Probing galaxy evolution in groups
with Chandra and XMM

Jesper Rasmussen
(Carnegie Observatories)

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T. Ponman (Birmingham, UK), L. Verdes-Montenegro (IAC, Spain), M. Yun (UMass Amherst)

Why study (galaxy evolution in) groups?

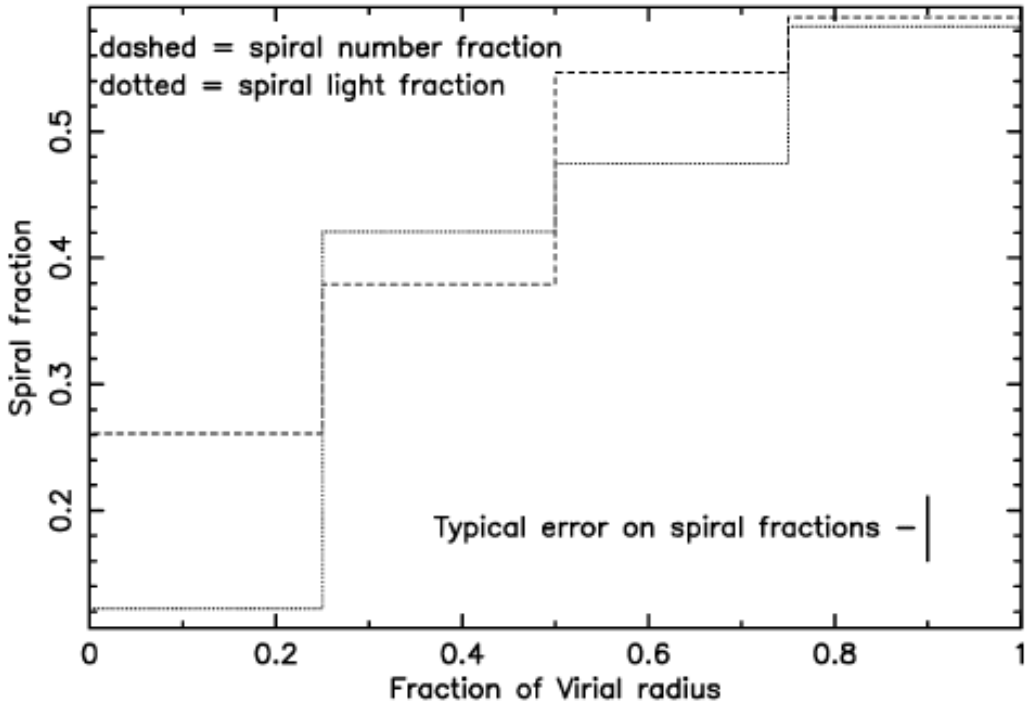
Most galaxies

- not isolated
- affected by environment.

Clusters:
rare + “evolved”

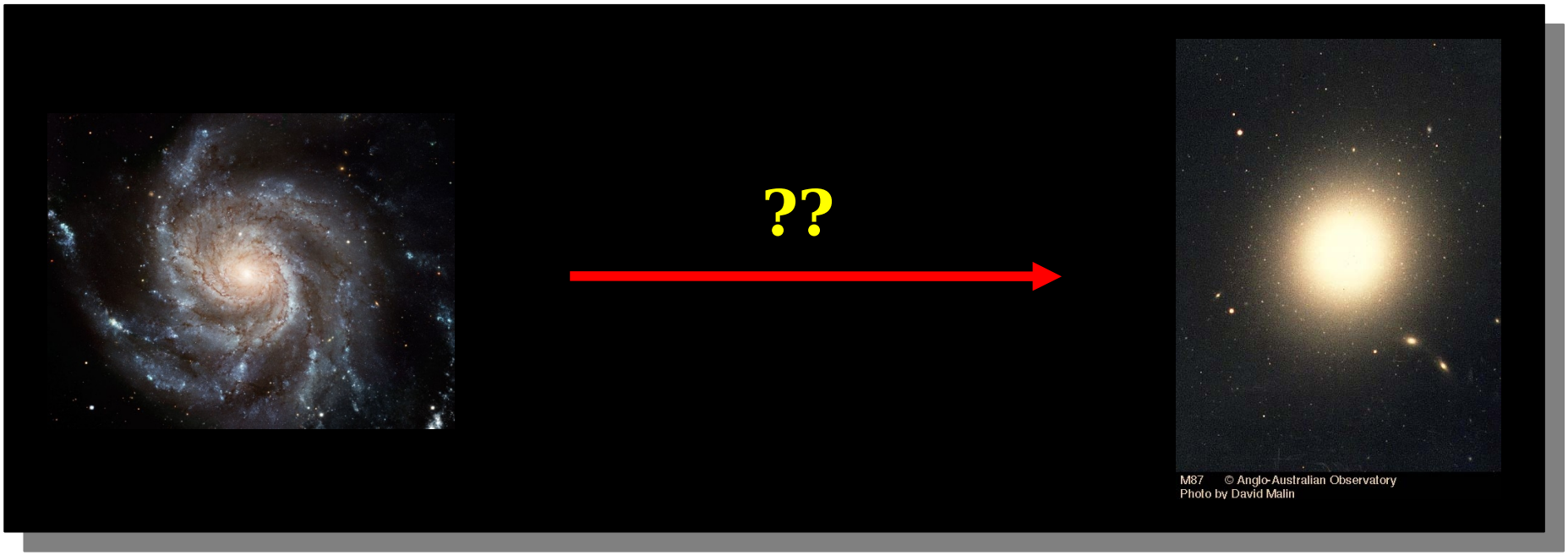
Groups:
Common + “evolving”

