Star formation in XMMU J2235.3-2557: a massive galaxy cluster at z=1.4

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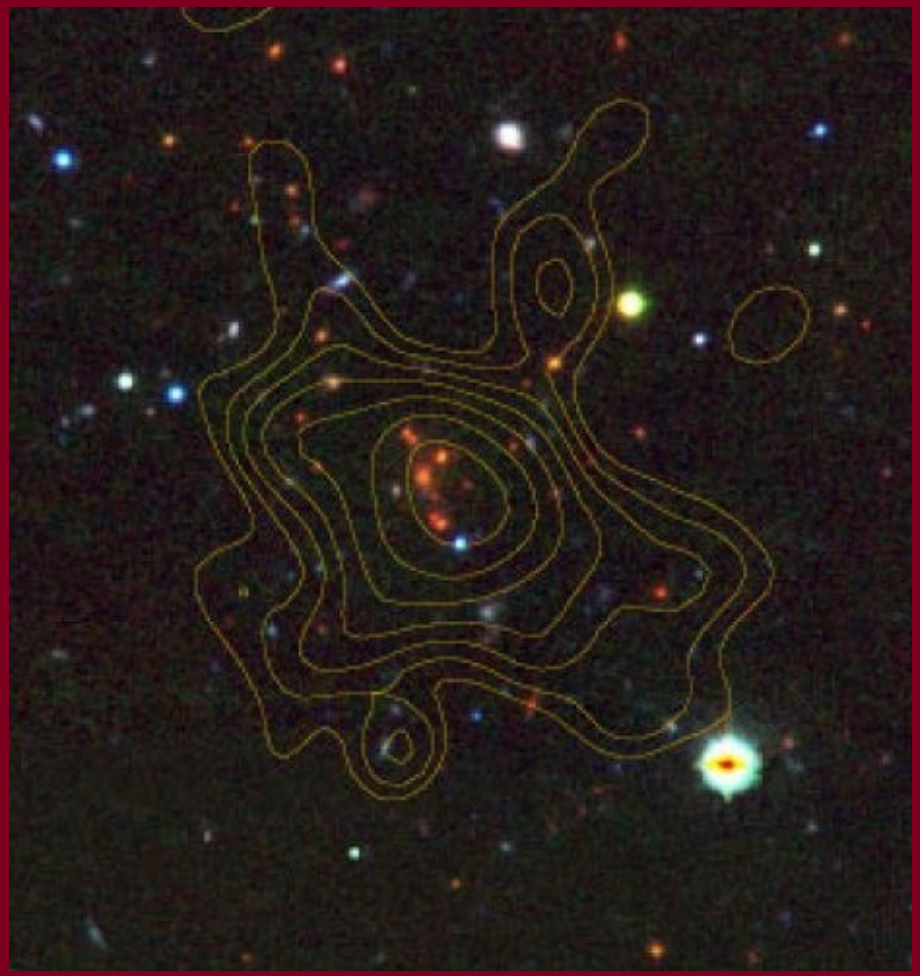
Galaxy Clusters in the Early Universe
Pucón, Chile, November 9-12, 2009

XMMU J2235.3-2557

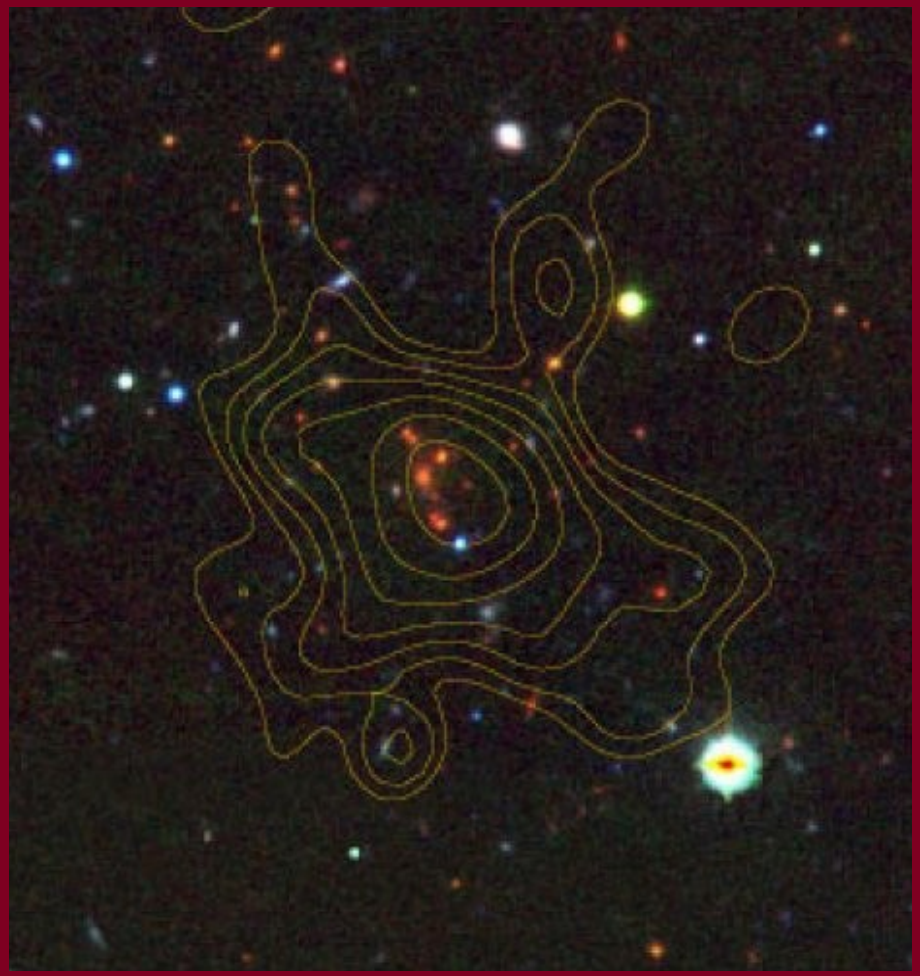


Mullis et al. 2005

z=1.39 (~4.5 Gyr old)

