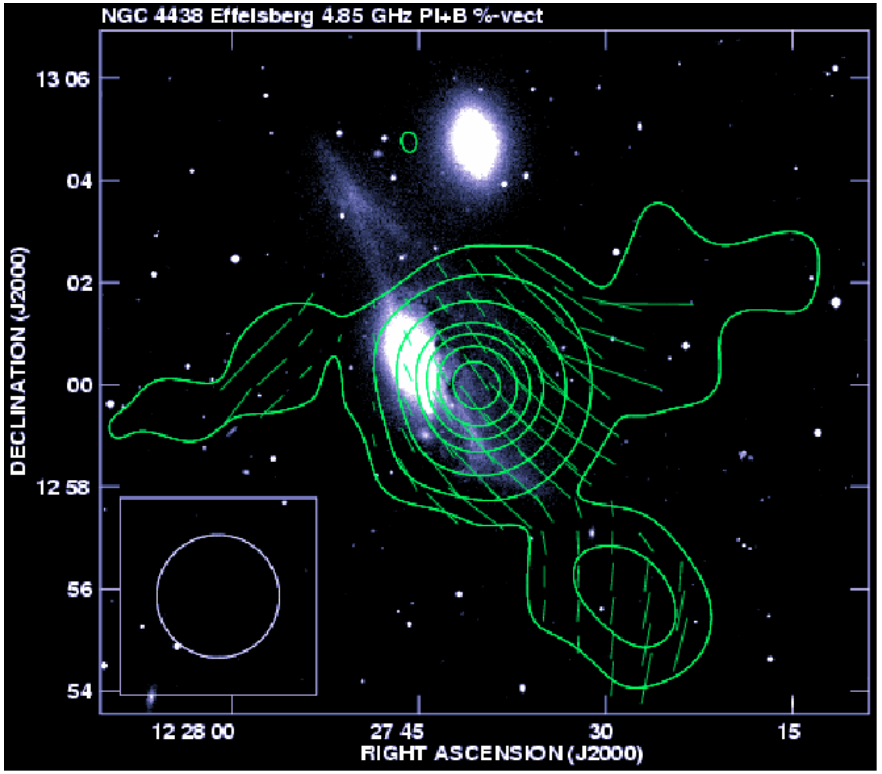

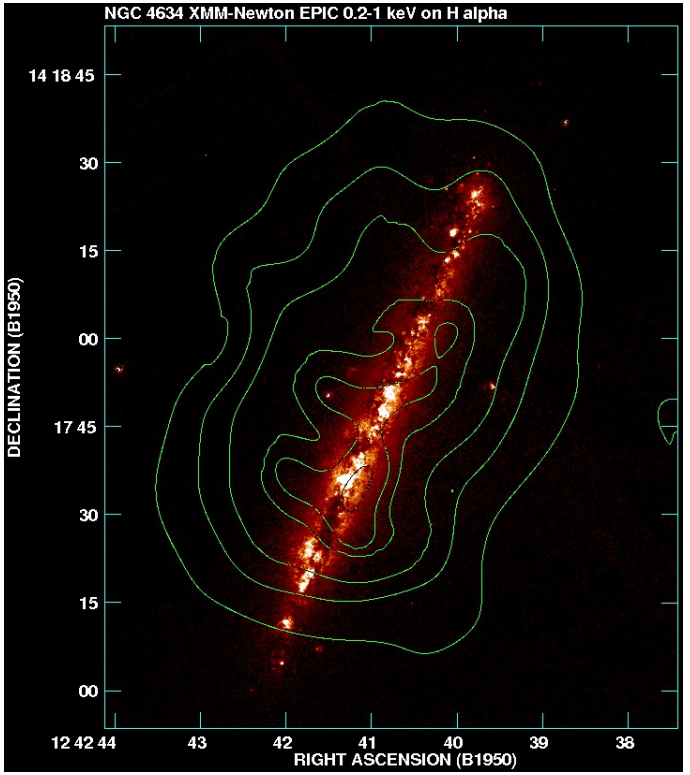

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Hot gas and magnetic fields in Virgo Cluster spiral galaxies

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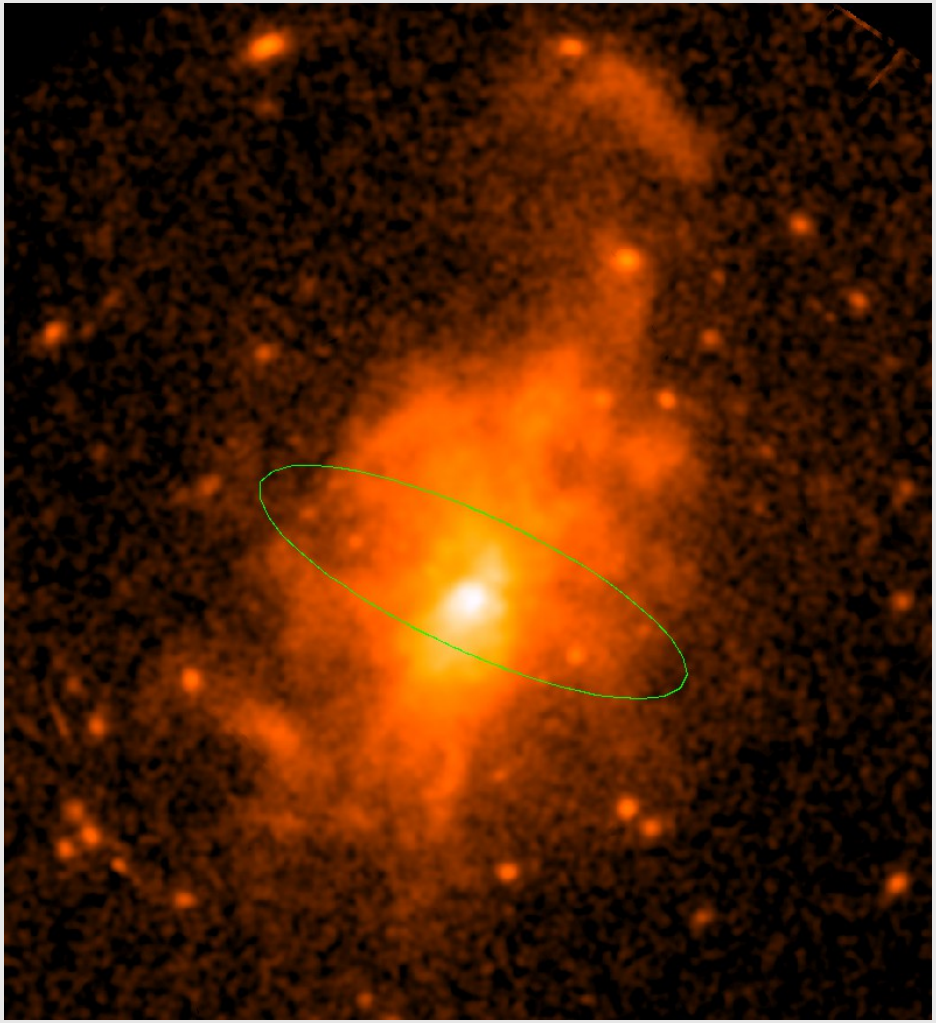
X-ray diffuse emission
Distribution and properties

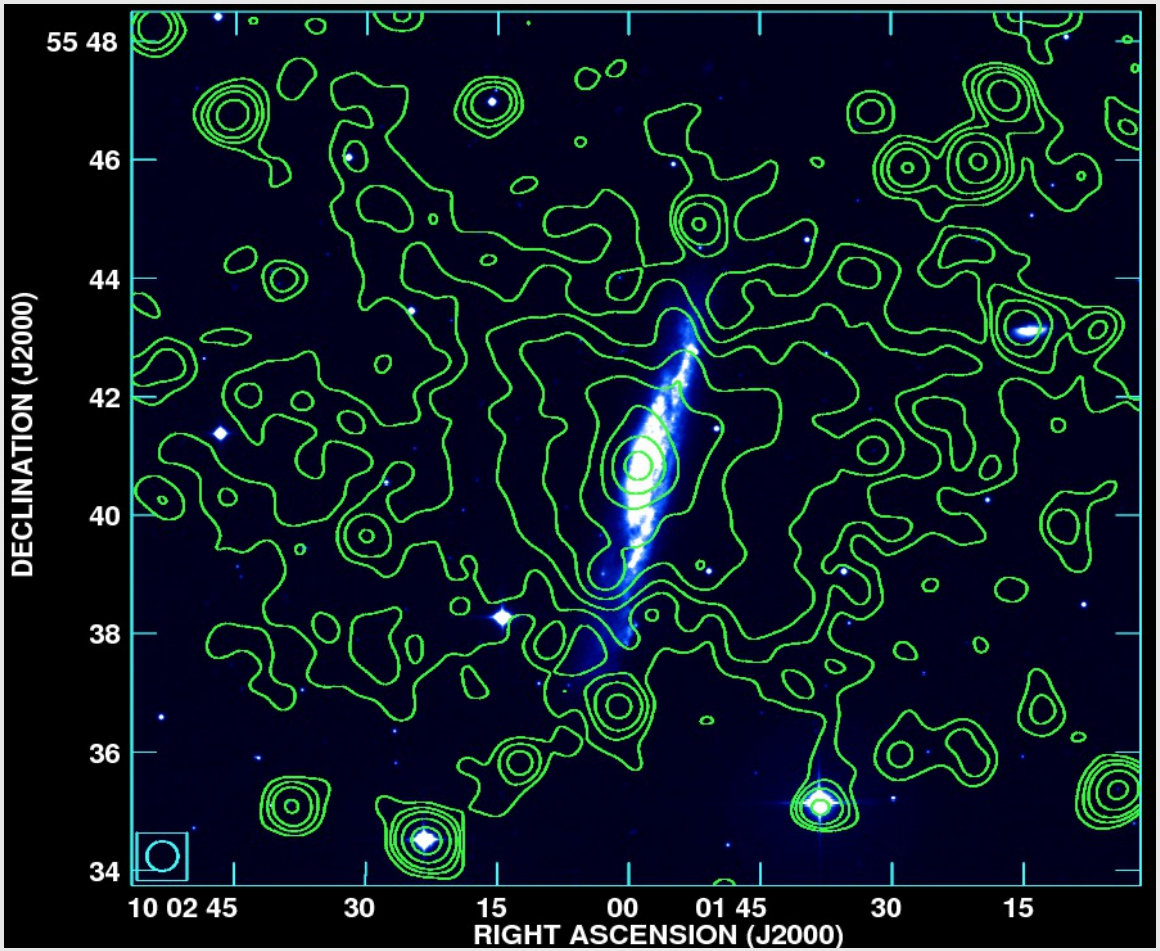


- Diffuse X-ray emission traces hot gas
- XMM-Newton provides currently the best sensitivity to such emission
- The XMM-Newton Science Archive is already full of interesting (often unpublished!) data
- Check your object!

