weak lensing cluster surveyで探る構造形成

(宇宙論・構造形成)

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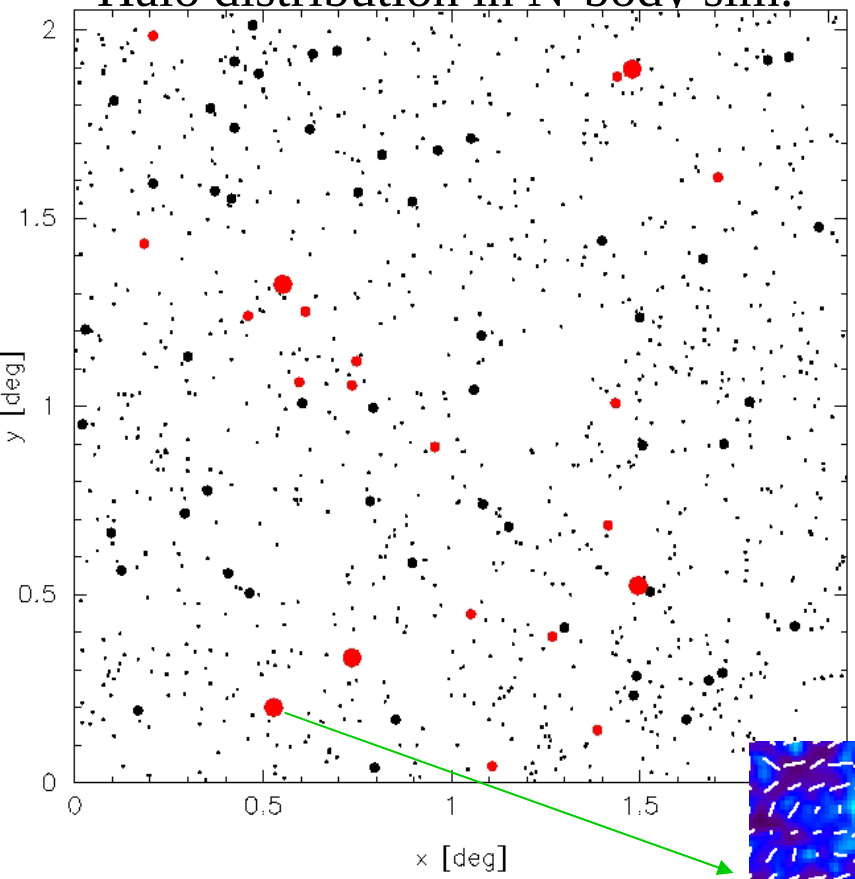
Weak lensing 銀河団探査の意義

- 質量でもって選択された銀河団カタログ
  - 構造形成シナリオの直接的検証
    - halo mass function, clustering
    - L-M relationや力学状態の仮定は不要
- dark matter分布の直接測定
  - 銀河団の構造の研究
    - 力学構造、dark matter profile
  - X線、可視光銀河surveyとの組み合わせ
    - Hot gasの物理状態
    - 銀河進化とdark matter

