A transit survey at Antarctica Dome A

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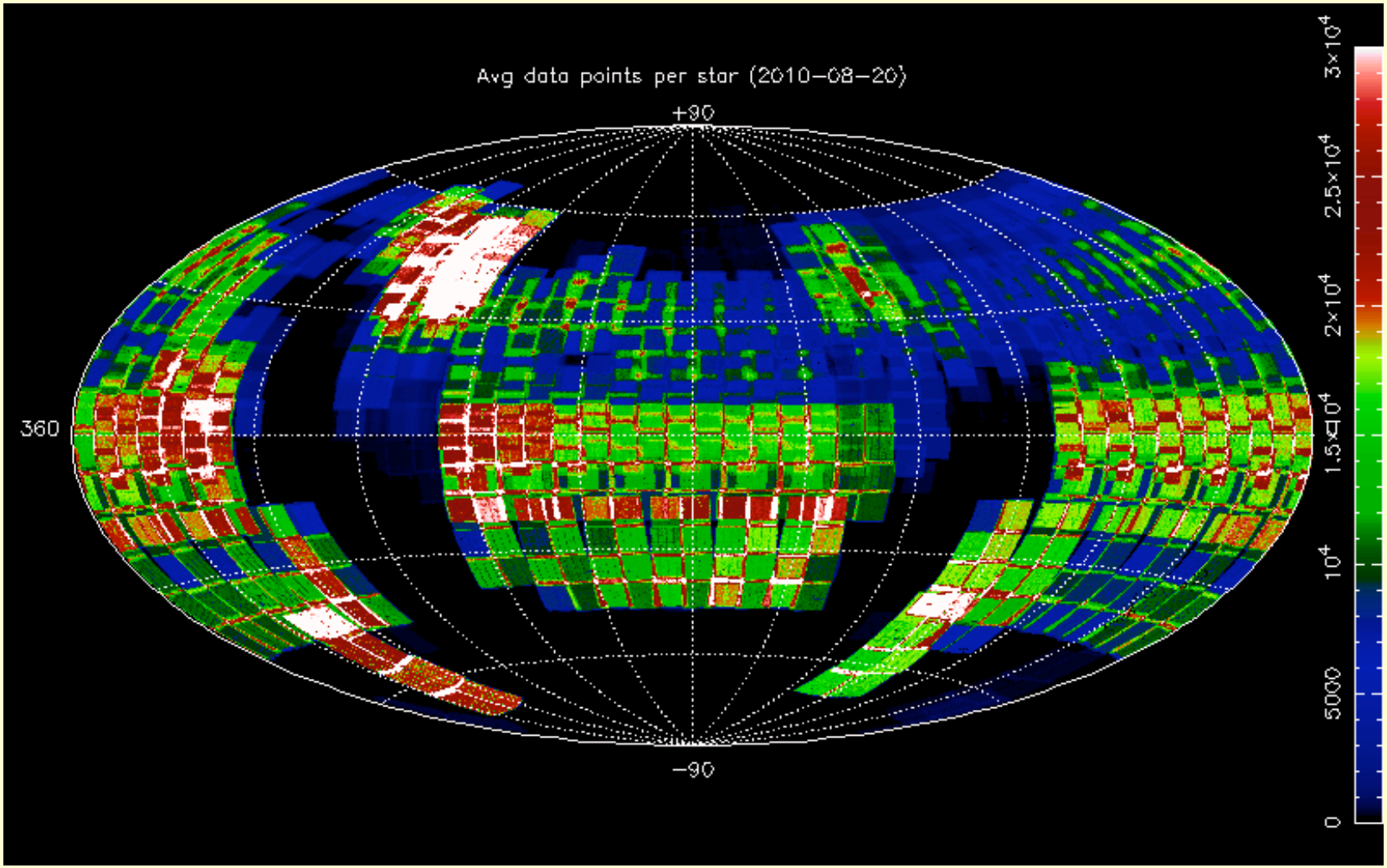
5.Australian National University, Australia

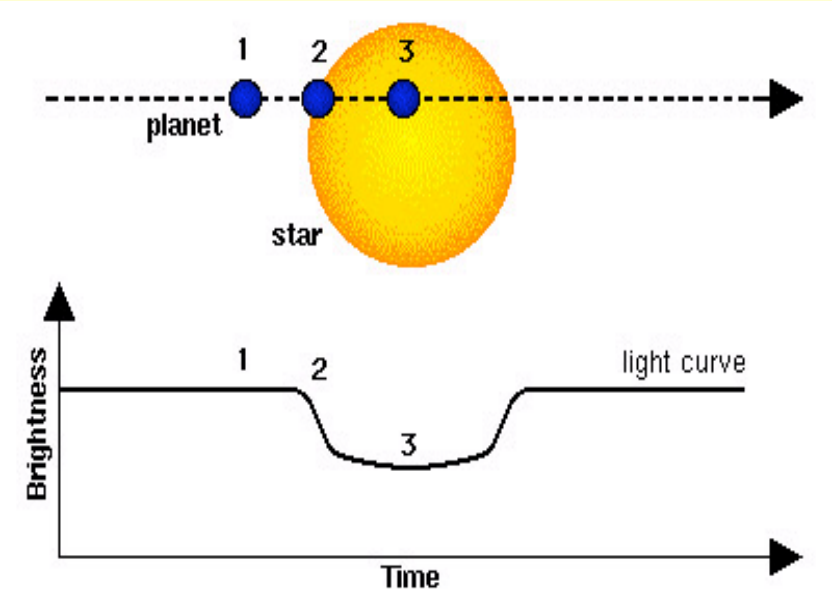
Topics

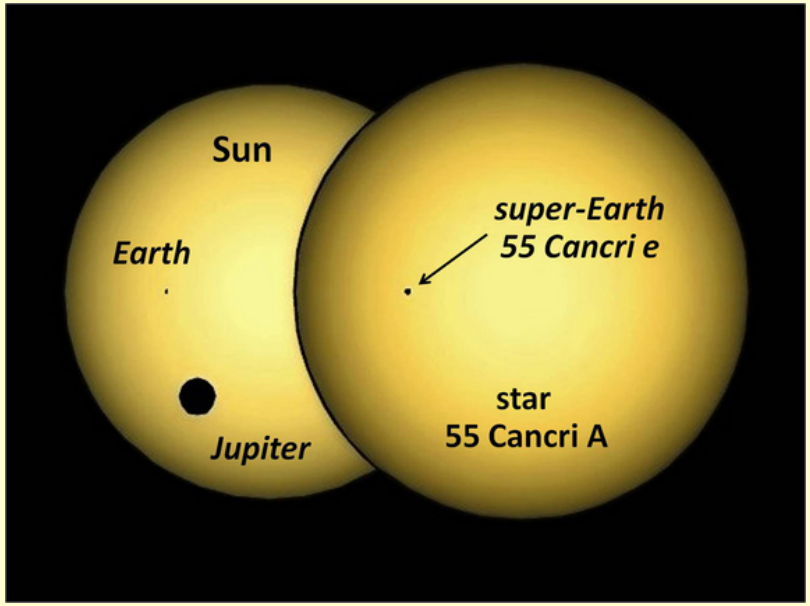
- Why we chose Dome A?
- Recent progress and results.
- Plan in the coming future.

Why Dome A—transit survey



- Transit is one of the most effective way to detect exoplanet
  - High photometric precision: stable、clean, instrument
  - Continuous observation: site, weather, instrument





$$f \sim (\frac{R_p}{R_*})^2$$

- Dome A is a very good photometric observation site

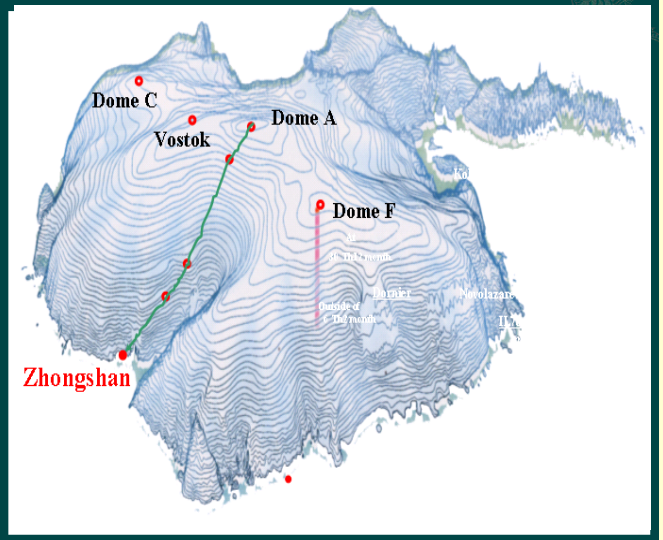
High elevation，low temperature，shallow turbulence layer

- **stable**
- **Low extinction**

Dome A

- Position:
  - 80.3° S, 77.5° E
- Temperature:
  - Mean: ~50° C
  - Lowest: ~80° C
- Altitude:
  - 4093m

(Dome C: 3250m)



