The curious case of NGC4342, an optically faint but gas rich early-type galaxy

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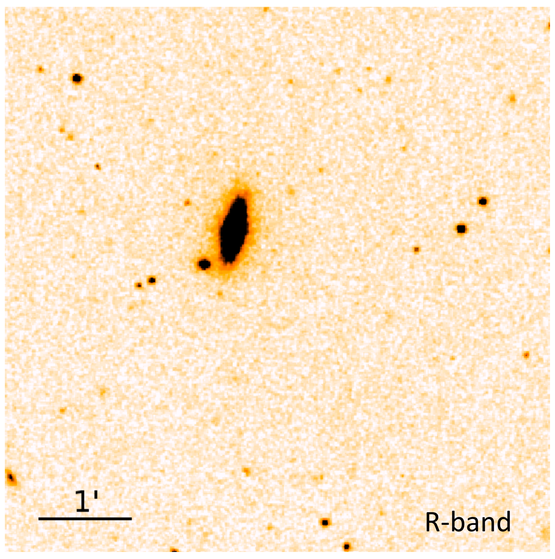
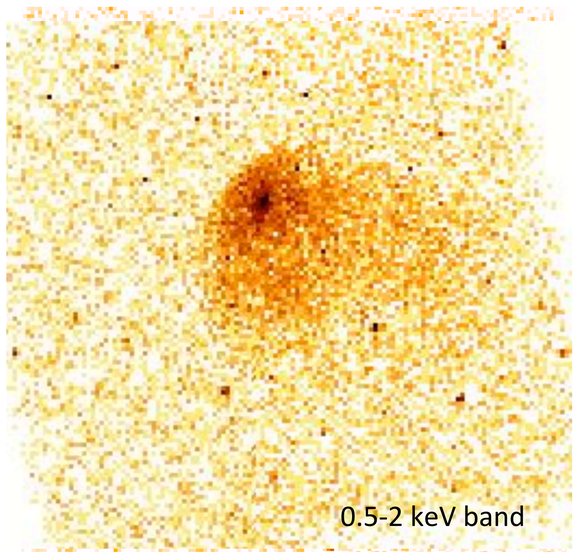
Optical vs. X-ray image of NGC4342

DSS

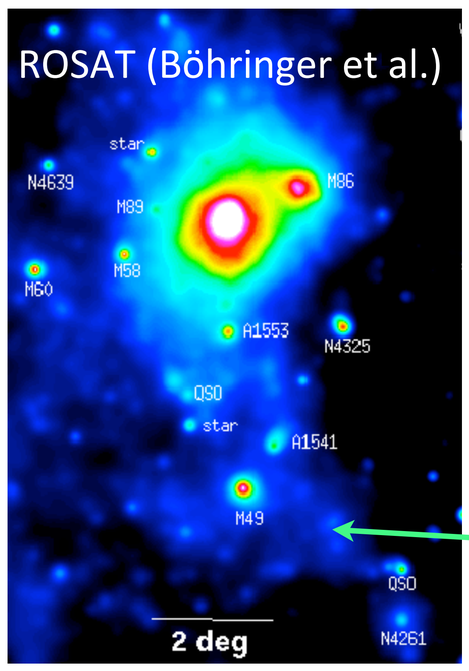


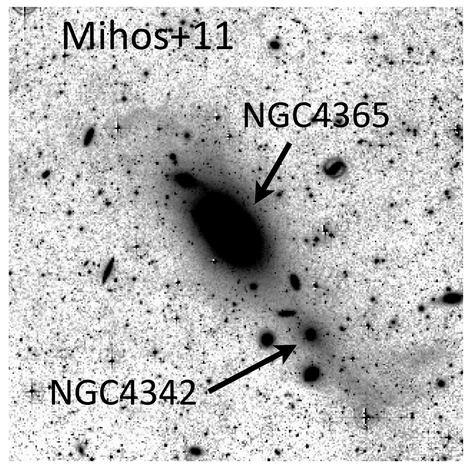
Chandra



- Optically faint early-type galaxy (E7, RSA; S0, RC3): $M \sim 10^{10}\ M_\odot$
- Remarkably bright X-ray corona originating from 0.5 keV gas: $L_X \sim 10^{40}$ erg/s
- Sharp surface brightness edge to NE indicates high velocity: M~2
- cz = 751 km/s ("near" Virgo cluster; M87 cz = 1307 km/s)

