

PFSが拓く近傍宇宙論の新展開

千葉 柁司
(東北大学)

近傍宇宙論の最重要課題

Λ CDM宇宙論の検証

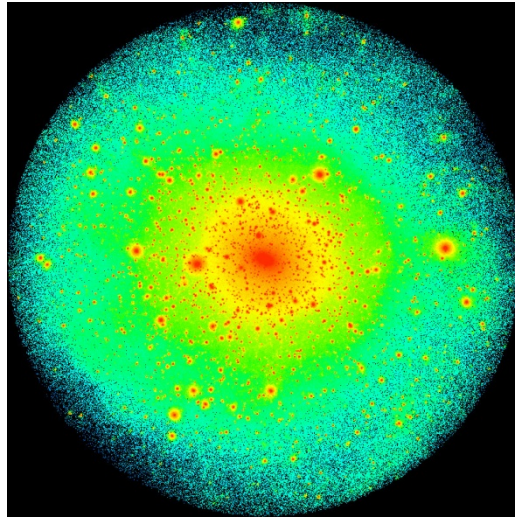
- 暗黒物質ハローの存在形態
 - Missing satellite problem? Too big to fail problem?
 - Central cusp/core, Global shape (triaxial? flattened?)
 - Anisotropic spatial distribution? (cosmic web?)
- 暗黒物質の階層的合体による銀河構造形成
 - 恒星系ハローの合体史と各Building blockにおける星形成史
 - 銀河円盤構造の形成史

銀河系サイズのダークハロー

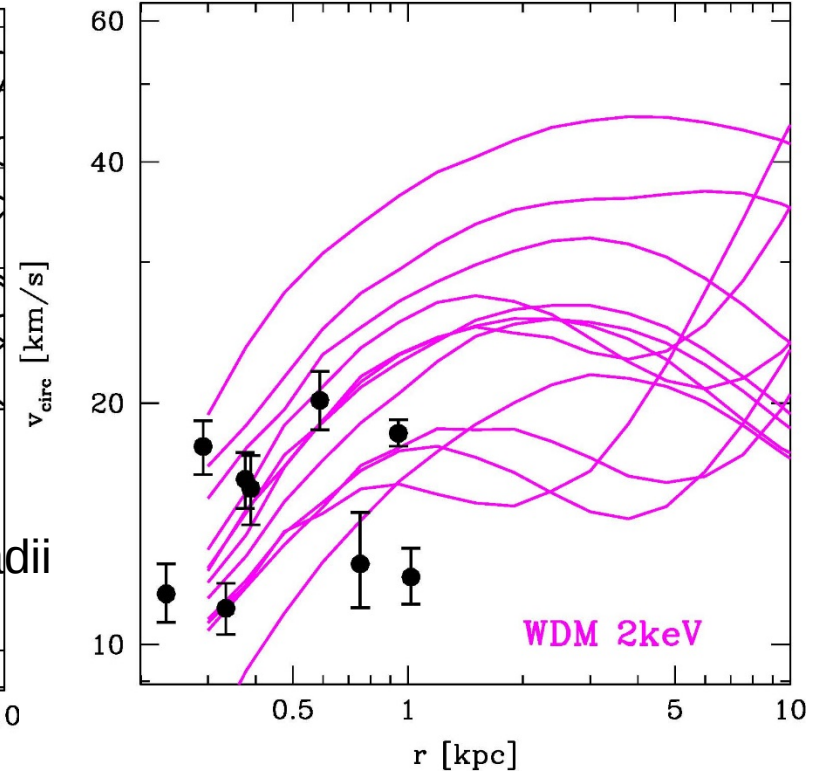
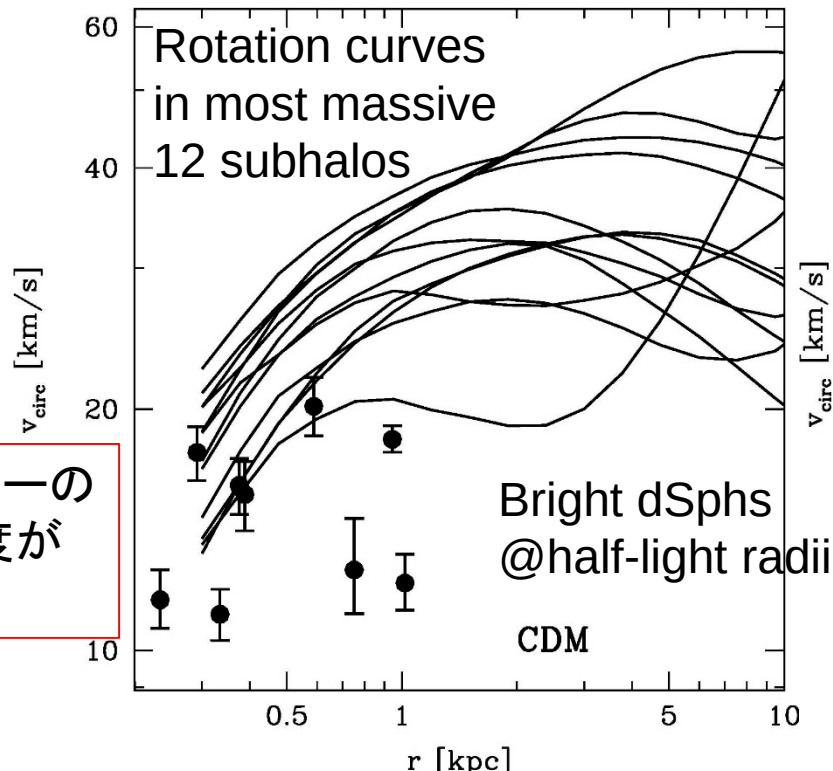
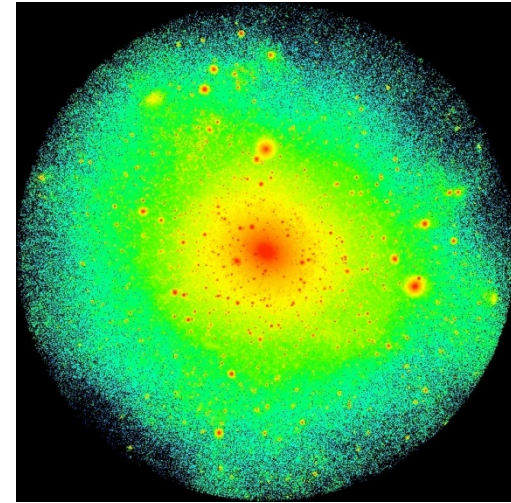
Anderhalden+12

CDM

サブハローが多すぎる



WDM
2 keV



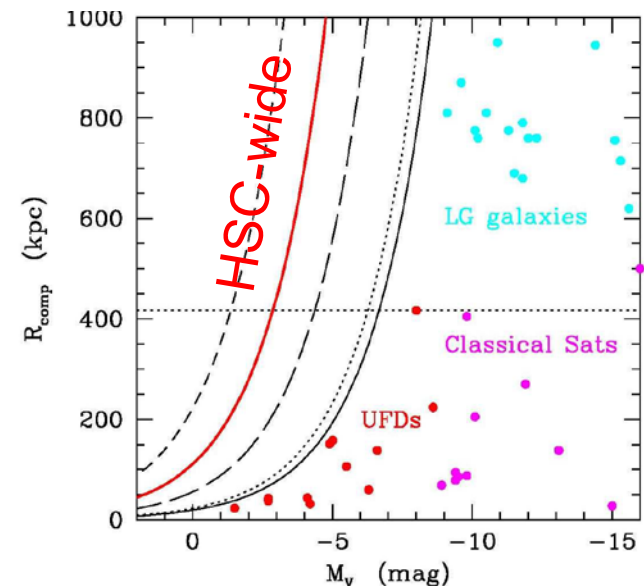
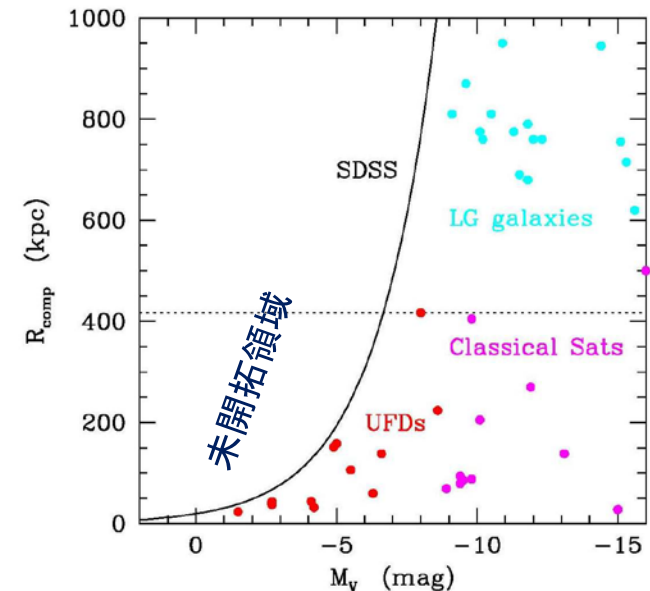
サブハローの
内部密度が
高すぎる