24 X-ray bright groups:



Helsdon & Ponman 2003

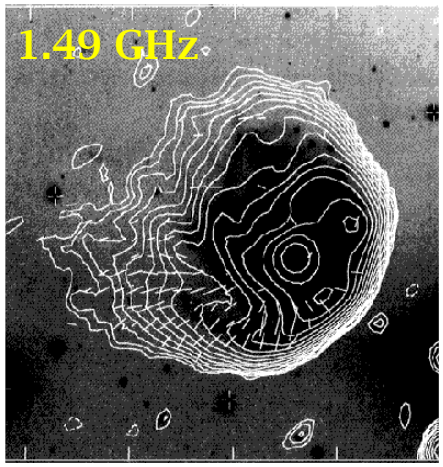
Galaxy transformations



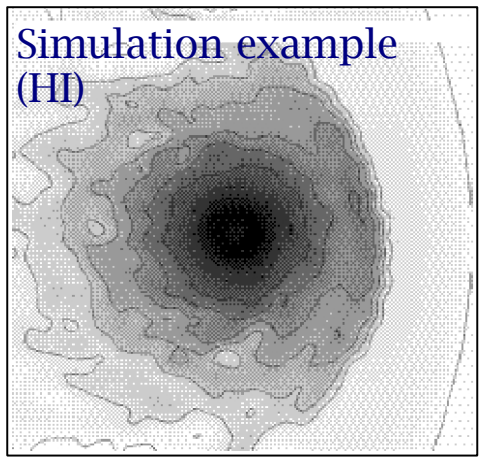
- Galaxy-galaxy interactions
- Galaxy-gas interactions: Ram pressure $\mathbf{P = \rho_{gas} v^2_{gal}}$

NGC 2276 – a transforming spiral

Starbursting (~ 5 $M_\odot$/yr) spiral embedded in T ≈ 10^7 K group gas.



Hummel & Beck 1995



Quilis et al. 2000

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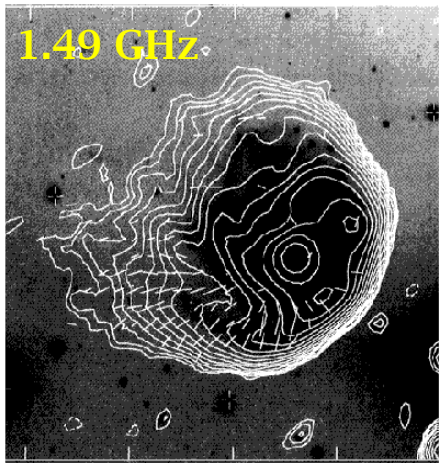

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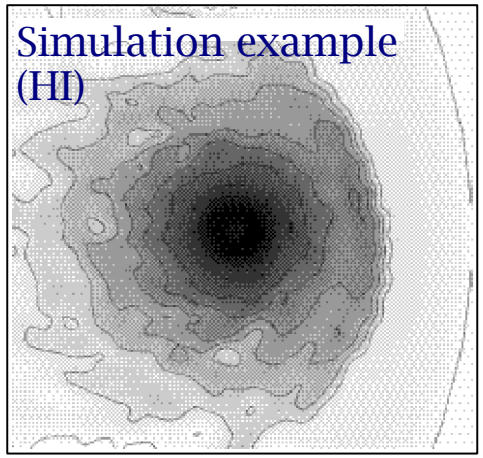

