NGC 741

Mergers and AGN feedback at the galaxy group scale

X-ray Universe 2017

– Rome –

Gerrit Schellenberger
Jan Vrtilek
Laurence David
Ewan O'Sullivan
Simona Giacintucci
Melanie Johnston-Hollitt
Stefan Duchesne
Somak Raychaudhury
Introduction

Structure formation predicts number density of halos

Many more galaxy groups than clusters

Around 50% of galaxies are in galaxy groups (only few in clusters)

The baryonic evolution in the Universe by looking at galaxy groups

Observed properties of galaxy groups not represented well in simulations (see Poster N01 → HICOSMO)

Many interactions happen in galaxy groups

Structure formation is believed to happen hierarchically (galaxies → groups → clusters)
Open questions:

How is the group environment influenced by member galaxies?

What triggers star formation?

How important is the AGN activity in member galaxies?

Is the central AGN more important than in clusters?
~5% galaxies
~15% hot gas
~80% Dark Matter

Multiwavelength studies are of key importance

Cluster mergers
Influence on cluster environment
Bias cosmological samples and scaling relations
Gas motion and turbulence in the ICM

Interaction processes also lead to production of relativistic particles
→ Radio relics and halos
Strong AGN activity will produce radio lobes and create low-density bubbles in the ICM

Abell 3667

Röttgering+97

Fabian+00
### Basic properties

Nearby galaxy group

Redshift $z = 0.0185$, $D_A = 77$ Mpc

$L_x = 3.2 \times 10^{42} \text{ erg s}^{-1} \text{ cm}^{-2}$

High quality X-ray data
Chandra [180ks] cleaned exposure time
XMM-Newton [30ks] cleaned exposure time

Multi wavelength coverage
High resolution radio and HST data available

Galaxies NGC741 & NGC742 are confirmed cluster members with strong radio AGNs

Past results comprise:
Identification of ghost cavities (Jetha+08)
Radio bright ridge (Birkinshaw & Davies 85)
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Radio bright ridge (Birkinshaw & Davies 85)
previous work

Birkinshaw & Davis, 1985

- compact nucleus
- Extended emission to the west
- Eastern component connected to the nucleus by a bright ridge
previous work

Possible ghost cavity to the west

Area could be filled with hot plasma (>10keV) or relativistic plasma of non-radiating particles

Both scenarios are not compatible with high energy cut-off in radio spectrum

Origin of the bubble remains unclear
Available data:

X-ray
- Chandra: 30+150ks
- XMM-Newton: 30ks

Radio
- VLA: 1.4 & 4.9 GHz
- GMRT (MWA): 150, 235 & 610 MHz

NGC 741

XMM-Newton
235 MHz GMRT

Chandra
4.8 GHz VLA (BnA)

NGC 741
ARK66
ARK65
SRGb119.030

GMRT
150, 235 & 610 MHz
(MWA)

60 arcsec = 22 kpc
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![XMM-Newton 235 MHz GMRT map](image)

**NGC 741**

**ARK66**

**SRGb119.030**

**NGC 742**

**ARK65**

**60 arcsec = 22 kpc**

**Dec**

**RA**

1h56m40.0s

30.0s

20.0s

10.0s

(MWA)
Available data:

**X-ray**
- Chandra: 30+150ks
- XMM-Newton: 30ks

**Radio**
- VLA: 1.4 & 4.9 GHz
- GMRT: 150, 235 & 610 MHz
- (MWA)
X-ray data – residuals

No indications

Strong indications

Extended radio emission

Potential cavity

ARK66

Jetha+08 Cavity

New Cavity

NGC741

NGC742

Dec 38'

Dec 36'

RA 1h56m30.0s 24.0s 18.0s 12.0s
~1.4keV system
High peak temperature & cool core
Consistency between XMM and Chandra
The radio picture

- 5 frequency high resolution data (160MHz → 5 GHz)
- Bent lobes of NGC742
- Long and complex shaped radio tail to south west → emission mainly from NGC742
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NGC741

- MWA + GMRT/VLA slope -0.76
- GMRT/VLA only slope -0.87
- VLSSr, NVSS, Becker+91
- MWA

Fluxdensity [JY]

- integrated radio spectrum

50kpc
The radio picture

Measurement of the powerlaw

Steepening / exponential cut-off (assuming spectral index of 0.76)

Spectral index

NGC742

NGC741

Spectral aging

60Myr

80Myr

-0.58

-0.62

-0.82

-1.02

-0.81

-0.93

-1.23

0 Myr

0 Myr

34 Myr

59 Myr

29 Myr

50 Myr

81 Myr
Scenario

Small filament 15% lower temperature
Bent radio lobes from AGN of NGC742
AGN emission of NGC741

X-ray filament
Gas mass $3 \times 10^8$ M$_\odot$
50% lower entropy, consistent abundance, slightly lower temperature and 50% higher density
→ Gas stripped from NGC742 during close encounter with NGC741

optical
1.4 GHz
610 MHz
X-ray

NGC742 $v \sim 1000$ km/s