しかし、観測データが不十分

- 銀河系矮小銀河の真のLF?
 - 観測領域が限定
 - HSC wide-field survey
- 矮小銀河内の真のDM分布?
 - 速度分布の観測が内側に限定
 - PFS survey
- 矮小銀河全体に渡るバリオン過程?
 - 元素比の観測が中心部に限定
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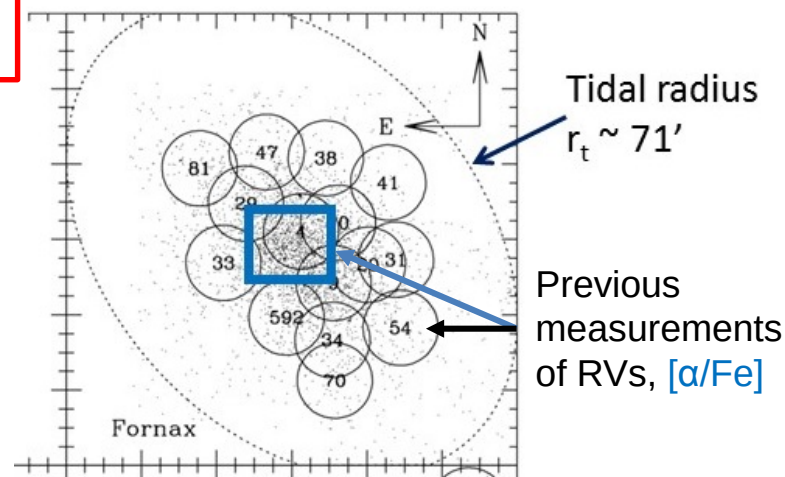
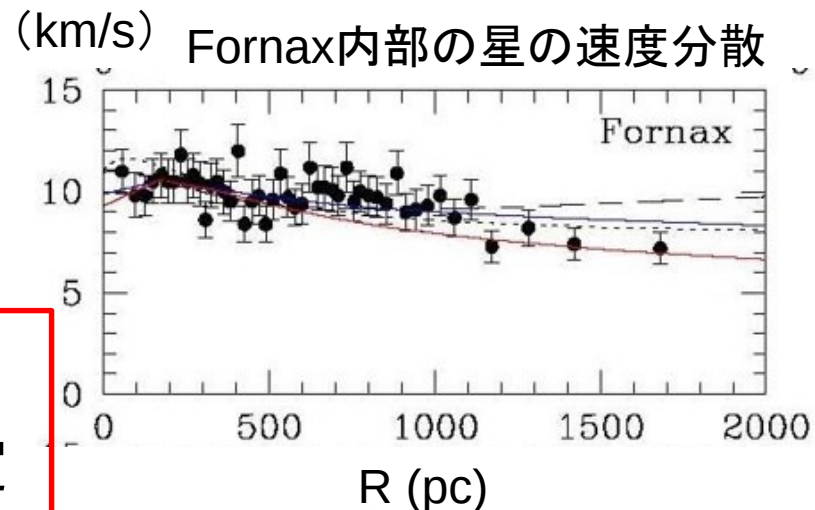
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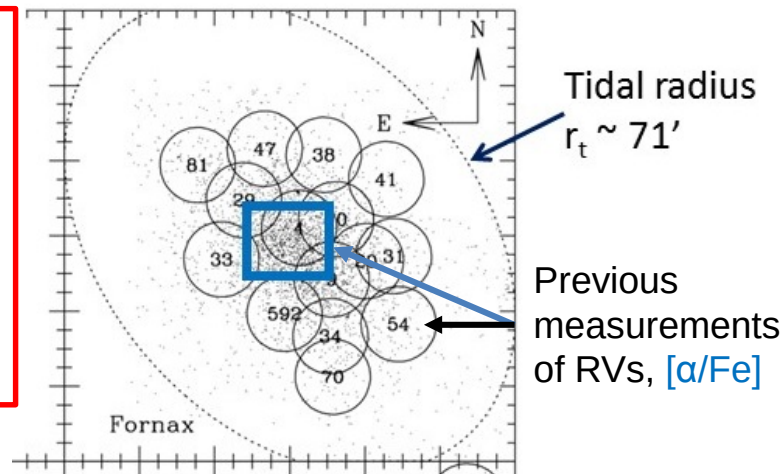
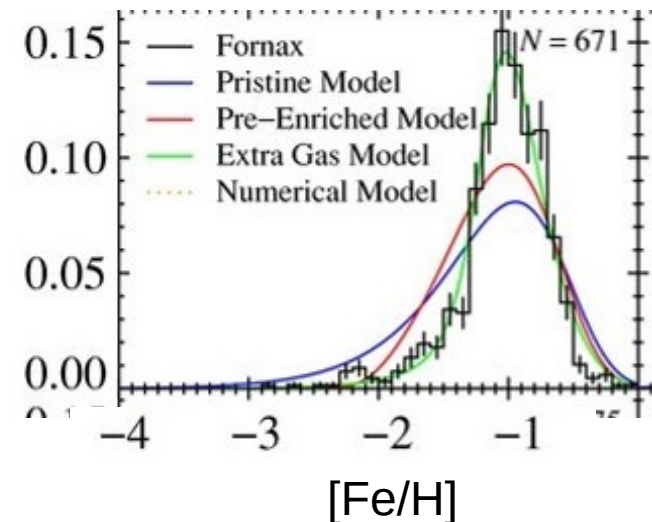


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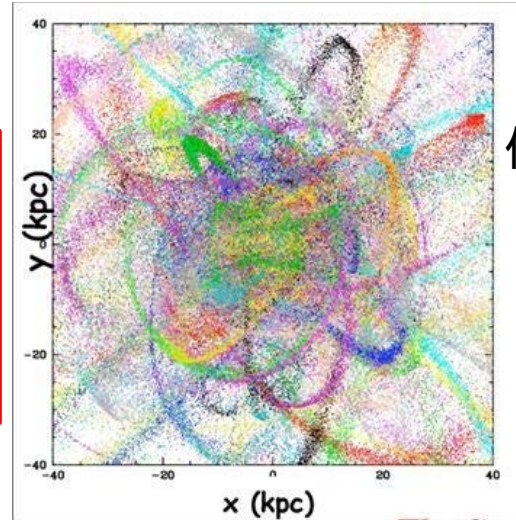
本間君のポスター、岡本さんの講演