M82 soft X-ray image based on XMM-Newton archives

X-ray diffuse emission

Distribution and properties: pros

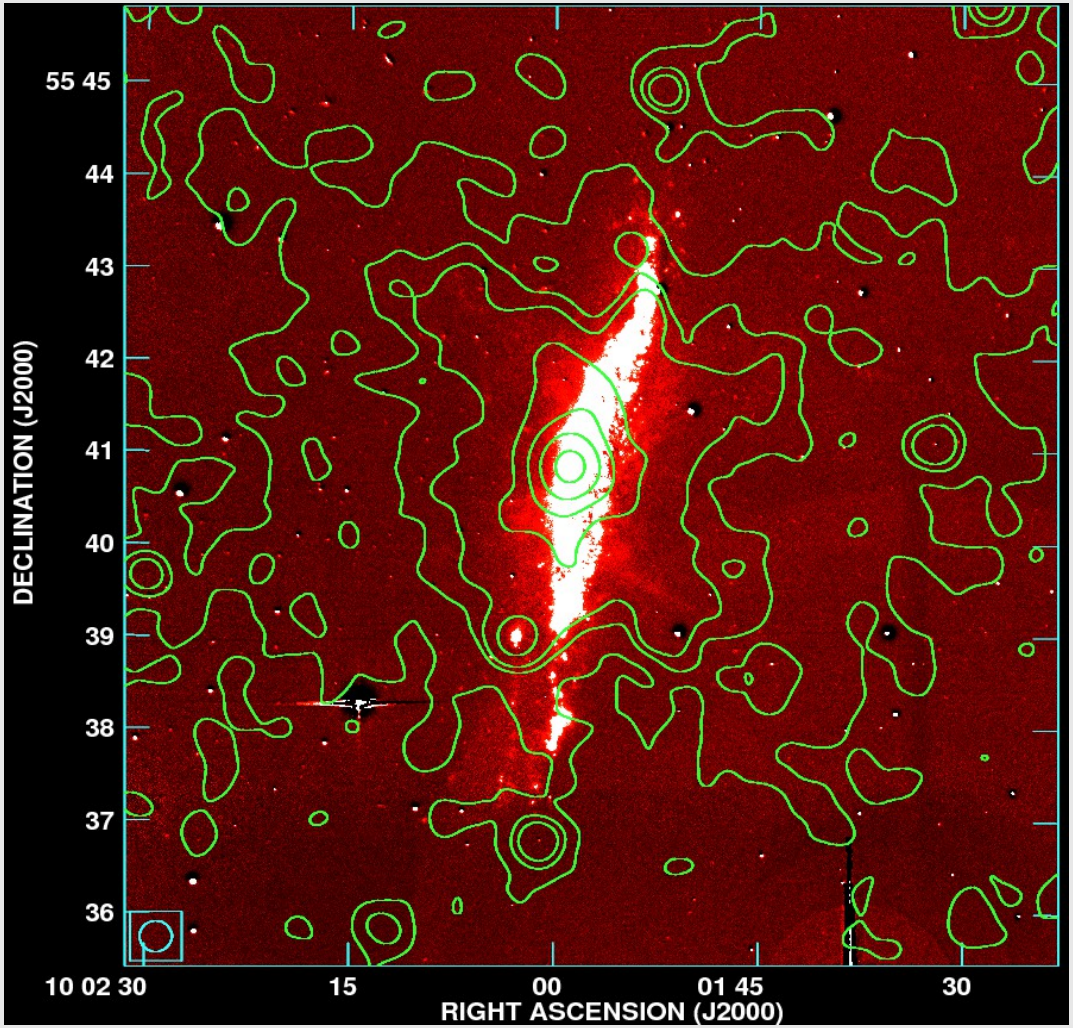


NGC 3079 soft X-ray image based on XMM-Newton archives (Weżgowiec et al. in prep)

- Provides important parameters of the galactic/halo medium
- Supports well PI studies
- Is often a “by-product” of AGN/ULX observations (archives!)
- You can “choose” your resolution

X-ray emission

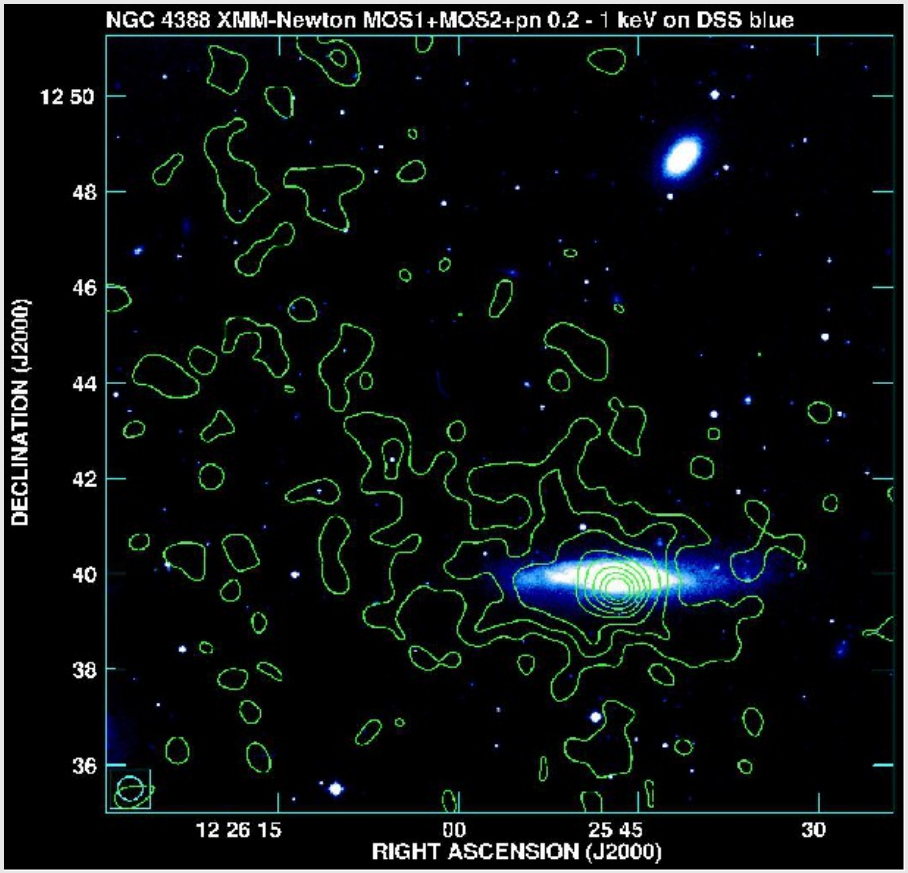
…and cons



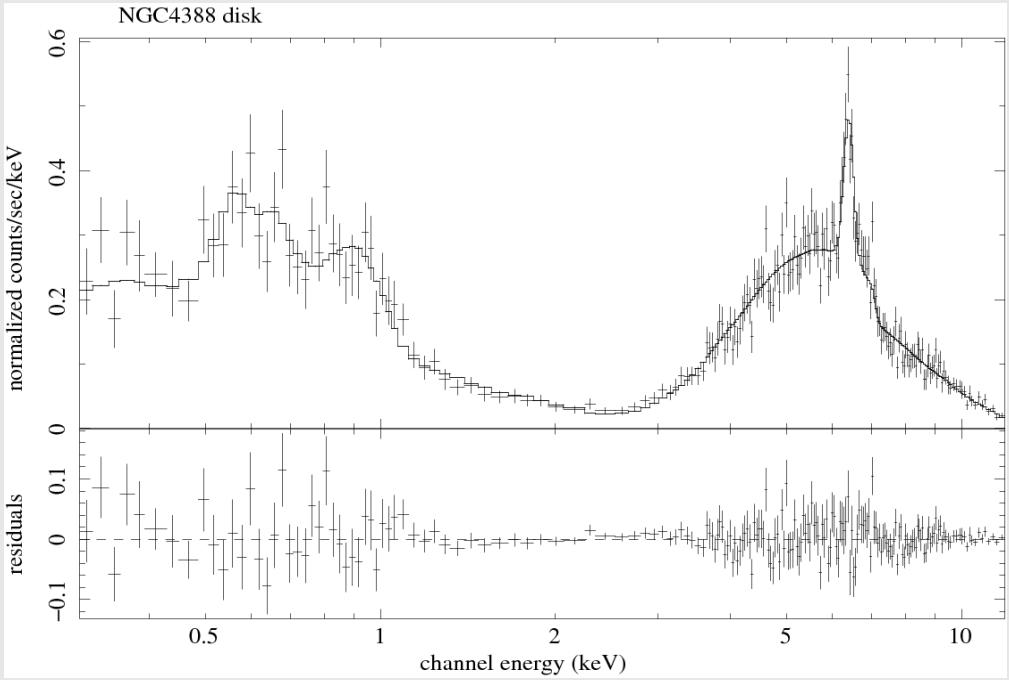
NGC 3079 soft X-ray image based on XMM-Newton archives (Weżgowiec et al. in prep)

- Hard to get sensitive/long observations
- Accurate background subtraction is difficult but crucial for good spectra, especially for low surface-brightness emission
- In the end we have not too many photons in our spectra

