 2.5M spectra

(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:
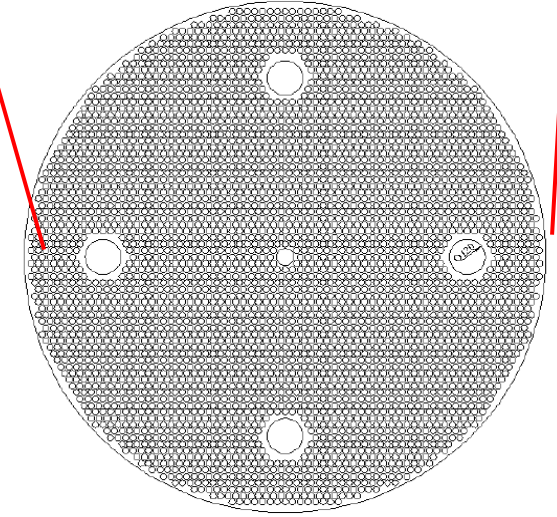 - Star forming regions (WANG Hongchi et al.)
  - Could Belt

Disk Survey problems

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

➔ Total ~ 5000d² ➔ 250 plates as LOWER LIMIT

Density ~ 2500 stars/d²   for V<16

- one plate ~ 20 d² × 2500 ~ 5 × 10⁴ stars

➔ need 3600 fibres × 14 exp × (0.5+0.5)hour ➔ ~ 3.5 obs-nights

   250 plates × 3.5 = 750 nights (~ 10⁷ spectra)

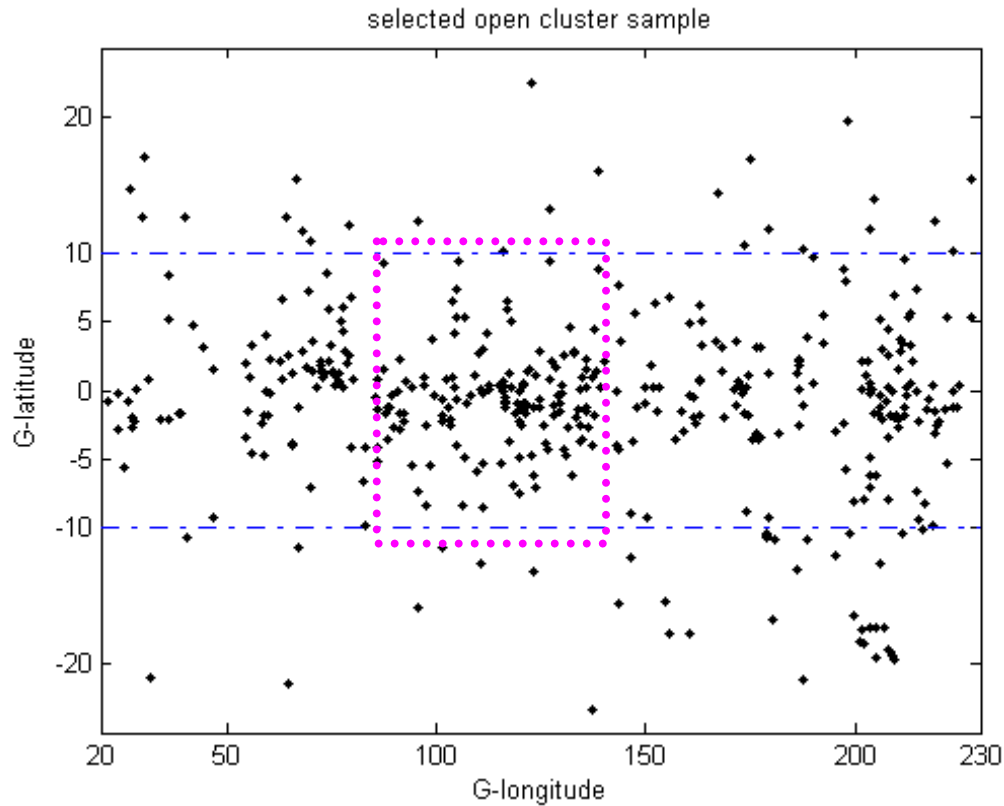- Observable nights (spectra) for LAMOST：~200/yr