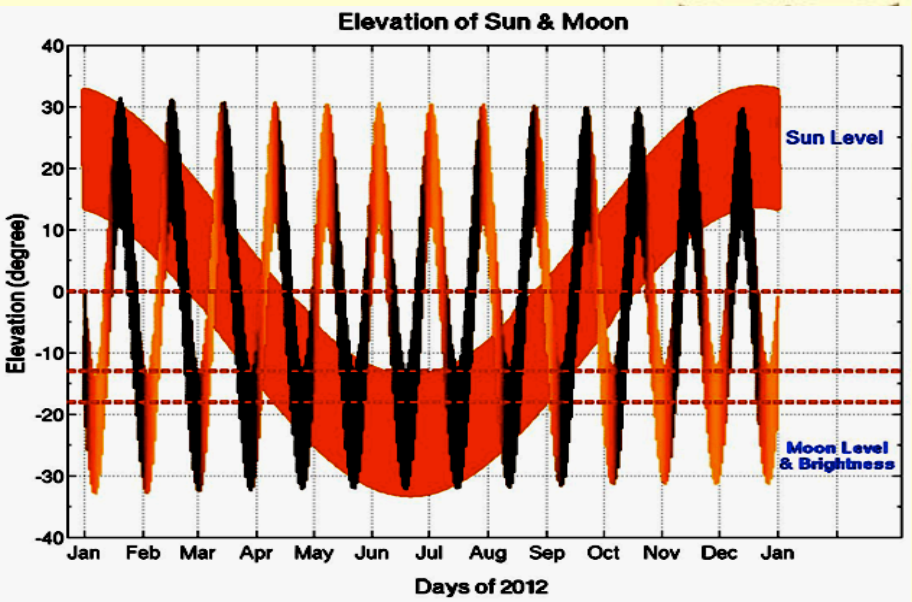
Will Saunders et al, 2009

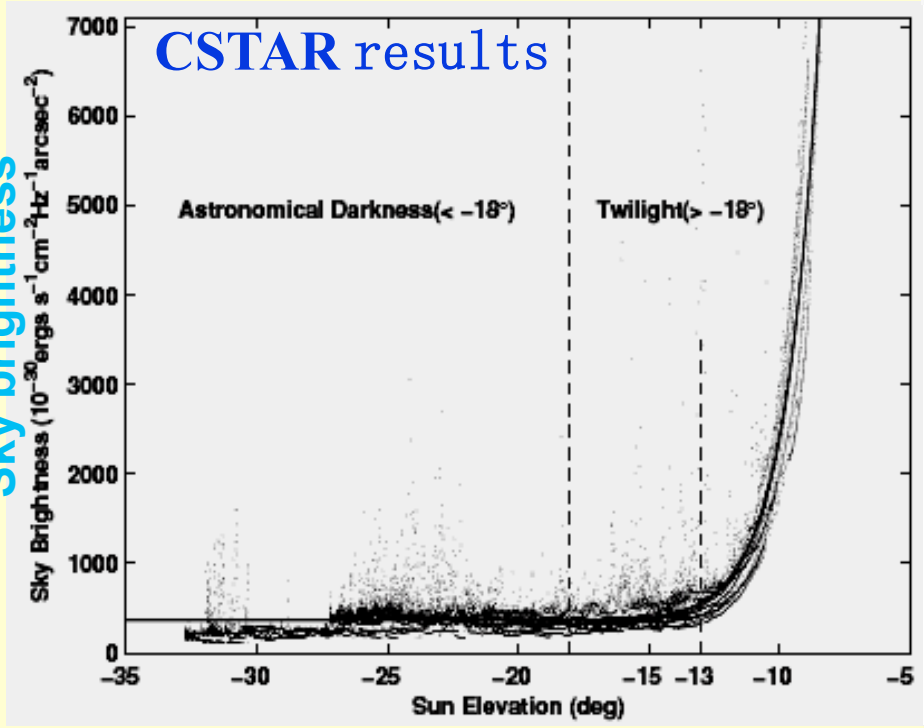
Sky brightness in *i* band

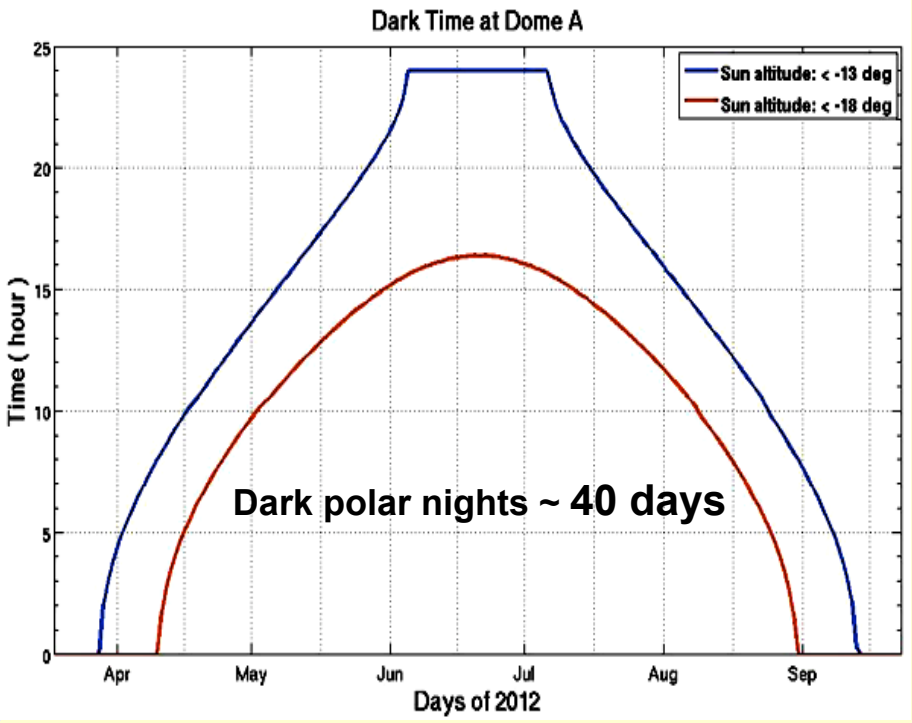
Dome A		20.5	
La Palm	20.10	Cerro Tololo	20.07
Paranal	19.93	Calar Alto	19.57

Total valid time

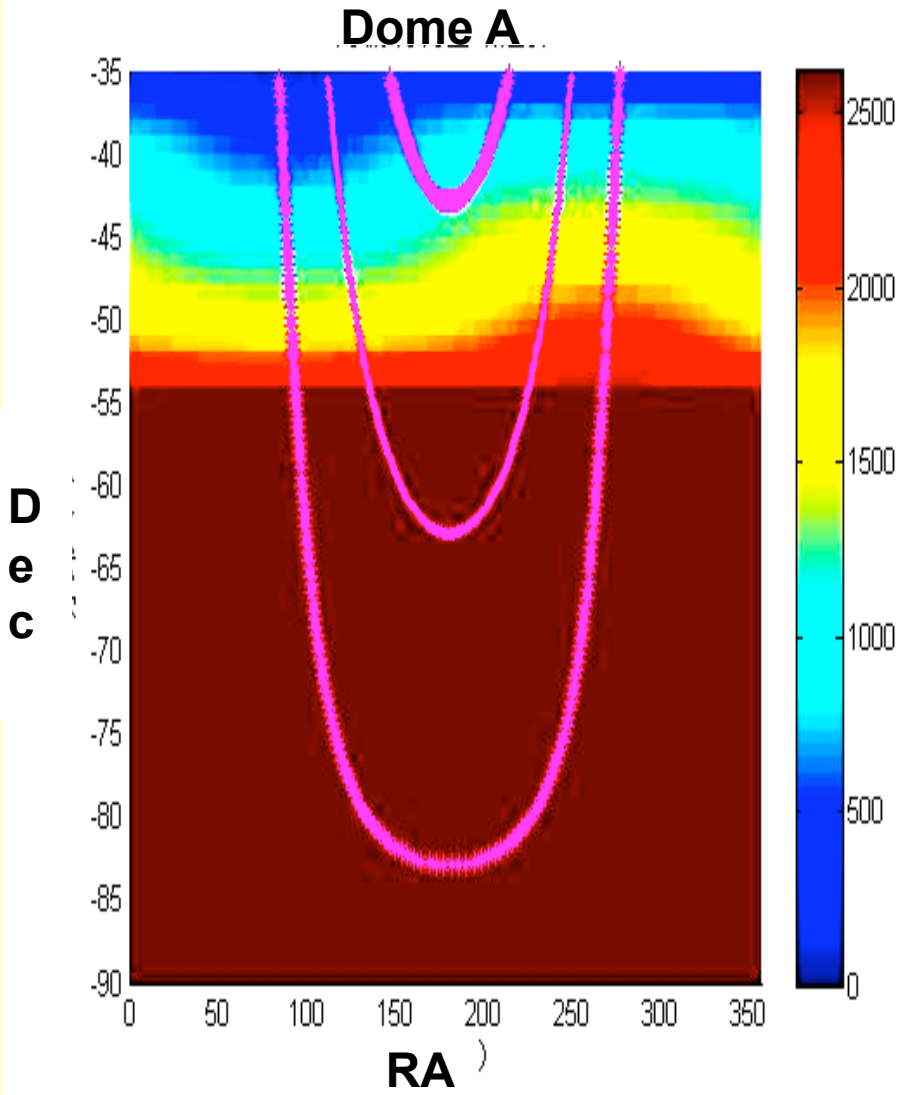
Polar night ~ 40 days
(hours / day > 18) ~70 days
(hours / day > 12) ~112 days