VLT ISAAC/FORS2 Ks, z, I band image
+ XMM-Newton X-ray contours

XMMU J2235.3-2557



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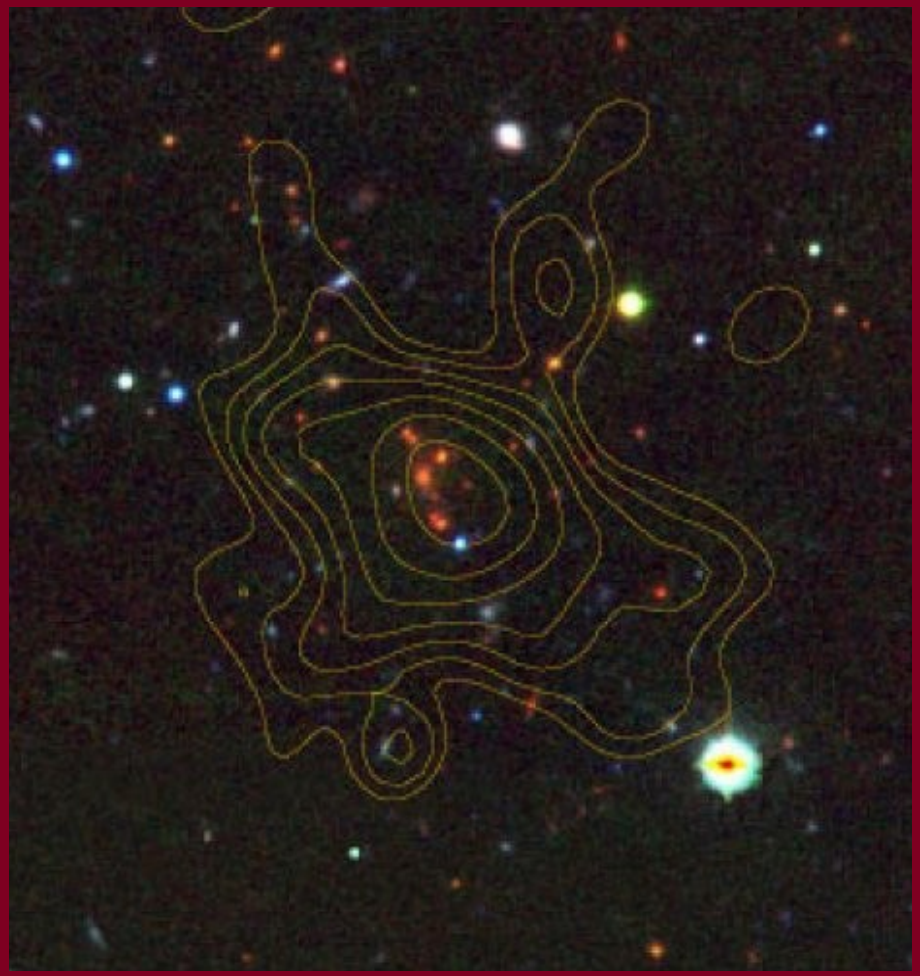

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– velocity dispersion:

$\sigma \sim 800$ km s^{-1}

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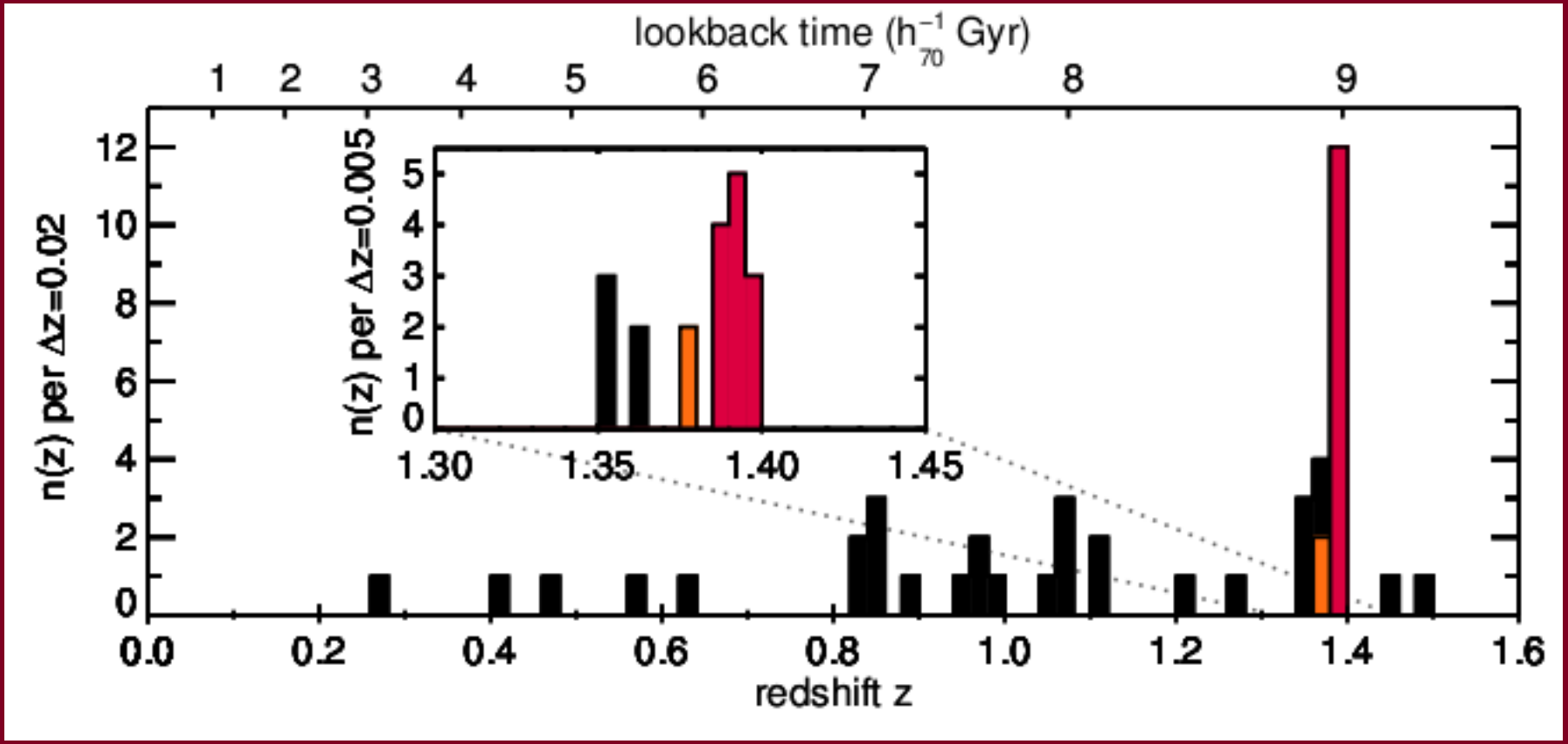

Redshift histogram showing 12 confirmed members
(Mullis et al 2005)

