Asynchronous growth of bulges and black holes in the optically faint, gas rich, early type galaxies NGC4342 and NGC4291

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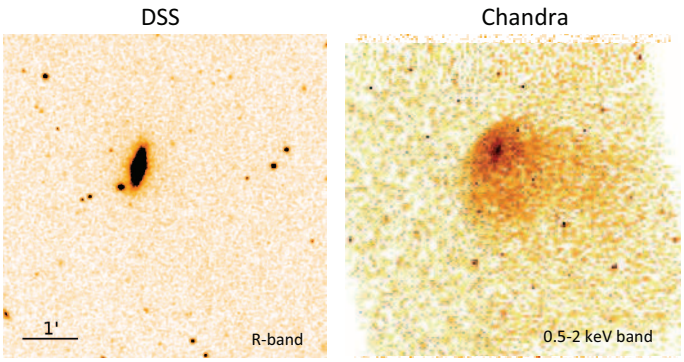
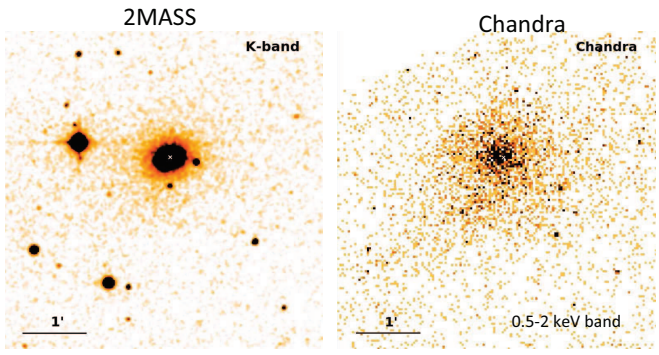
Optical vs. X-ray image of NGC4342



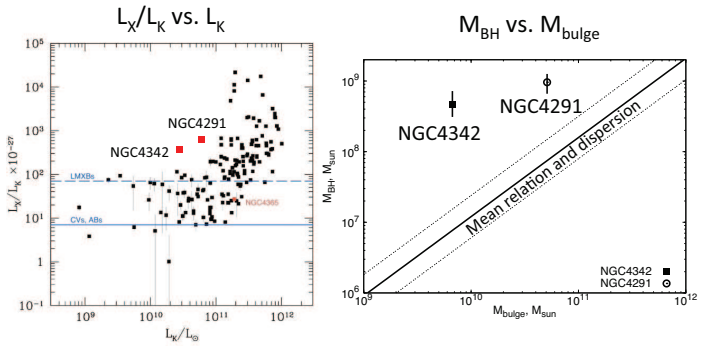
- Optically faint early-type galaxy (E7, RSA; S0, RC3): M_{bulge}~7x10^9 M$_\odot$
- Remarkably bright X-ray corona originating from 0.5 keV gas: L_X~10^{40} erg/s
- Sharp surface brightness edge to NE indicates high velocity: M~2.6
- Behind Virgo cluster (D~23 Mpc)
- M_{halo}/M_{stars} ~ 20 - 40 (for R<10 kpc; assuming hydrostatic equilibrium of the gas)

Optical vs. X-ray Image of NGC4291



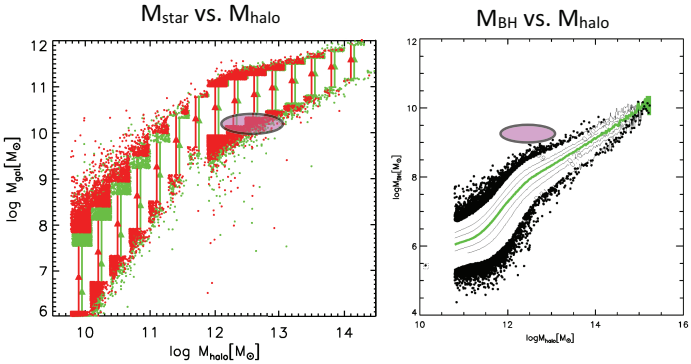
- Moderately faint early-type galaxy (E3, RC3): M_{bulge}~5x10^{10} M$_\odot$
- Bright X-ray corona originating from 0.5 keV gas: L_X~4x10^{40} erg/s
- No obvious structure in X-ray image
- Located in a poor group (D=26 Mpc)
- M_{halo}/M_{stars} ~ 5 (for R<10 kpc; assuming hydrostatic equilibrium of the gas)

Observational comparison



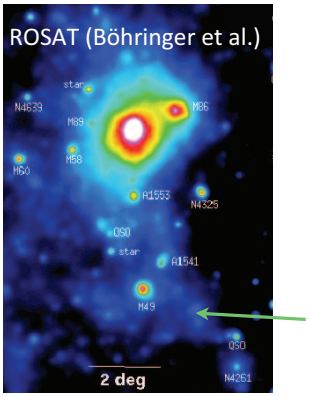
- Unusually high L_X/L_K ratio in compared with other low mass early-type galaxies (Jones et al. 2012)
- Surprisingly massive black holes (NGC4342 ~ 4.6 × 10^8 M$_\odot$; NGC4291 ~ 9.6 × 10^8 M$_\odot$) relative to low bulge masses (Cretton & van den Bosch 1999; Haring & Rix 2004; Schultze & Gebhardt 2011)

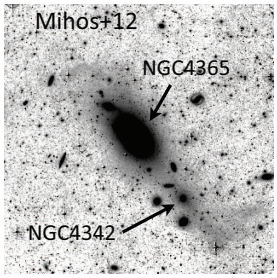
Theoretical comparison for NGC4342



- Galaxies, halos, black holes from Millenium simulation (Guo+11)
- **NGC4342 - an extreme outlier (5.1σ outlier on M_{BH}/M_{bulge} relation)**
- More extreme than 99% of the population
- NGC4291 is less extreme (3.4σ outlier on M_{BH}/M_{bulge} relation)
- What is the evolutionary history of these galaxies?

Large scale environment of NGC4342





- 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; possibly a member of the W' group
- Tidal tail extends (~200 kpc) SW of NGC4365 : m_B~28 mag/arcsec^2 (Mihos+12)
- Tidal interaction between NGC4365 and NGC4342?

Summary

- NGC4342 and NGC4291 host dark matter halos at least within the inner 10 kpc
- M_{BH}/M_{bulge} =0.069 for NGC4342 and 0.019 for NGC4391; 60x and 13x larger than expected for their observed M_{bulge}, based on the mean correlation

  Why are the stars missing (or why is the black hole so massive)?
- Evolutionary scenarios for NGC4342 and NGC4291

  1) Stripping unlikely - dark matter (DM) halos stripped before stars, but DM halos are present; also, deep optical image of NGC4342 limits "missing" stars (to <10% of required stellar mass)

  2) Star formation suppressed: black hole grew faster than stars; violation of BH-bulge co-evolution (e.g., Merloni+10; Booth & Shaye 2010)

References

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