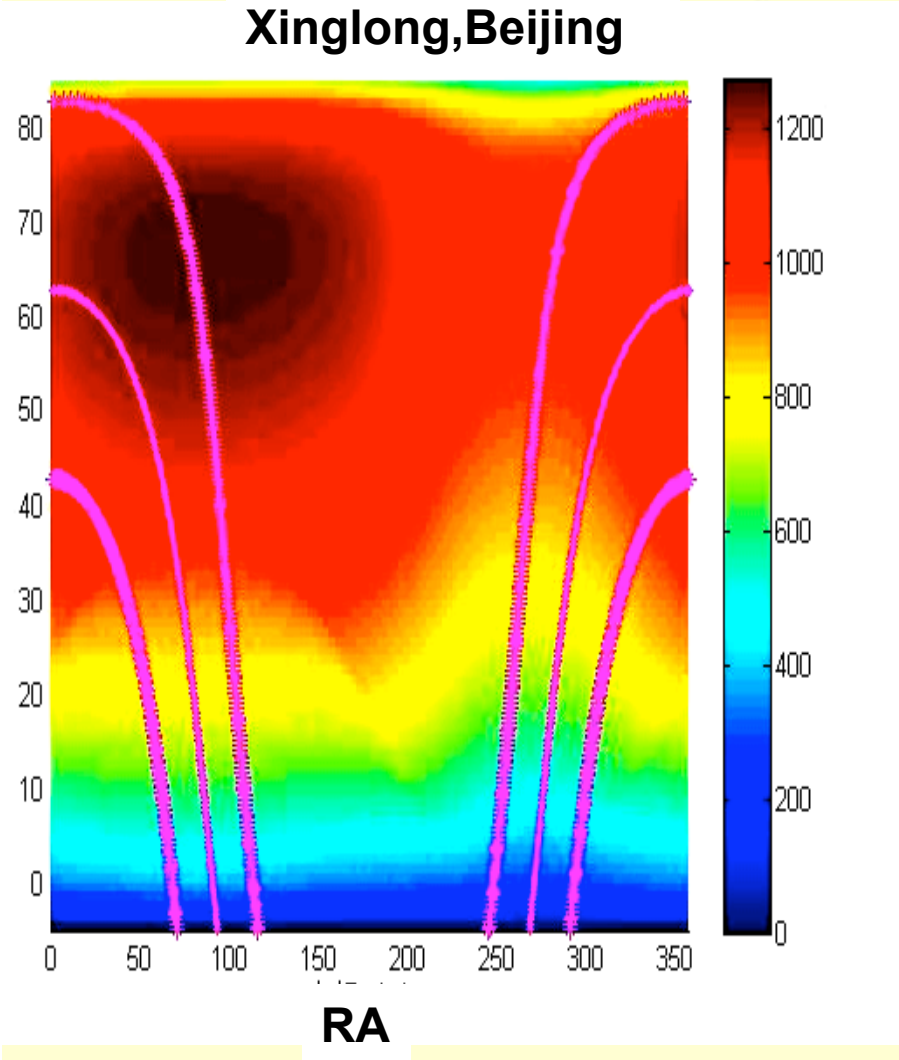




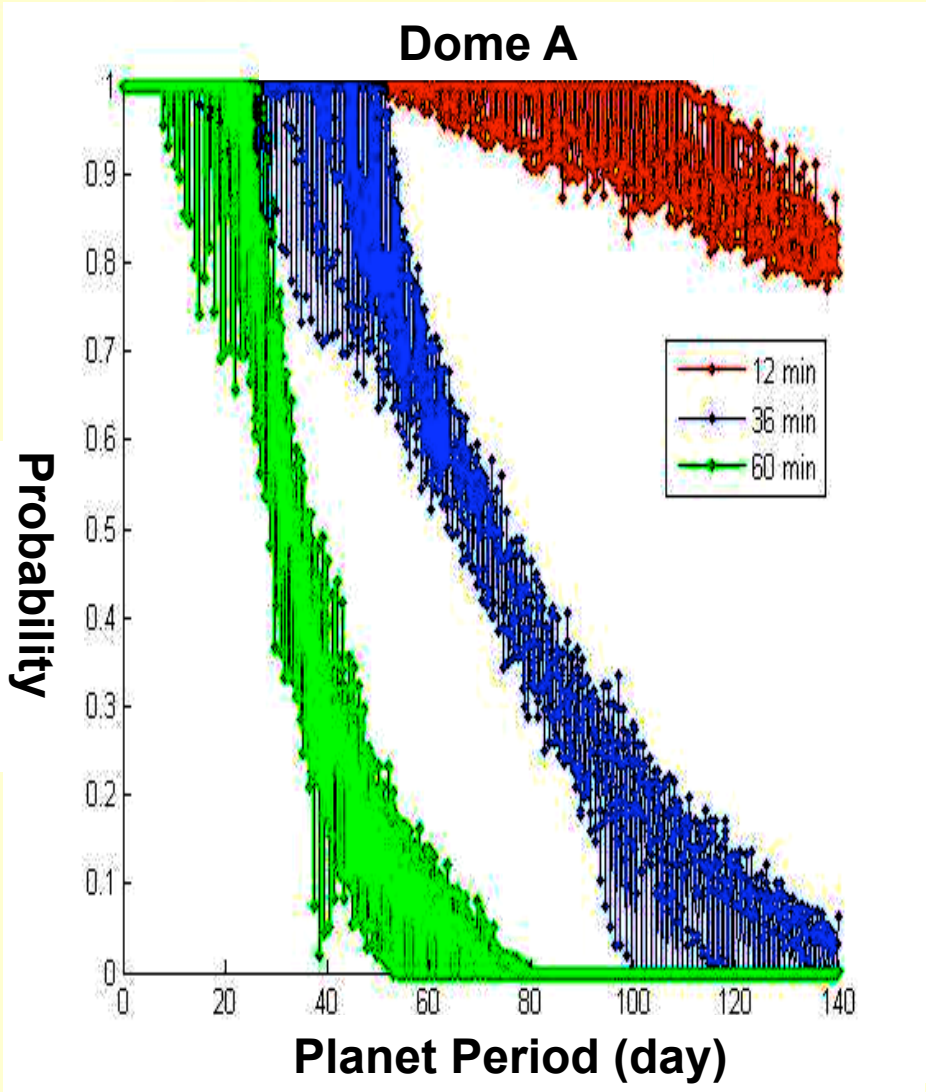


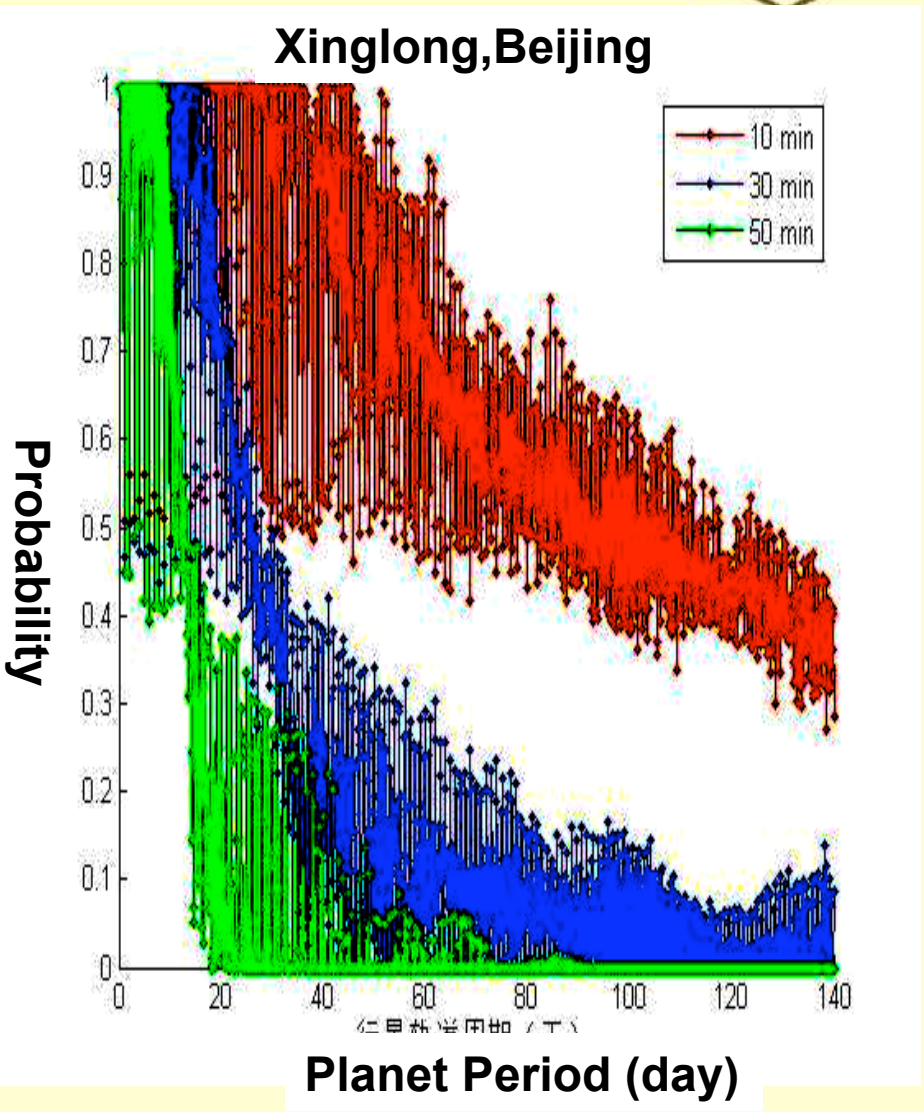
observable hours/yr





Detection Probability:1yr's continues observe





progress

Chinese Small Telescope Array

- **CSTAR （2008）**

➢**aperture: 4x10cm， Schmidt Telescopes**

➢**FOV : 4.5 x 4.5 sq. degree**

➢ **bands: open, g, r, i**

➢**Fully automatic, fixed to point the south-pole**

Use CSTAR 2008 catalog

- SDSS *i*-band
- Whole Antarctic winter
- 20-30s
- <14m_i
- 300,000 frames
- 10,000 light curves
- rms 2%～3%

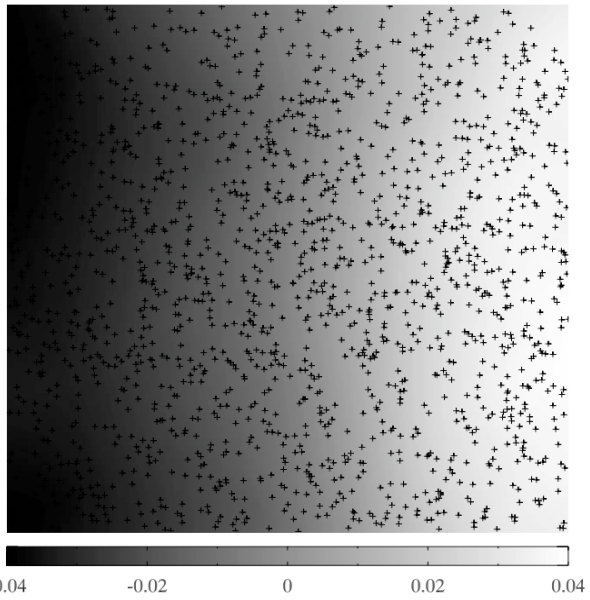
TABLE 1

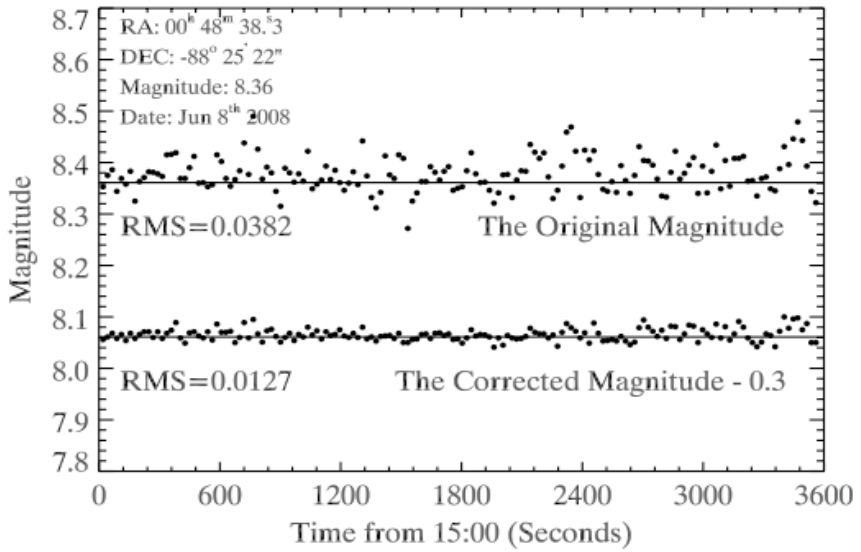
PHOTOMETRY OF SEVERAL SOURCES IN THREE DIFFERENT APERTURES;
CATALOG HEADER: −59 2008 JUNE 02 22:50:42.20 20 *i* 10398 154.954086

Number	R.A. (J2000)	Declination (J2000)	*M*1 (r = 3 pixel)	σ1	*M*2 (r = 4 pixels)	σ2	*M*3 (r = 5 pixels)	σ3
277	23:23:46.274	−89:25:17.81	11.095	0.022	11.011	0.022	10.838	0.025
278	10:43:24.023	−88:42:00.78	11.099	0.026	11.048	0.022	11.013	0.022
279	16:13:39.187	−87:44:30.11	11.100	0.026	11.030	0.022	11.014	0.022
280	14:09:08.706	−89:07:12.63	11.100	0.026	11.035	0.022	10.987	0.022
281	13:46:15.127	−88:26:01.94	11.100	0.026	11.013	0.022	10.885	0.025
282	17:54:27.175	−89:42:21.70	11.103	0.026	11.065	0.022	11.032	0.022

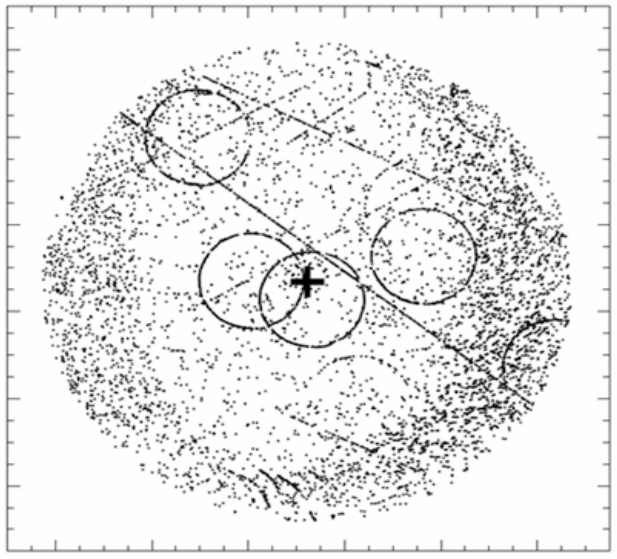
NOTE.—Catalog header parameters are decoded as: CCD temperature (°C), date, exposure time (in seconds), the number of sources detected in the image, day of the year during 2008. The catalogs can be downloaded from National Astronomical Observatories Science Data Center, Chinese Academy of Science at http://archive.bao.ac.cn/en/cstar.