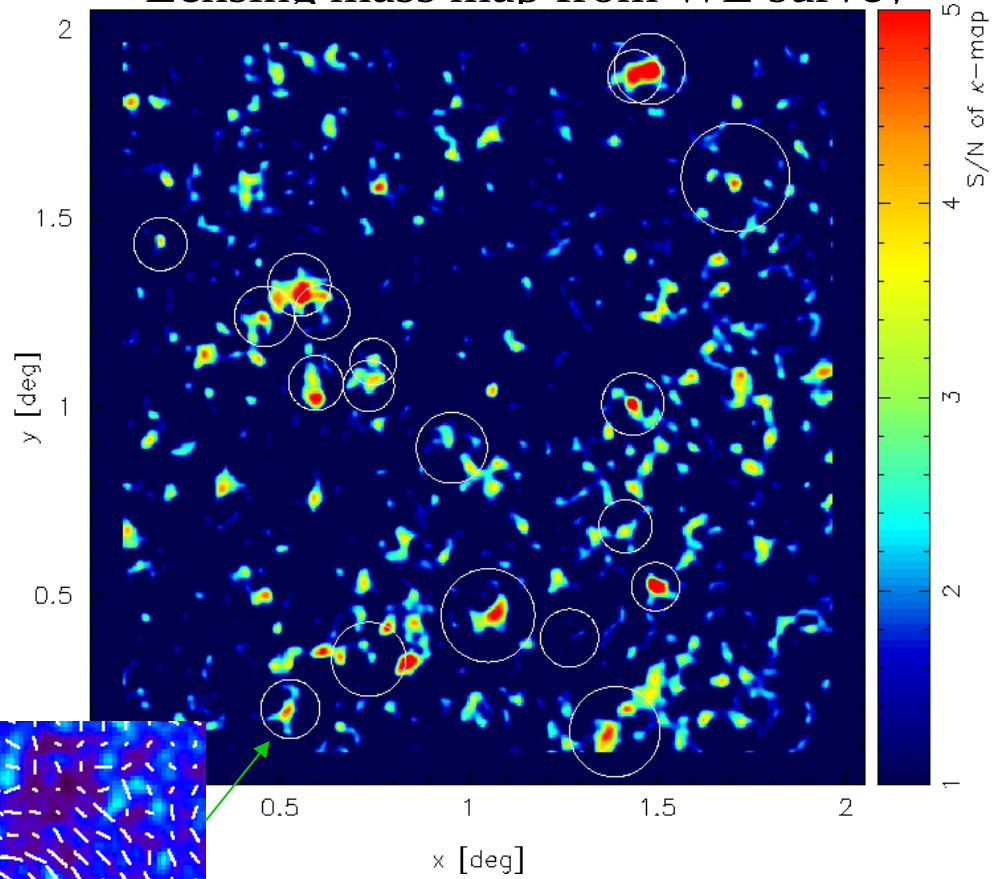
Mock numerical simulation

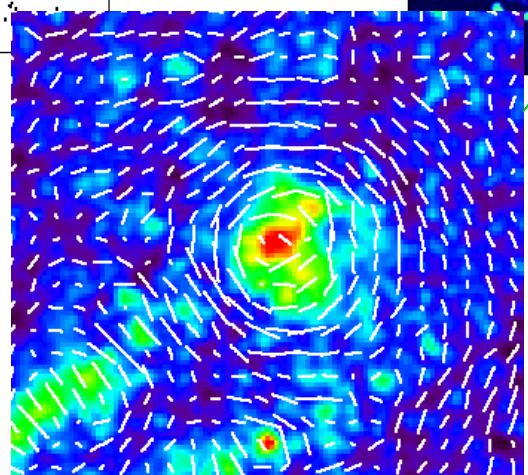
Hamana, Takada & Yoshida, (2004)

Halo distribution in N-body sim.