X-ray emission
Spectral analysis

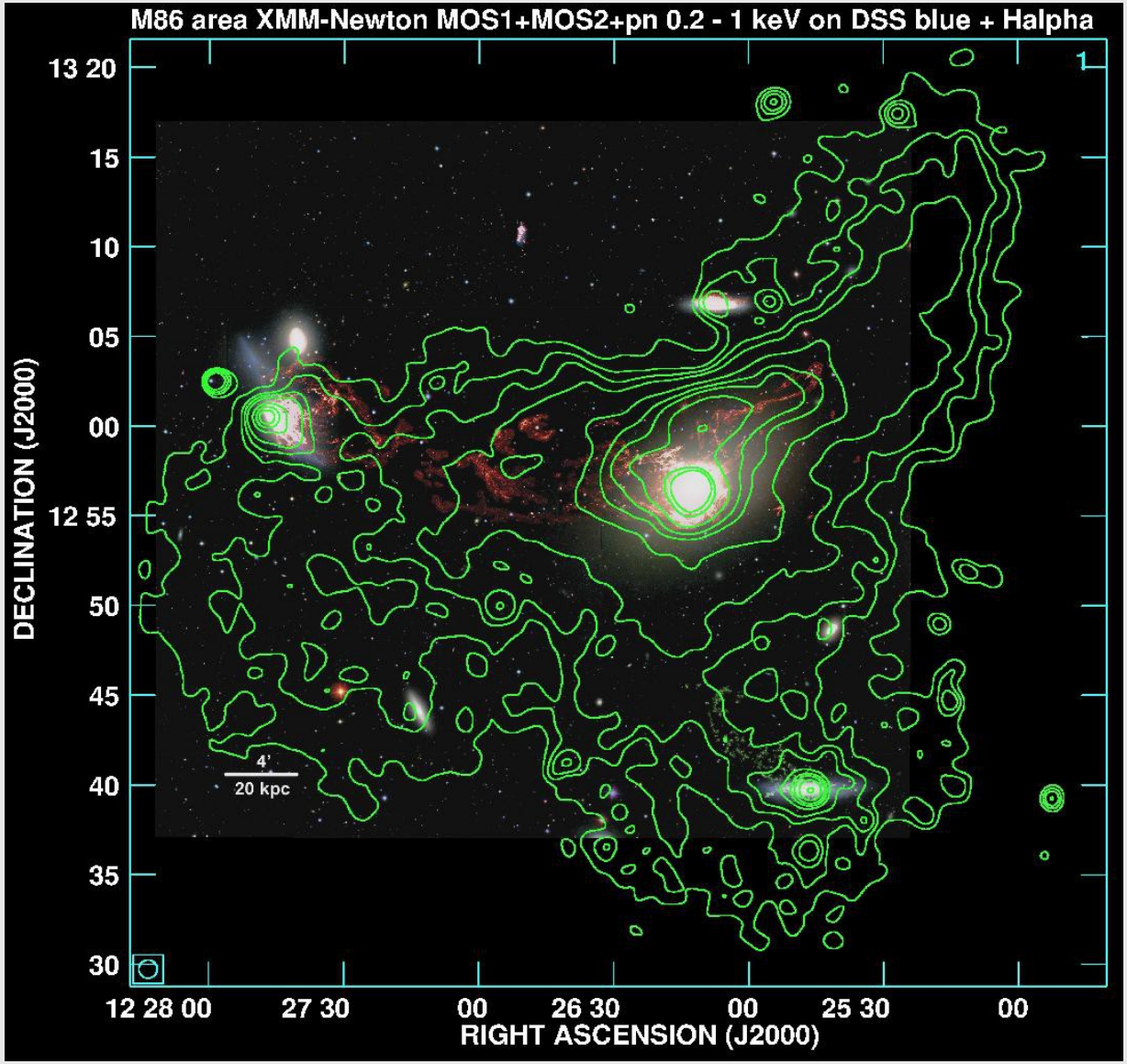


Weżgowiec et al. 2011, A&A, 531, 44



- Even with low statistics we are not helpless
- Above: a complex model (two temperature component + power-law + absorbed power-law with an iron line) fits the data quite well

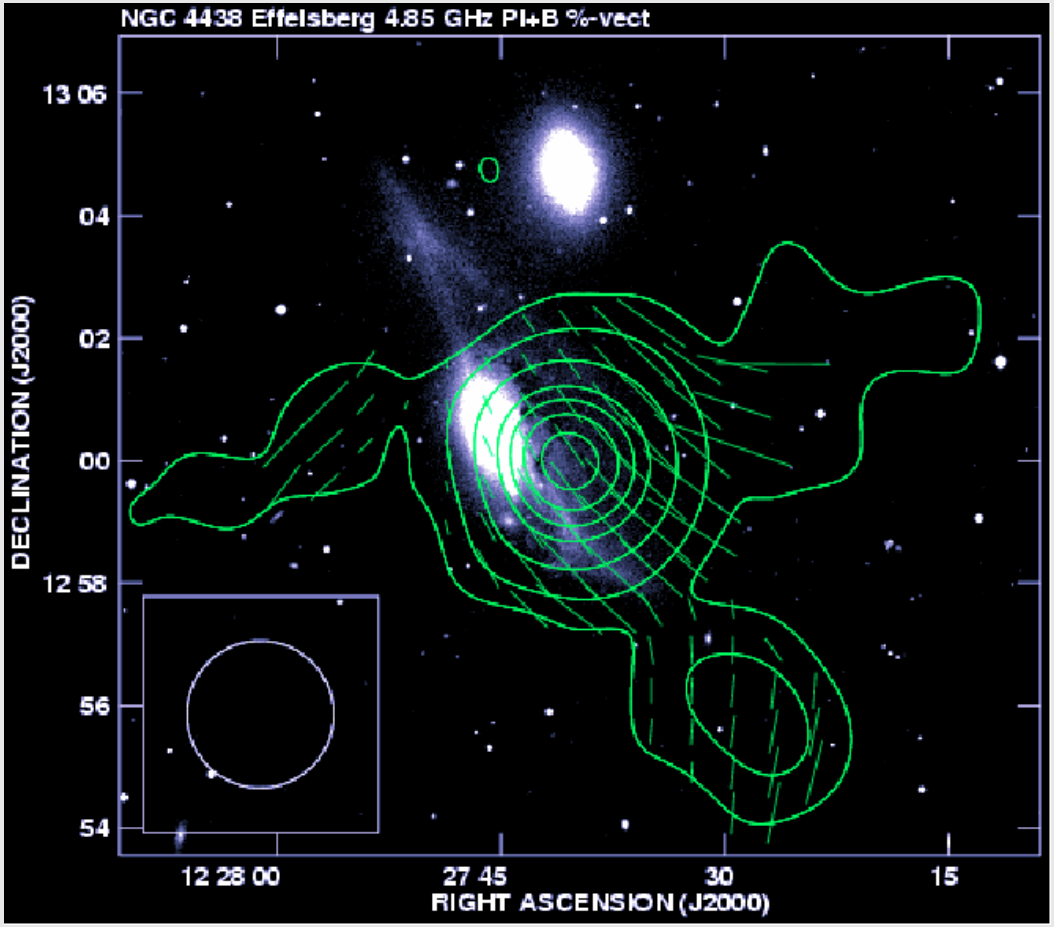
Virgo Cluster
M86 group



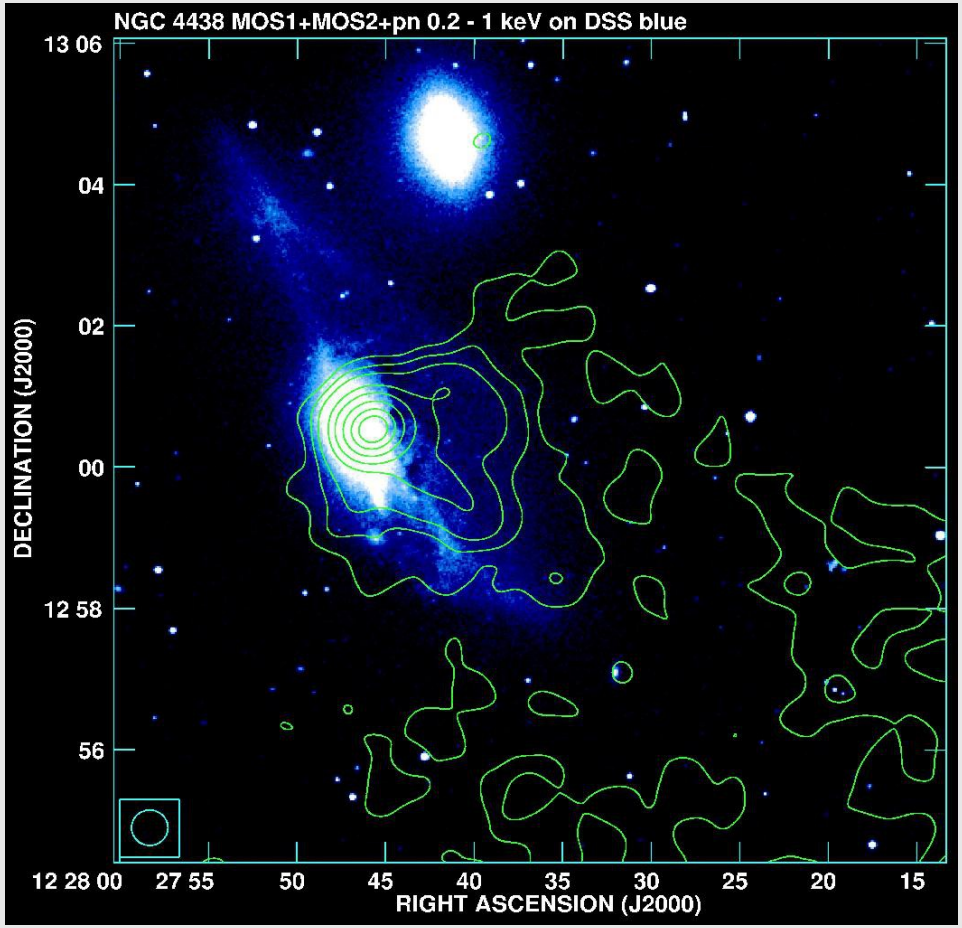
- Hot gas nicely follows Hα filaments and traces the cluster interactions
- We see hot gas tails and temperature gradients throughout the scene

M86 group in the Virgo Cluster. X-ray contours: Weżgowiec et al. in prep., DSS + Hα: Kenney et al. 2008, ApJ, 687, L69