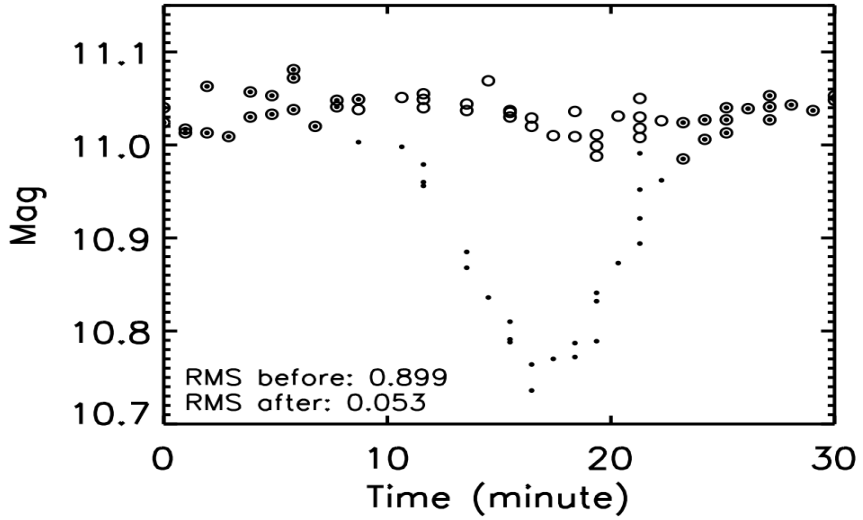
Zhou X. et al. 2010



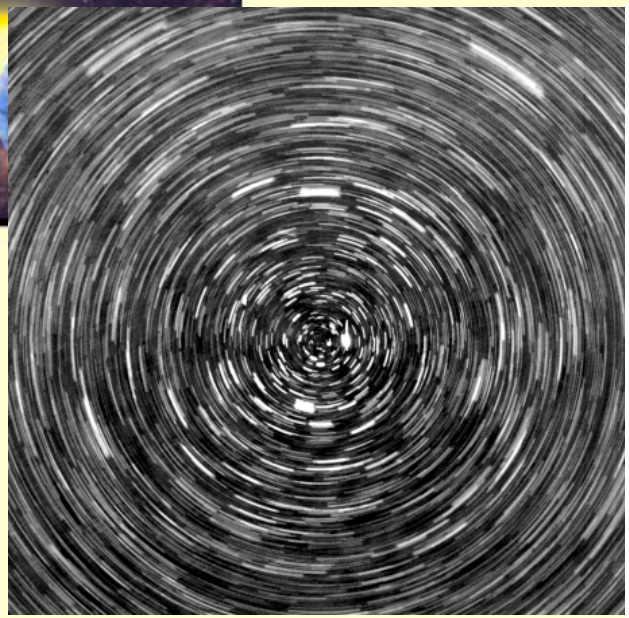


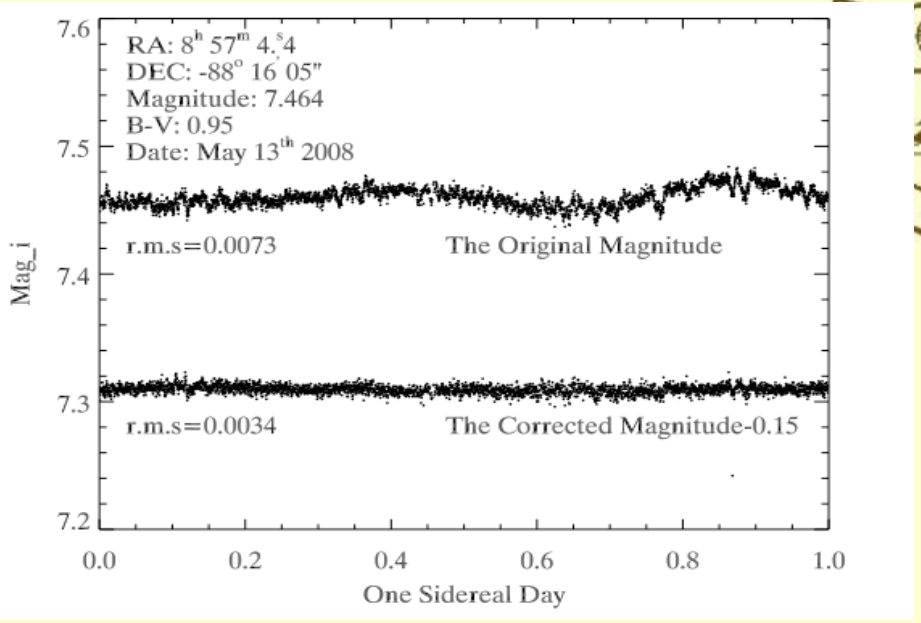
1. Correction for the inhomogeneous extinction（ Wang et al. 2012 ）





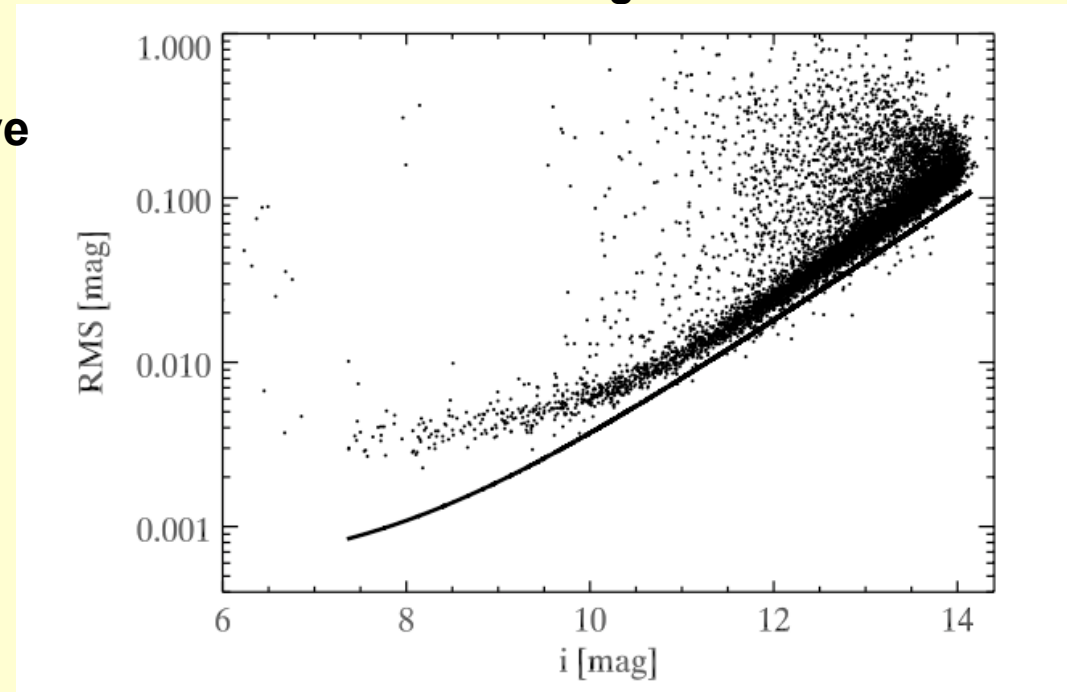
2. Correction for the ghost images（ Meng et al. 2013）





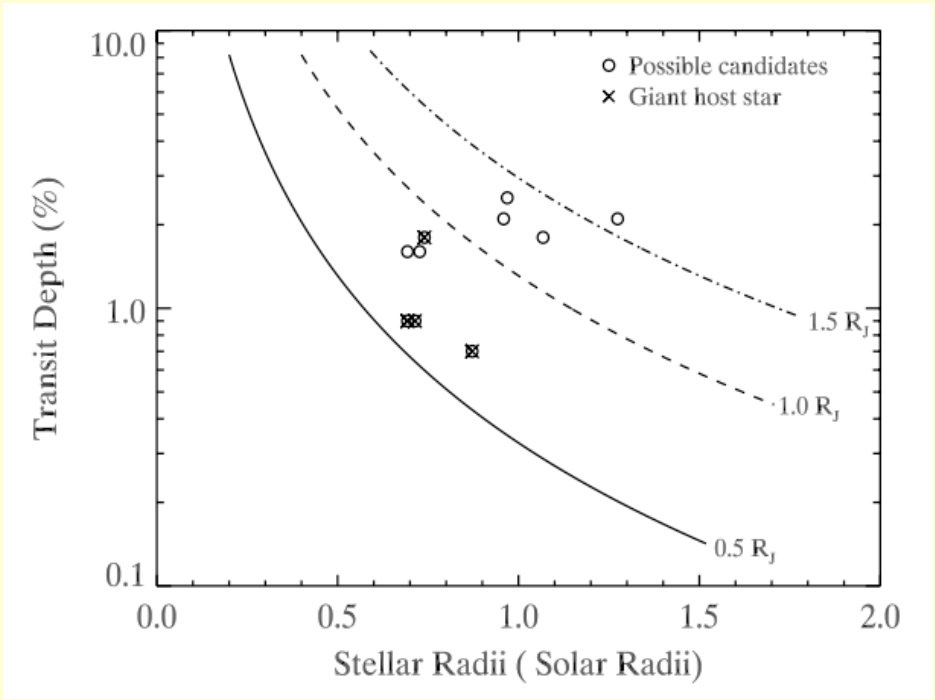
3. Correction of the movement of stars within the FOV（ Wang et al. 2014 ）

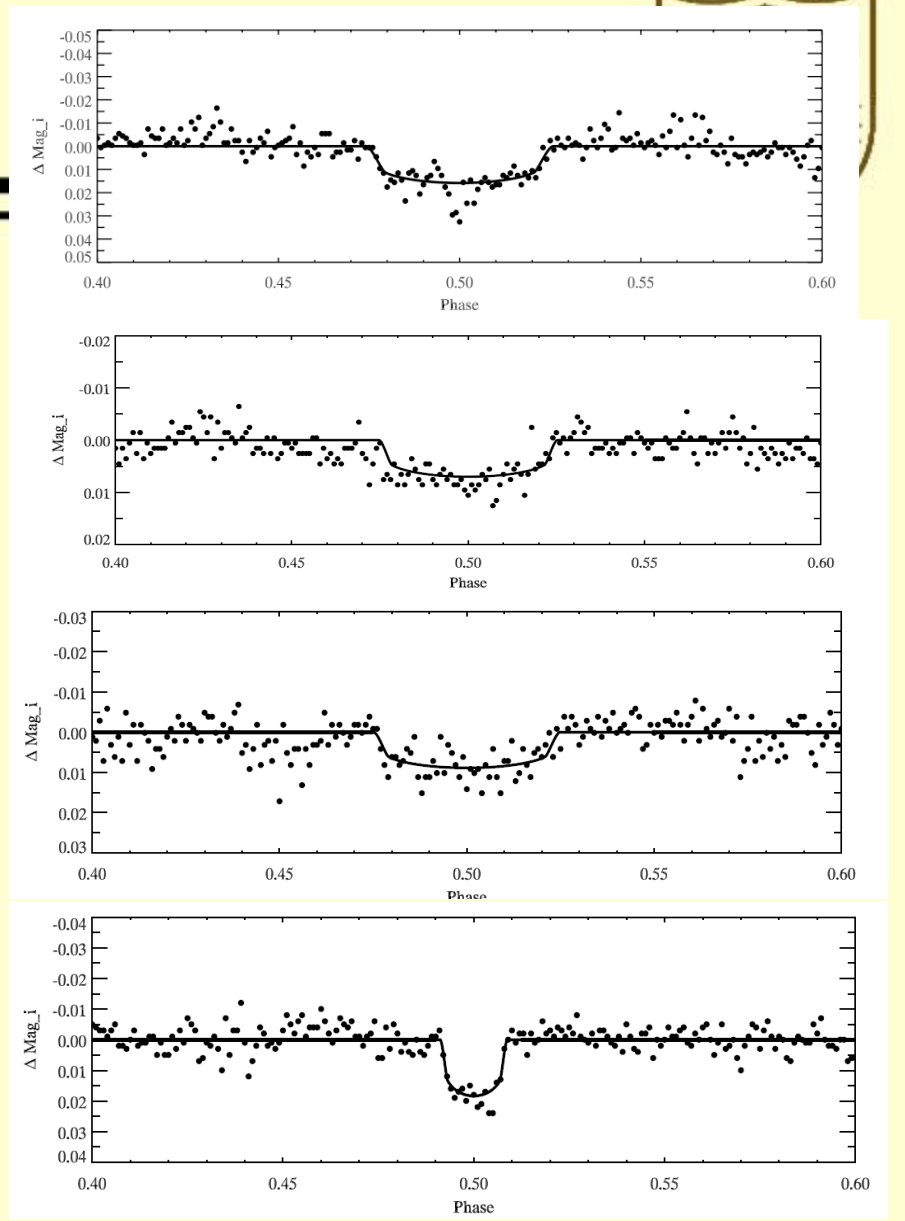
After corrections, we achieve 0.4% at the bright end