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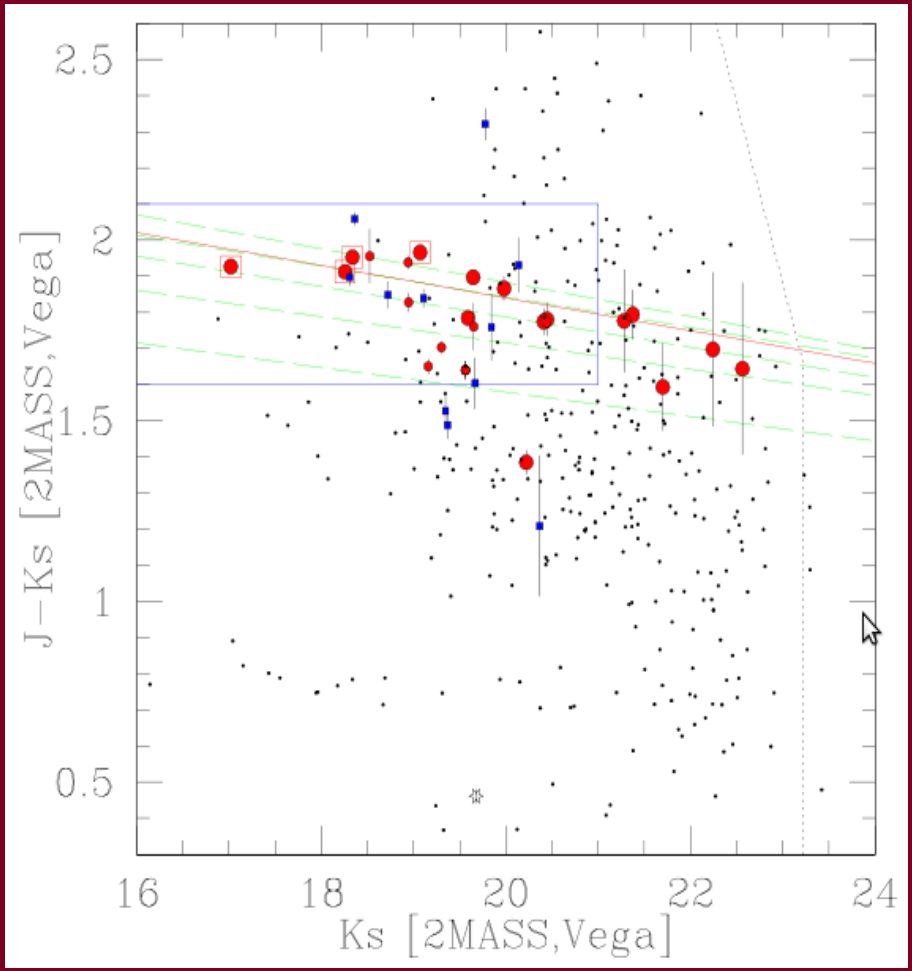
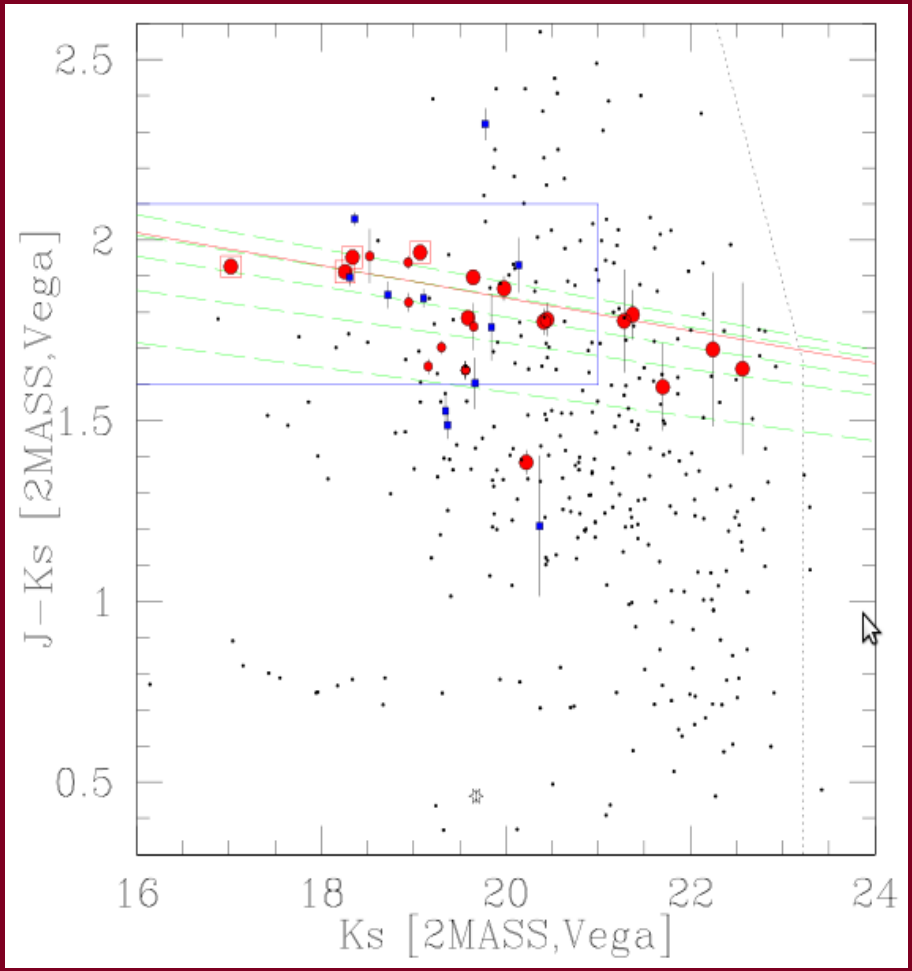


Color-Magnitude Relation of Ks vs. J-Ks
(Lidman et al 2008)