Virgo Cluster
M86 group: NGC 4438



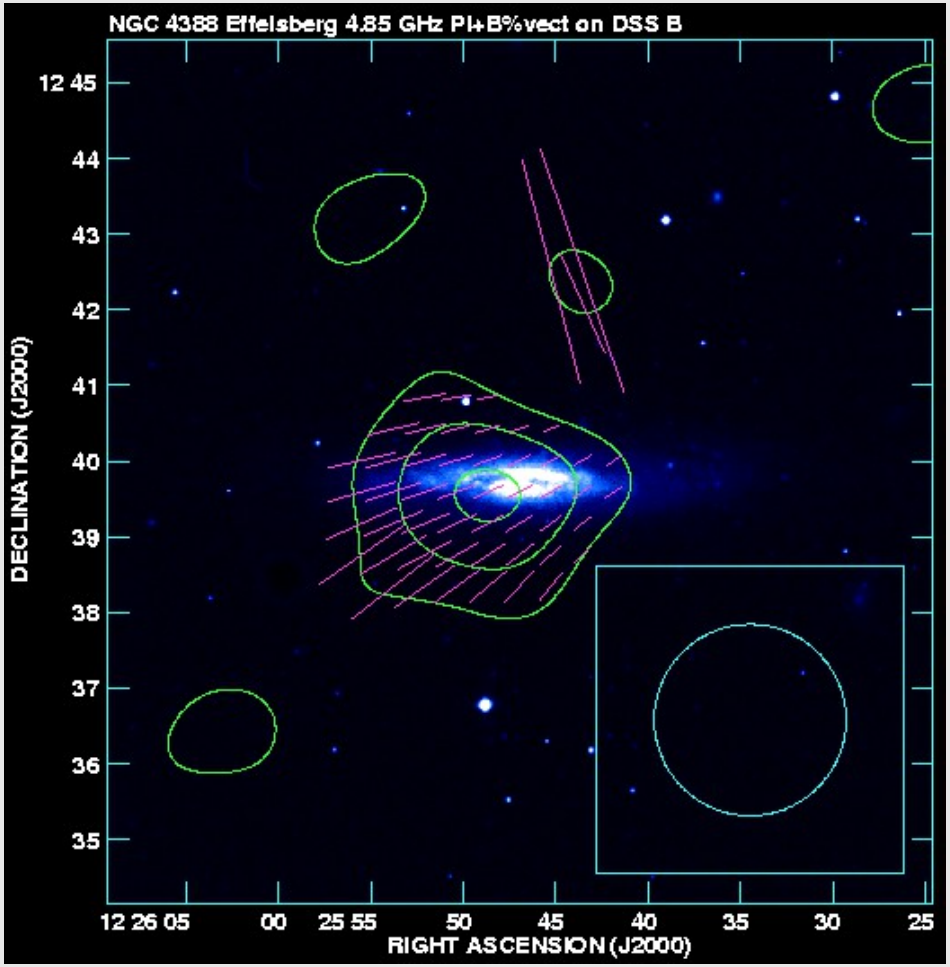
Weżgowiec et al. 2007, A&A, 471, 93



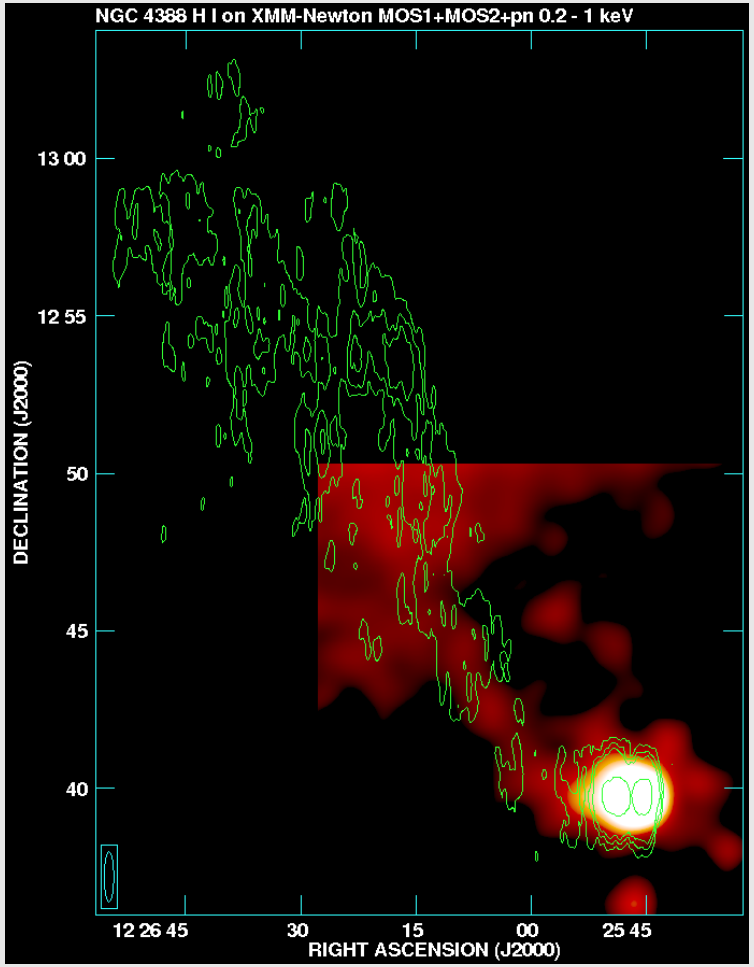
Weżgowiec et al. in prep.