Fornax内の星の金属量分布



銀河構造の合体史・形成史

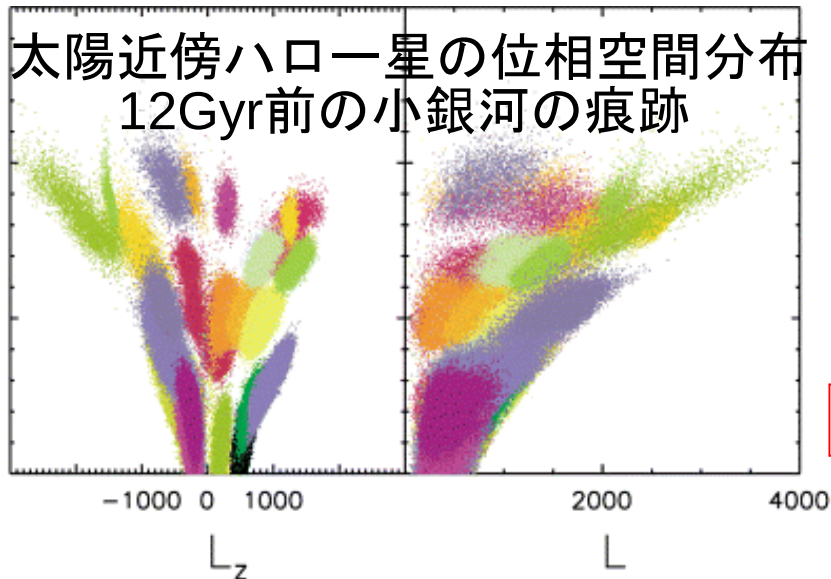
そもそも銀河は合体過程
で形成されたのか？
直接の証拠は？



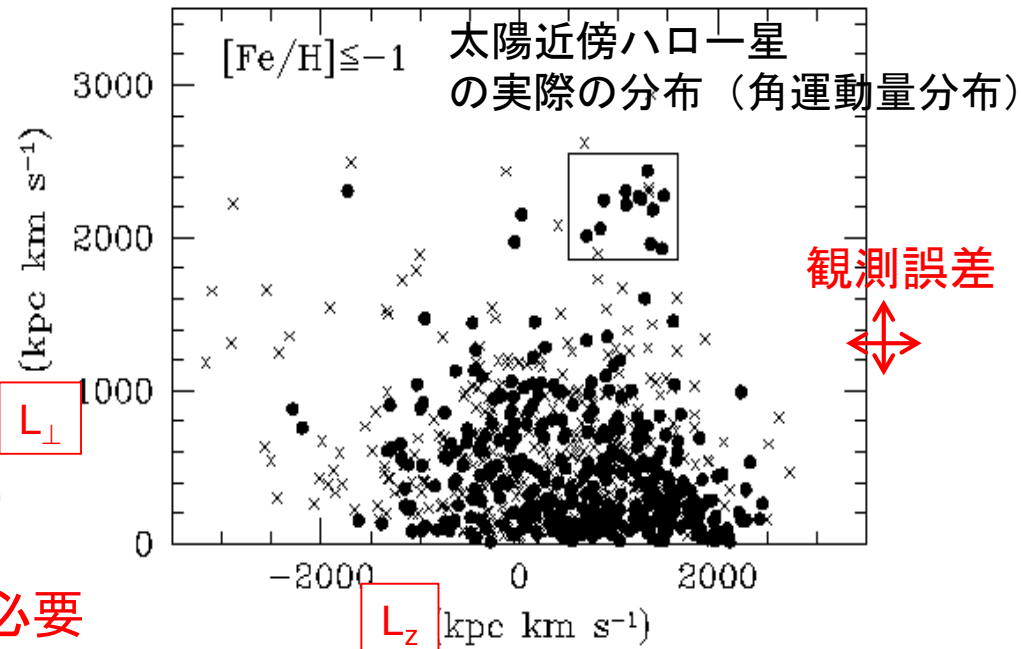
小銀河の潮汐流
但し、数力学時間の寿命

銀河系ダークハローの
分布に対する制限
⇒ 石垣さんの講演

太陽近傍ハロー星の位相空間分布
12Gyr前の小銀河の痕跡

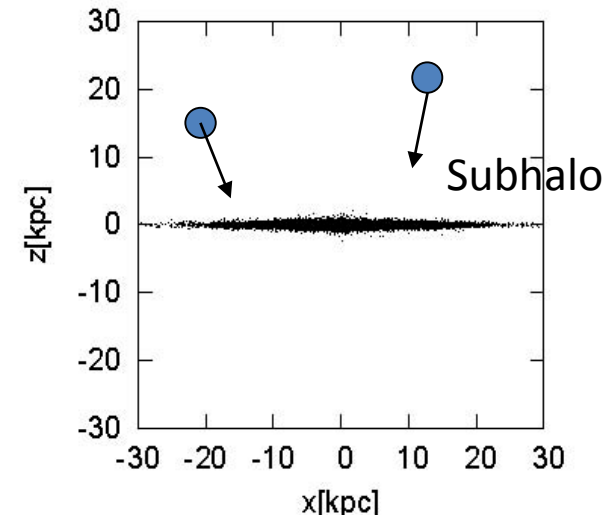
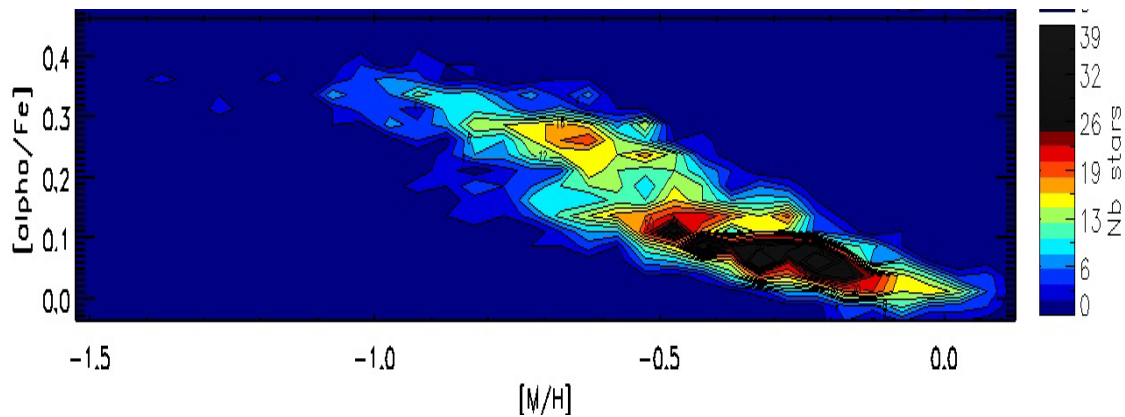


星までの正確な距離と空間運動が必要



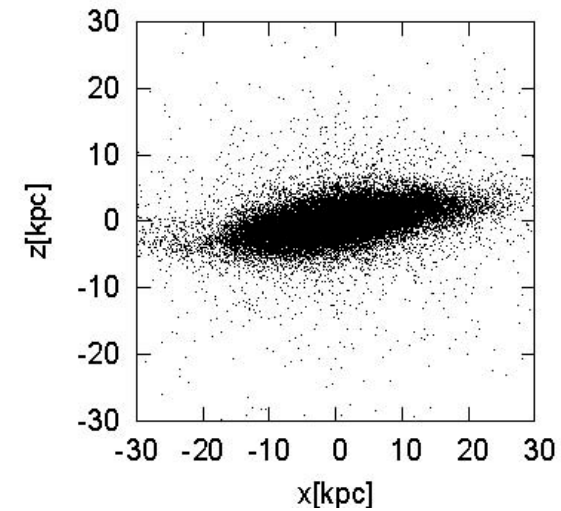
銀河構造の合体史・形成史

太陽近傍における厚い円盤の化学元素比 (Gaia-ESO)

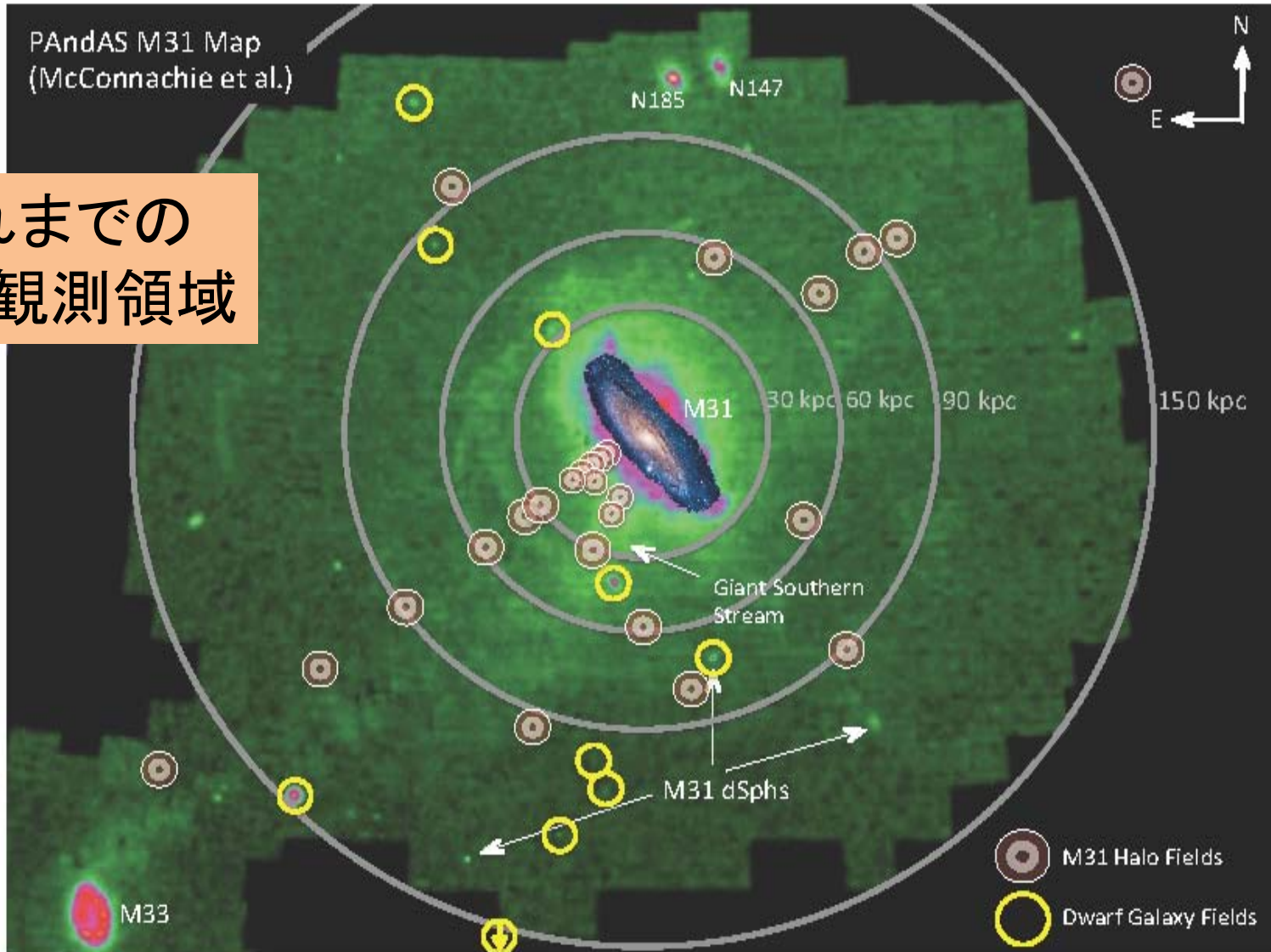


厚い円盤の起源？

- 外側はどこまで広がっているか？
 - 金属量分布、年齢分布
 - Radial migration?
- 速度分布の空間依存性は？
 - 化学動力学、subhalosの力学加熱？