Lensing mass map from WL survey

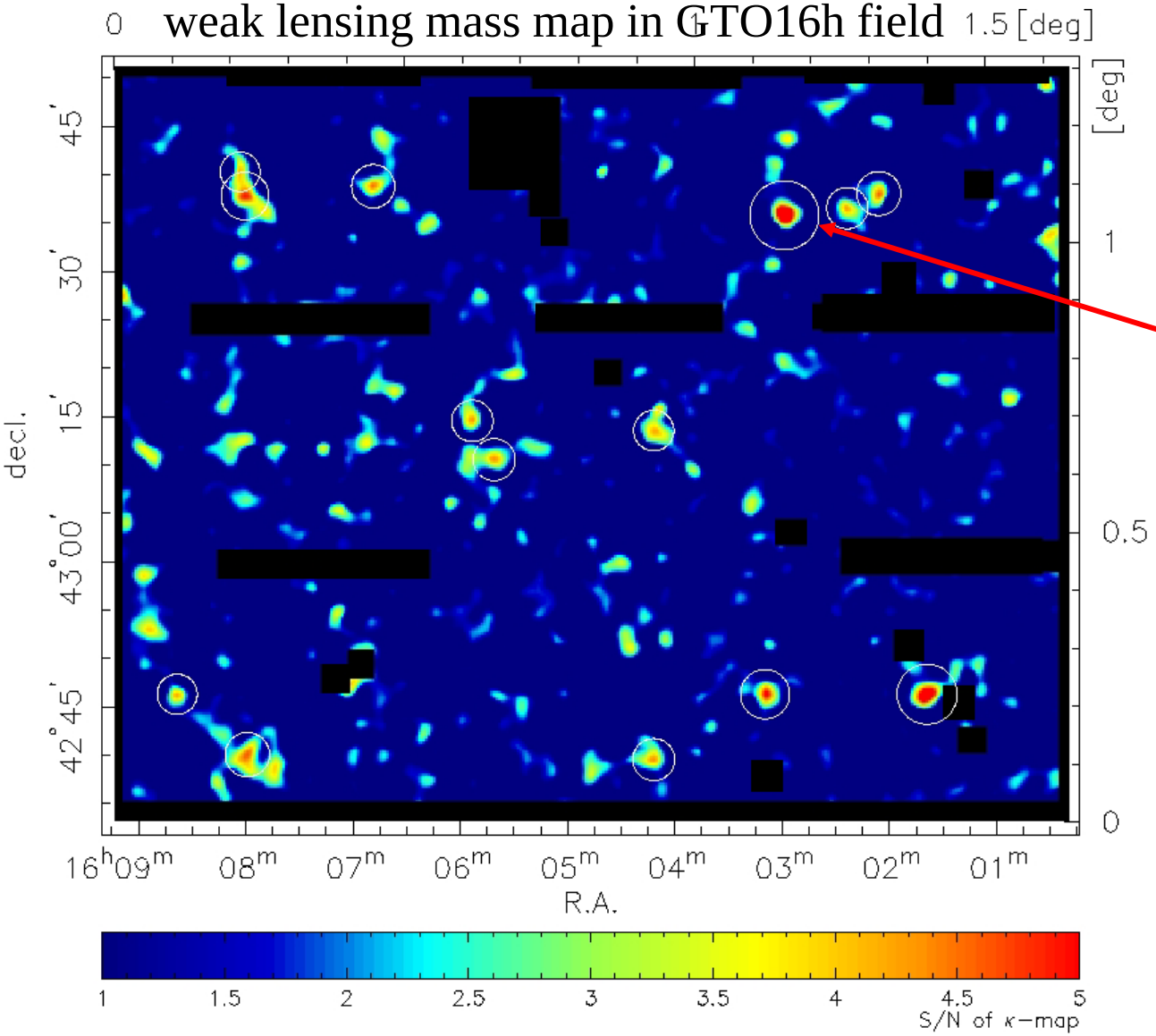




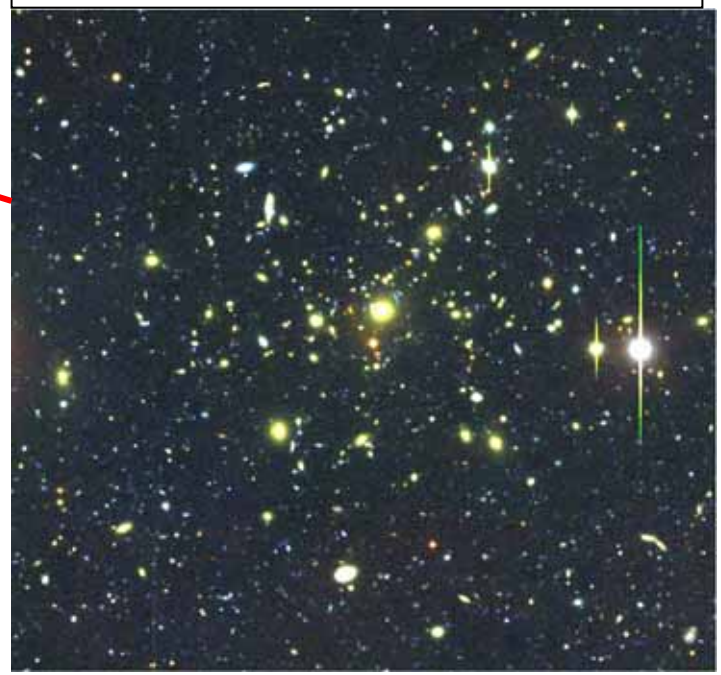
Large symbols: M>3e14
small: 3e14>M_{14}>8e13
dots: 8e13>M_{14}>1e13