Lidman et al. 2008

– Ks vs J-Ks color magnitude relation

XMMU J2235.3-2557



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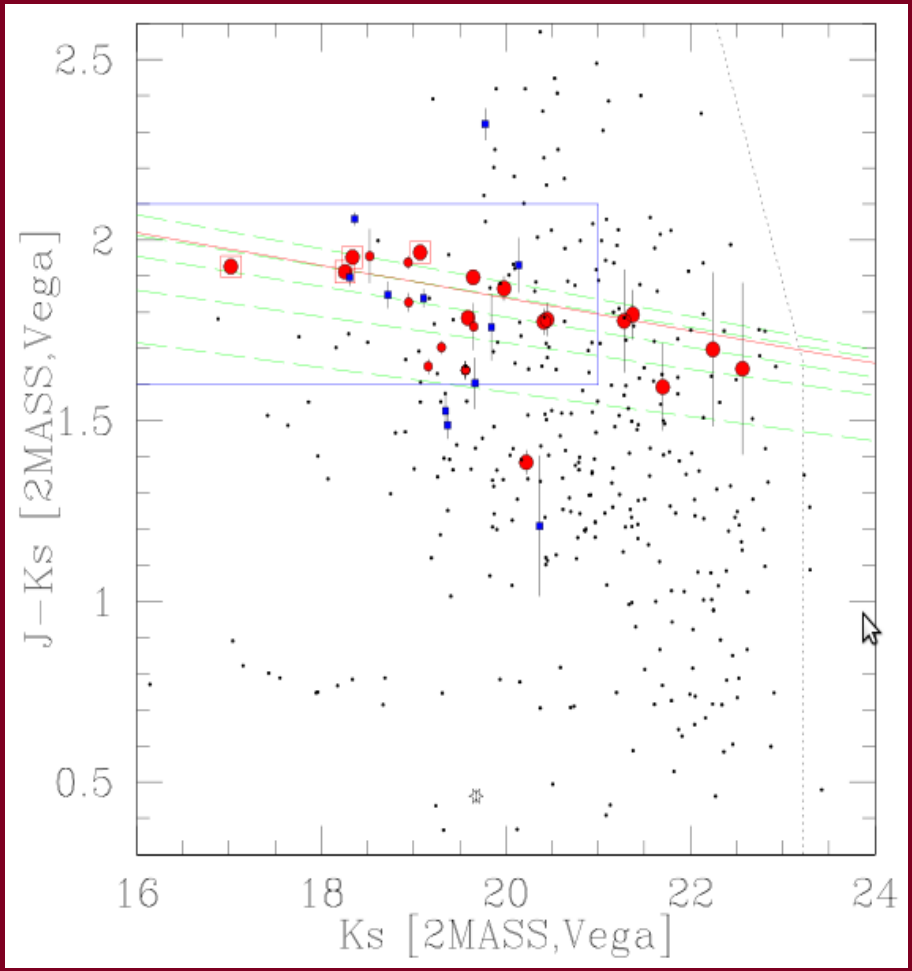

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– (relatively) tight red sequence already in place

– galaxies in centre (big symbols) older than in outskirts

Our observations

direct measure of SFR?

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– NIRI@GEMINI-North:
narrow band filter at
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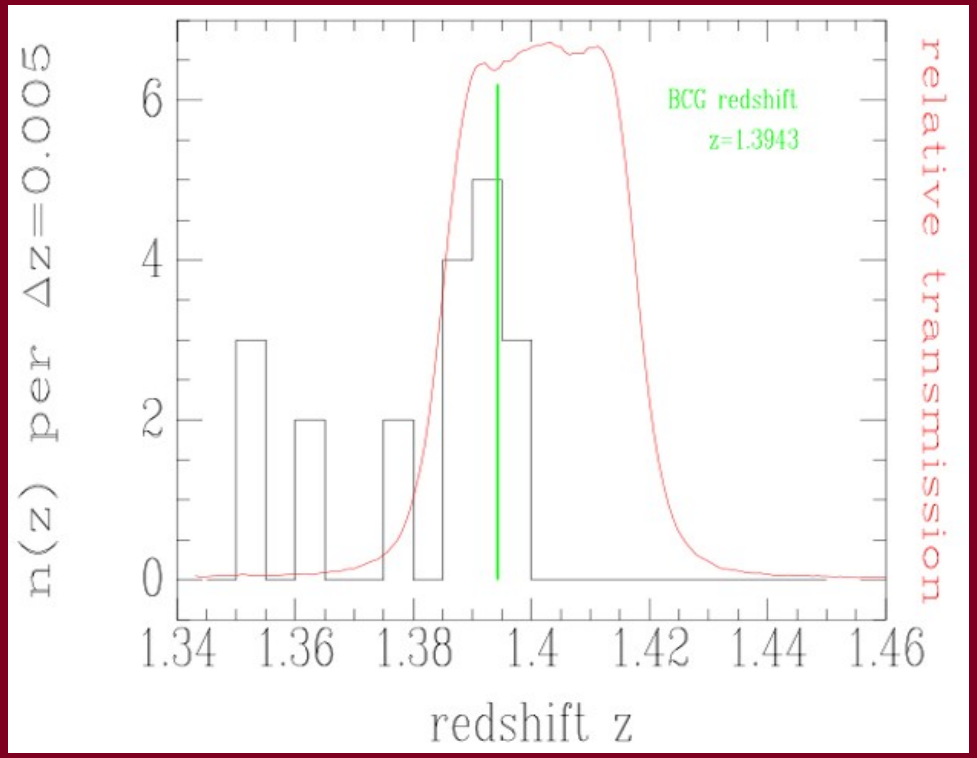
= H-alpha at z=1.39!



Our observations

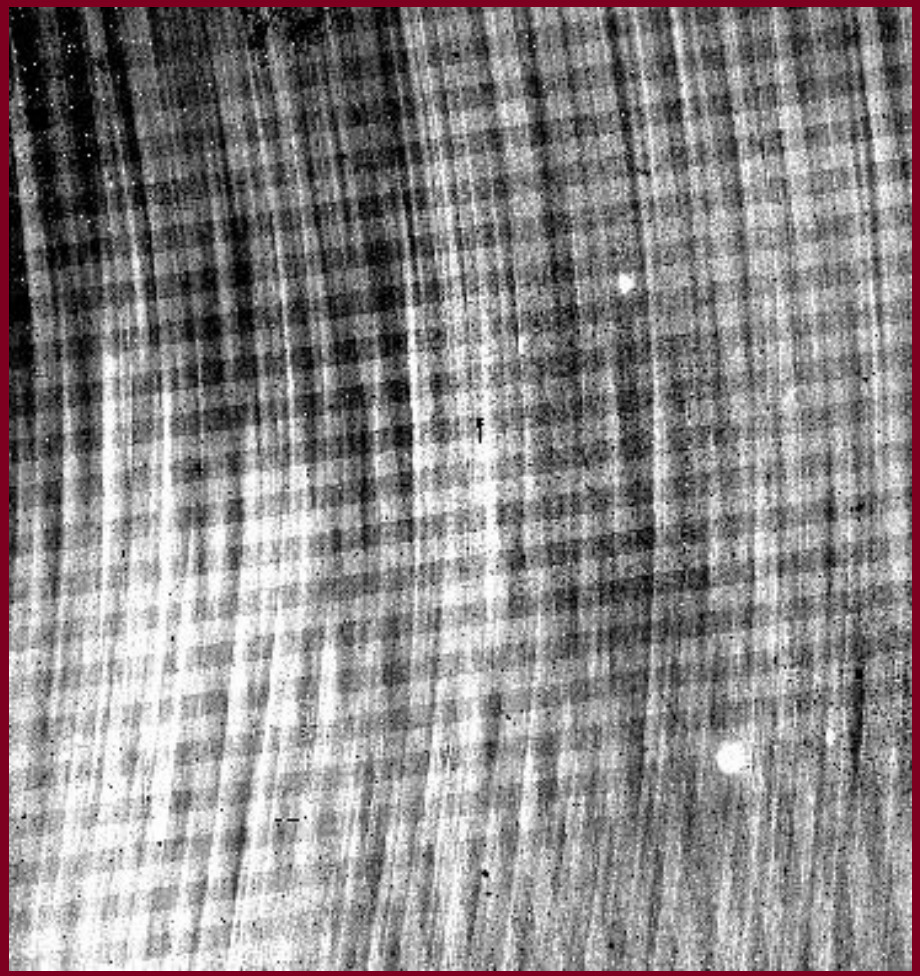
direct measure of SFR?