M31の化学動力学構造は？



PFSによる近傍宇宙論の主目的

PFSによる恒星系の視線速度と化学元素量：

- 暗黒物質の空間分布
- 星形成・化学動力学進化史

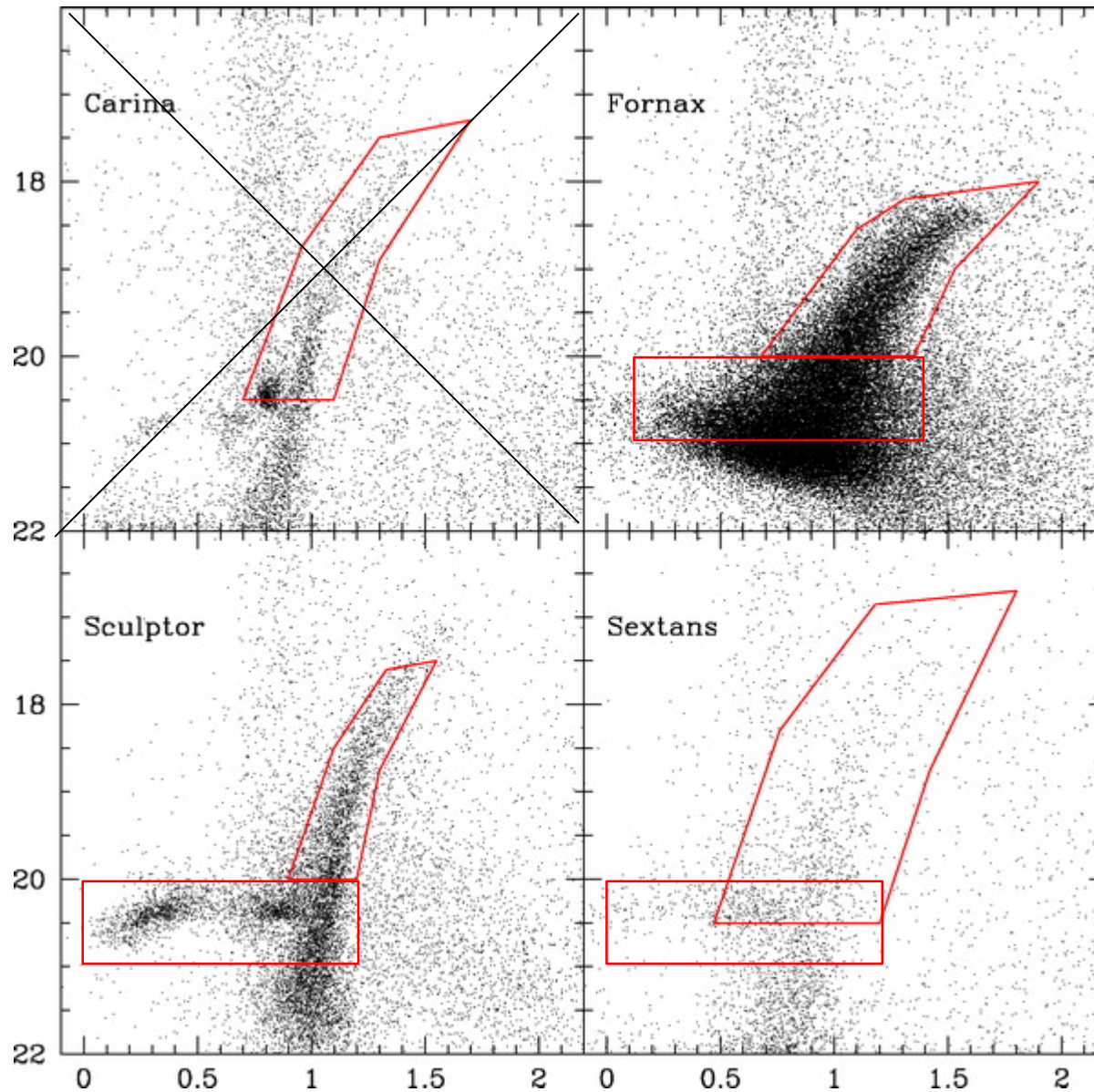
のベストトレーサー

1. 銀河系とその矮小銀河における暗黒物質構造の決定と Λ CDM宇宙論との比較
2. 銀河系及びアンドロメダ銀河における階層的合体史の決定と Λ CDMに基づく銀河形成論との比較

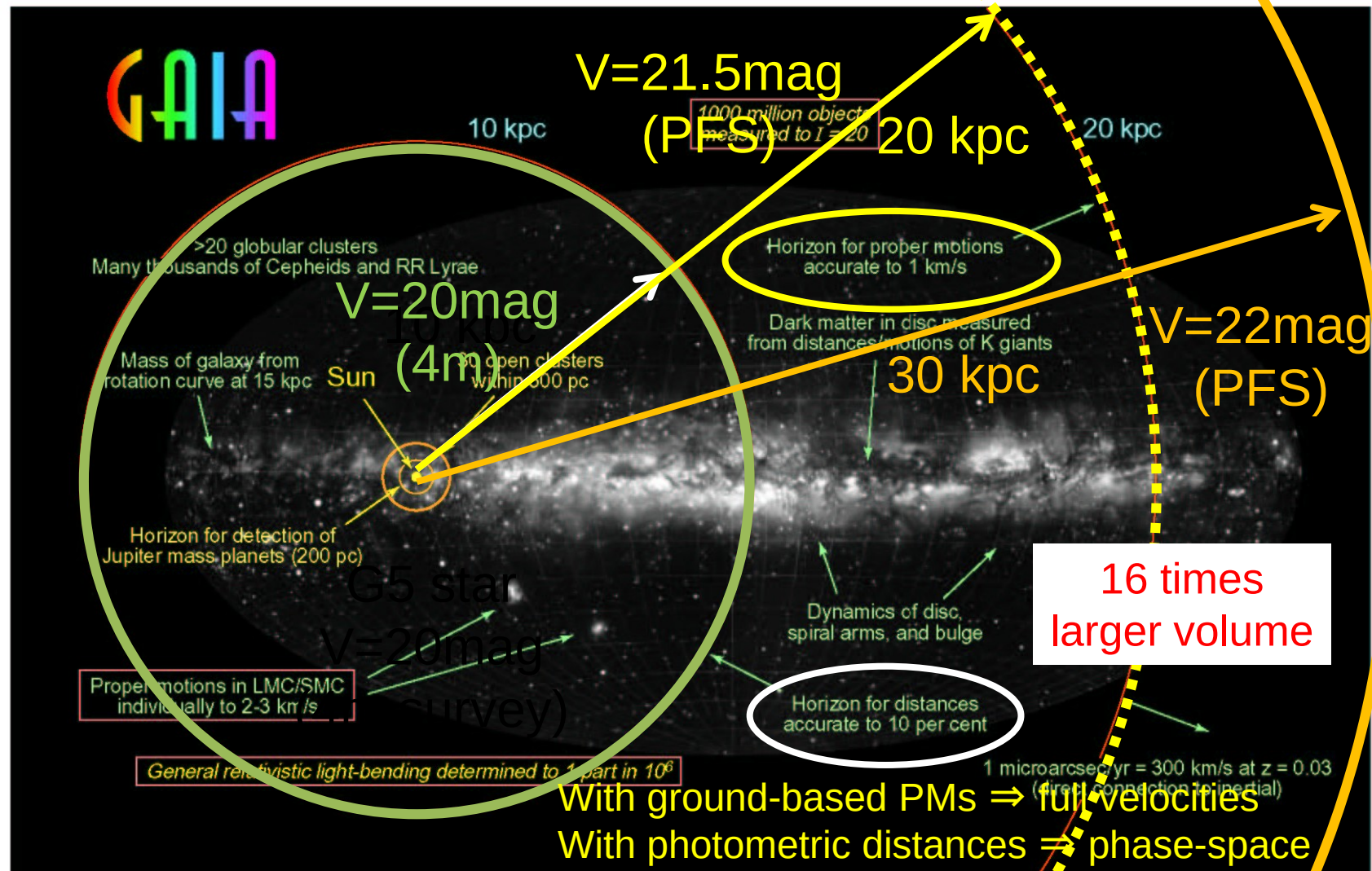
限界等級と露出時間

- MR mode (R=5000)
 - $[\alpha/\text{Fe}]$ determination with $\Delta=0.2\text{dex}$: S/N=60
 - + $[\text{Fe}/\text{H}]$ determination with $\Delta=0.15\text{dex}$: S/N=45
 - + radial-velocity measurement with $\Delta=3\text{ km/s}$
 - $V < 19\text{ mag}$, $T = 0.75\text{ hr}$, bright time
 - Targets: Gaia sample
 - $V < 21\text{ mag}$, $T = 2\text{ hr}$, grey/dark time
 - Targets: Galactic halo stars and member stars in Galactic dSphs
- LR mode (R=2000~3000)
 - $[\text{Fe}/\text{H}]$ determination with $\Delta=0.2\text{dex}$: S/N=20-30
 - + radial-velocity measurement with $\Delta=5\sim 10\text{ km/s}$
 - $V < 22\text{ mag}$, $T = 2\text{ hr}$, grey/dark time
 - Targets: faint stars in outer disk and halo streams
 - $V < 22.5\text{ mag}$, $T = 5\text{ hr}$, dark time
 - Targets: M31 halo and Local Group dlrrs

Target selection in CM diagrams for some dSphs (adapted from Walker+2007)