Large scale environment



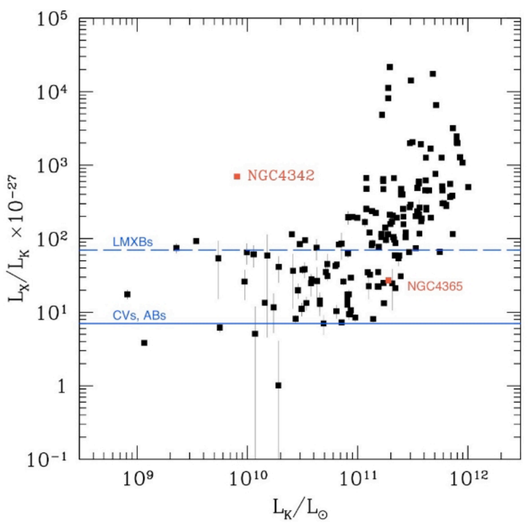


- 5.25 degrees (1.5 Mpc) from M87
- 0.5 Mpc from NGC4472=M49
- 20' from "large" galaxy NGC4365
- In diffuse Virgo cluster emission?

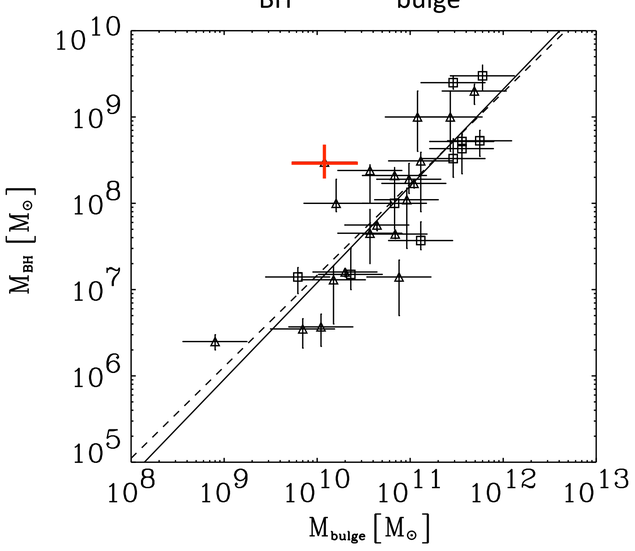
- NGC4365 at 23 Mpc (7 Mpc "behind" Virgo; Mei+07)
- Distance to NGC4342 is uncertain
- Tidal tail extends (~200 kpc) SW of NGC4365 : $m_B \sim 28$ mag/arcsec^2 (Mihos+11)
- Tidal interaction between NGC4365 and NGC4342 (130 kpc)?