- Tidally induced gas compressions

Virgo Cluster
M86 group: NGC 4388



Weżgowiec et al. 2007, A&A, 471,93

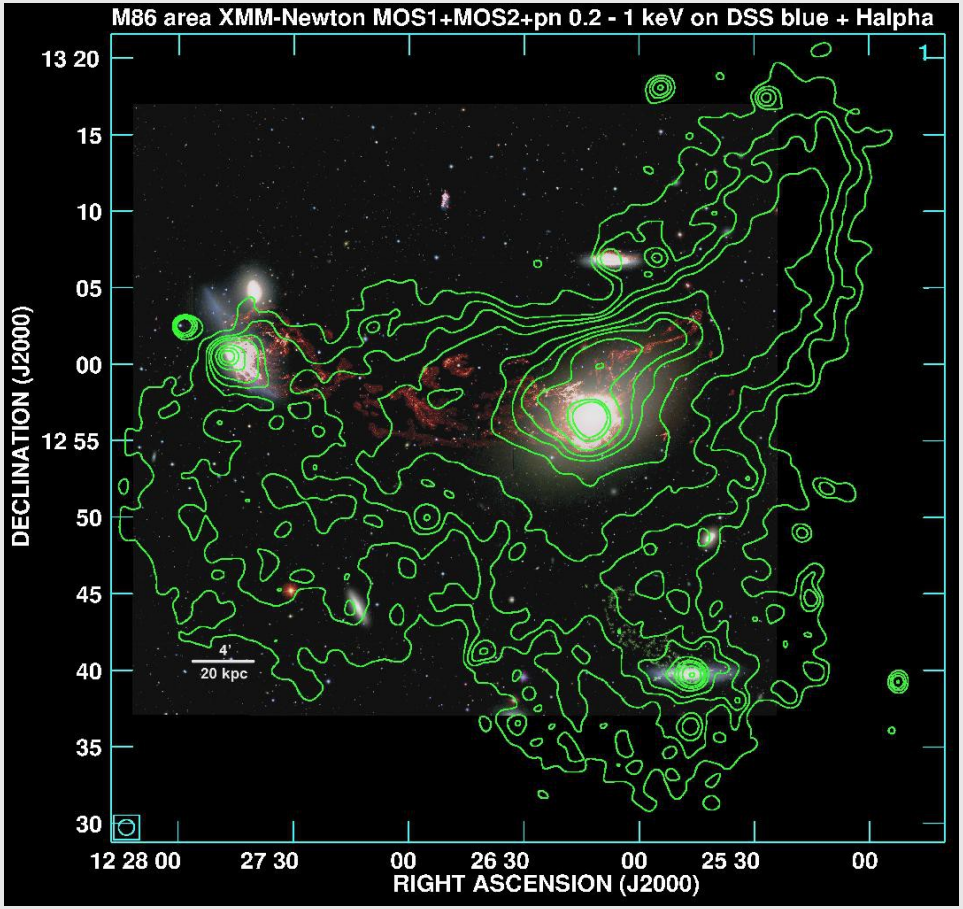


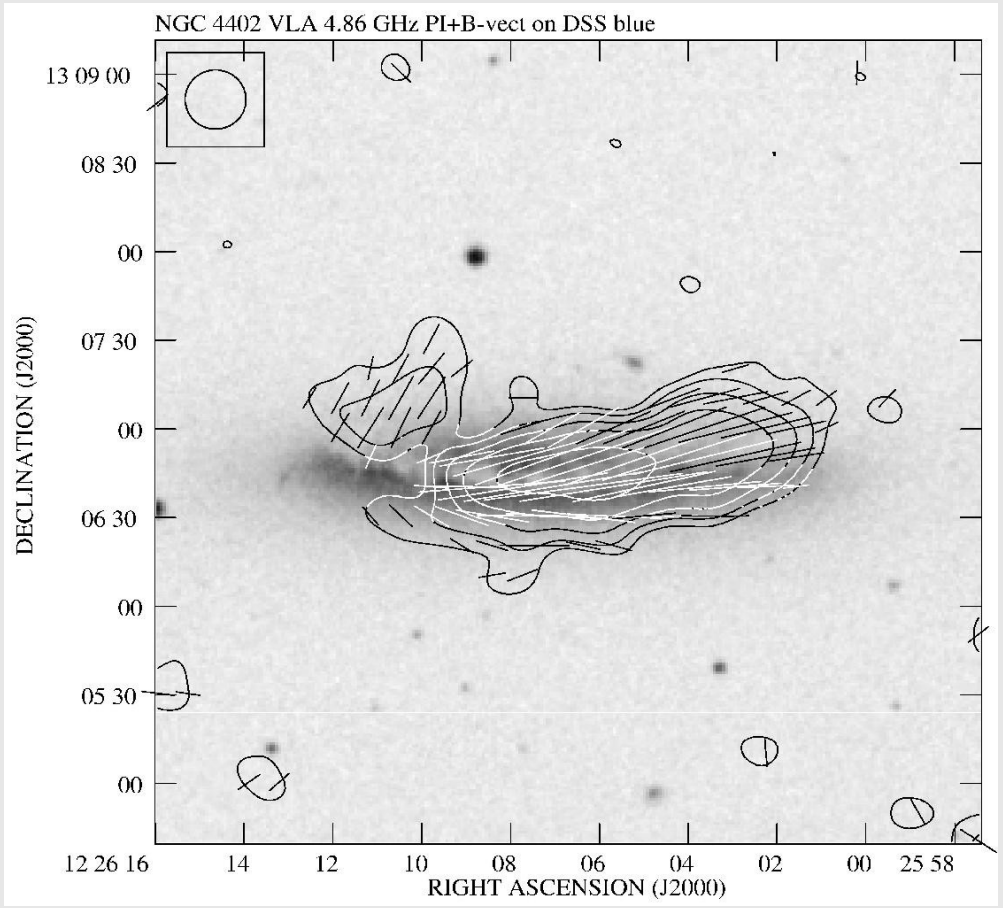
Weżgowiec et al. 2011, A&A, 531, 44

- Large scale ordered magnetic field and impressive tails

Virgo Cluster

M86 group: NGC 4402

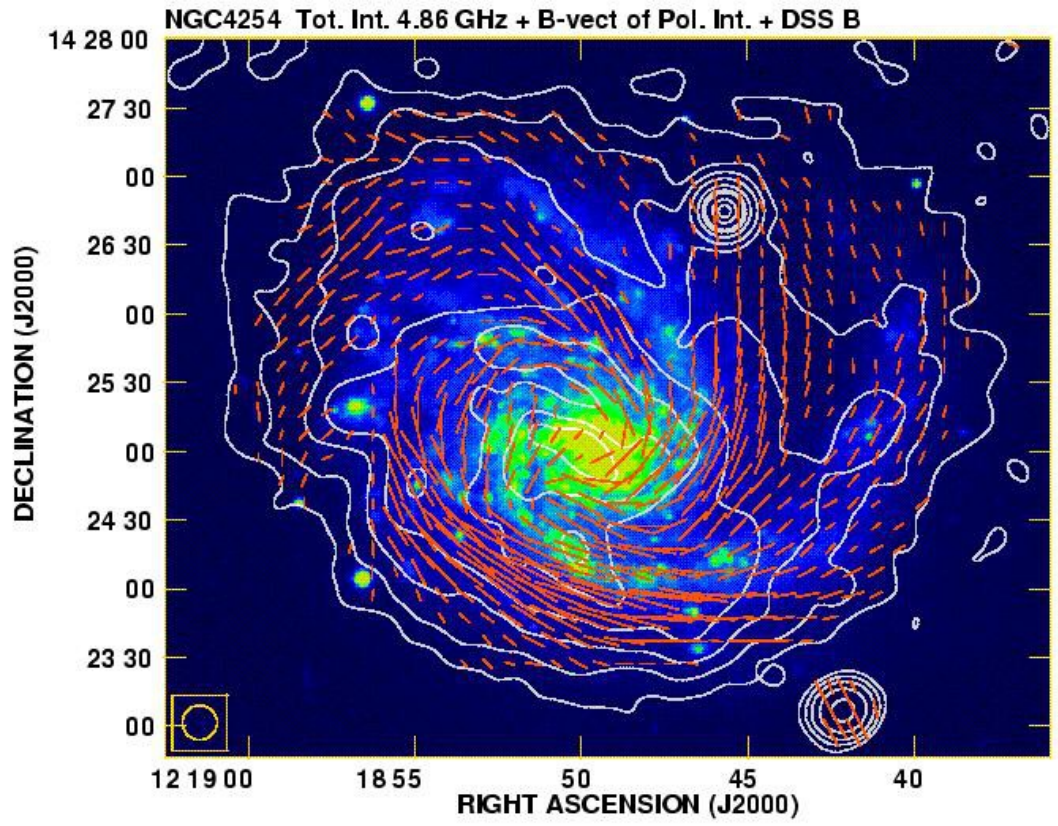


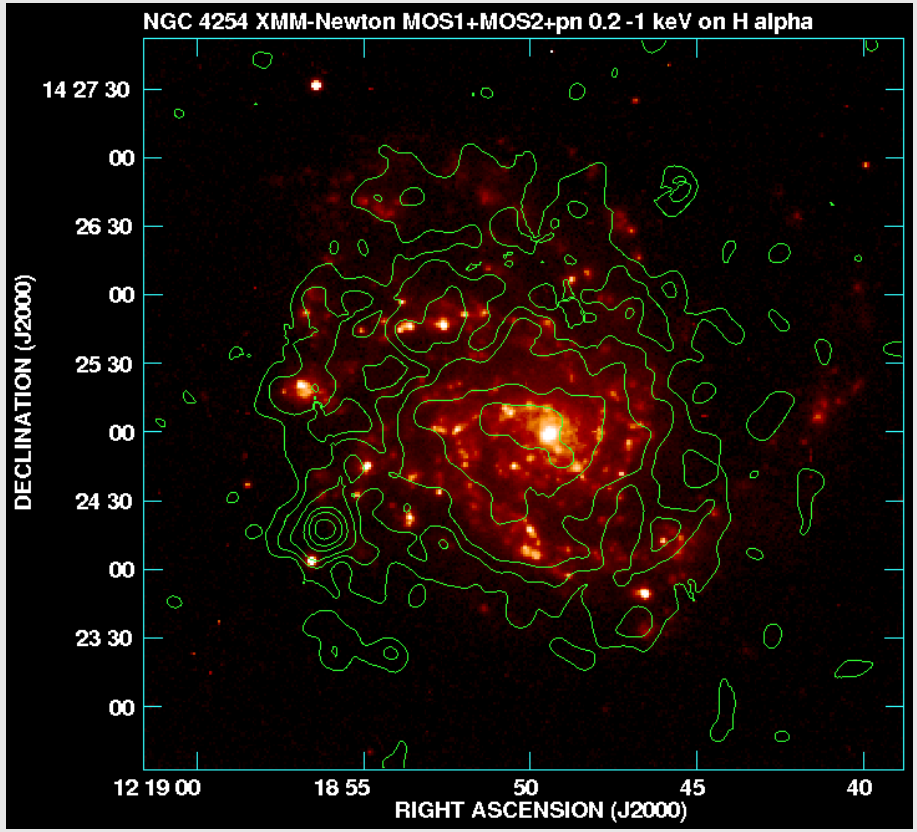


Vollmer et al. 2010, A&A, 512, 36

- Distortions of the magnetic field often find confirmations in X-ray emission
- X-rays can even help to trace the origin of the distortions...

Virgo Cluster
NGC 4254



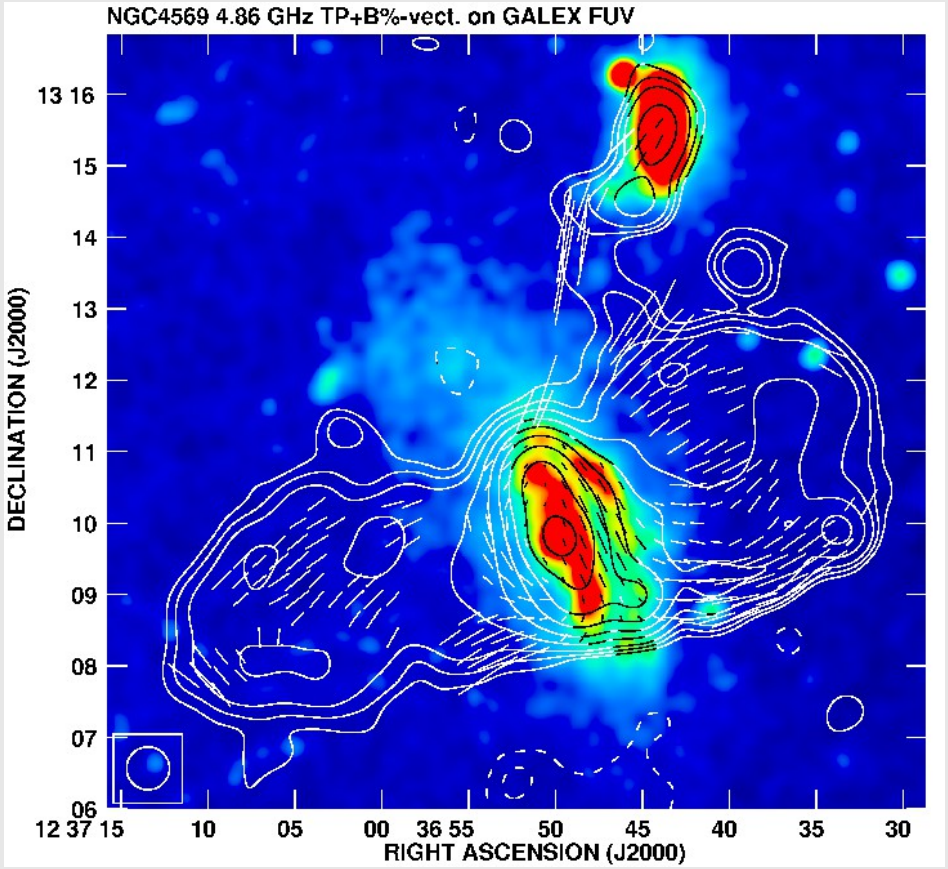


Chyży et al. 2007, A&A, 474, 415

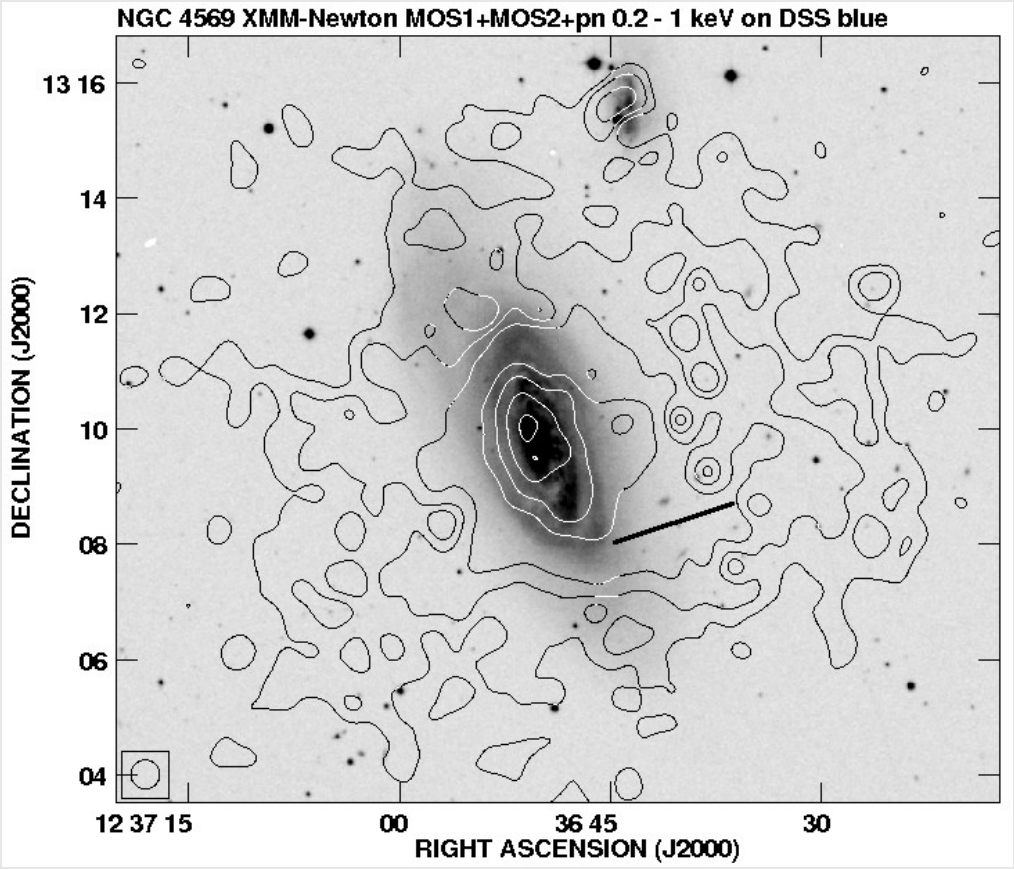
Wężgowiec et al. 2012, A&A, accepted

- No increase in the hot gas temperature in and outside the polarized radio ridge suggests enhancements of the magnetic fields caused by shearing forces → tidal interactions