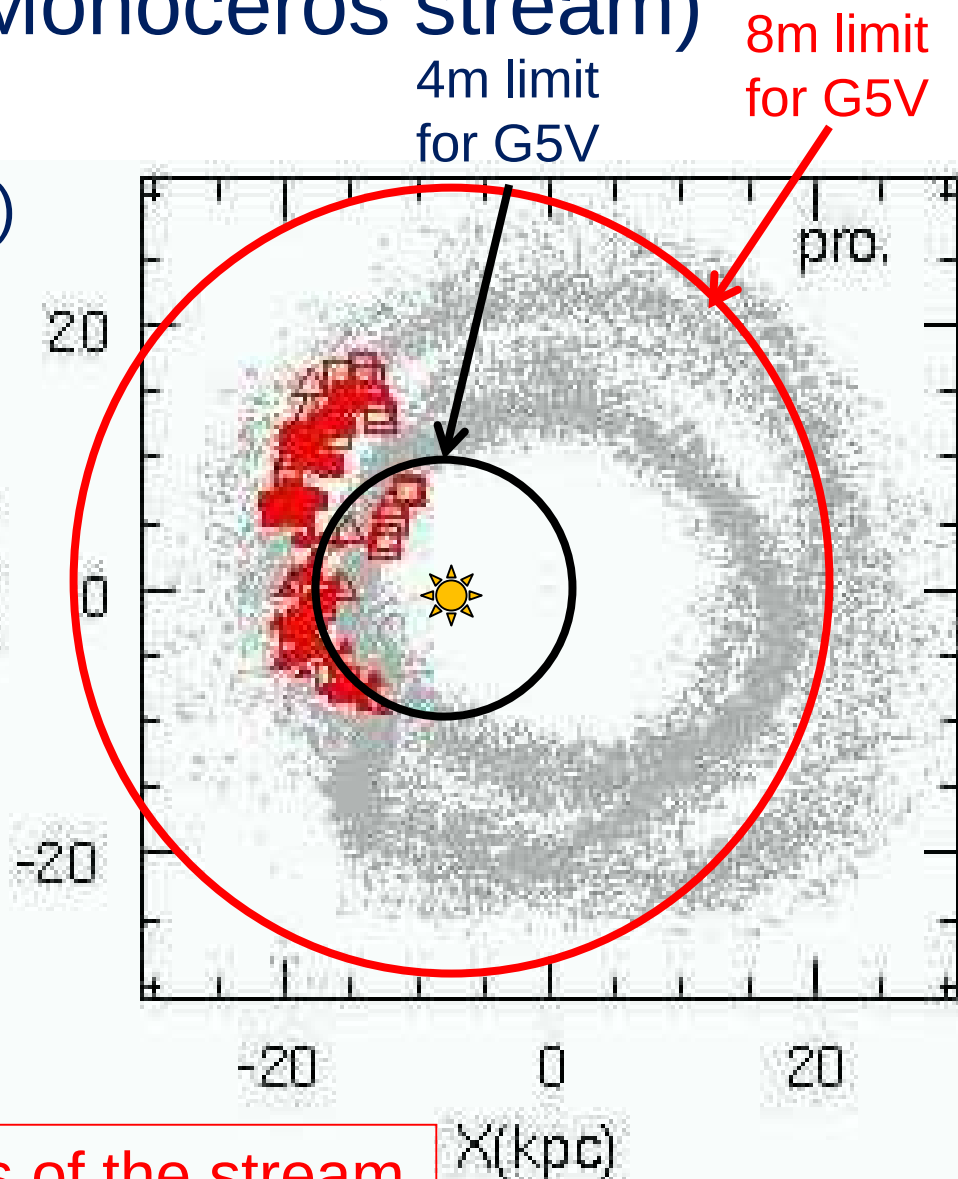
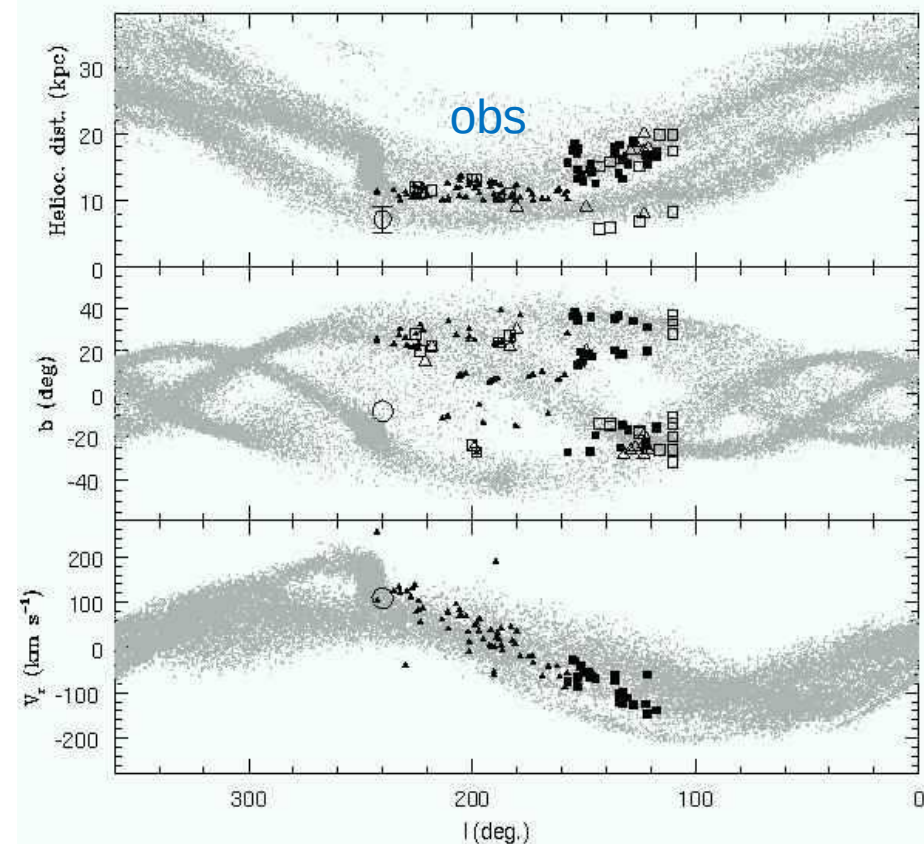
4m vs. 8m spectroscopic survey (G5V) (compared with Gaia astrometry)



$10\mu\text{as} = 10\% \text{ distance @ } 10\text{kpc}$, $10\mu\text{as/yr} = 1\text{km/s @ } 20\text{kpc}$

4m vs. 8m spectroscopic survey (G5V) (Outer disk incl. Monoceros stream)

Monoceros stream
(Penarrubia+ 2005: simulation)