- We found six exoplanet candidates

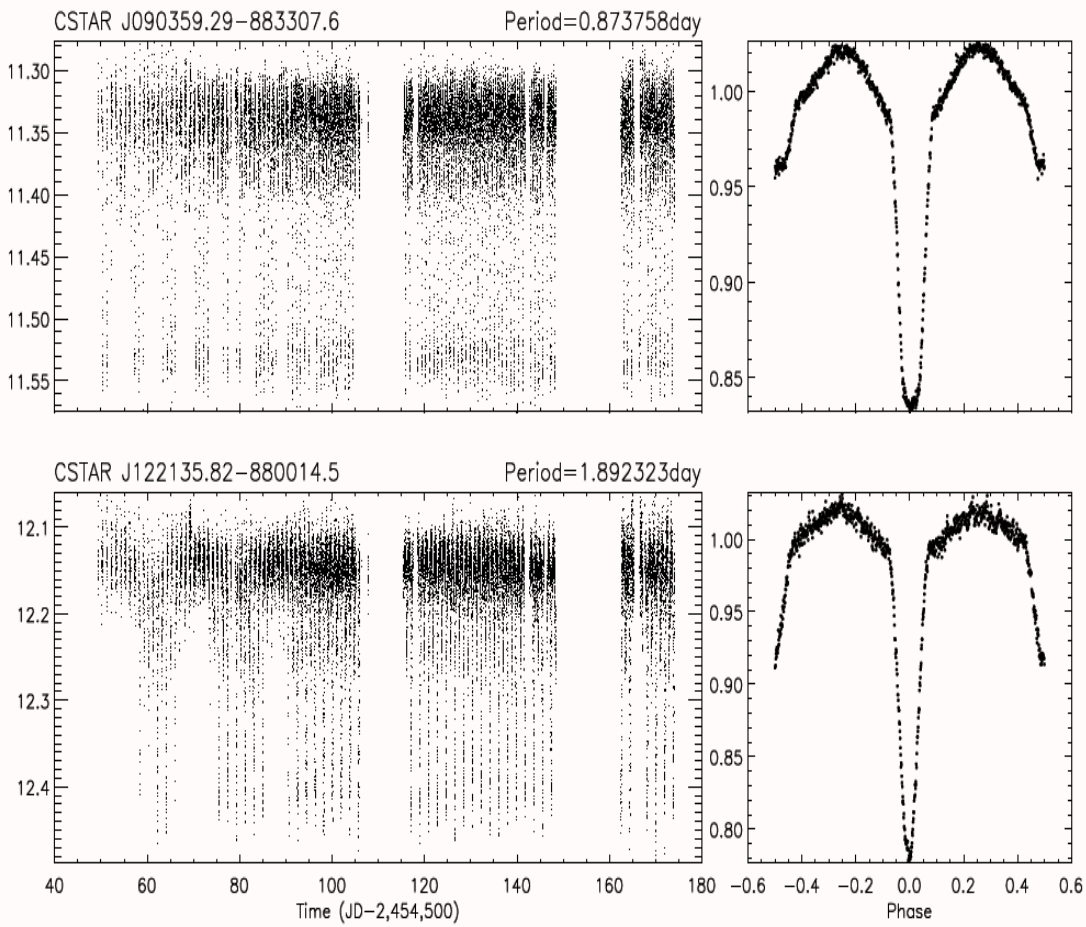
Wang et al. 2014，ApJS

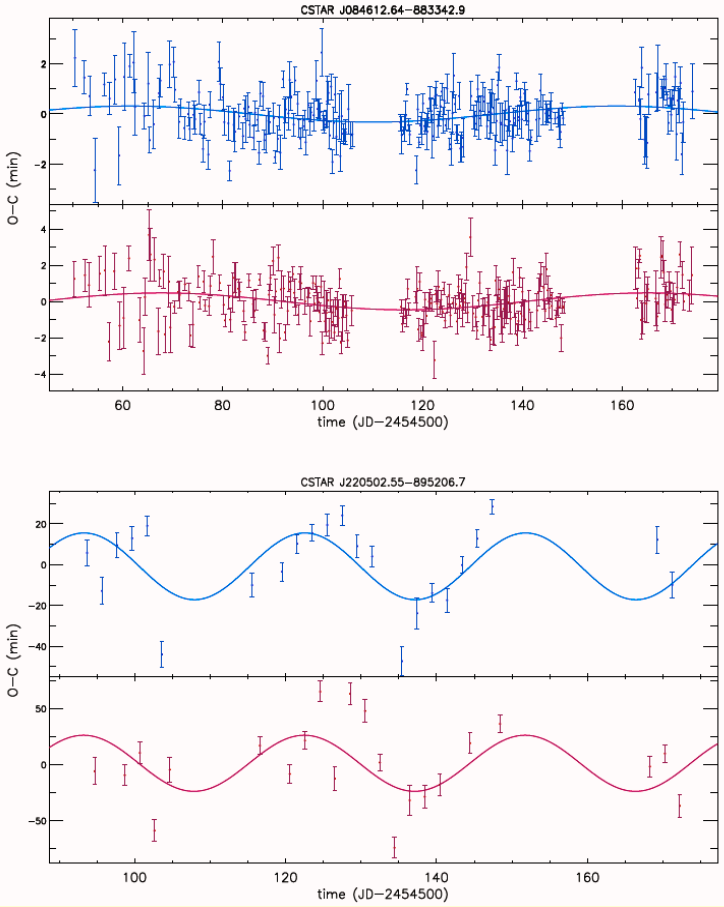




- We found 45 eclipse binaries

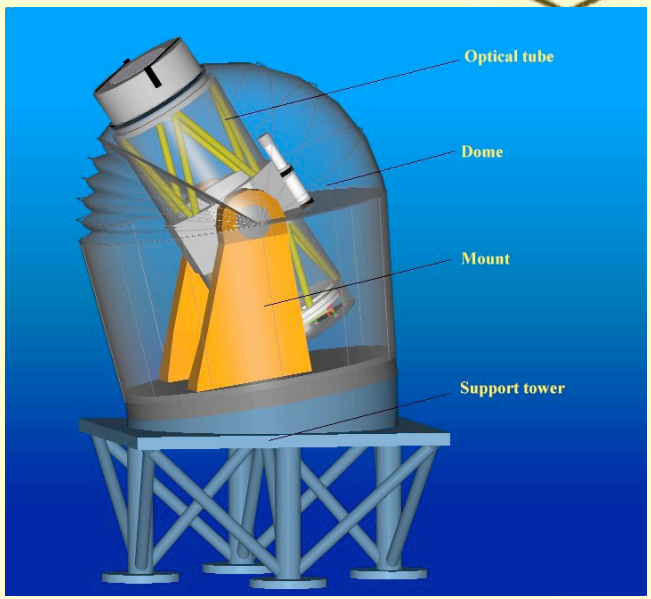
19 detached，6 semi-detached，20 contacted，ETV analysis show 2 systems may have companions. Yang et al. 2014，in preparation





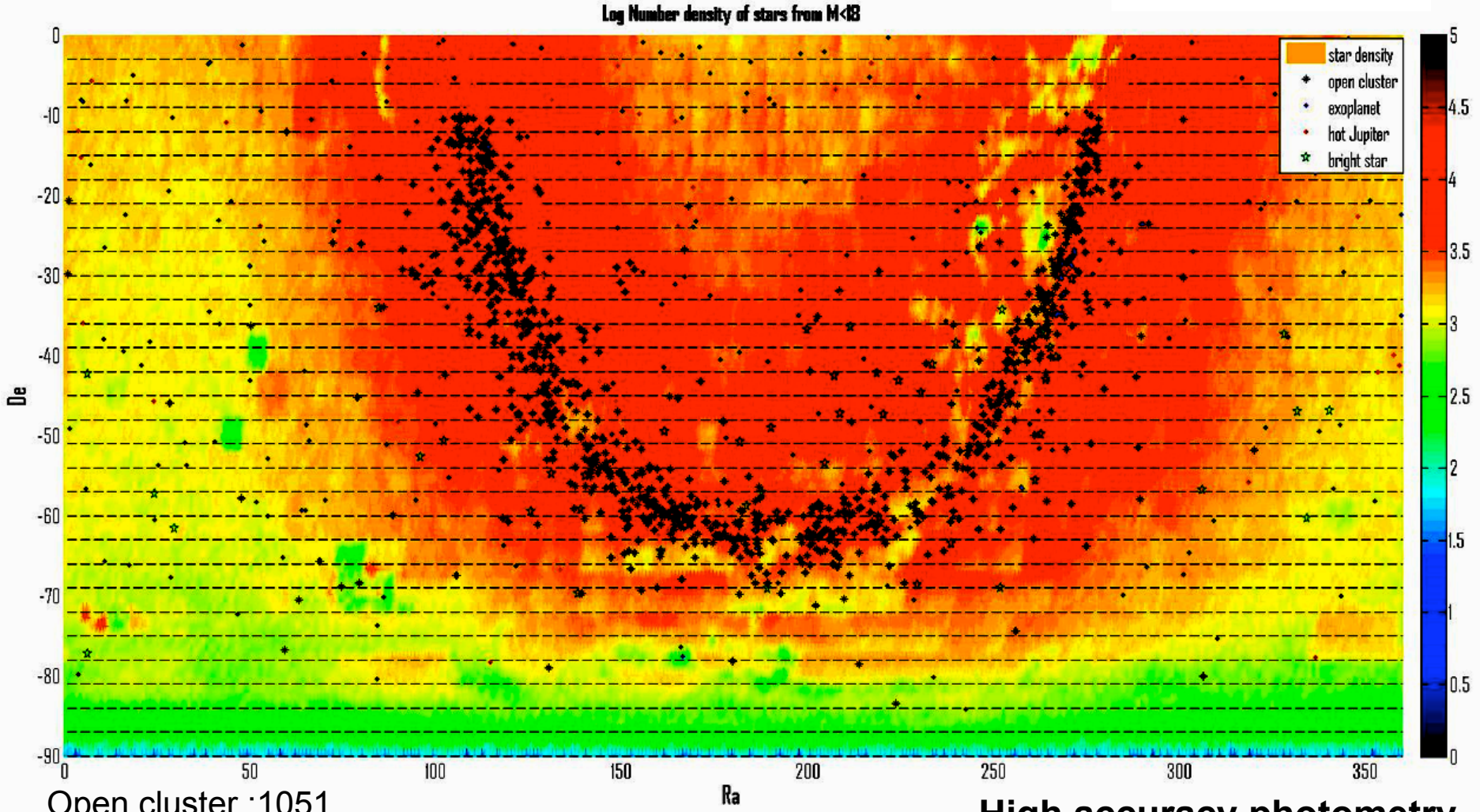
- So, what's Next?