- 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

selected open cluster sample

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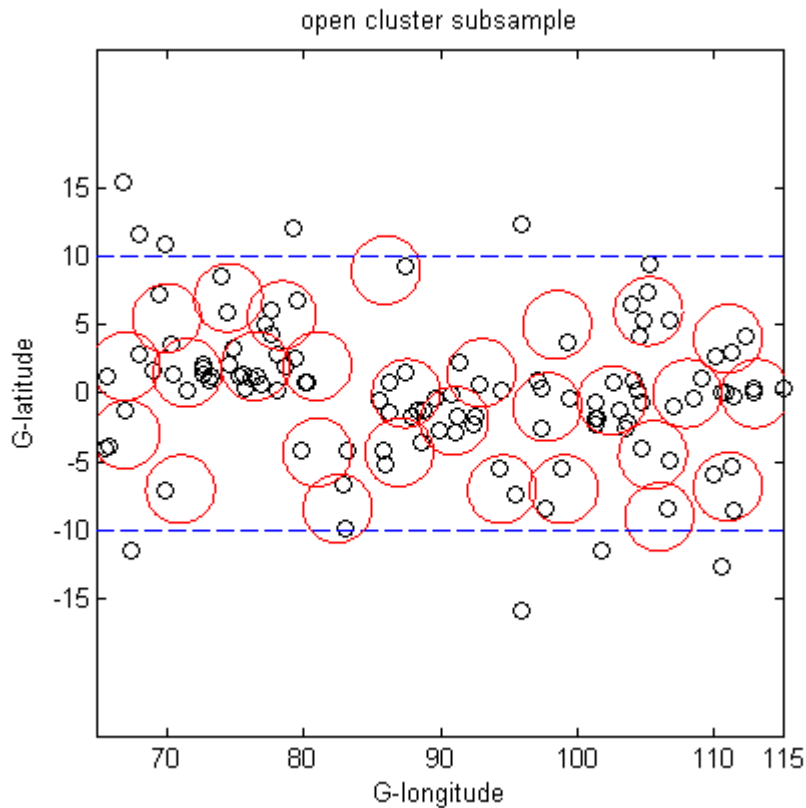$R_V \quad \sim 5$ km/s
[Fe/H] ~ 0.2 dex

OC dominated sky area

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

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

OCs observable with LAMOST: total N ~ 720
With distance (> 200pc) information N ~ 400

open cluster subsample

A 1/4 subsample of LOCS:113OCs

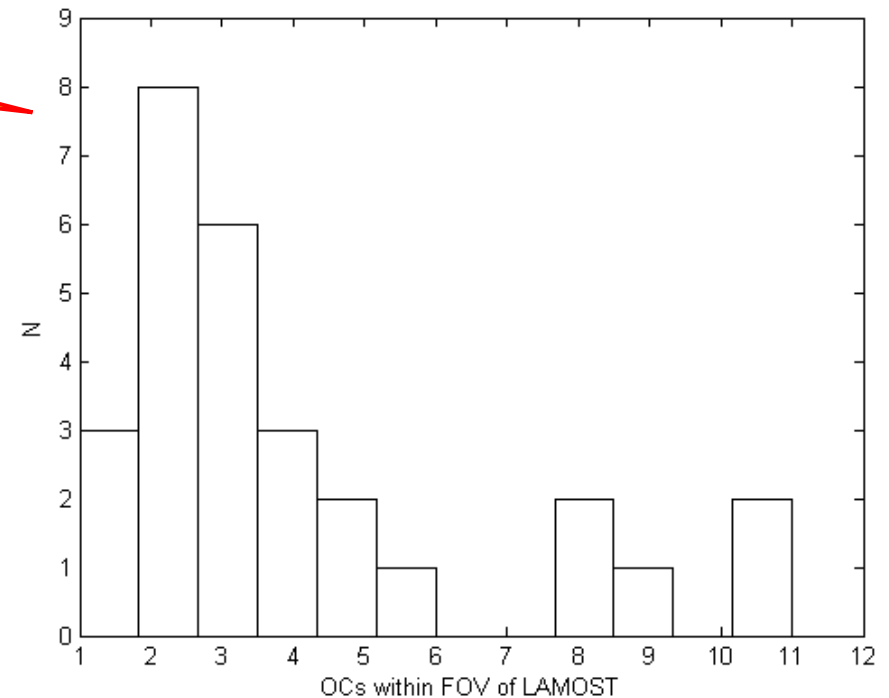$$\Delta Gl \approx 115° - 65° = 50°, \Delta Gb = 20°$$