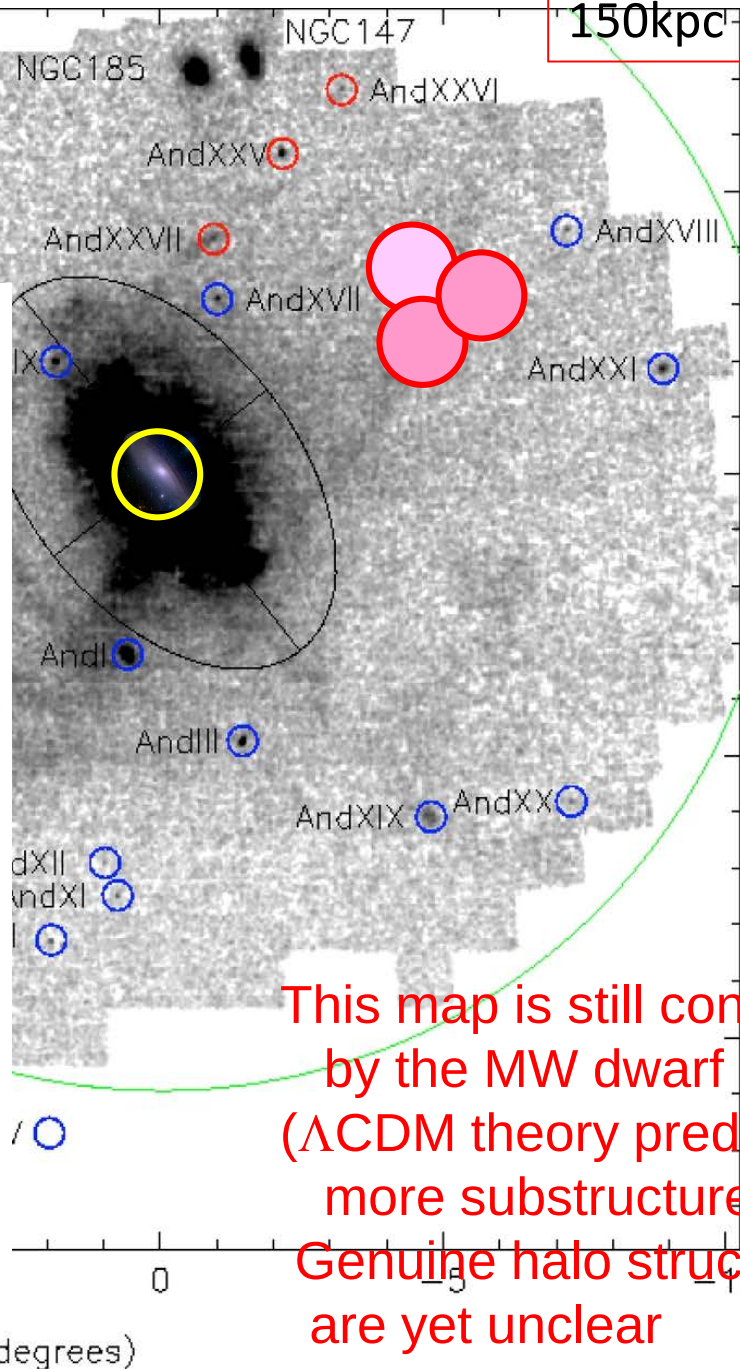
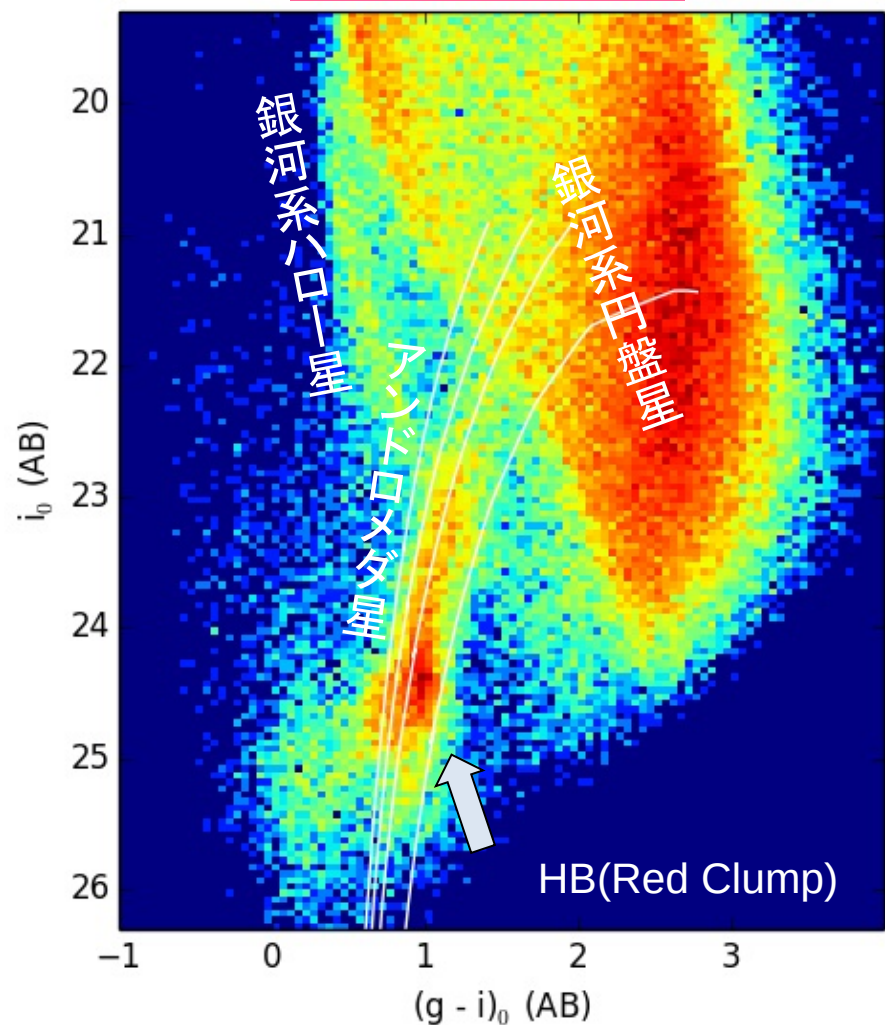


Can explore much large areas of the stream

PAndAS image
($i < 23.5$ RGBs)

HSC (S14B)

150kpc



This map is still contaminated
by the MW dwarf stars
(Λ CDM theory predicts
more substructures)
Genuine halo structures
are yet unclear

PFSによるサーベイ計画

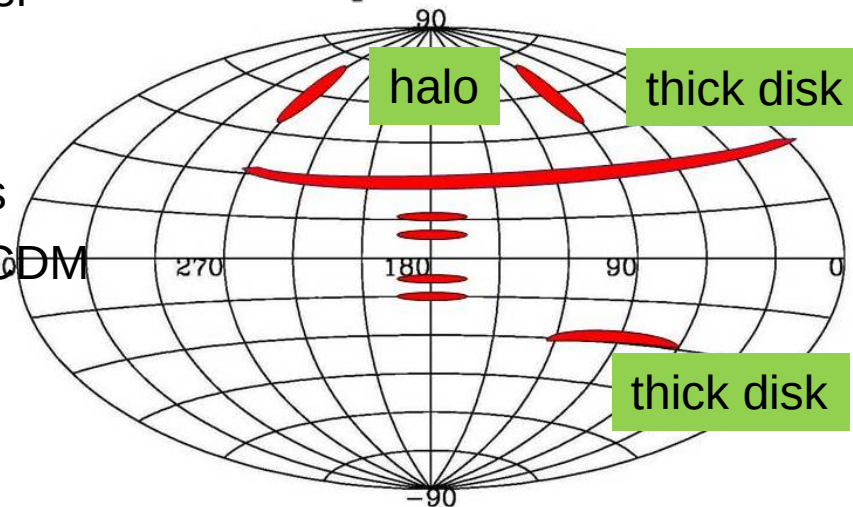
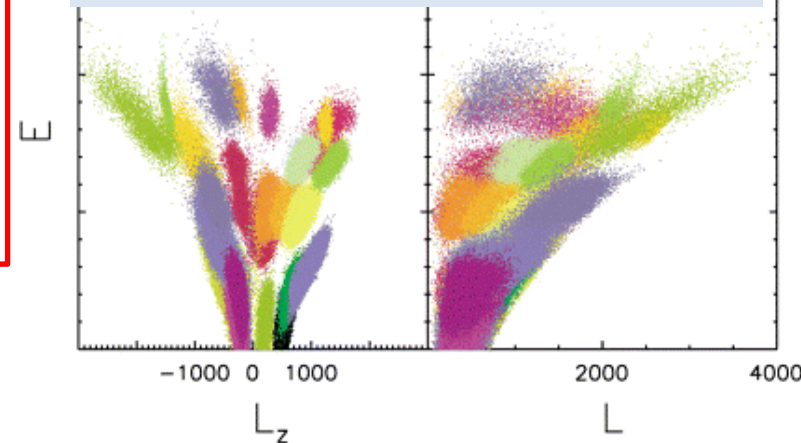
- The MW science

- 6d phase-space distribution of Gaia sample with $V < 20$
 - Merging + SF history of MW (inner parts)
- Chemodynamics of faint outer-halo/disk/stream stars with $V < 22$
 - Merging + SF history of MW (outer parts)
- Chemodynamics of MW dSphs
 - SF history of MW building blocks
 - Dark matter structure in light of Λ CDM

- M31 halo science

- Chemodynamics of M31 halo
 - Global + local structures

Halo stars in phase space:
full of **long-lived** substructures



PFSによるサーベイ計画

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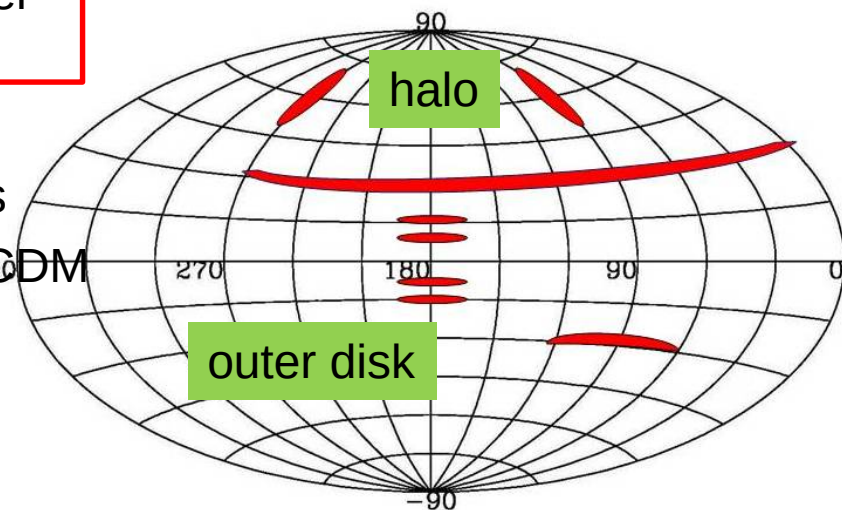
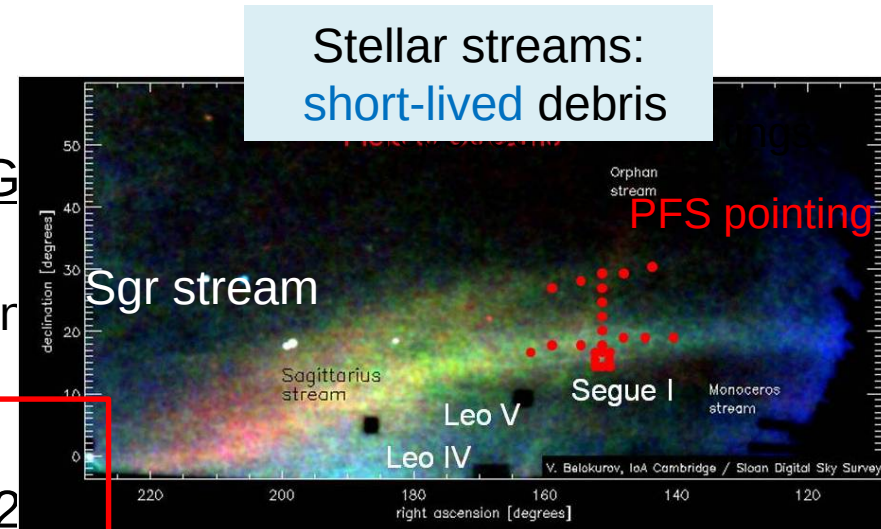
- Merging + SF history of MW (outer parts)

