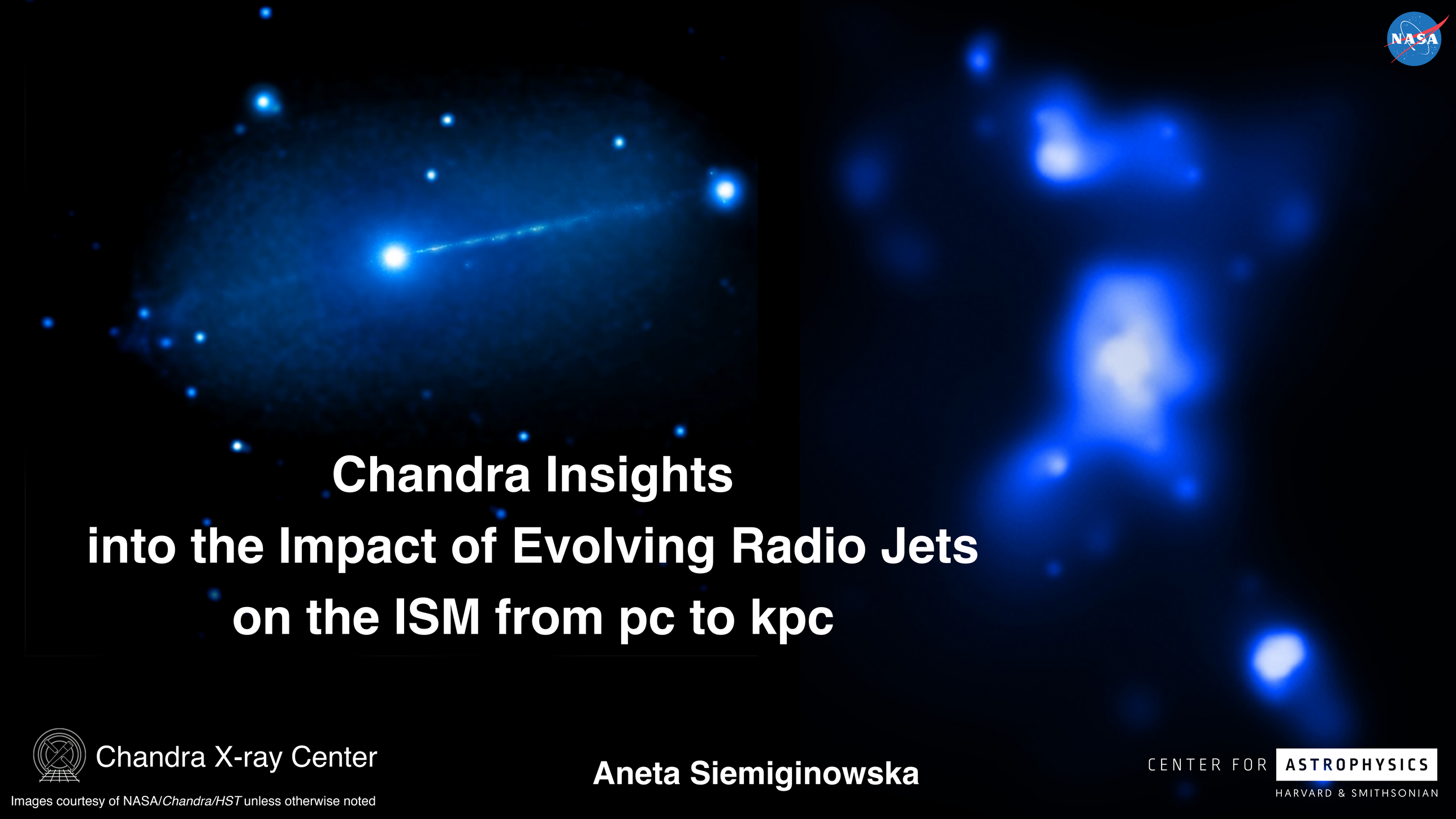


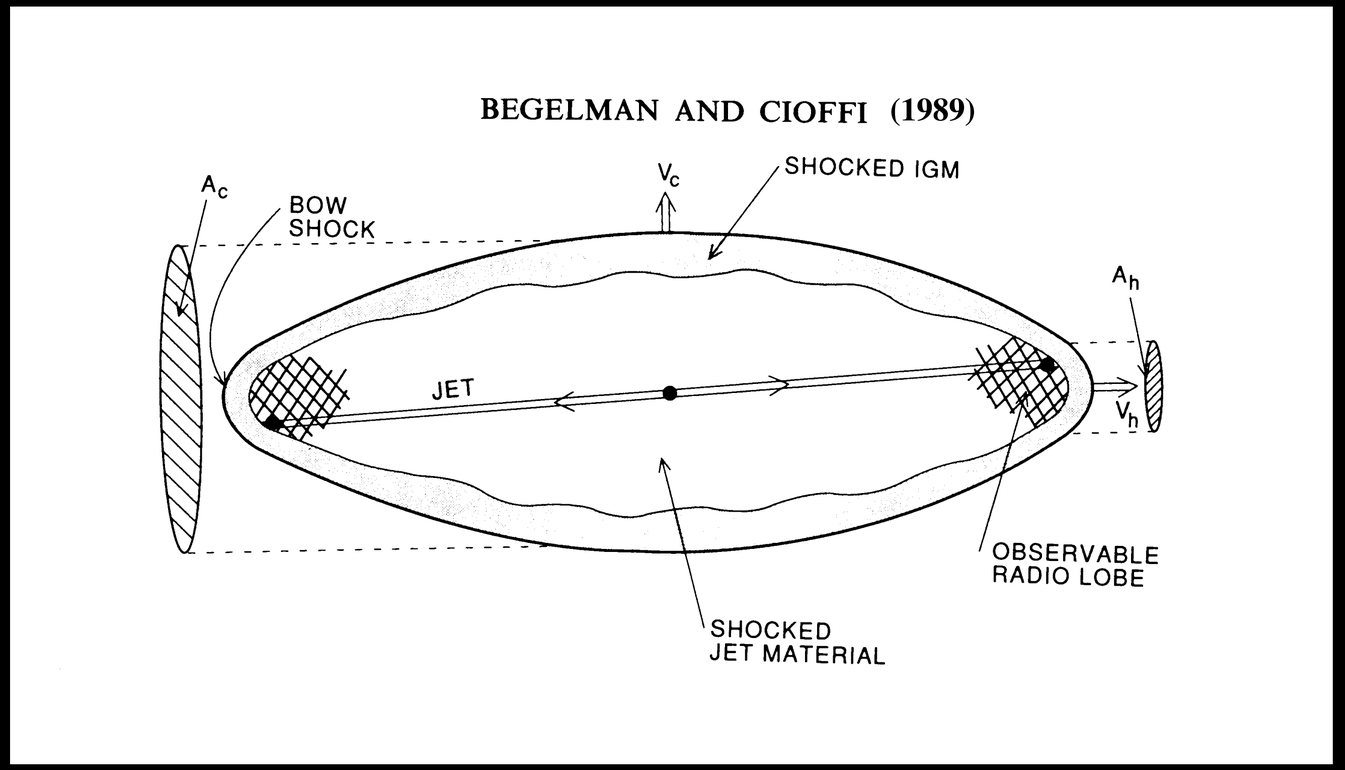
Chandra Insights into the Impact of Evolving Radio Jets on the ISM from pc to kpc