Virgo Cluster
NGC 4569



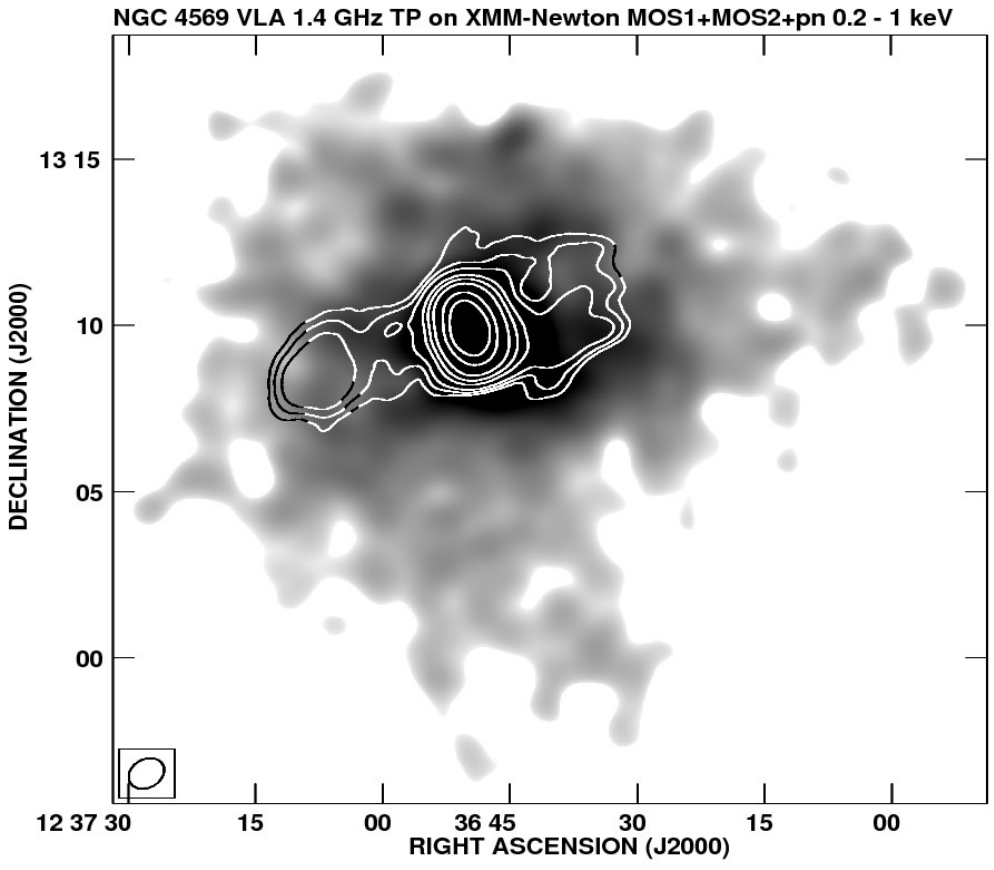
Chyży et al. in prep.

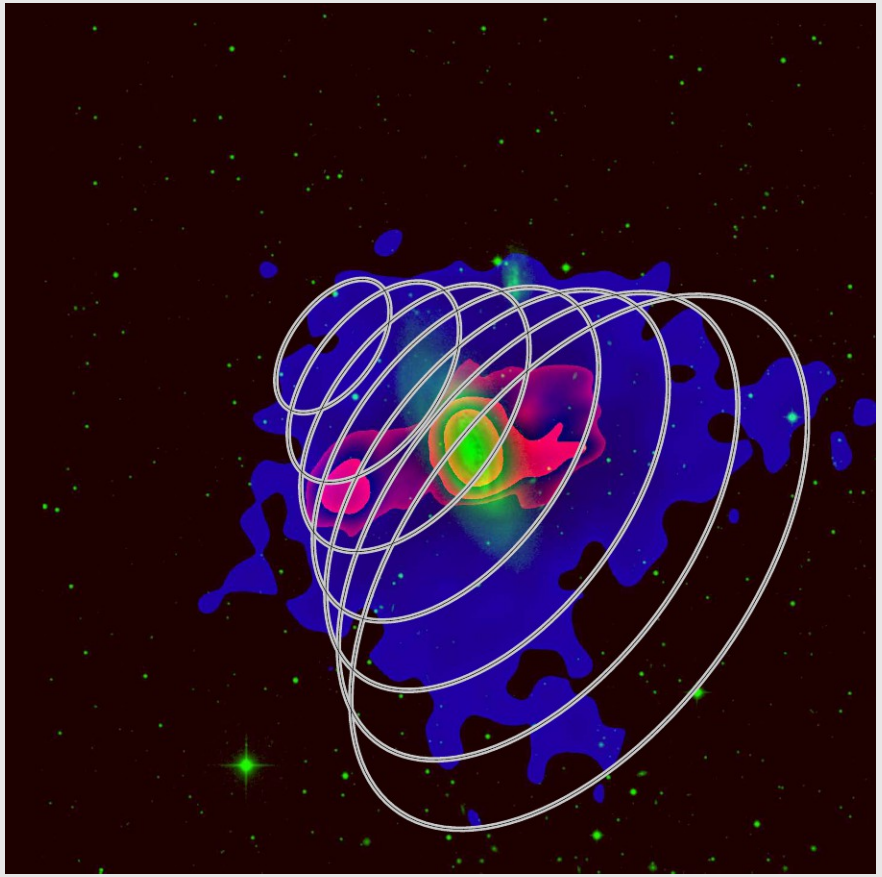


Weżgowiec et al. 2012, A&A, accepted

- When the temperature increases, we see a compression by a shock

NGC 4569
The Mach cone

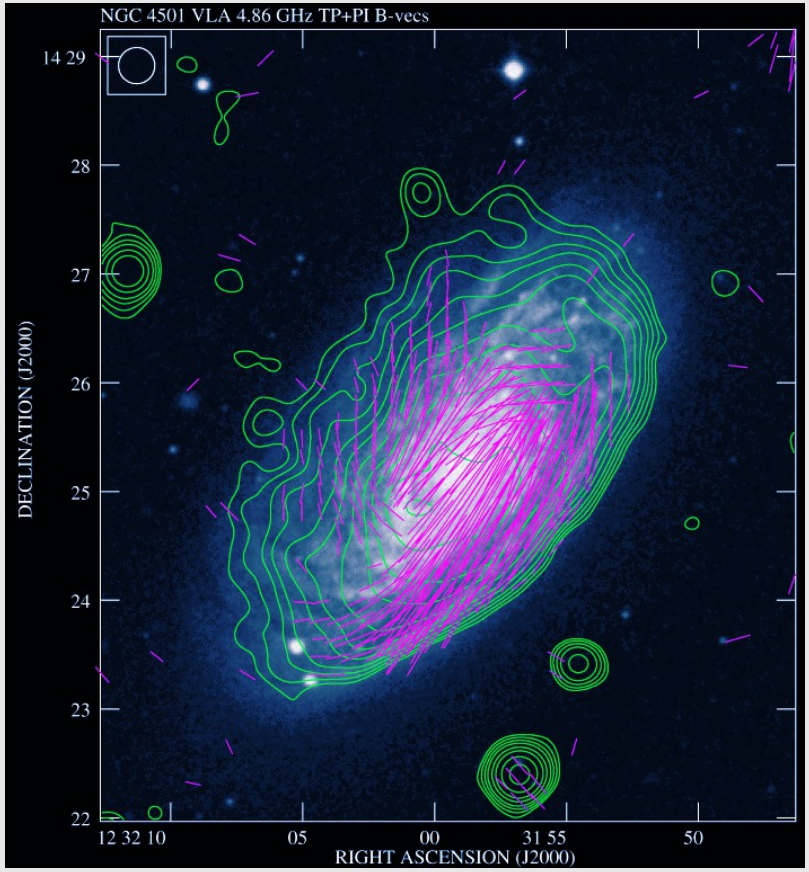


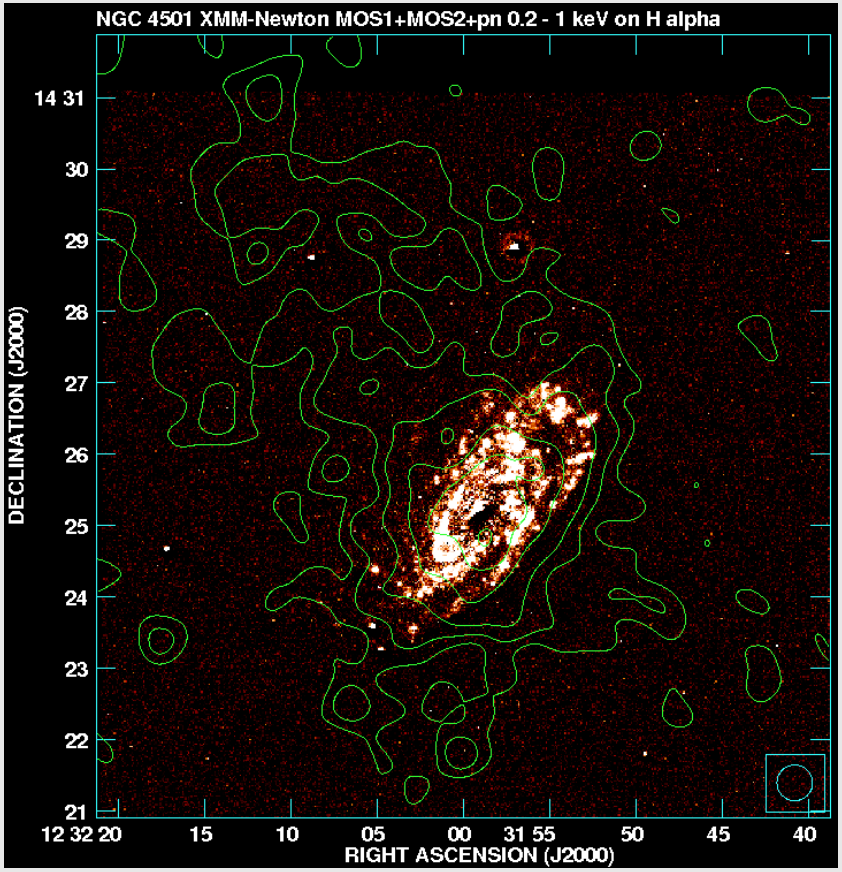


Weżgowiec et al. 2011, A&A, 531, 44

- Detection of a large scale halo shaped possibly filling a Mach cone (galactic velocity of almost Mach 3)