– NIRI@GEMINI-North:
narrow band filter at λ=1.57 μm = H-alpha at z=1.39!

– proposed: 2 pointings
1 central, 1 at ~1.5 Mpc from cluster centre
7 hours integration in narrow band filter

– got: 1 pointing (central)
4 hours integration

H-band imaging



Raw single exposure

H-band imaging

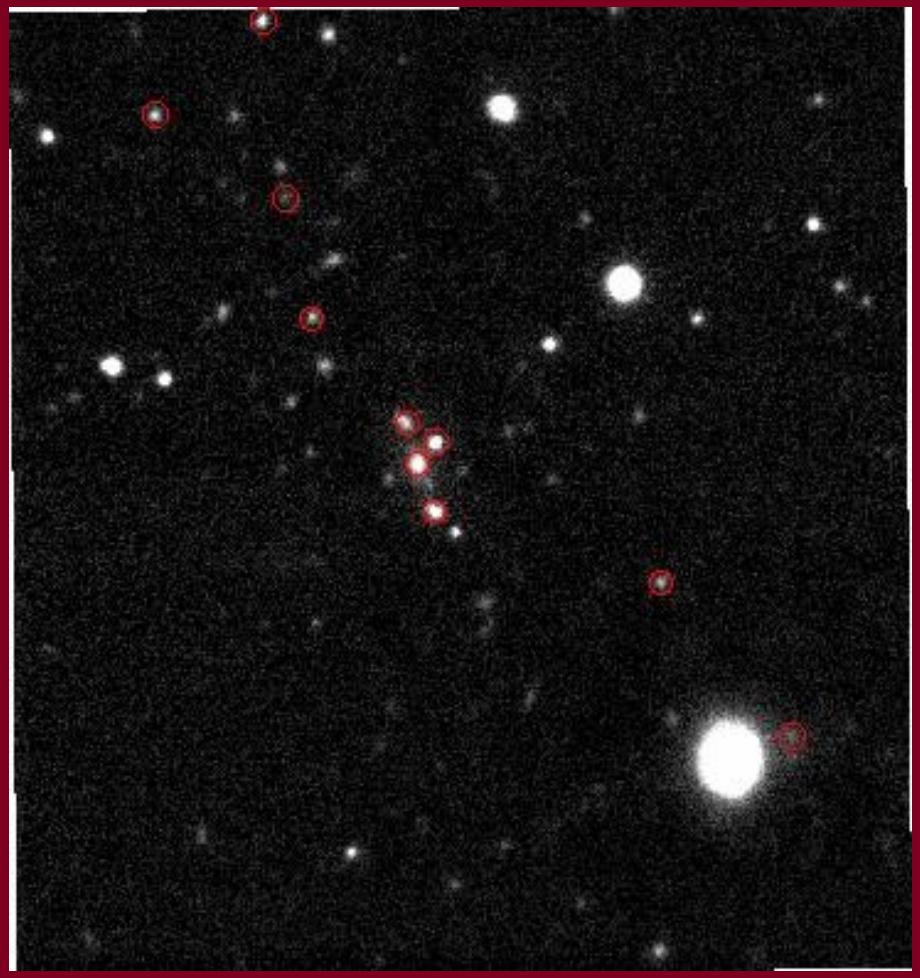
Reduced single exposure

H-band imaging

Combined images:

- 1.5 arcmin =~800 kpc
- H broad-band:
  3390 sec, min S/N~6
- H narrow-band:
  13800 sec, min S/N~2.5