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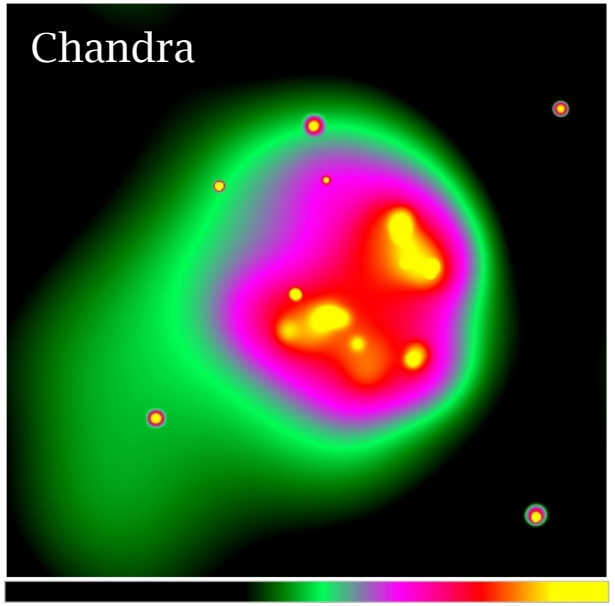
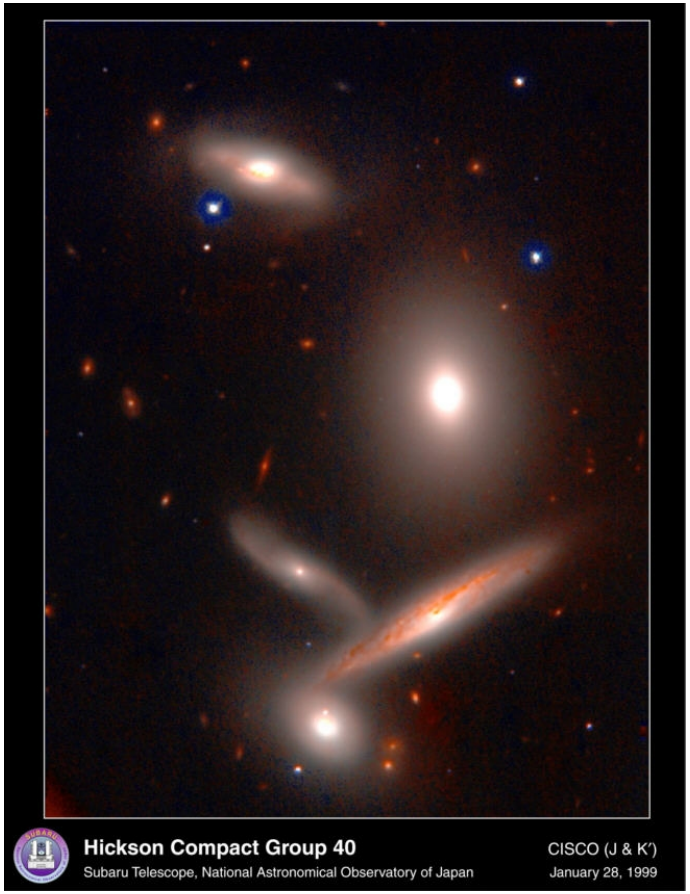


- v_{gal} ≈ 850 km/s
- Current mass-loss rate of gas: ~ 5 $M_\odot$/yr.
- Gas supply lost in 1–2 Gyr

→ **S0** ?

HI–deficient compact groups

Compact groups (Hickson 1982): Deficient in HI.



HI–deficiency related to X–ray emission from group gas?
(Verdes–Montenegro+ 01)

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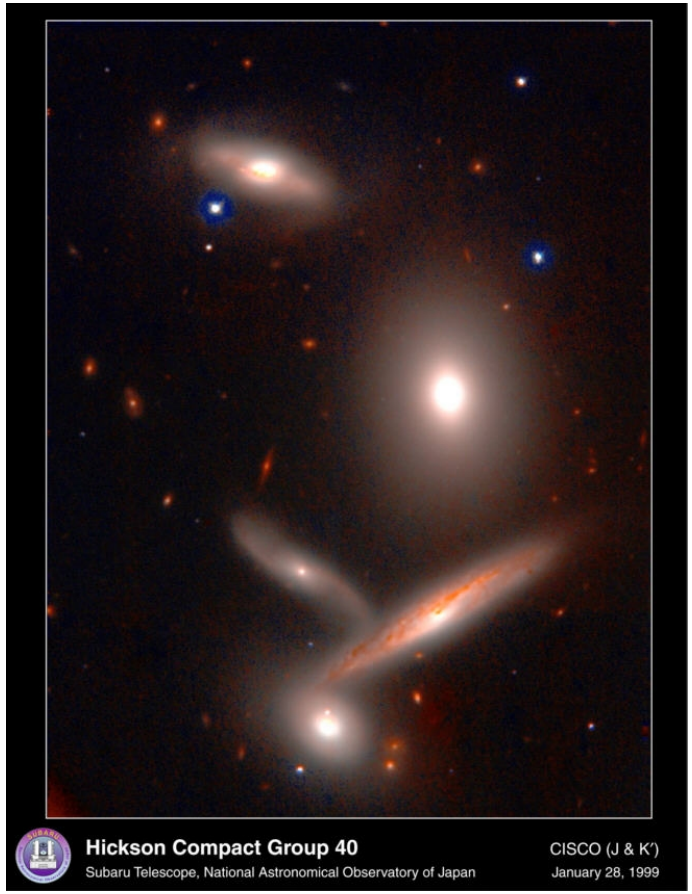