Virgo Cluster
NGC 4501





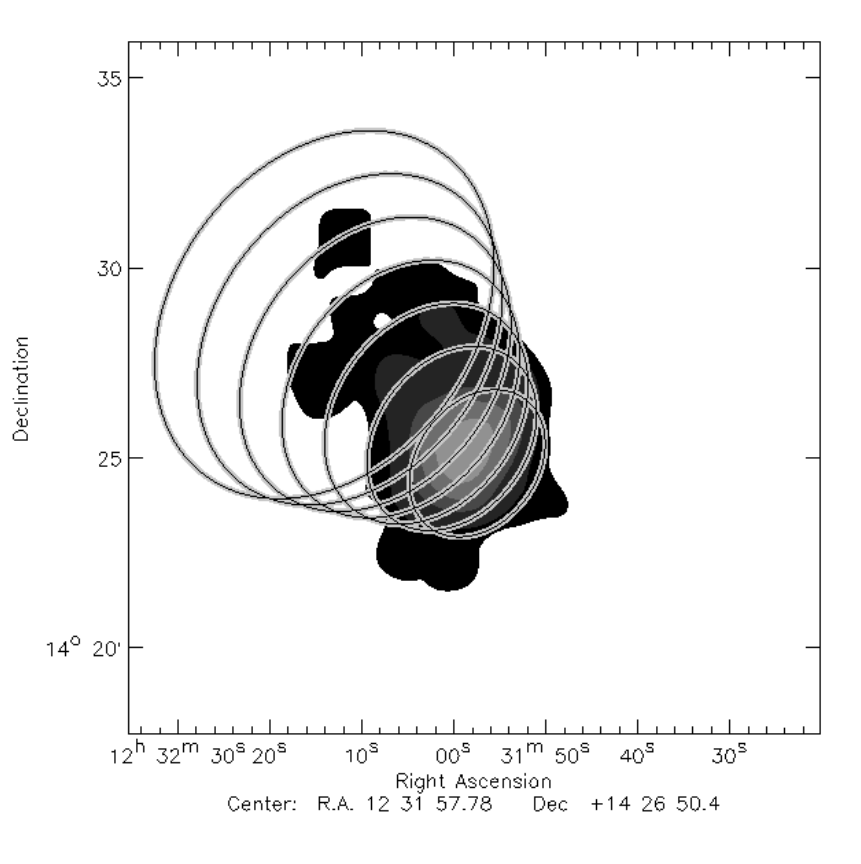
Vollmer et al. 2010, A&A, 512, 36

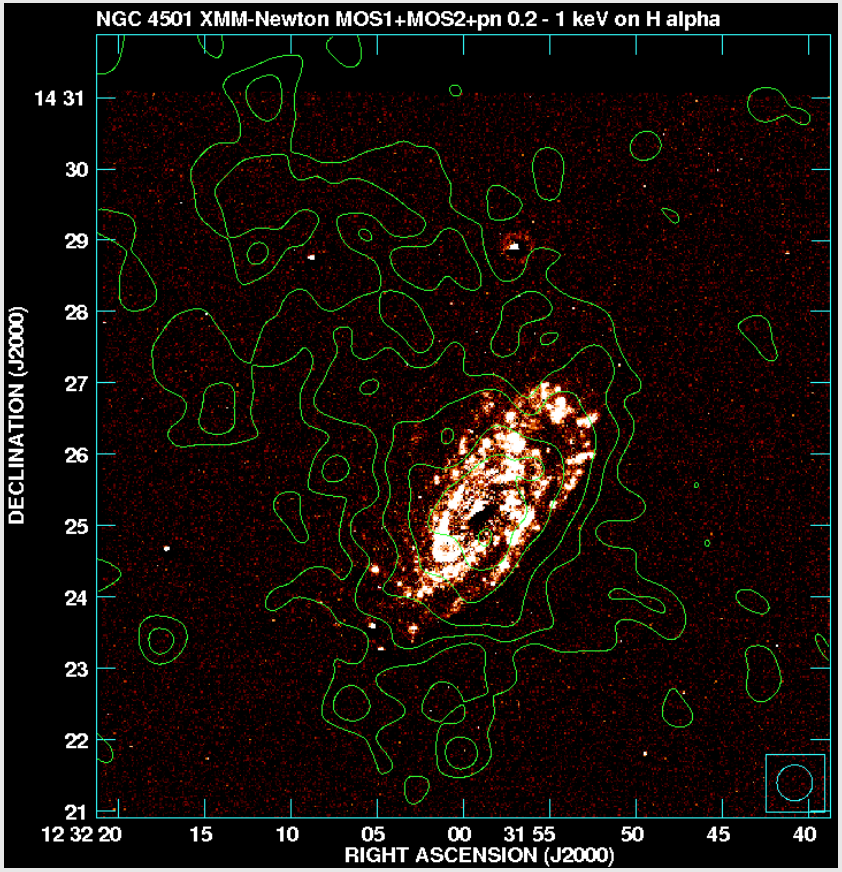
Wężgowiec et al. 2011, A&A, 531, 44

- But note that gas compressions are not always obvious
- In X-rays, hot gas tails are easier to detect than shock fronts/compressions