Total of ~28 plates ~98 nights
-- about 1.5 year of observation
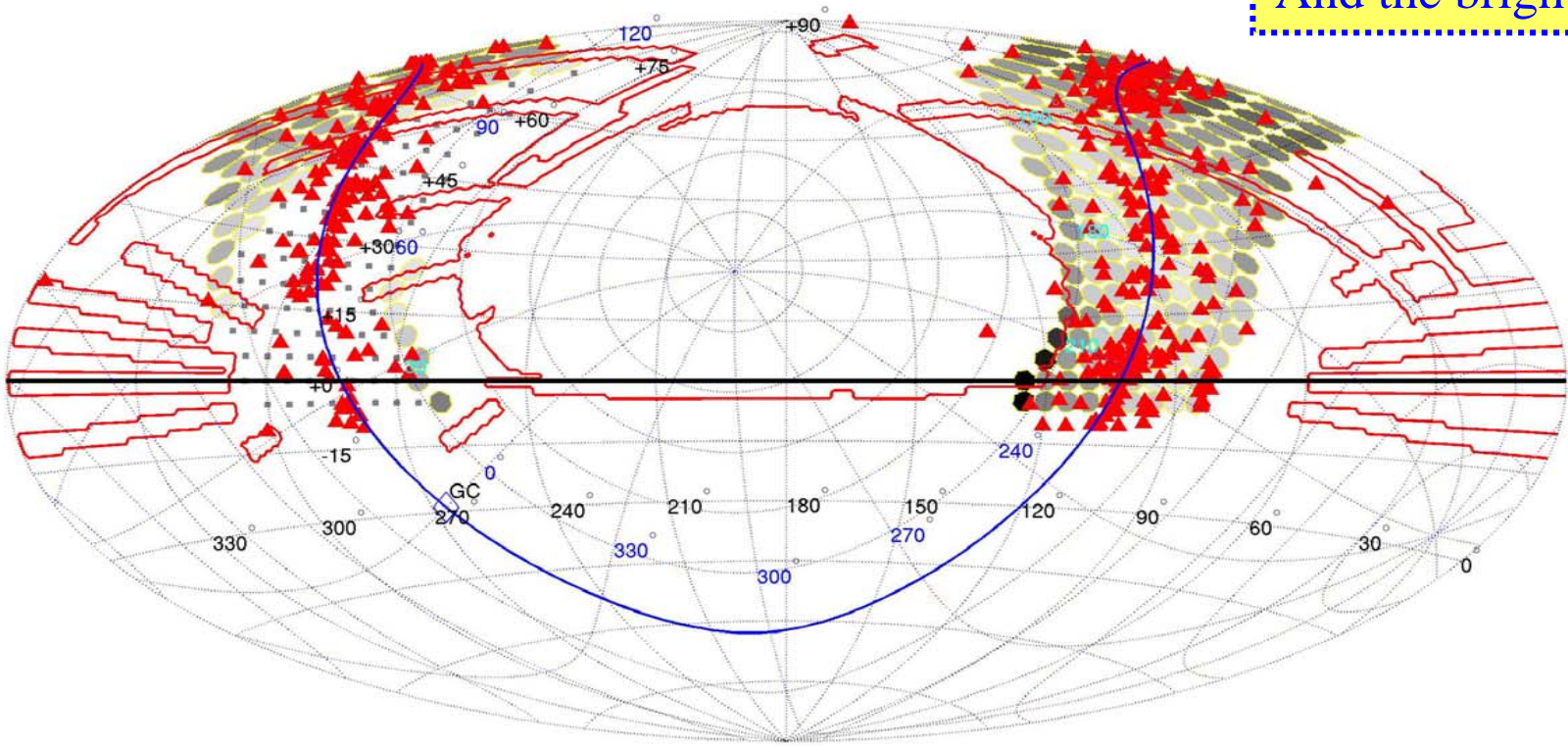→ 113 OCs & 560d² (~1×10⁶ stars)