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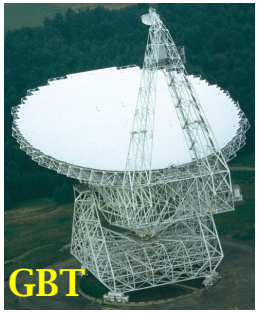
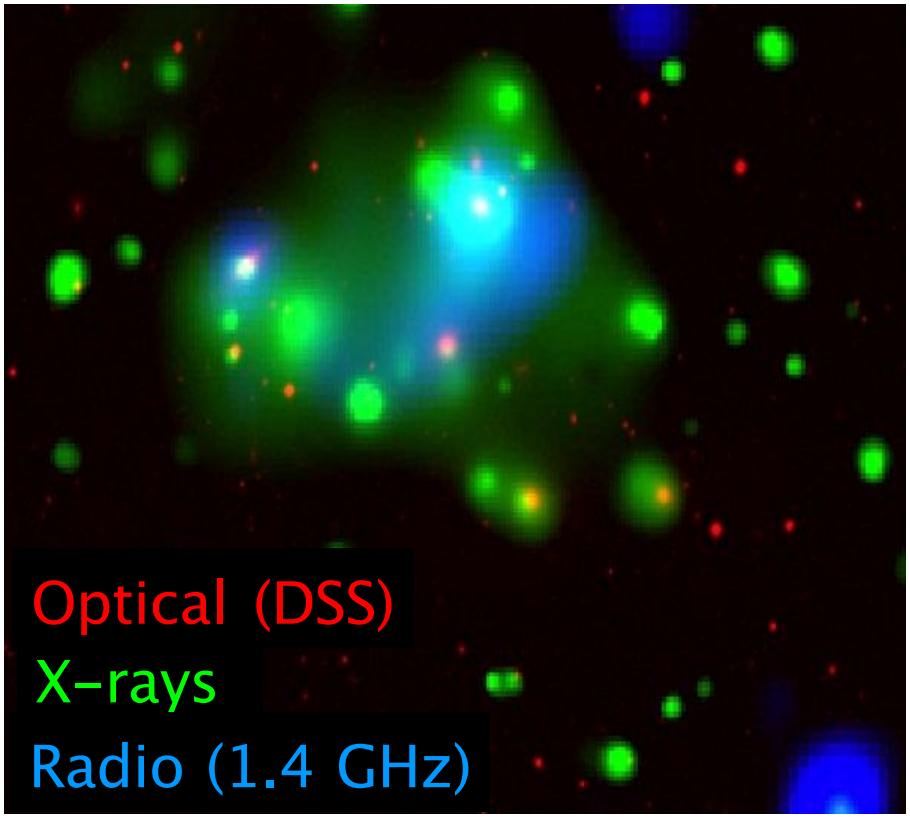