Chandra X-ray Center

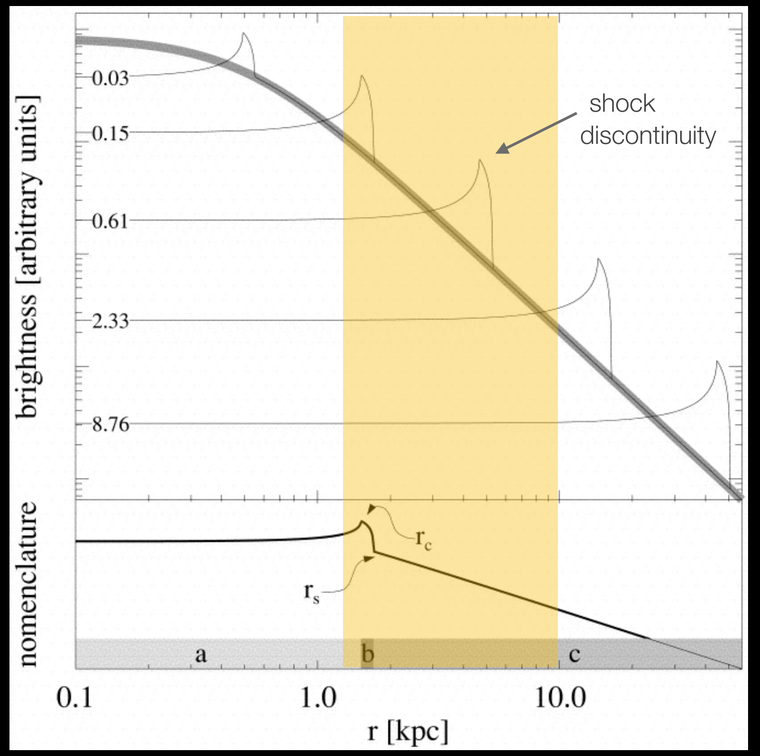
Aneta Siemiginowska

CENTER FOR ASTROPHYSICS
HARVARD & SMITHSONIAN

Evolution of a Radio Source

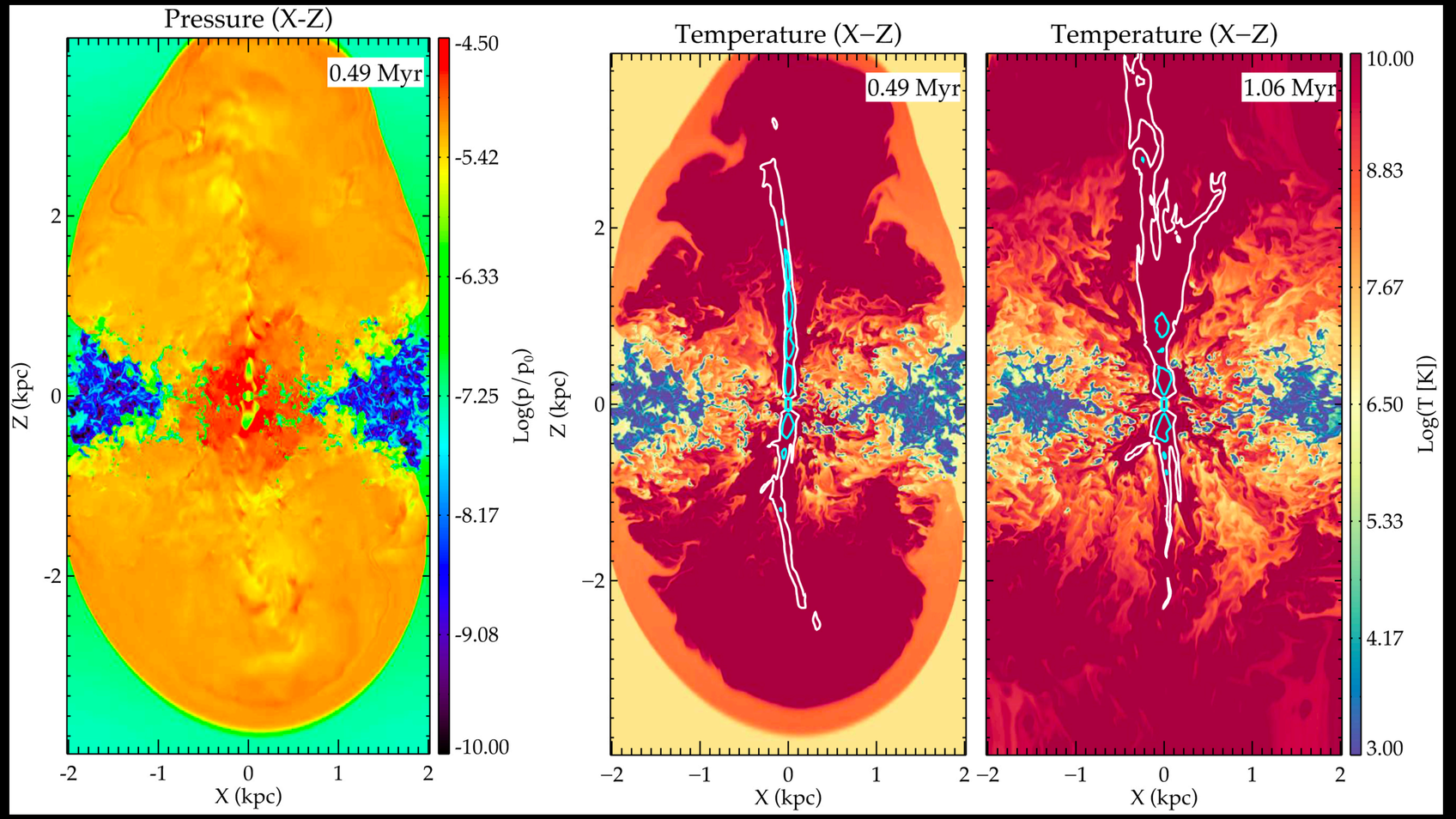


Host Galaxy



Heinz et al 1998

Jet-ISM interactions / Simulations