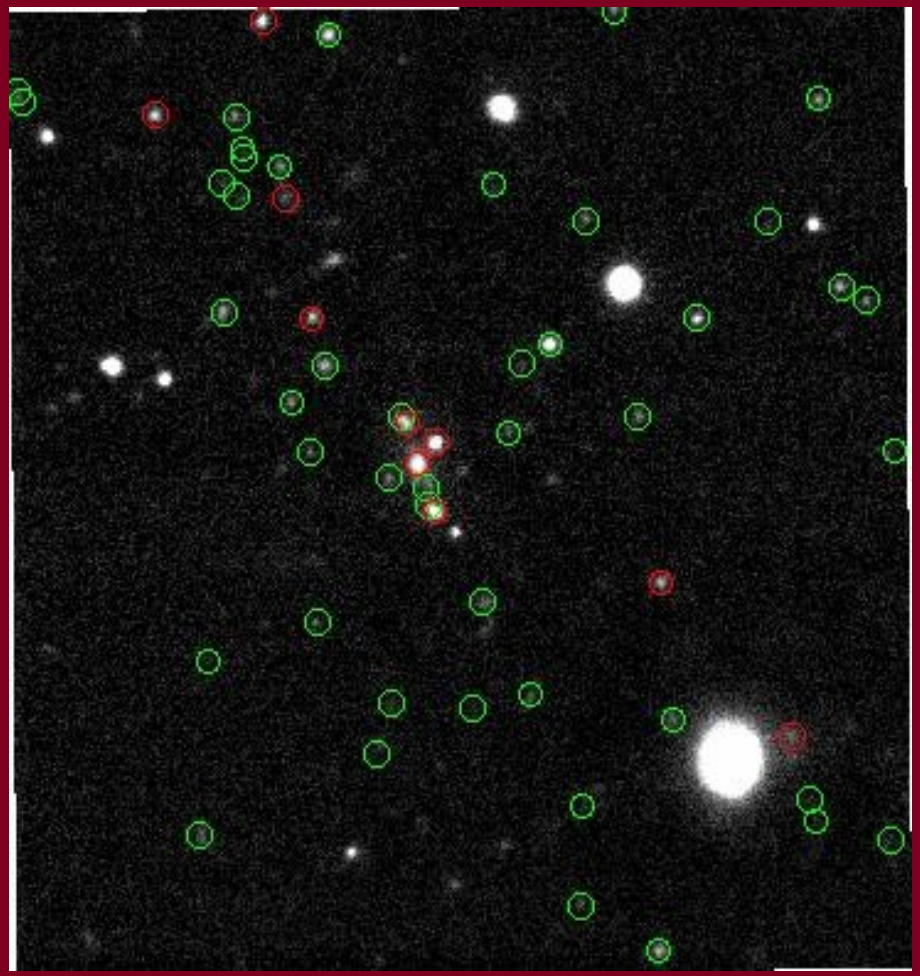
Confirmed cluster members



Combined H band image

cluster members, spectroscopically confirmed (red circles)

All detected galaxies



Combined H band image

cluster members, spectroscopically confirmed (red circles)

all other detections, removed stars, artifacts, foreground objects (green circles)

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– broad band fluxes from standard star images

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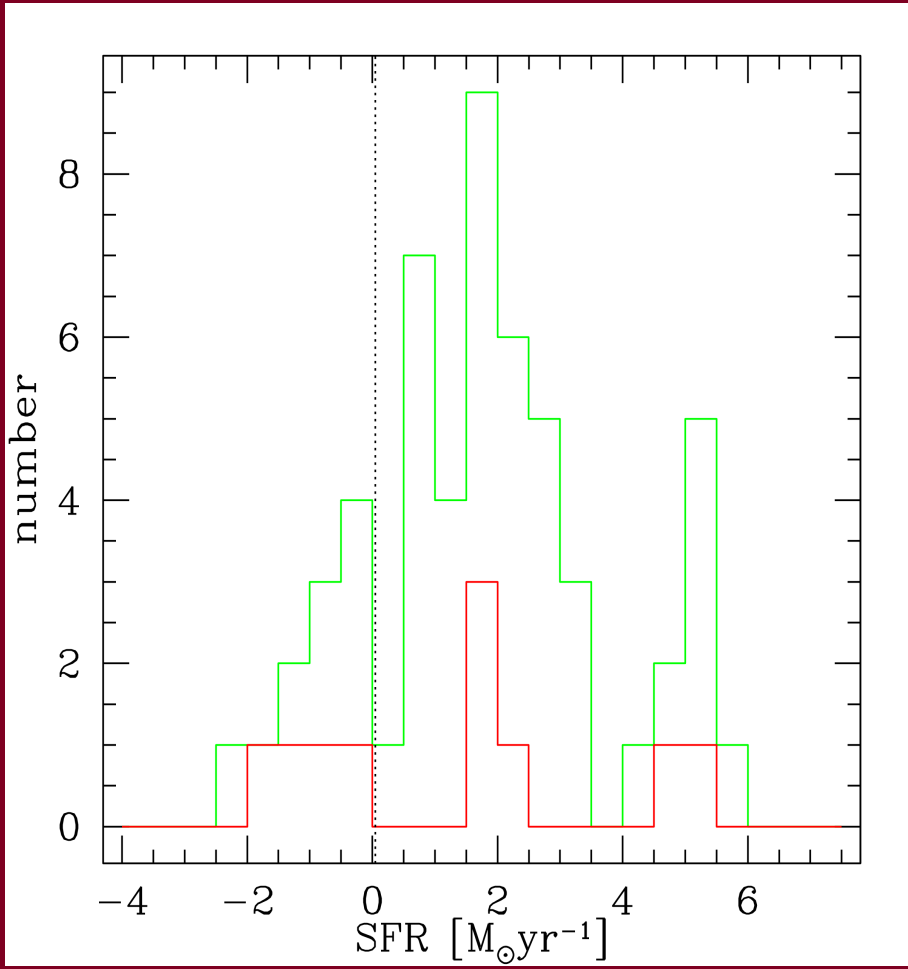
– 1 erg s^{-1} = 7.9 x 10^{-42} $M_\odot$ yr^{-1} (Kennicutt et al 94)

→ zeropoint 2.3 $M_\odot$ yr^{-1}, detection limit 0.05 $M_\odot$ yr^{-1}

SFR - results



confirmed members (red)
other detections (green)

– SFR range: -2 – 6 $M_\odot$ yr^{-1}

– same for members and other detections

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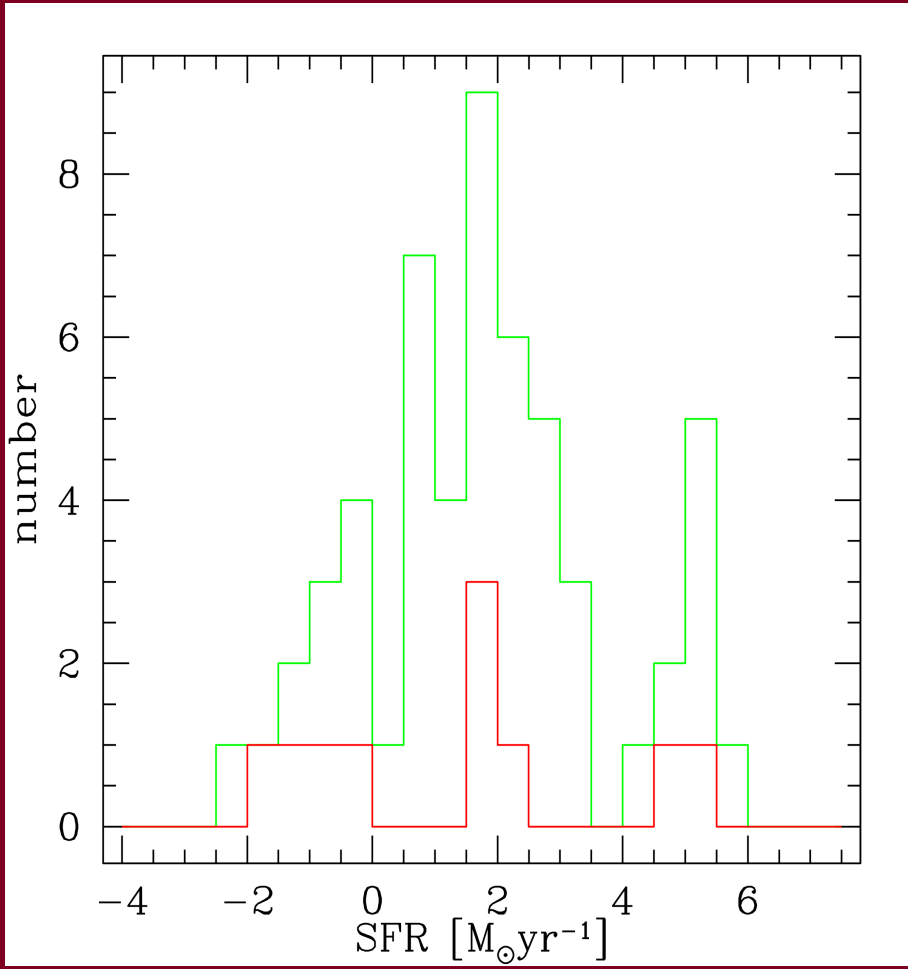