Two examples: HI vs. hot gas

HCG 15



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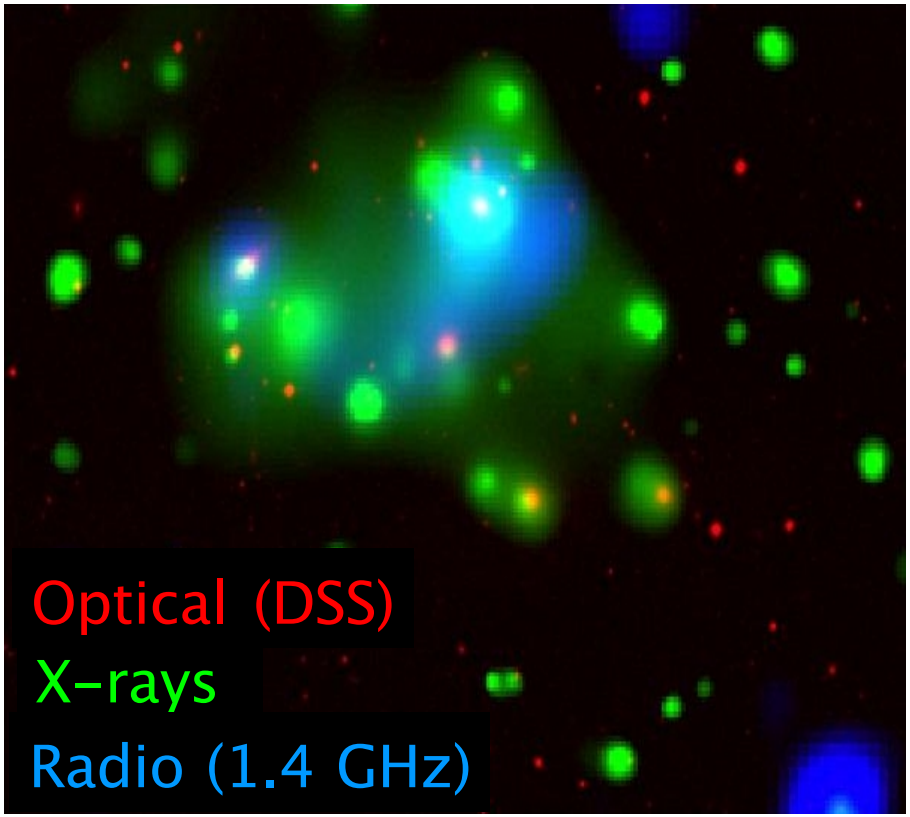
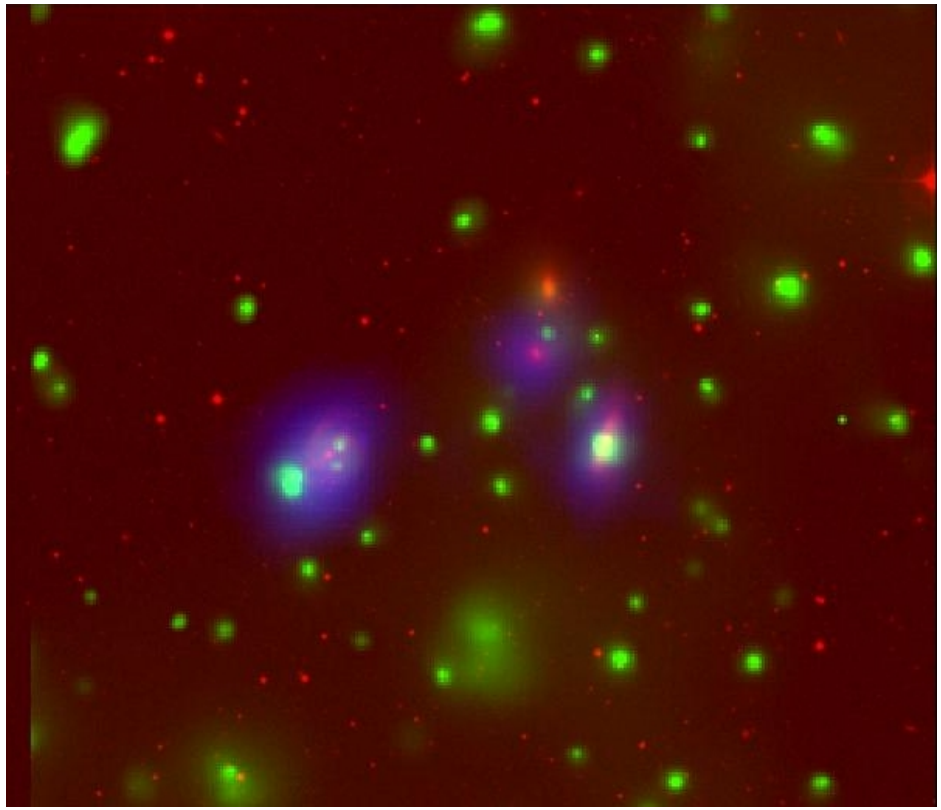
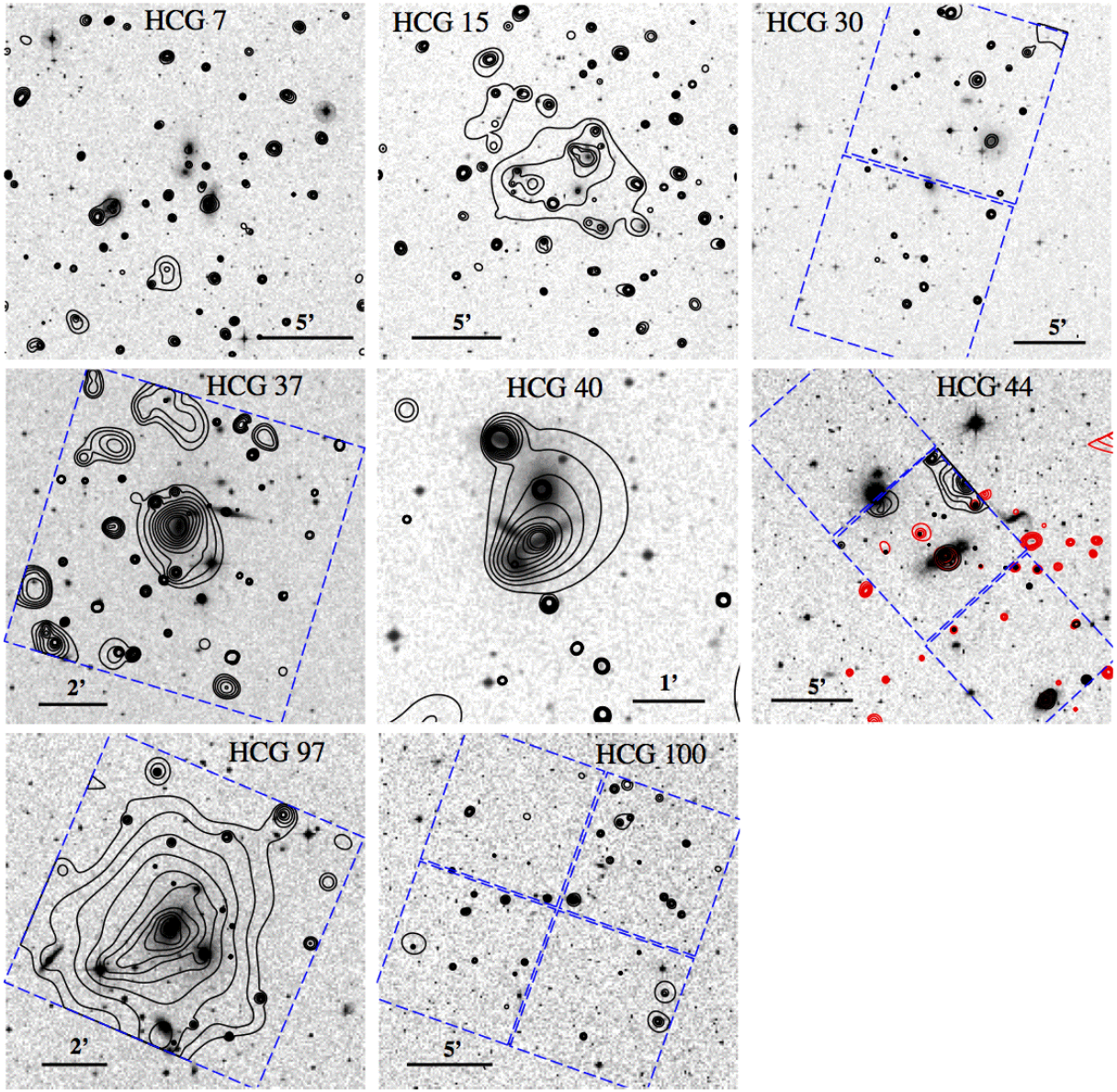