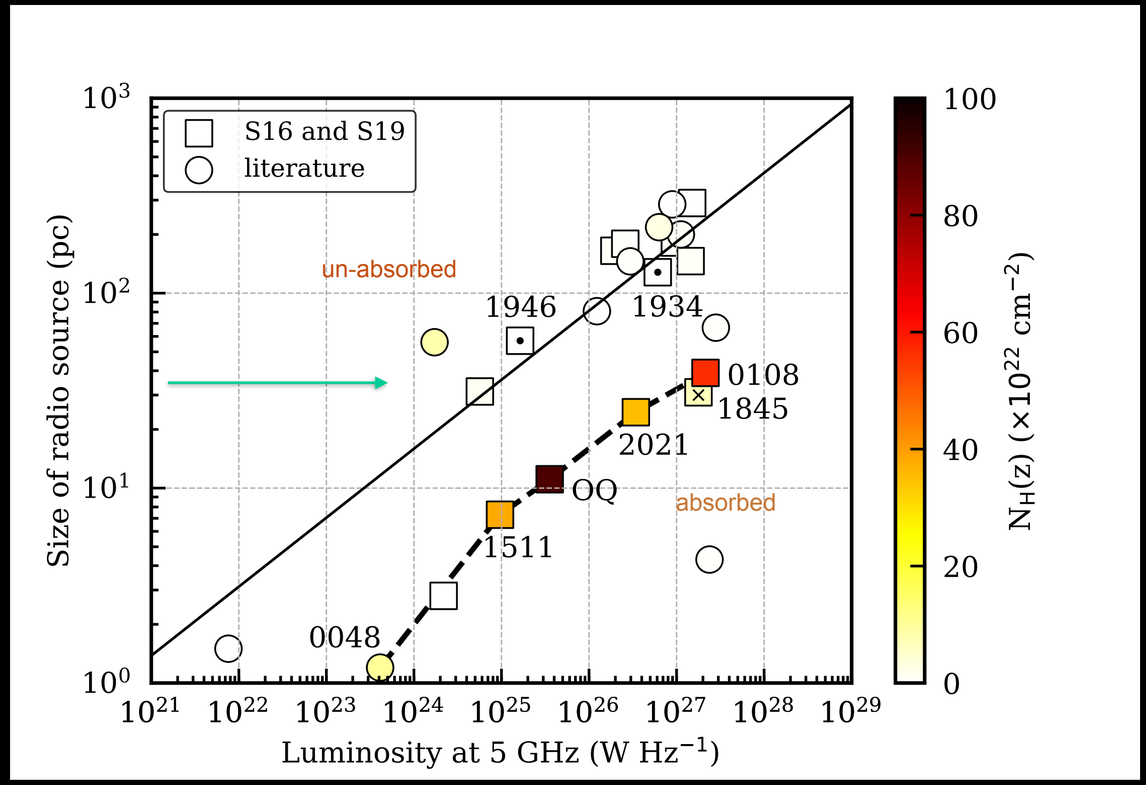


Mukherjee et al 2018

Young Radio Sources

Compact Radio Size < ~500 pc
Unresolved in X-rays

Limiting size of the absorbing medium

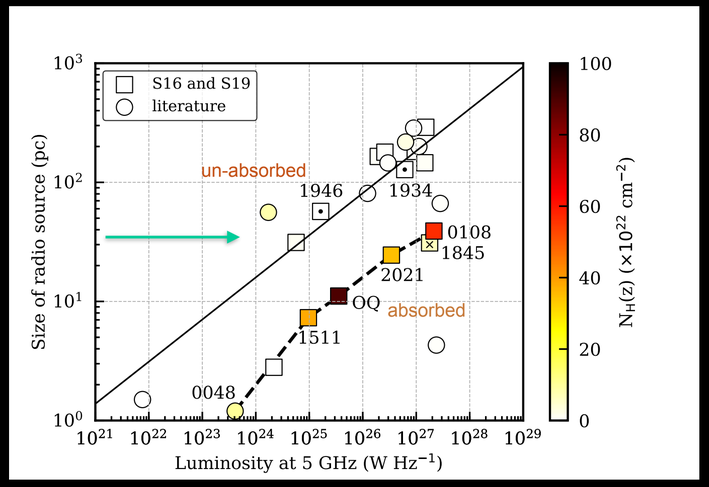


Siemiginowska et al 2016
Sobolewska et al 2019

Young Radio Sources