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– 3 subgroups:
  non star-forming 20%
  low SFR (<3.5$M_\odot yr^{-1}$) 60%
  high SFR(>3.5$M_\odot yr^{-1}$) 20%

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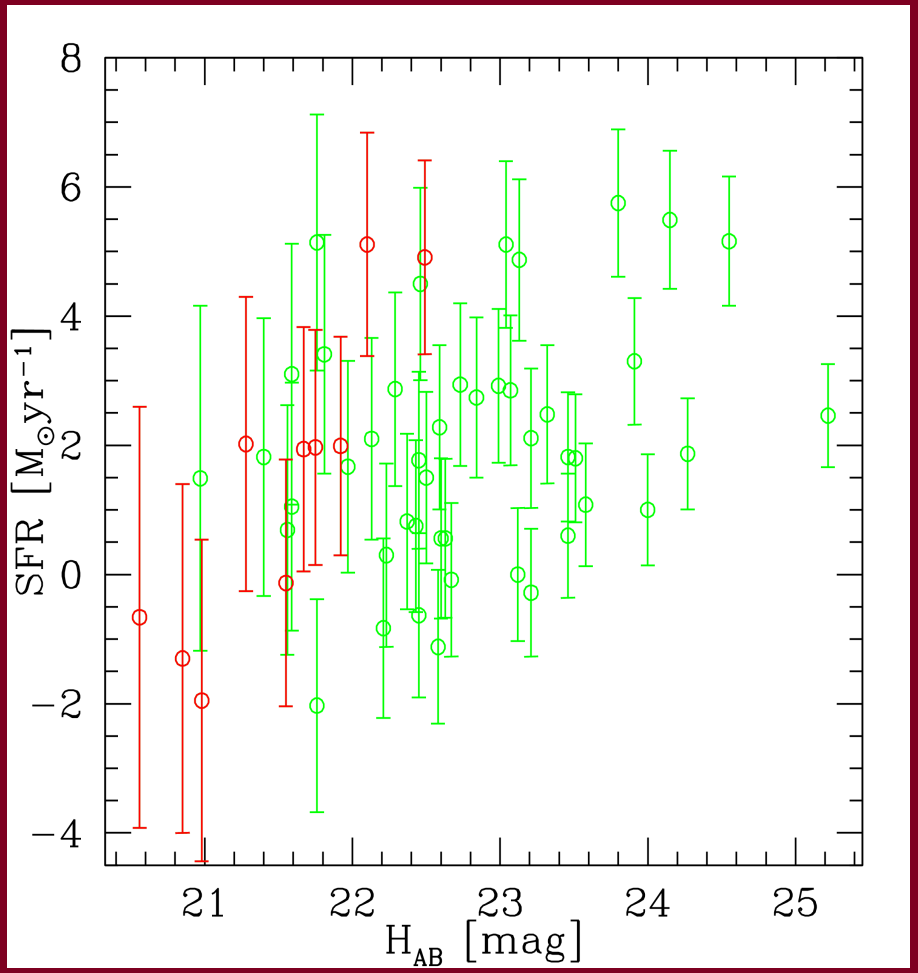

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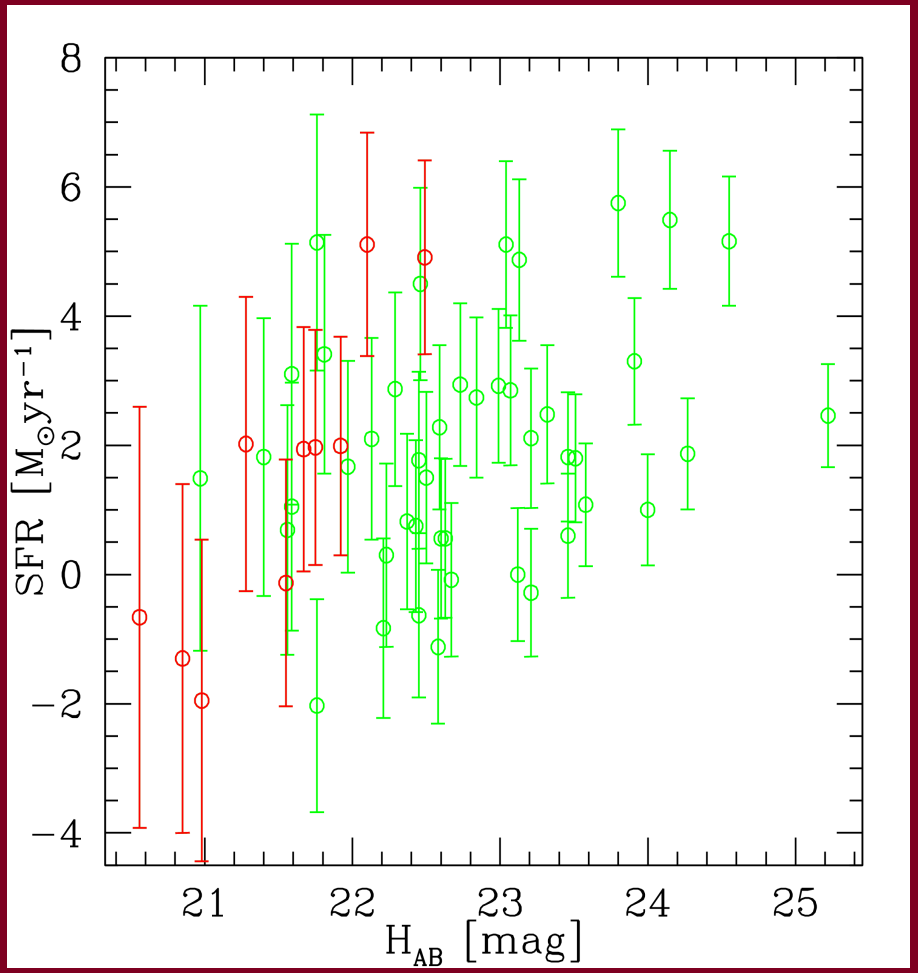