HCG 7

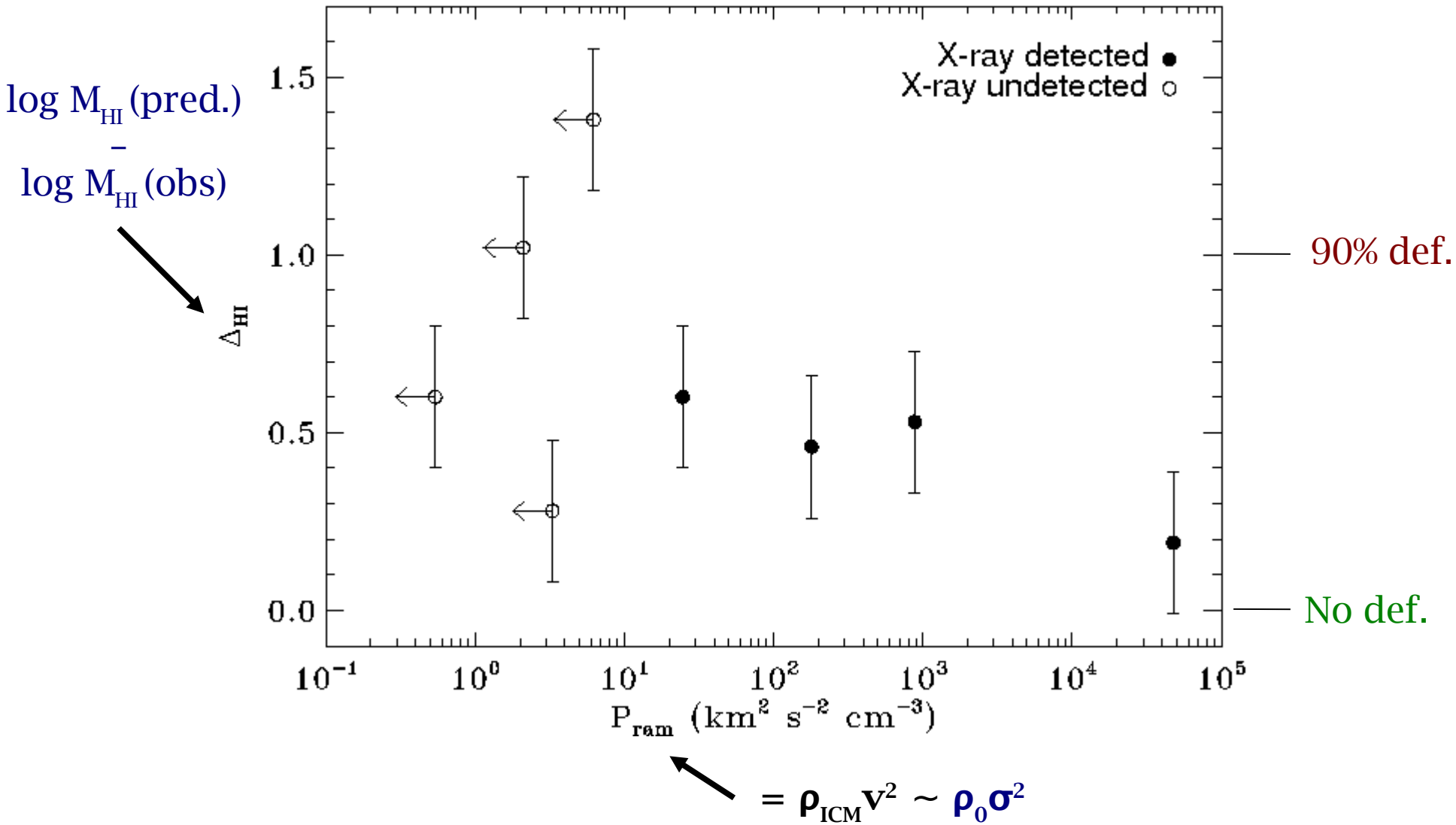


X–ray gallery of Hickson groups

Chandra/XMM 0.3-2 keV contours over DSS images

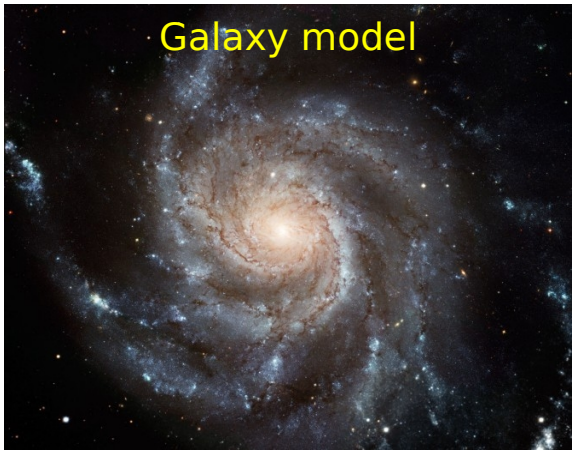


HI deficiency: Caused by ram pressure?



Simple modeling of ICM interactions

Ram pressure stripping: $F_{grav}/D^2 < \rho_{ICM} v^2$



- DM halo
- bulge
- gas+stellar disks

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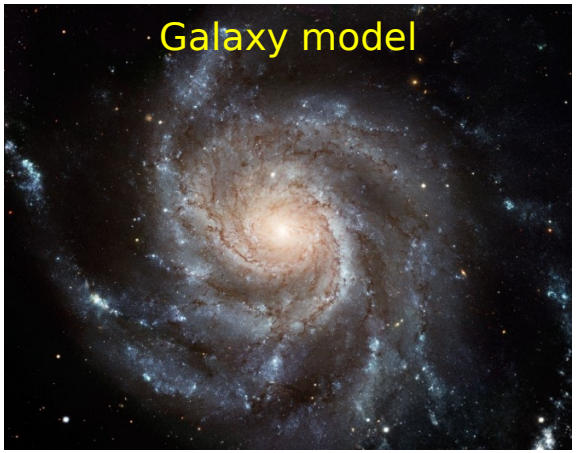
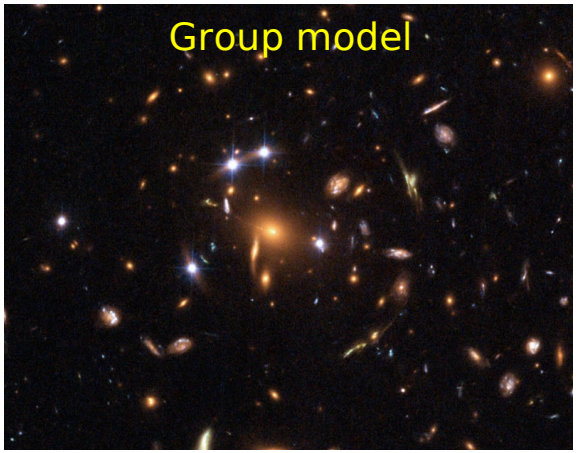