Realistic noise added
and smoothing applied

Suprime-Cam WL survey



Newly discovered cluster
z=0.42



Miyazaki, Hamana et al. (2002)

Weak lensing S/N

$$\text{Signal} \sim \text{Mass}^{1/3} f(z_l) f\left(\langle z_s \rangle\right)$$

$f\left(\langle z_s \rangle\right) \uparrow$ for $z_s \uparrow$

z_l peaks at $\sim z_s / 3$

$$\text{Noize} \sim \sigma_e / n_{gal}^{0.5}$$

$\sigma_e \sim 0.4$

How can we get a large n_{gal} ?

Deeper surveyをすれば z_s & n_{gal}とも大？
そう単純ではない

まとめ：From ground

Very deep imaging is not efficient for a WL survey,
because the seeing limits a size of usable galaxy.
➔Go wider with a wide field camera on a 10m class telescope.
➔Multi-color info. is essential to link the dark matter with galaxies

- nights available for WL (dark, clear, good seeing <0.7”)
  ~7nights/month (Mauna Kea)
  →~85nights/year

- 8m telescope
  0.5h (0.7h incl. overhead) exp ➔ R~26mag ➔ 30~40gals/arcmin^2
- wide field camera such like
  - 1deg^2 FV ➔ 10deg^2/night➔ 850deg^2/year (🡐Currently largest)
  - 4deg^2 FV ➔ 3,400deg^2(~1/9 of all sky)/year 🡐 HyperCam
  - 10deg^2 FV ➔ 8,500deg^2(~1/5 of all sky)/year 🡐 LSST

まとめ：From space

Size of mirror & FV of camera limit a survey area.
➔Larger mirror
➔Wide field camera with small CCD pixels(<0”.025)

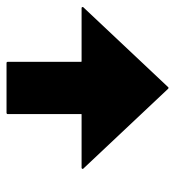
- 2m mirror
  2h exp ➔ ~100gals/arcmin^2
- wide field camera such like
  - 0.12deg^2 FV ➔ 100deg^2/1,700h(70d) ➔ HOP
  - 0.35deg^2 FV ➔ 100deg^2/600h(24d) ➔ SNAP
  - 1deg^2 FV ➔ 1,000deg^2/2,000h(83d) ➔?

Go deeper to get high resolution dark matter map

Subaru weak lensing cluster survey

Suprime-33

- **史上初の質量で選択された銀河団カタログ**(with X-ray deep data)**の作成**
  - 80 very massive cluster
  - 100 distant cluster (z>0.4)
  - Massive but faint cluster ?



Imaging survey (R=26) over a 33sq deg area

- **構造形成研究の基本的カタログ**
  - **構造形成シナリオの検証**
  - **銀河進化とダークマター進化の関係**
  - **銀河団の物理**

Suprime-33

Suprime-Cam weak lensing survey project

Core members:

S. Miyazaki (P.I.)
T.Hamana
T.Futamase
K.Umetsu
R.Ellis
A.Refregier
R.Massey
and many associates

Primary goal:

Mass selected cluster catalog

- ~80 most massive clusters, significant WL signal S/N>5
- >100 distant clusters (z>0.4) with WL signal S/N>4
- Next generation data base for understanding cluster formation, galaxy evolution and cosmology

Survey design:

- Weak lensing mass map over 33 deg^2 field
  - Field selection: Deep X-ray imaging data available ($f_X<10^{-13}$erg/cm^2/s)
  - Weak lensing mass reconstruction form Suprime-cam Rc(I)-band image (R=26)
  - Follow-up obs: shallower B-band imaging MOS for most massive cluster candidates