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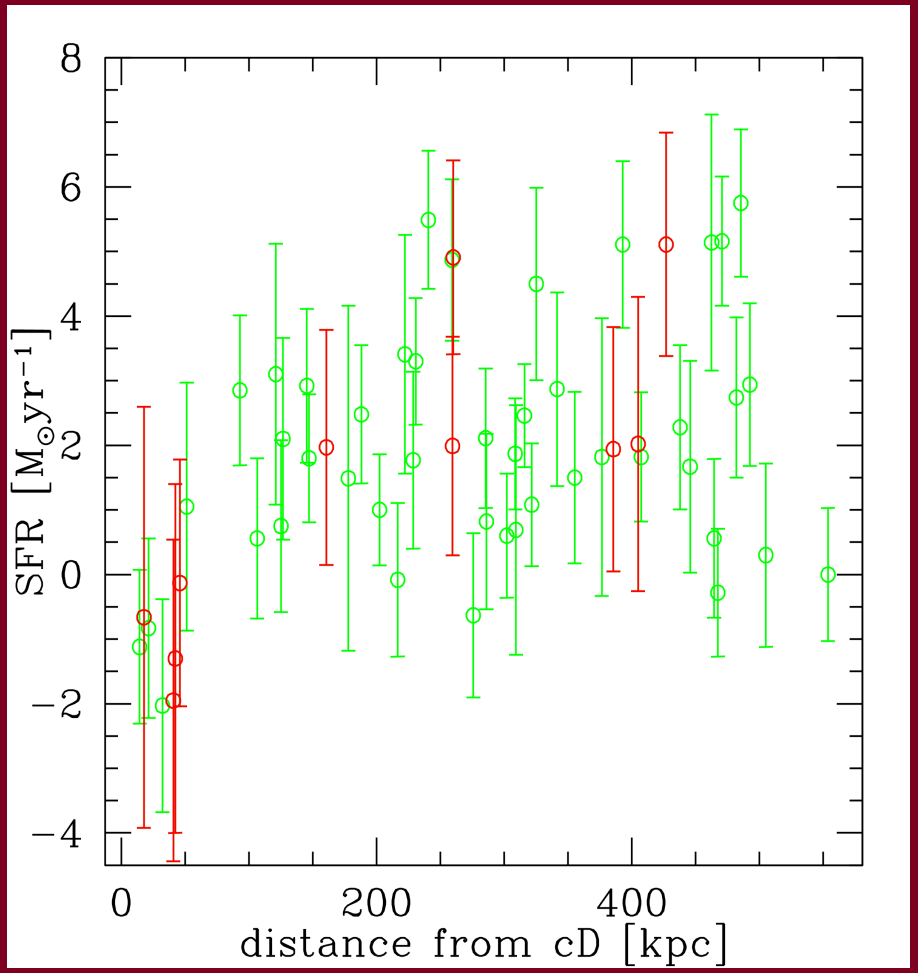
– SFR correlated with H band magnitude

– large spread for not confirmed members

SFR - distance



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SFR vs. distance from cluster centre (cD galaxy)

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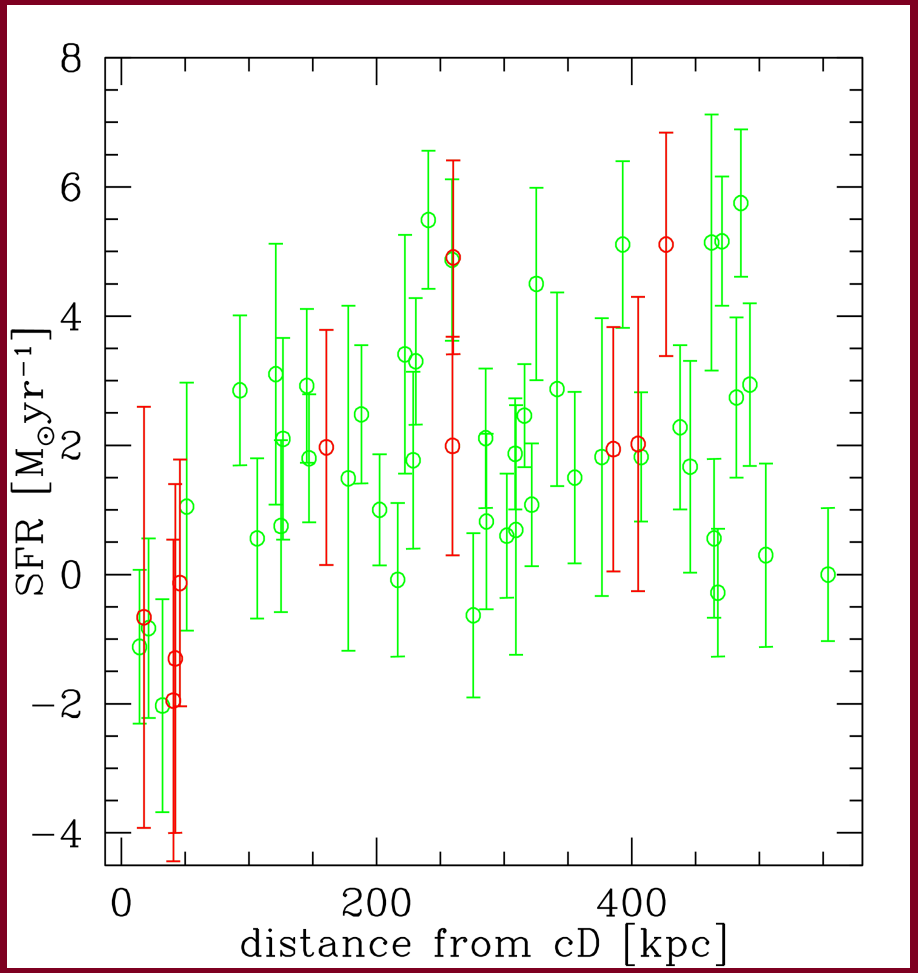

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SFR vs. distance from cluster centre (cD galaxy)

→ no SF within ~100 kpc
→ increasing SF with distance from cD

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→ SF effectively shut off in cluster centre already at z=1.4, i.e. when the universe was only ~4.5 Gyr old