- Chemodynamics of MW dSphs

- SF history of MW building blocks
- Dark matter structure in light of GDM

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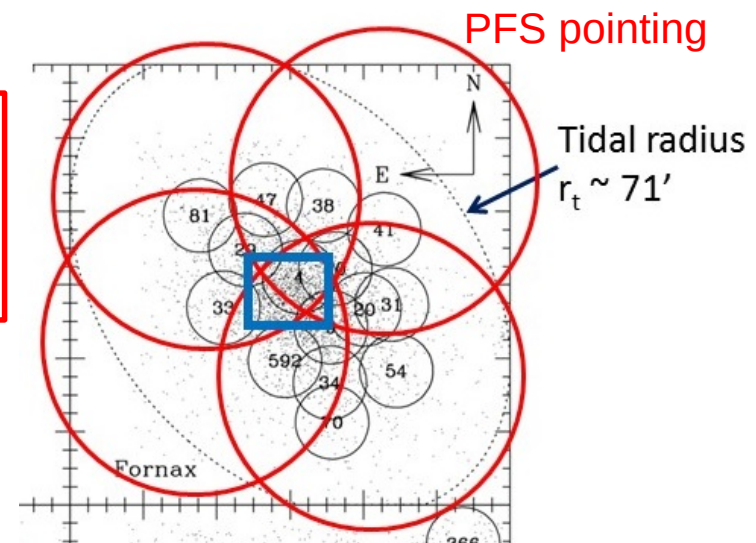
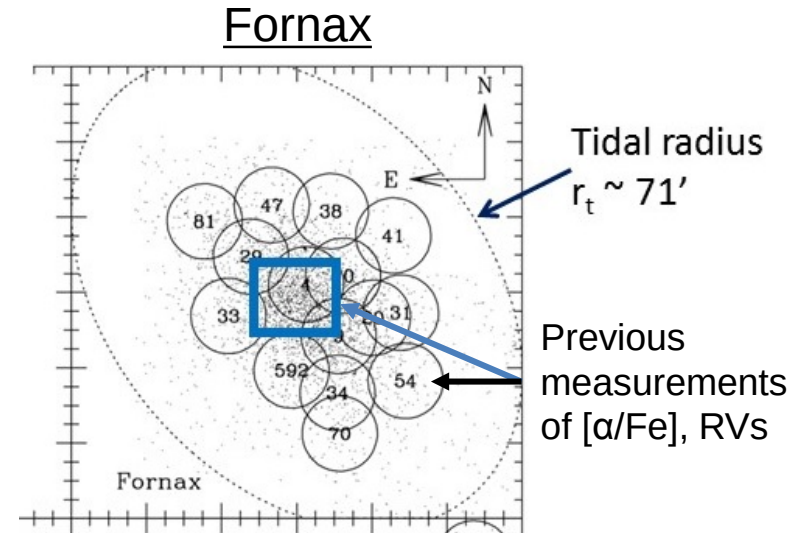
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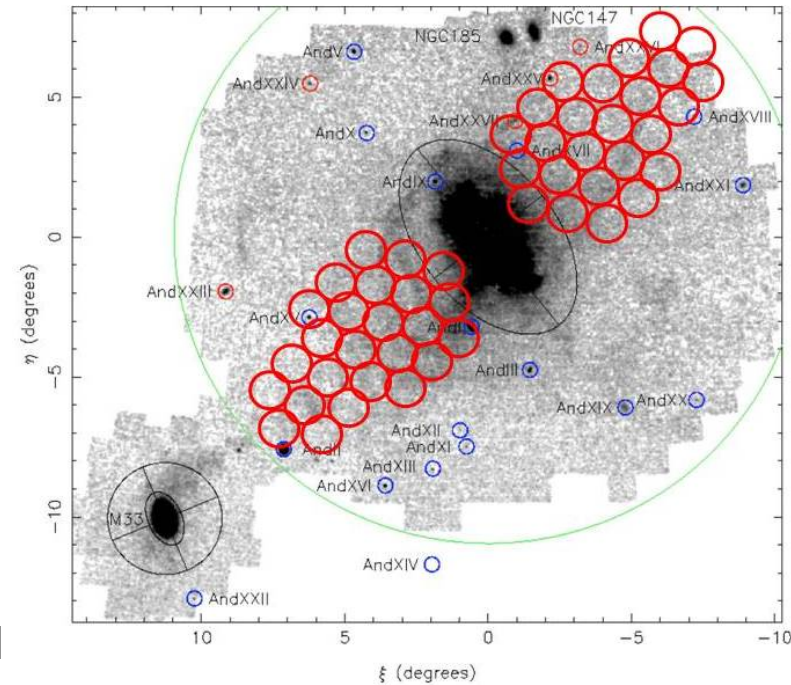
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PFS ターゲットの取得