Radial free–fall



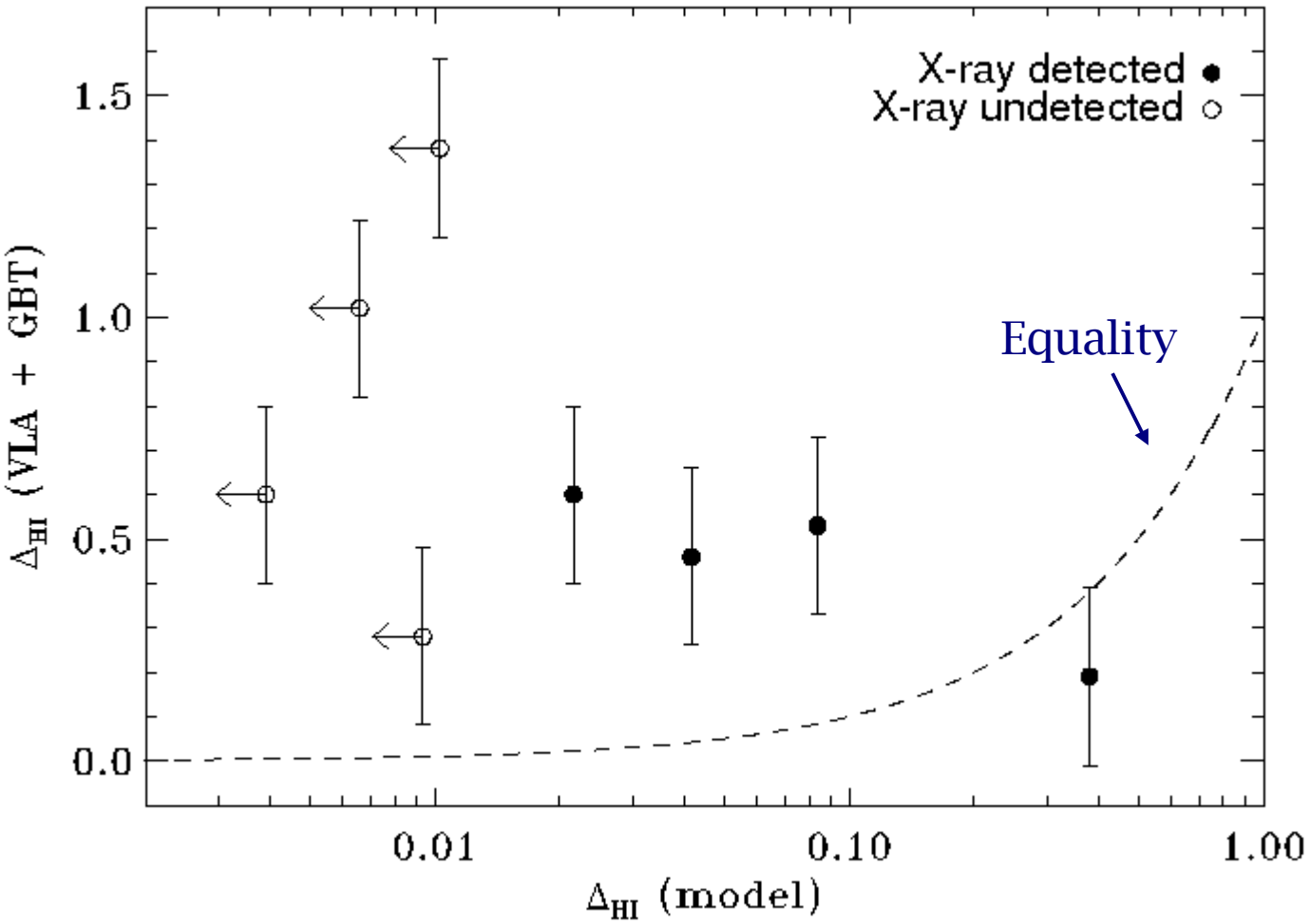
- DM halo
- bulge
- gas+stellar disks

- NFW potential
- Measured gas profile (eventually!...)

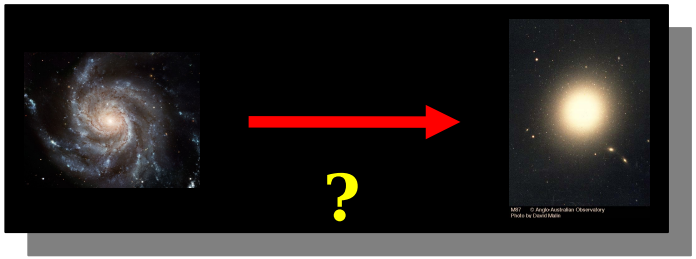
$$\Sigma_g \left(\frac{\partial \Phi_b}{\partial z} + \frac{\partial \Phi_h}{\partial z} + \frac{\partial \Phi_g}{\partial z} + \frac{\partial \Phi_*}{\partial z} \right) < \rho_1 (v_1 \sin\xi)^2$$

Mass loss from ram pressure

From predicted mass loss:



Conclusions & future work...



• HI removal in groups:
Ram pressure stripping not the whole story.

• Destruction of HI:
Not due to ICM heating in all cases.

• *Need to consider:*
Realistic orbits, DM halo (tidal) stripping,
viscous stripping (cf. N2276)...