Antarctic Schmidt Telescopes(AST3)



- **50cm, 10Kx10K CCD**
- **Ia Sne & dark matter;**
- **exoplanet;**
- **Variable stars;**
- **Stellar seismology;**

Overview of the south sky



Open cluster :1051

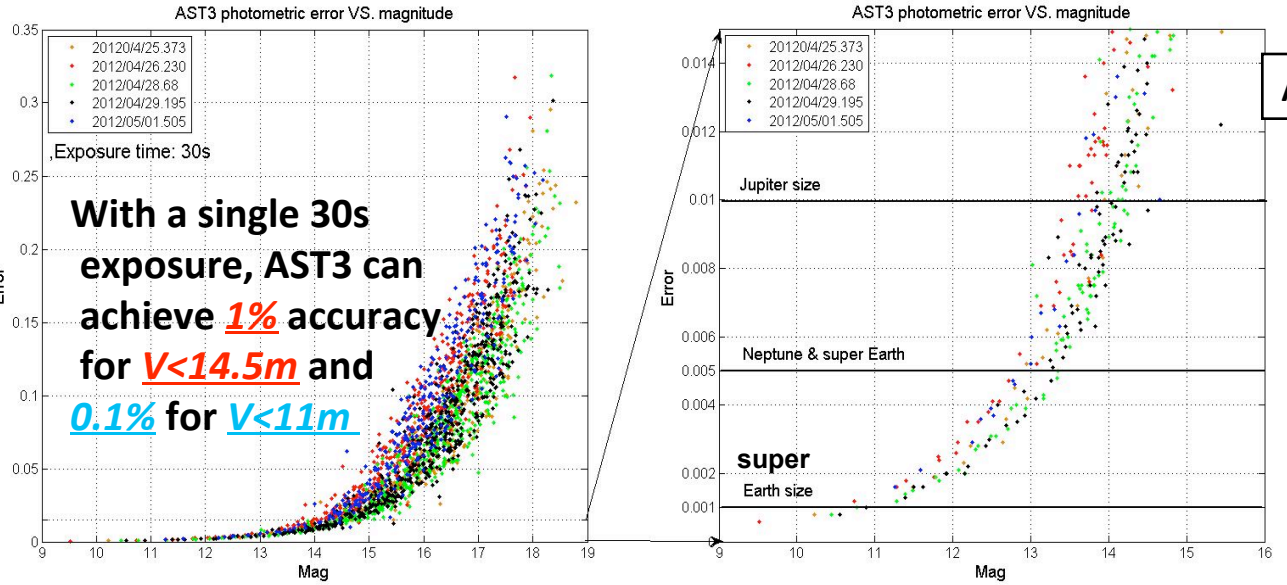
Exoplanet: 374; Dec > South 60 → only 60 exoplanets

Hot Jupiter : 53; Dec > South 60 → only 9 hot Jupiters

High accuracy photometry survey on high latitude southern hemisphere is needed

AST3 exoplanet survey can help to fill this deficit

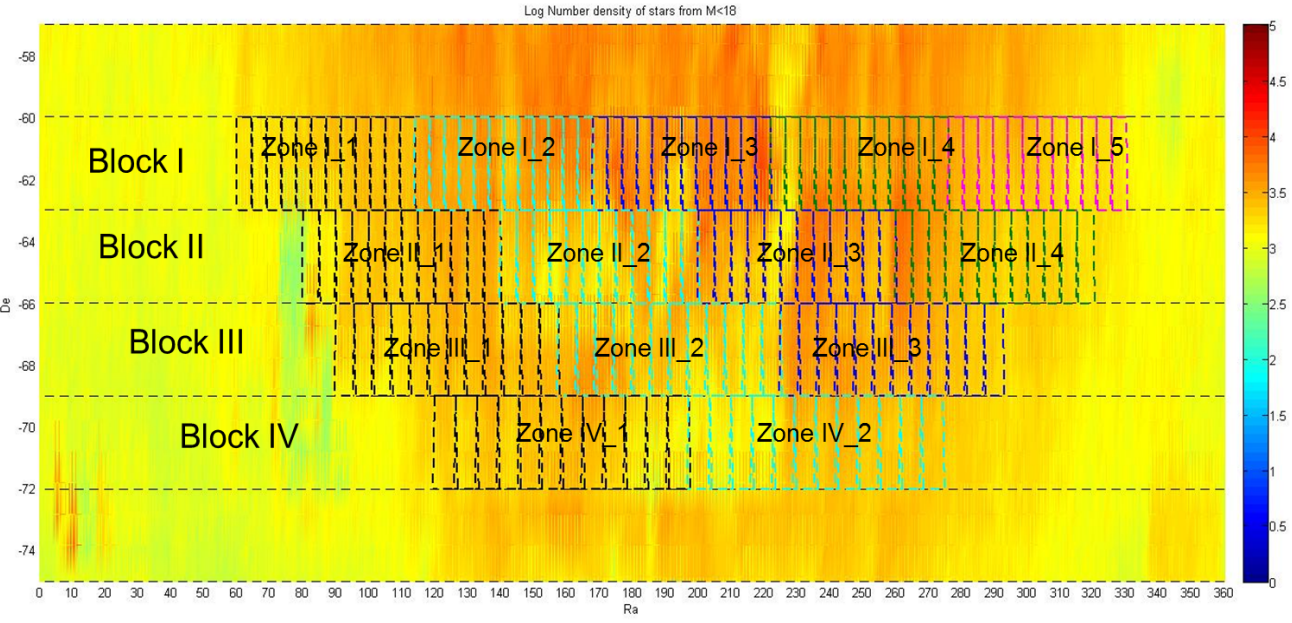
1 Transiting candidates expected by AST3



According to Kepler's results:

Photometric accuracy	Frequency of Exoplanet
1%	0.047%
0.5%	0.085%
0.1%	0.28%

Exoplanet searching area: cover 900,000 objects(8m -14.5m)

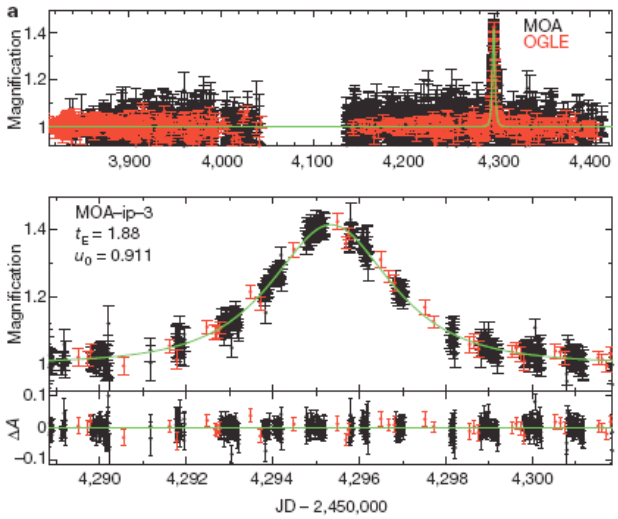


Total candidates expected:
90days/year, 5-10years

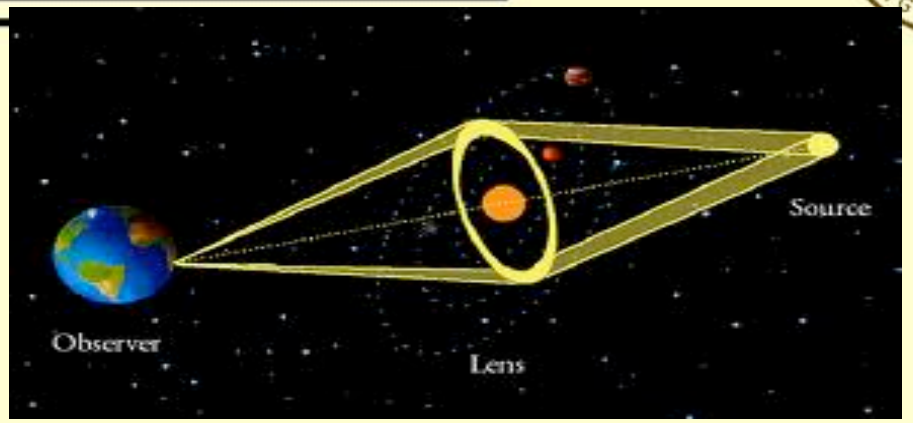
Planet size	Expected number
>Jupiter	> 400
Neptune - Jupiter	~ 250
Neptune	~ 150
Total	> 750