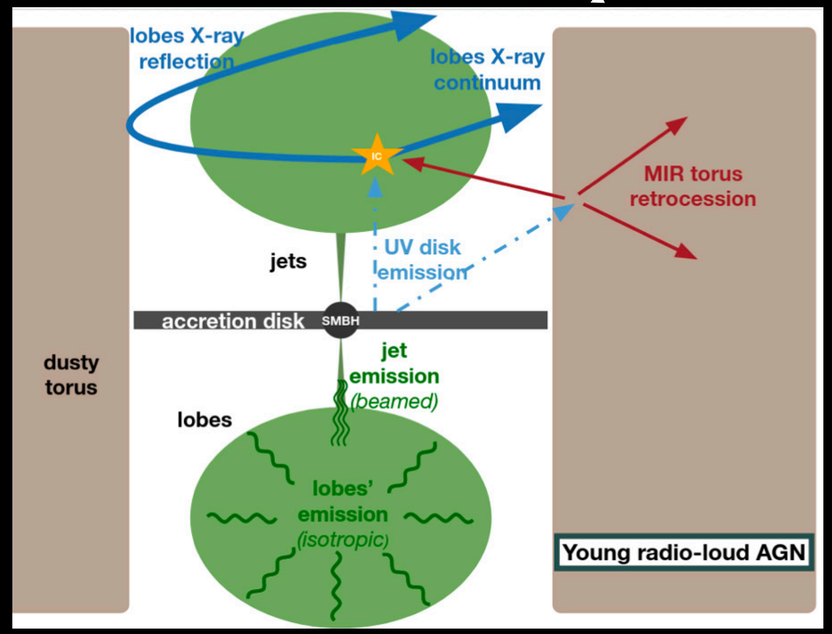
Nuclear Region
Jets impact the cloudy and dusty medium
Differences in the X-ray radiation **process**

Compact and unresolved in X-rays
Limiting size of the absorbing medium



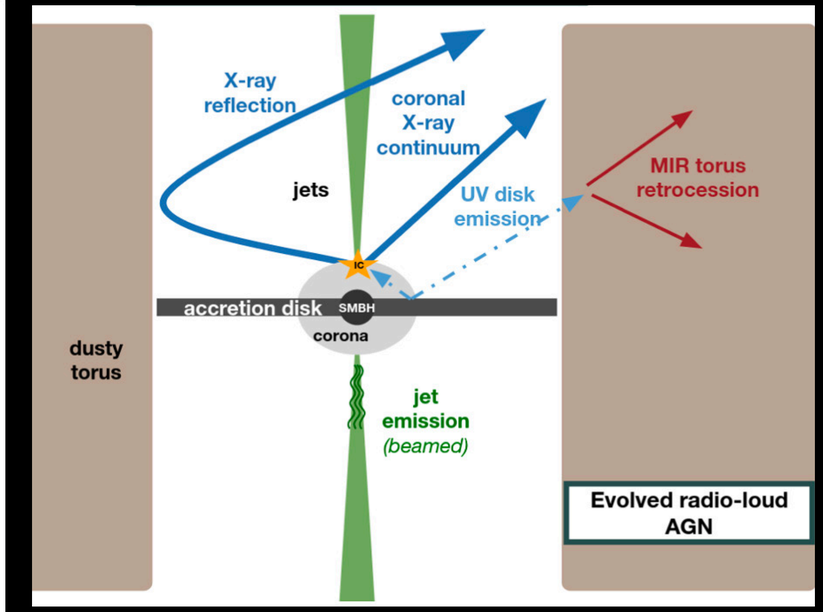
Siemiginowska et al 2016
Sobolewska et al 2019