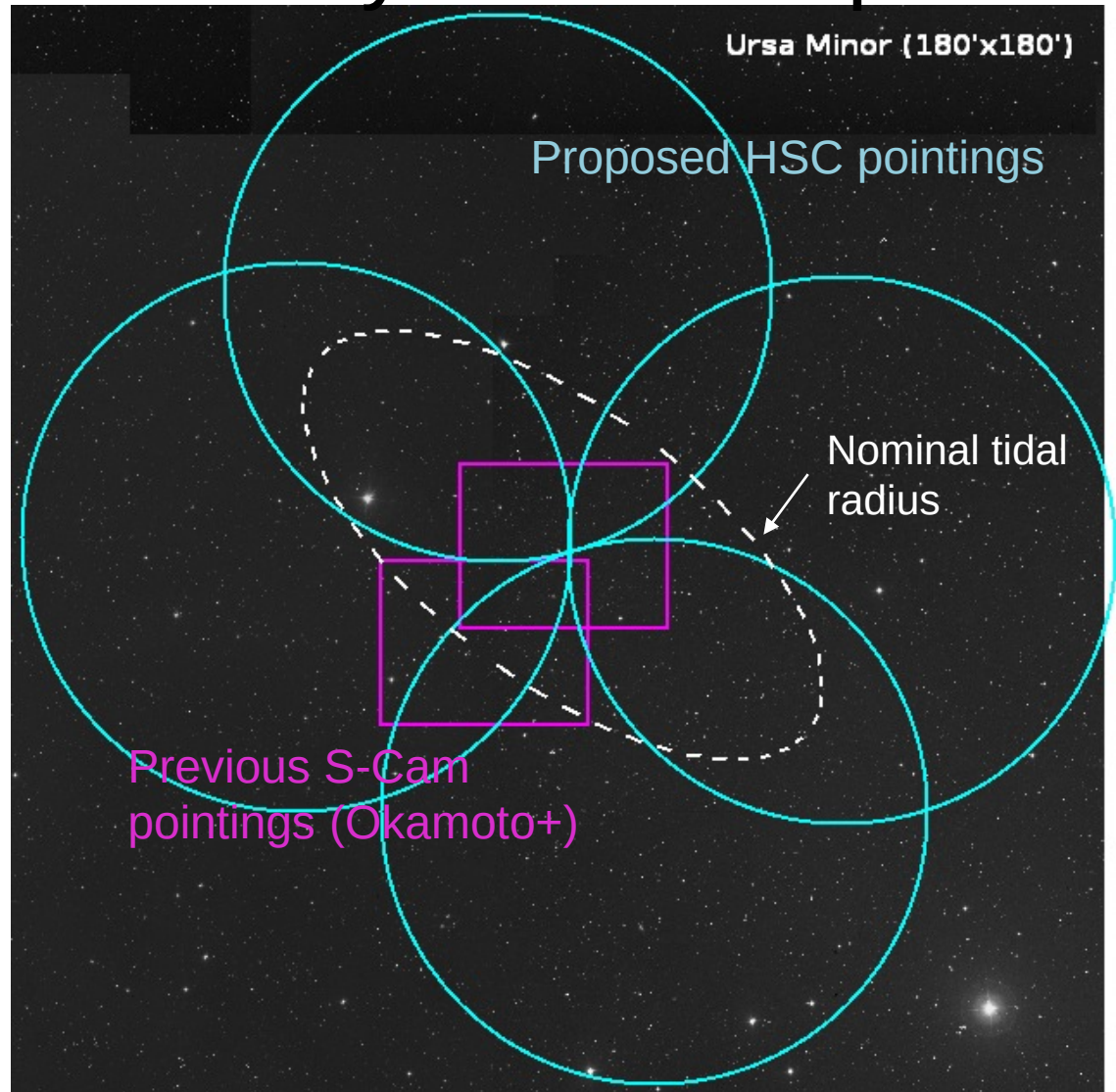
Wide-field HSC survey of MW dSphs

Ursa Minor

Okamoto+ S15A
one HSC night allocated
for (g, i, NB515) imaging

Cohen+ S15B
one HSC night allocated
for (g, i, NB515) imaging
of other dSphs

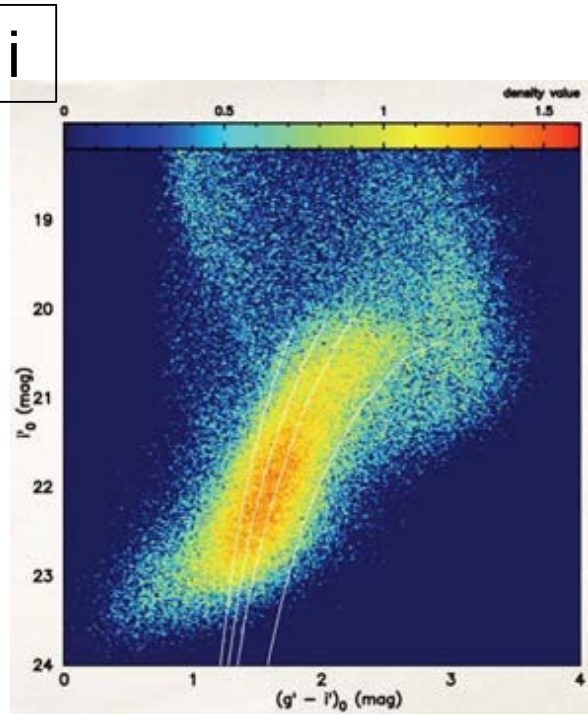
Plan to apply in S16A~S17B
for Fornax, Draco, Sculptor,
Leo I & Sextans
+ N6822, IC10, WLM



NB515 filter for HSC

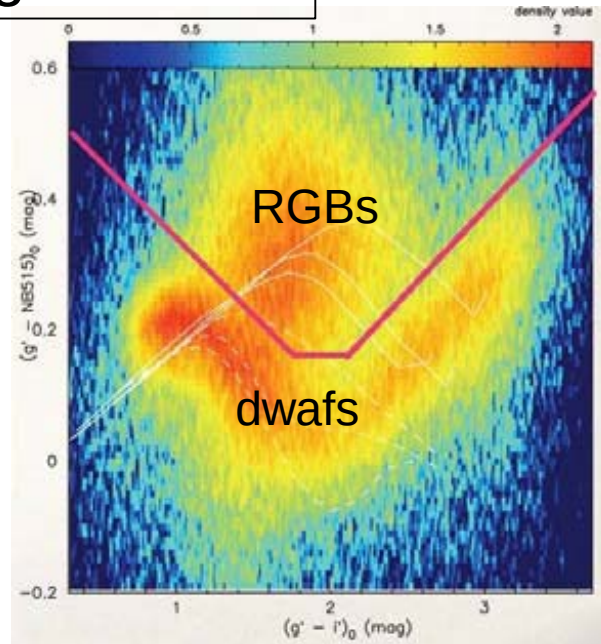
NB515 (CW: 515 nm, FWHM: 8nm) (from S15A)

Separation of RGB stars in M31 halo + MW satellites
from the foreground MW dwarfs

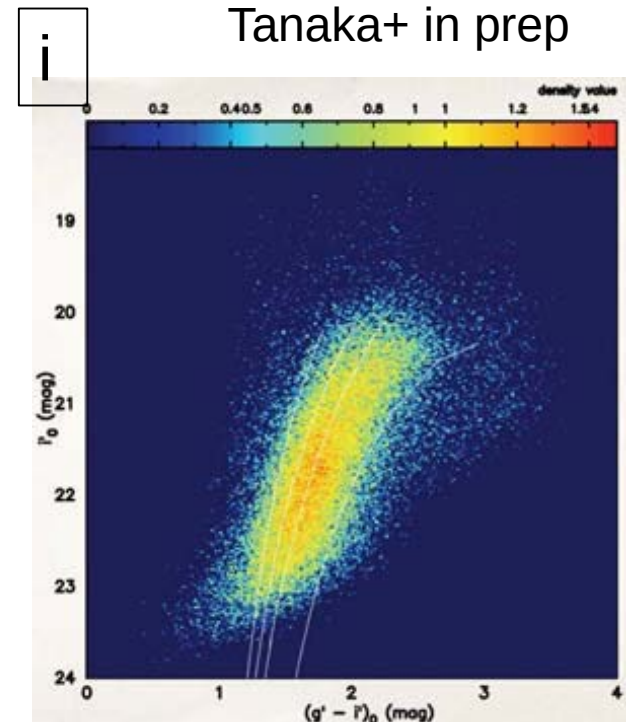


$g - i$

$g - \text{NB515}$

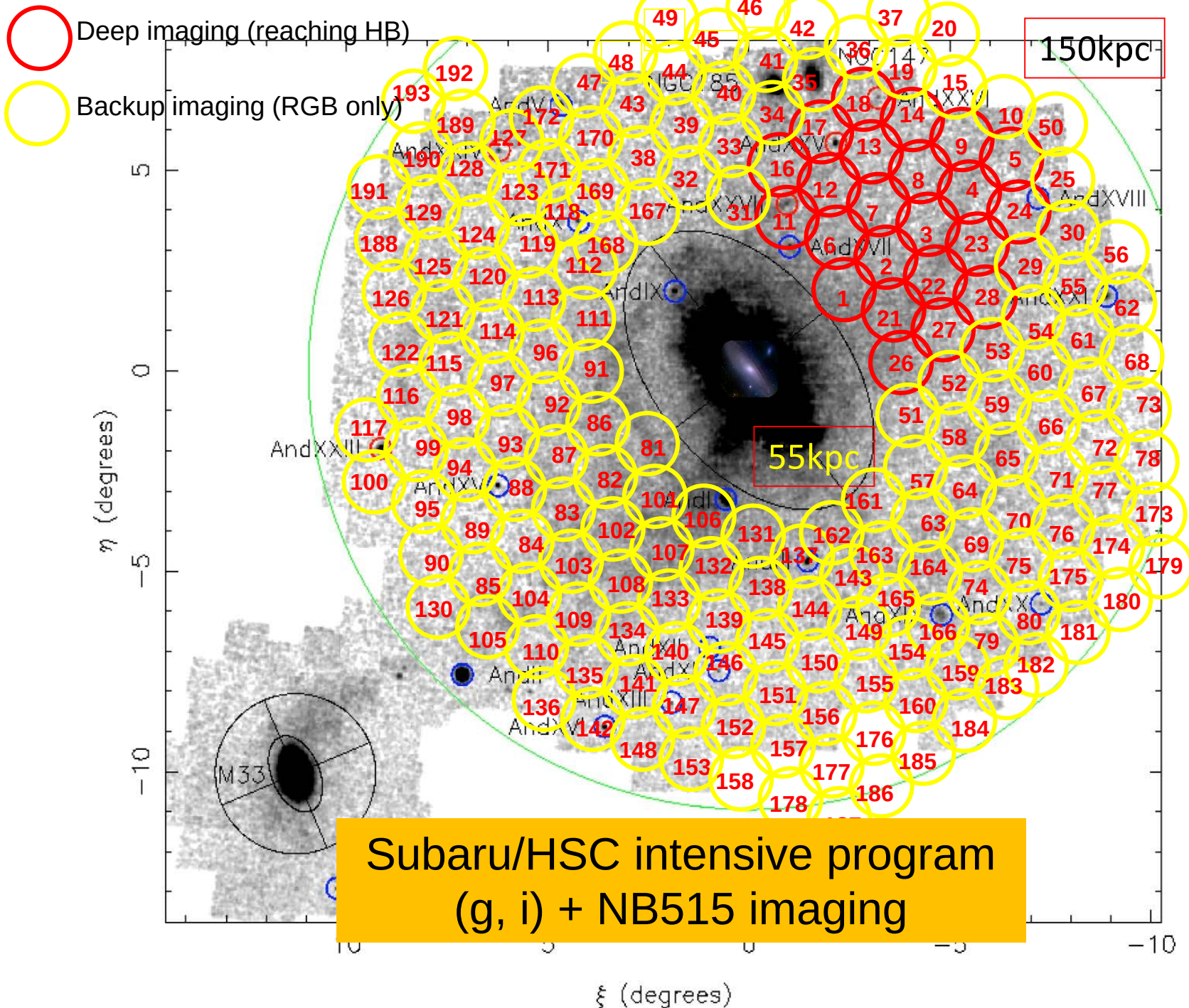


$g - i$



$g - i$

(32% success rate)



PFS/GAサーベイの問題点

- Bright timeがSSPサーベイでどのように扱われるか？
 - 明るいGaiaサンプル($V < 19$)を観測可能
- ファイバーの共有可能性
 - 他のサイエンスモード、共同利用観測
- Gaiaサンプル観測の調整
 - WEAVEとの競合を視野、観測のタイミング

新しいサイエンスの視点も考慮し、サーベイ計画の検討中
積極的な貢献を歓迎！