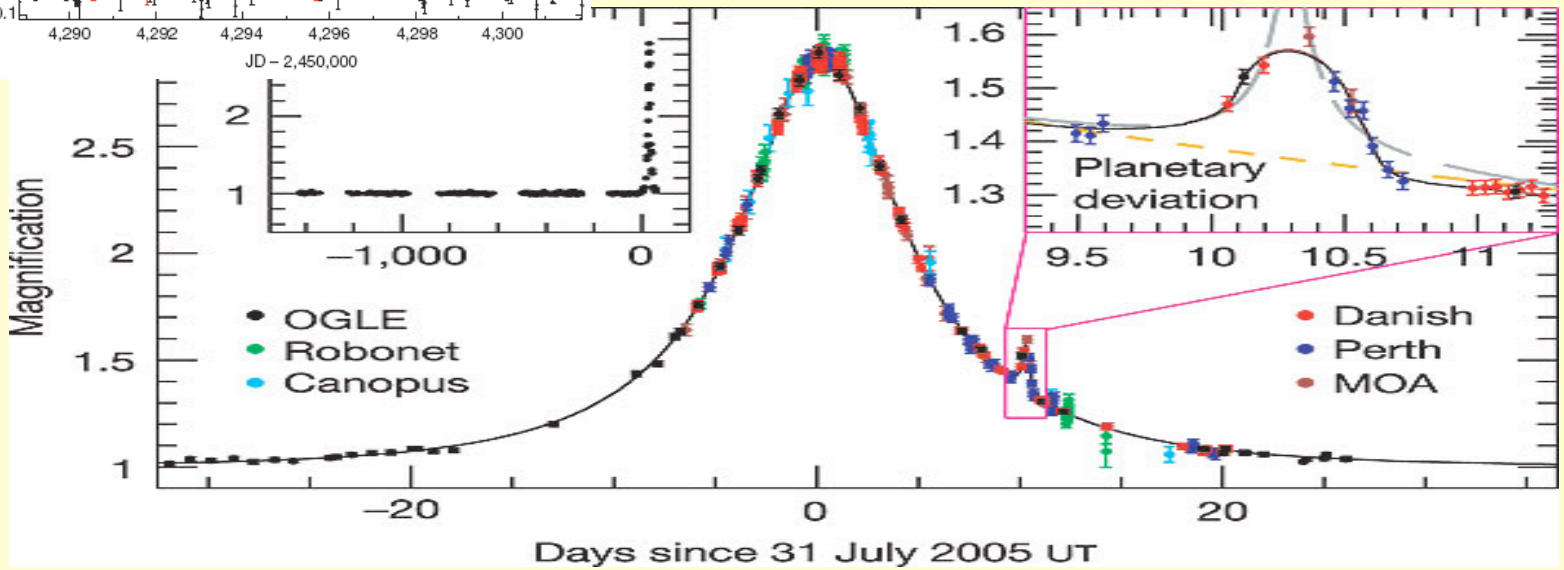
Microlensing

RESEARCH LETTER



Free floating planets





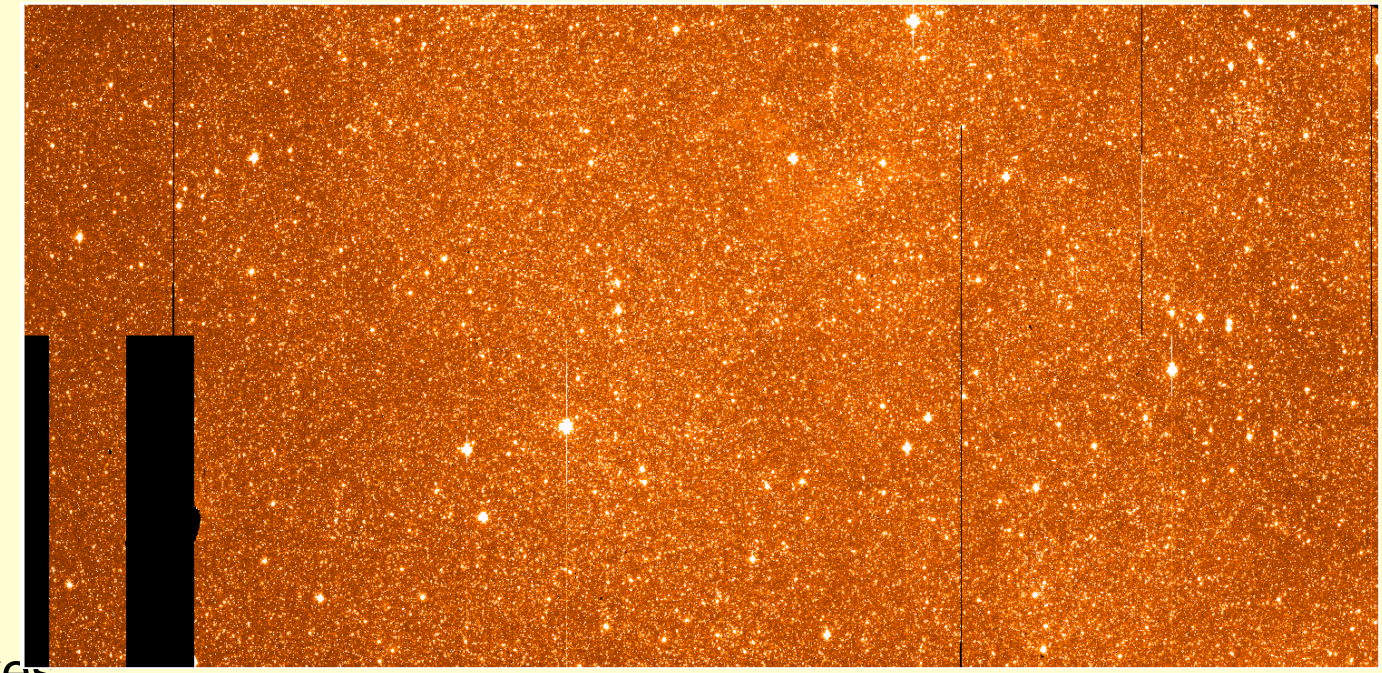
The observed light curve of the OGLE-2005-BLG-390 microlensing event

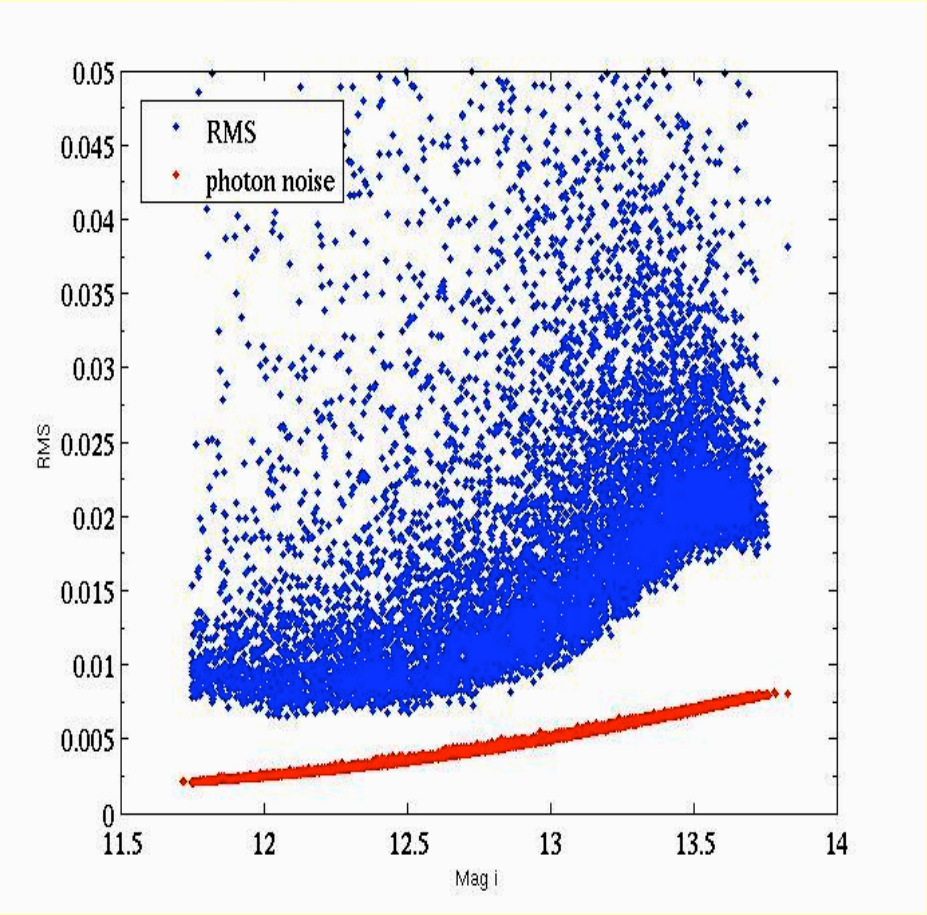
- **AST3-I （2012）**

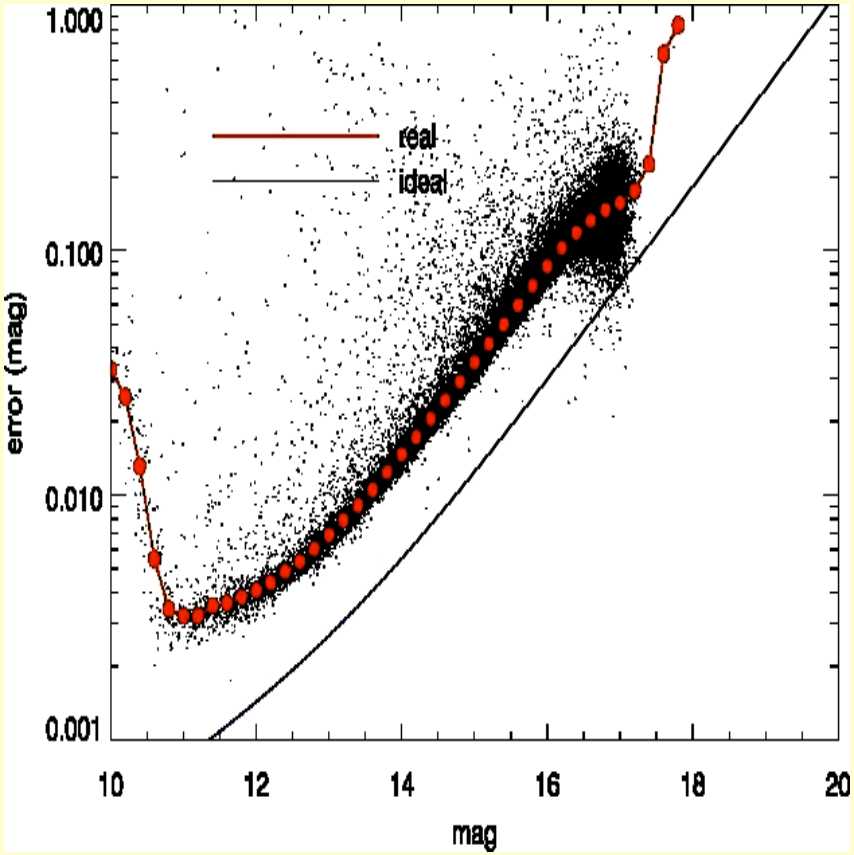
- **aperture: 50/68cm modified Schmidt Telescopes**
- **FOV : 4.2 sq. degree**
- **bands: 400nm-900nm, g, r, i filters**
- **remote control, tracking**

AST3-I 2012 raw data

- SDSS *i*-band
- 2012/03/15 ~ 2012/05/08
  - SN template
  - LMC & SMC
  - Transit search
    (04/25~05/01)
  - Variables
- 30s
- < 18m_i
- 1900frames
- pipeline
- 30,000 light curves





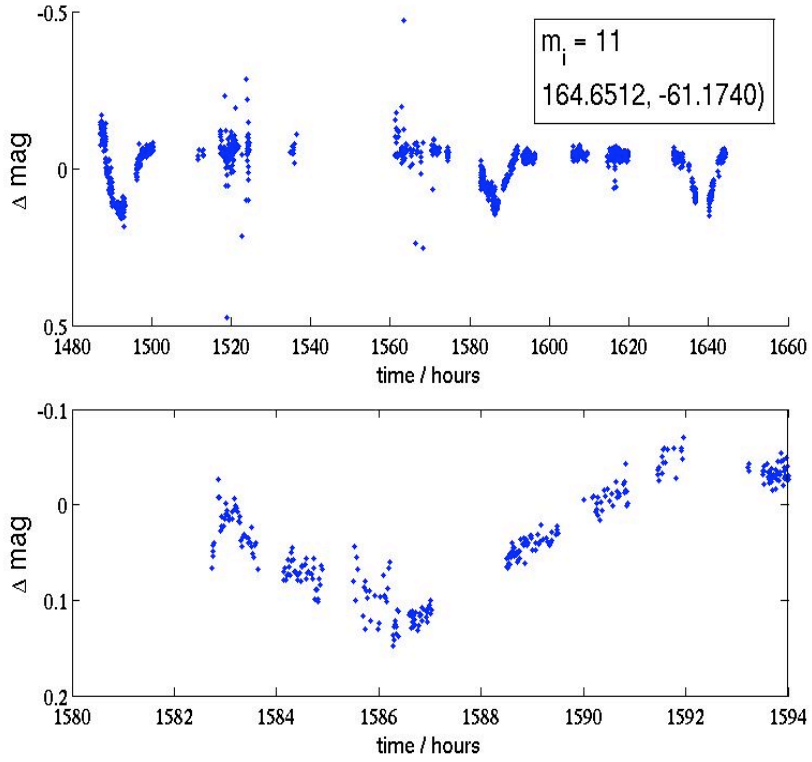


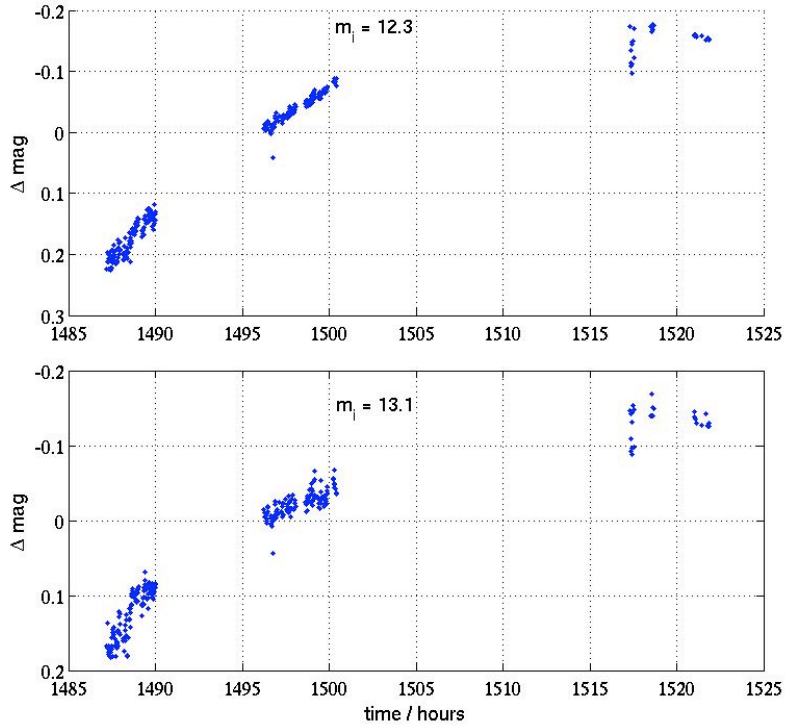
For crowed star field（11-13m_i）~ 0.6%

For normal star field（11-12m_i）~0.3%

(by Zhang H.)