Chen et al. 2008

OCs within FOV of LAMOST

And the bright nights
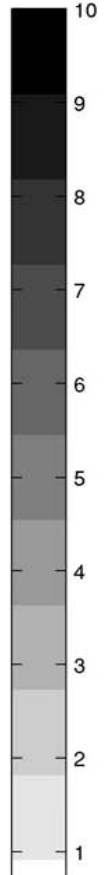
LAMOST OC dominated Disk Survey:

- 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
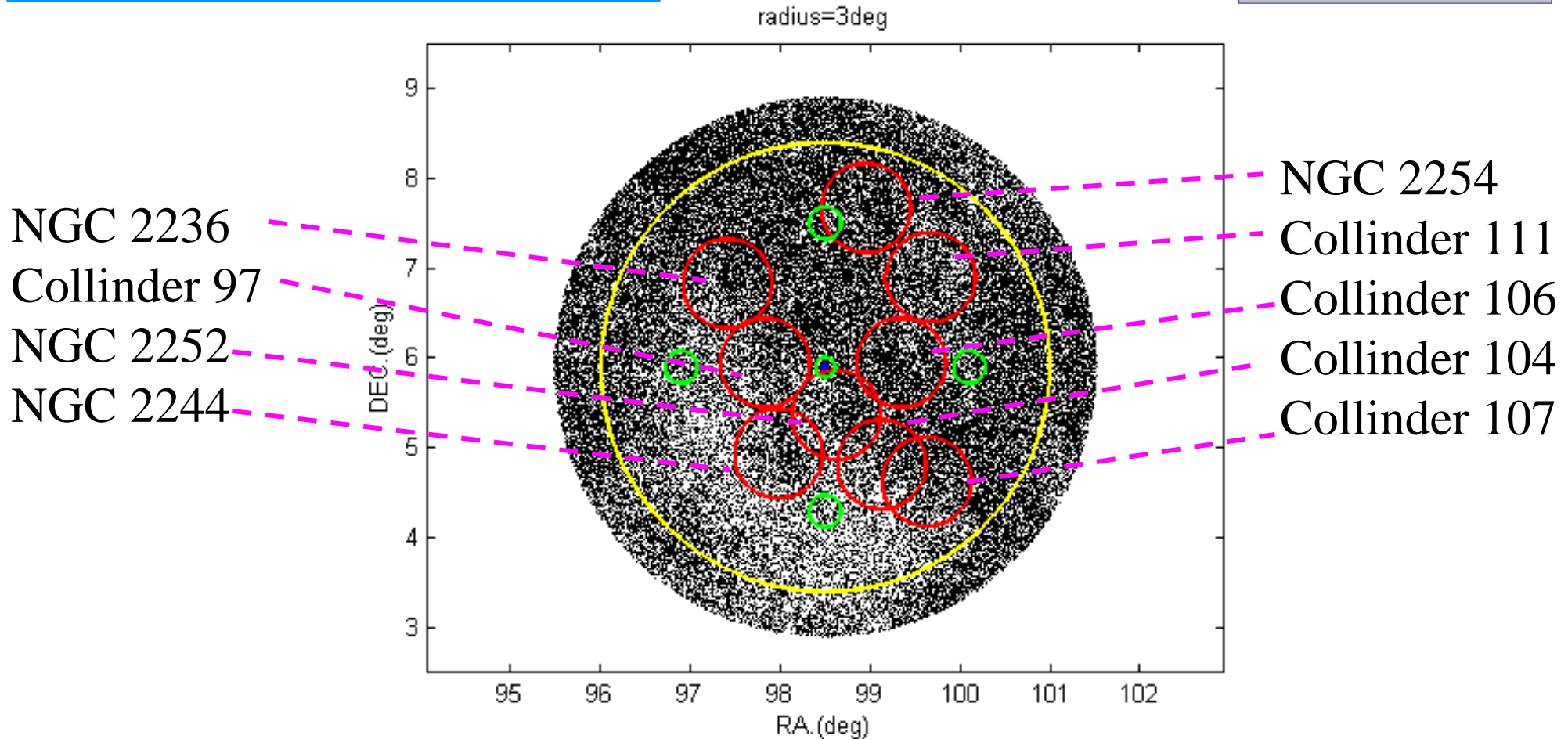   (Rv & [Fe/H])

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

radius=3deg

NGC 2236
Collinder 97
NGC 2252
NGC 2244

NGC 2254
Collinder 111
Collinder 106
Collinder 104
Collinder 107

Thanks