Observational comparison

L_X/L_K vs. L_K



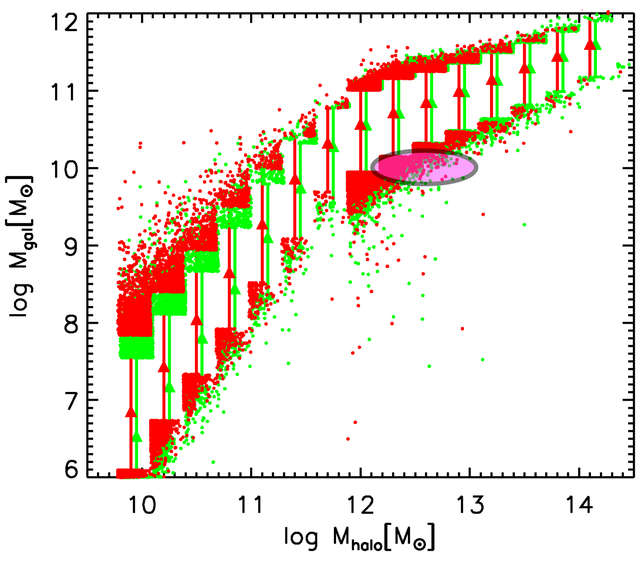
M_{BH} vs. M_{bulge}



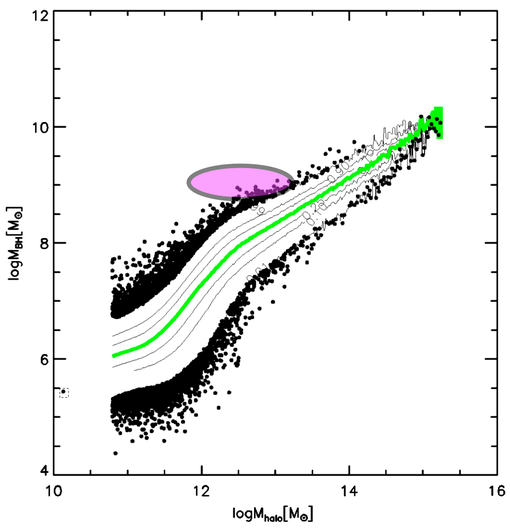
- Unusually high L_X/L_K ratio in NGC4342 compared with other low mass early-type galaxies (Jones et al. 2011)
- Surprisingly massive black hole (~3 × 10^8 $M_\odot$) relative to the low bulge mass (Cretton & van den Bosch 1999; Haring & Rix 2004)

Theoretical comparison

M_{bulge} vs. M_{halo}



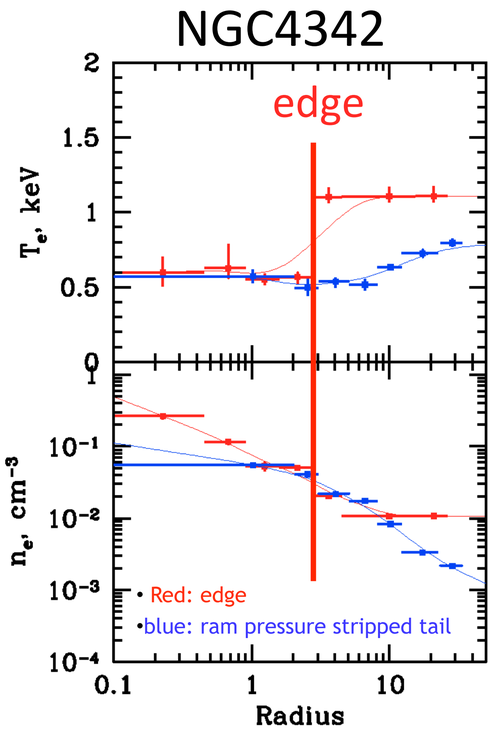
M_{BH} vs. M_{halo}



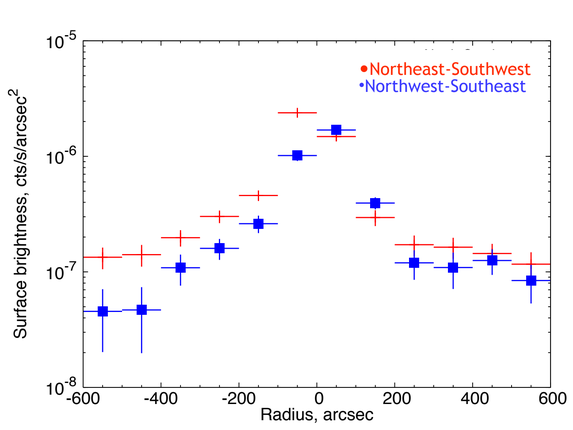
- Galaxies, halos, black holes from millenium simulation (Guo+11)
- **NGC4342 - an outlier, a "rare" object**
- More extreme than 99% of the population
- What is its evolutionary history?

Gas Physical Properties

NGC4342



Gas Around NGC4365



Gas around NGC4365

- Extended NE-SW toward NGC4342
- Is NGC4342 moving in a group centered on NGC4365?

- Temperature jump at leading edge ➡ contact discontinuity/cold front
- $\rho_{in} \sim 4 \times 10^{-3}$ cm^{-3}; $\rho_{out} \sim (0.6\text{-}1.8) \times 10^{-3}$ cm^{-3}
- Gas mass 4x10^7 $M_\odot$; gas replenishment time (~2 x 10^9 yrs)
- Require some dark halo to gravitationally bind gas around NGC4342

Summary

- NGC4342 is very gas rich for its optical luminosity
- M_{BH}/M_{bulge} =0.026!! (typically ~0.002)

  Why are the stars missing (or why is the black hole so massive)?
- Evolutionary scenarios for NGC4342

1) Stripping difficult - dark matter also stripped with stars, deep optical image limits "missing" stars

2) Star formation suppressed: black hole grew faster than stars; violation of BH-bulge co-evolution (e.g., Merloni+10)

- NGC4342 moving through group gas centered on NGC4365?
  - Map emission around NGC4365 to distance of NGC4342

References

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