Virgo Cluster

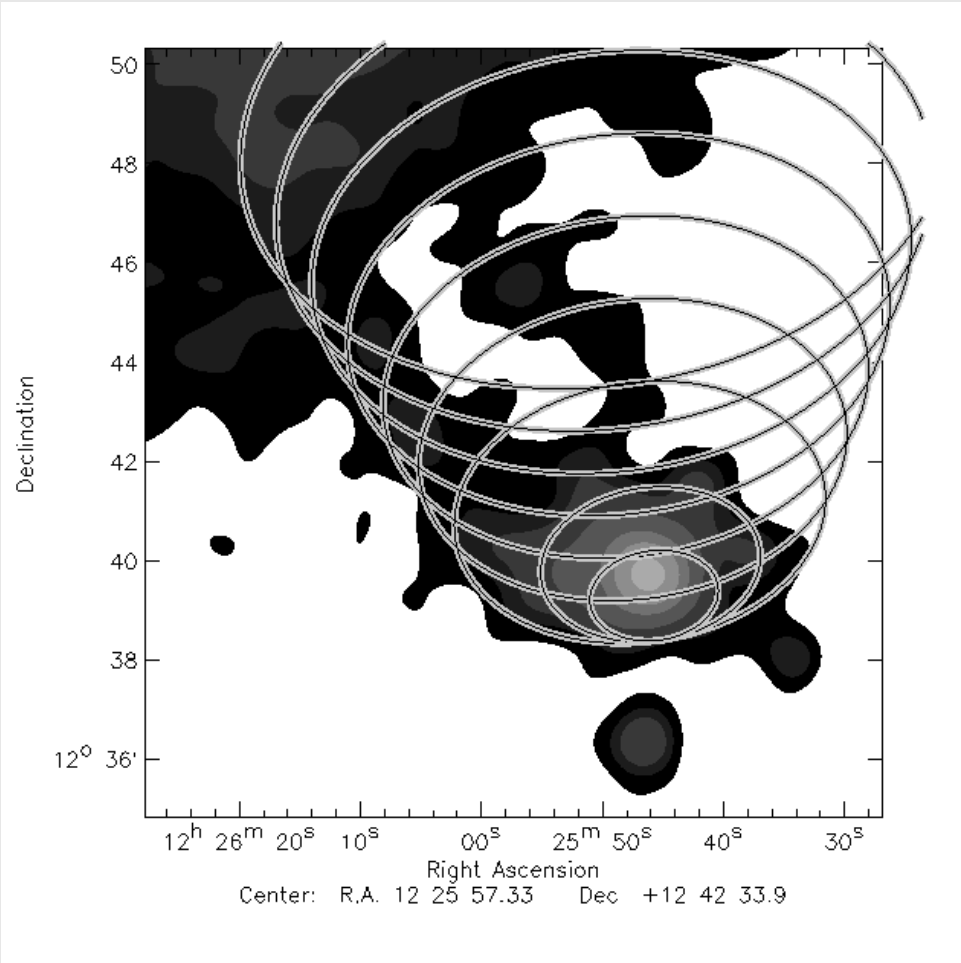
NGC 4501: Mach cone

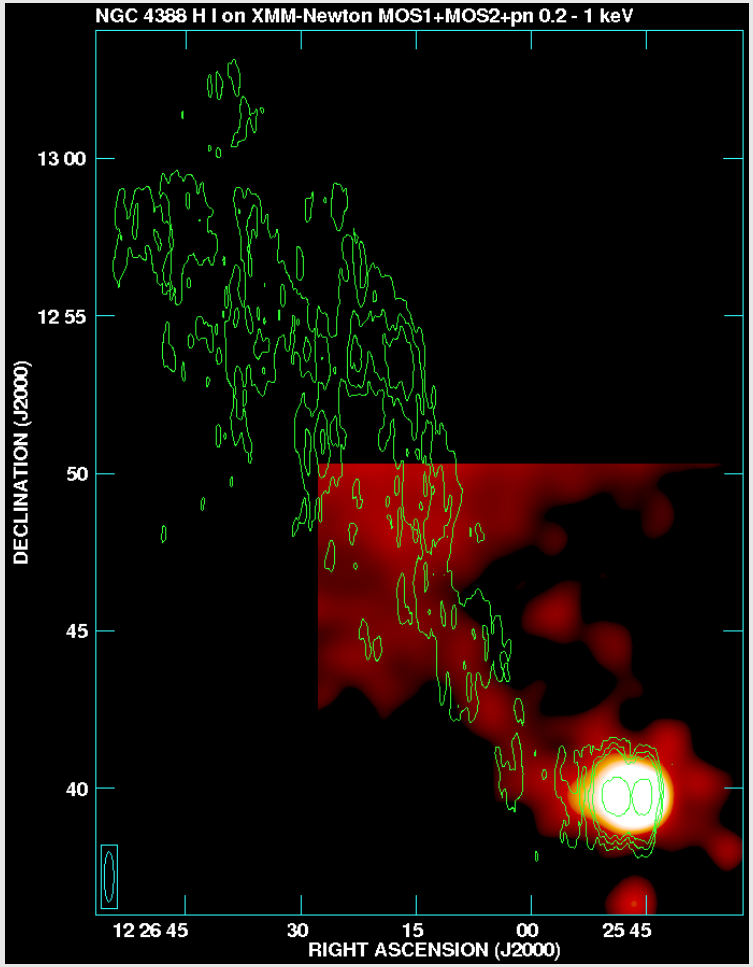




- A Mach cone is not obvious, but the hot gas stays within the structure

Virgo Cluster
NGC 4388: Mach cone

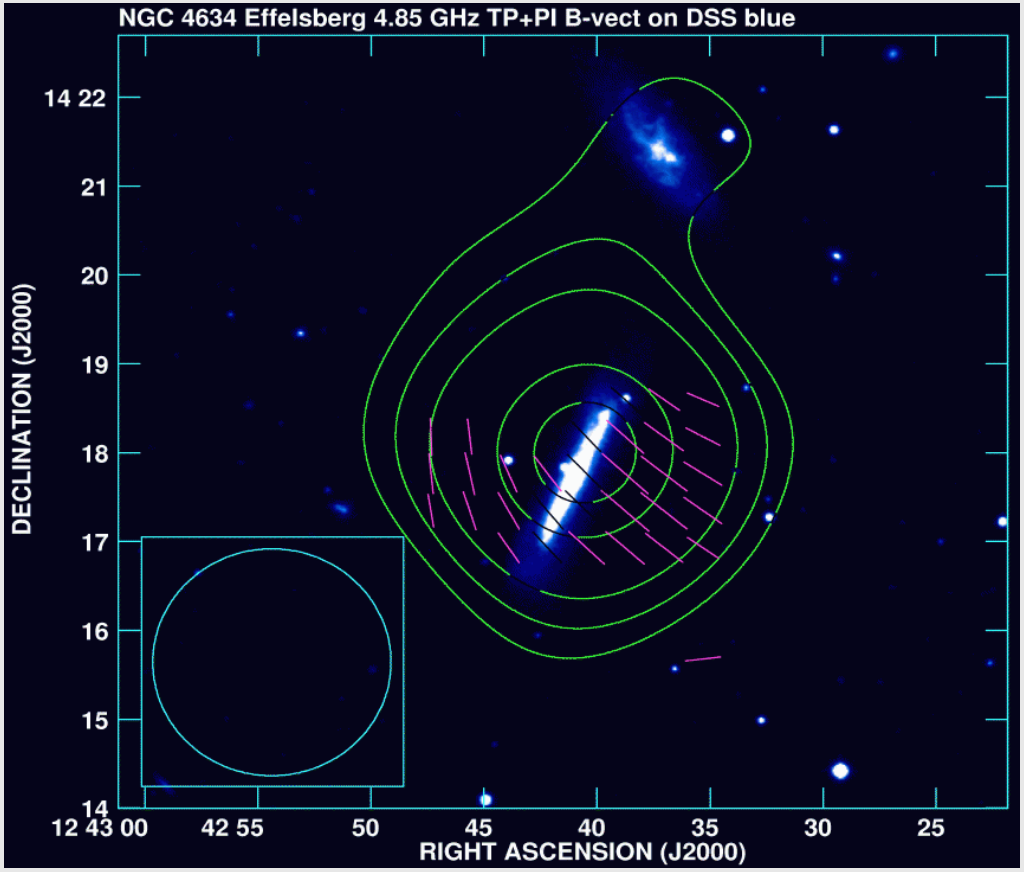


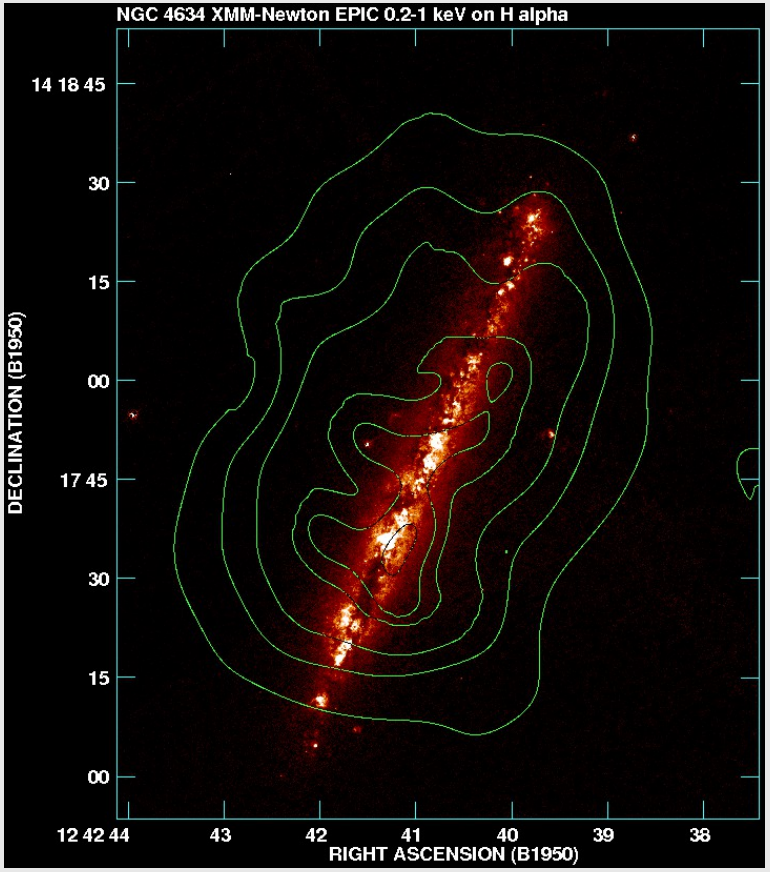


Weżgowiec et al. 2011, A&A, 531, 44

- Hot gas along the surface of the Mach cone?

Virgo Cluster
NGC 4634

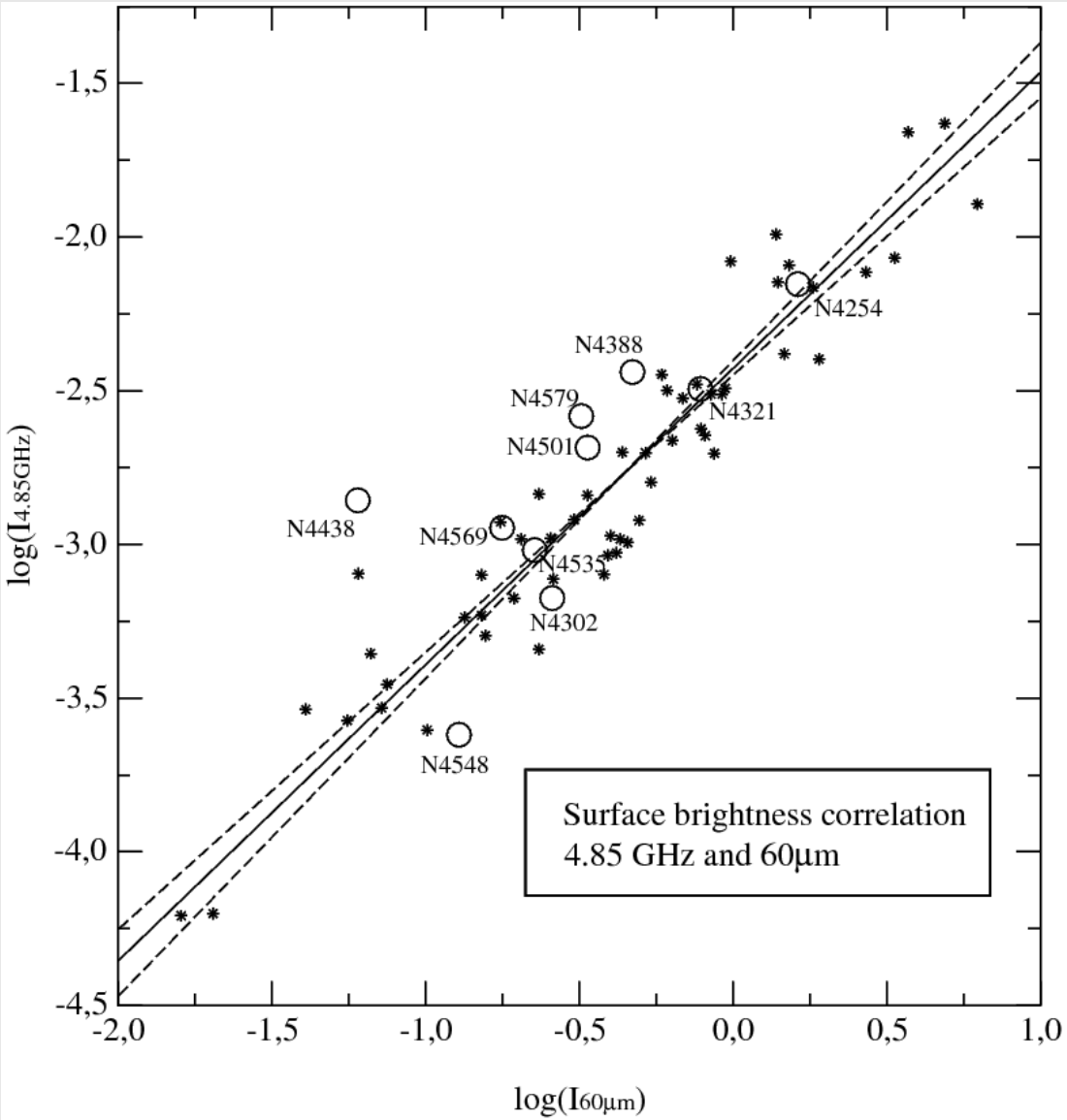




Wężgowiec et al. in prep.

- NGC 4634: magnetic field geometry contradicting (?) ram-pressure scenario?
-

Virgo Cluster
Radio-FIR correlation



- Even disturbed galaxies follow well the correlation
- Only central non-thermal sources can cause deviations

Wężgowiec et al. 2012, A&A, submitted

Summary
Combining X-ray with PI studies

- X-rays add important information to radio polarized intensity studies
- Many (all?) Virgo Cluster spirals show signs of interaction both in the magnetic field and hot halo morphologies
- With X-rays we can investigate origins of magnetic field enhancements
- We detected a cone-like-shaped hot halo around NGC 4569, which most likely entirely fills its Mach cone
- For NGC 4388 and NGC 4501 we do not have direct detections of Mach cones but the observations match well the derived geometries
- While hot gas tails are “easily” visible, to see a shock front in X-rays we probably need velocities above ~ Mach 3
- Milder shocks, however, can be traced via spectral analysis of the hot gas and the PI observations