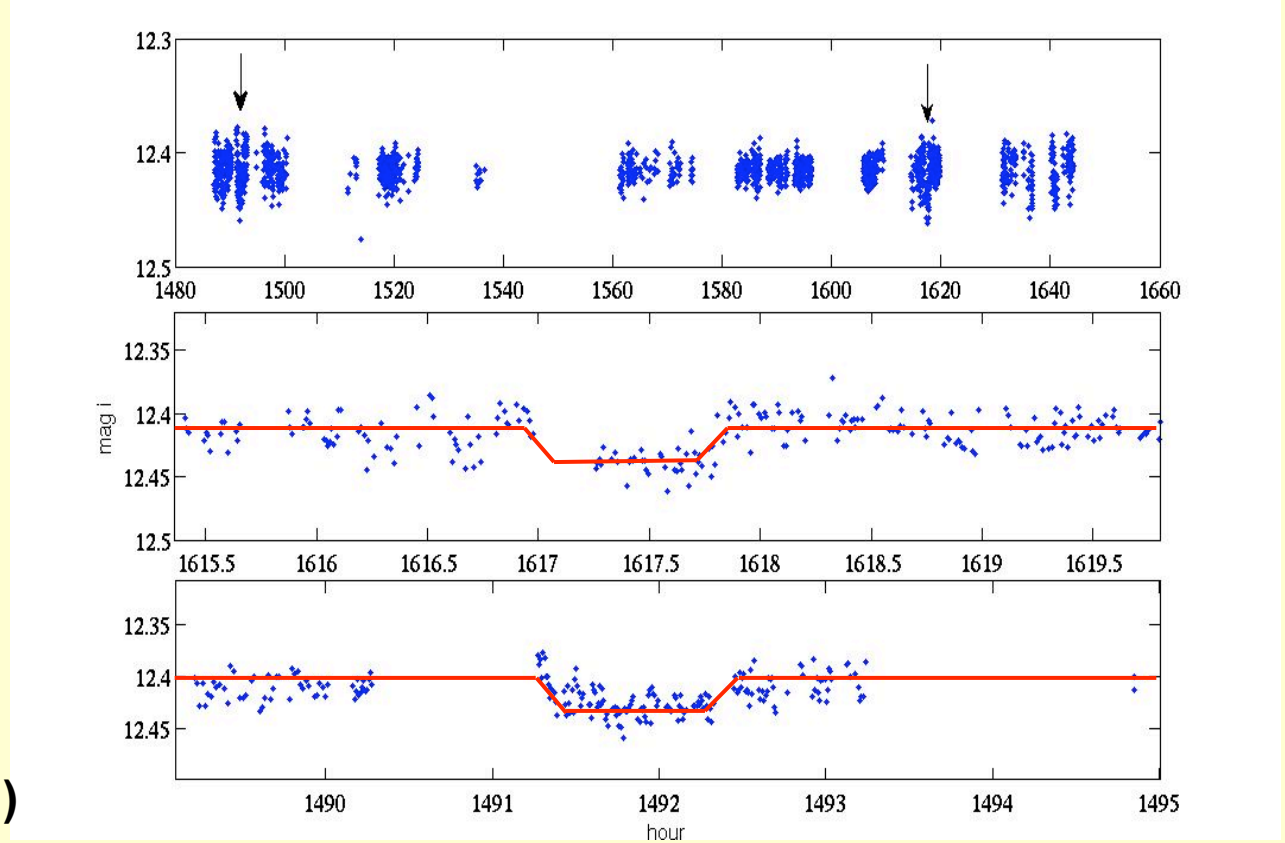
- Eclipse binaries and variables > 200





- Found 1 exoplanet candidate

depth：3%
period：～4days
duration：～1 hour



(by Zhang H.)

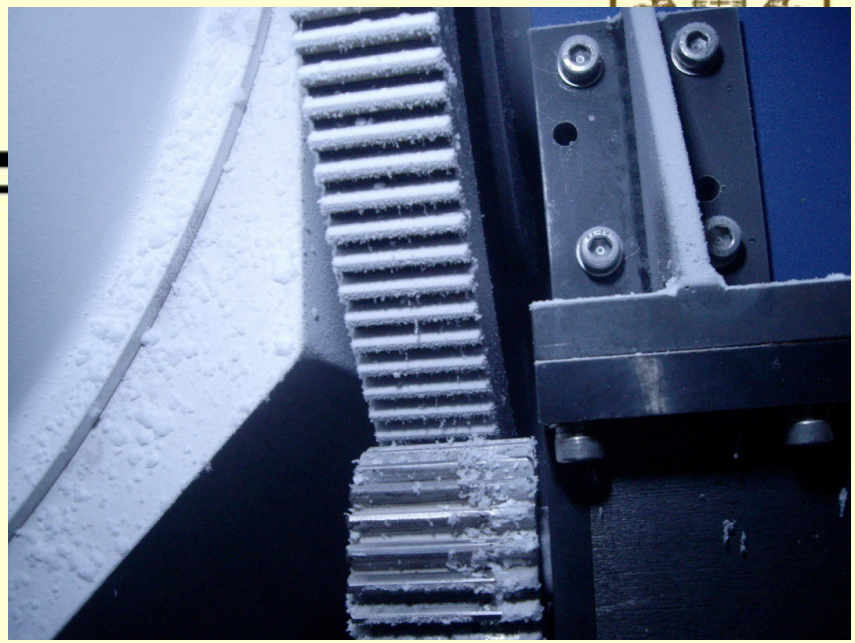
Coming soon…

- AST3-II (G-band)

Set up in 2015, update 2013, test observation at Mohe

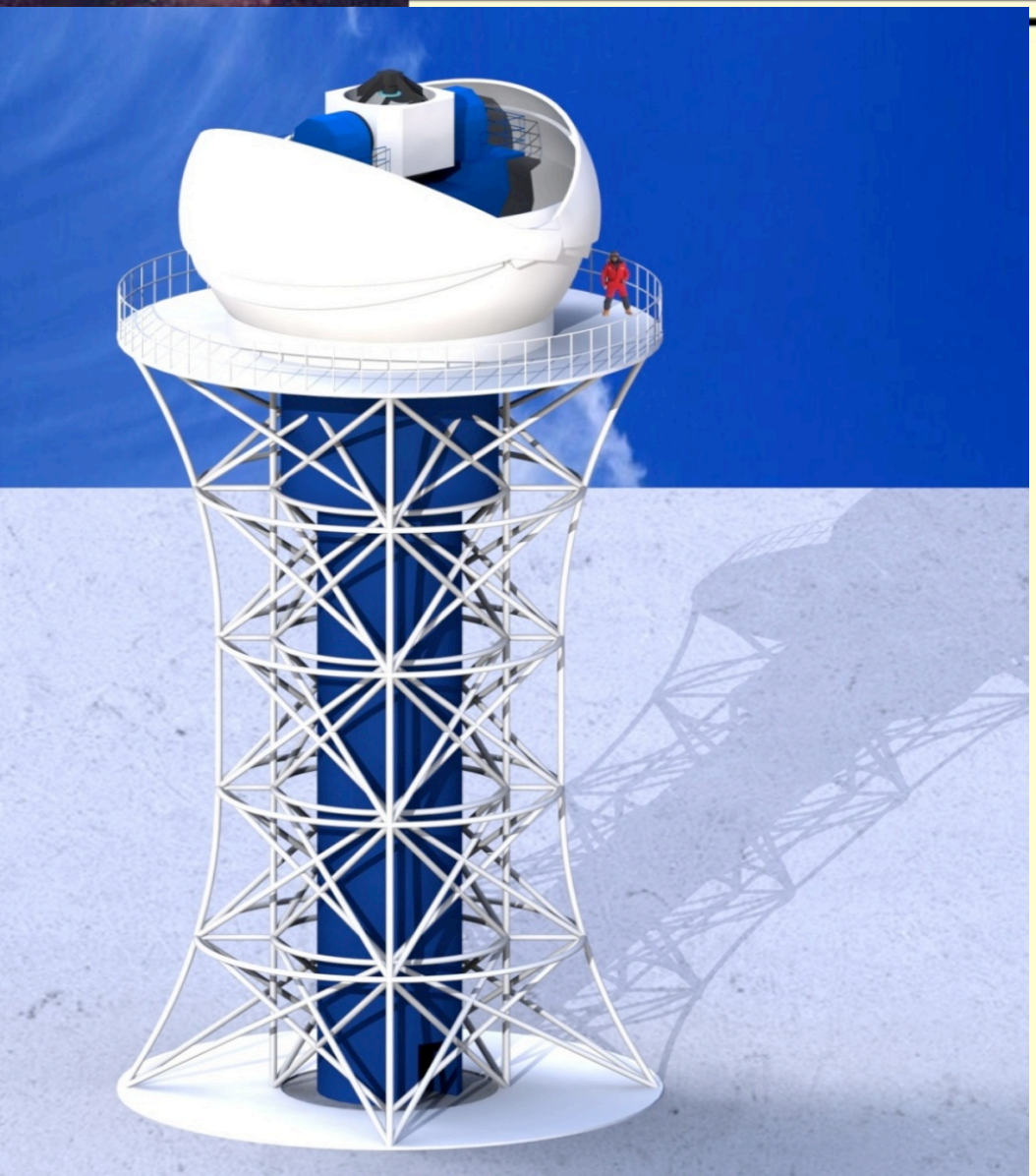
- AST3-III (NIR)

Set up in 2017



- So, what's next after next?

We are marinating that….



KDUST
(Kunlun Dark Universe Survey Telescope)
aperture: 2.5 m
(optical & Infrared)

Chinese Polar Astronomy Center
PI: Lifang Wang

Hubble FOV

KDUST FOV

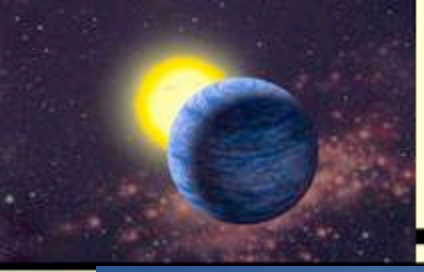
- Weak lensing
- Galaxy and back holes
- High Z- super Nova, gamma-ray
- Exoplanet characterization

Conclusions:

1. Dome A is one of the best sites for time-domain astronomy, especially for exoplanet transiting survey, micro-lensing…

2. However, as now it is fully ‘automatic’ site, we are still facing many challenges to make it work.

3. A successful transit survey on Dome A can complemental to some ground projects (e.g. WASP, HAT, NGTS, etc,) and space projects (TESS, PLATO) .



Thank you !