Compact



Krol et al 2024

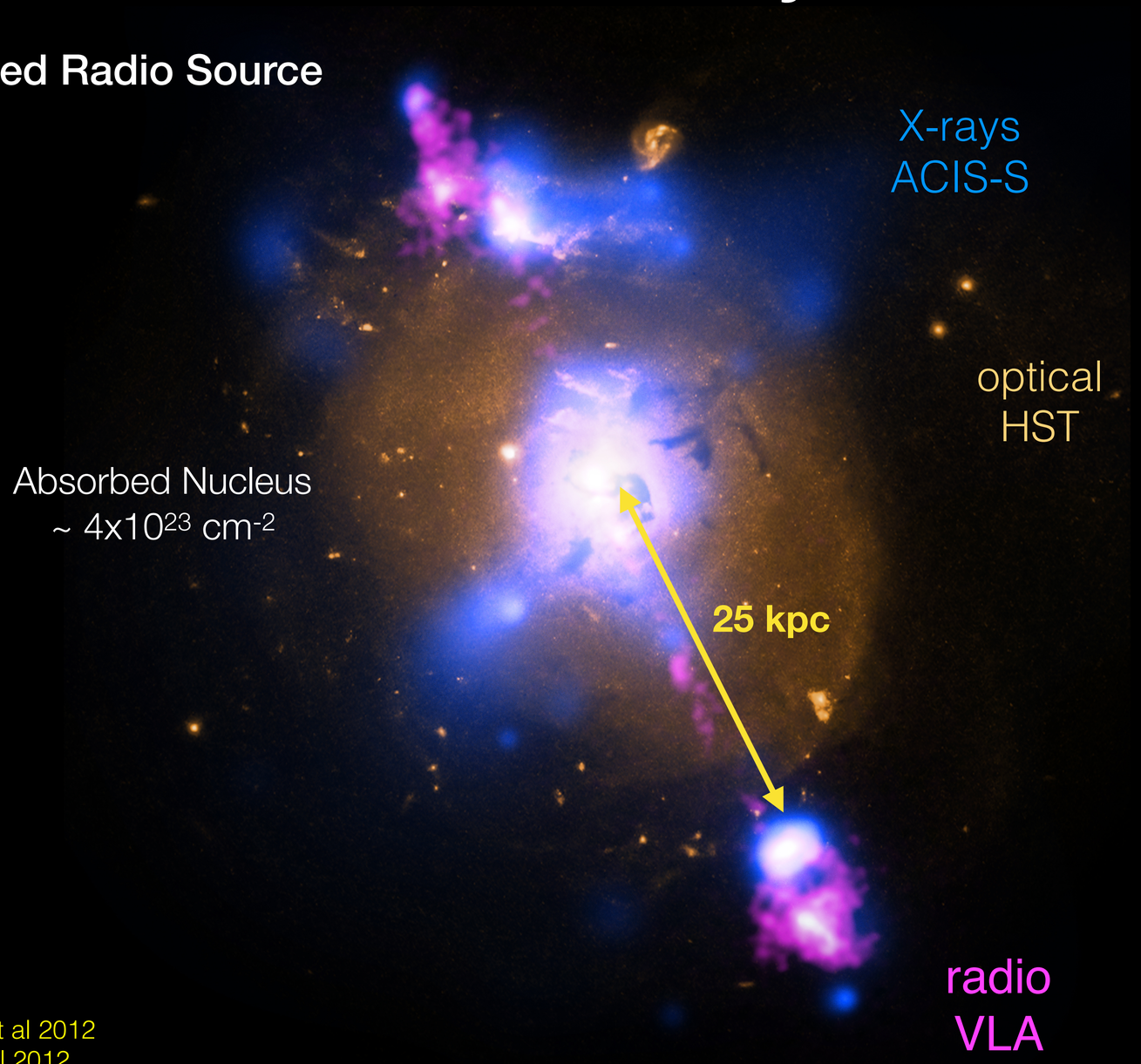
Evolved



also poster 01-06

Radio Galaxy 4C 29.30 (z=0.0647)

Evolved Radio Source



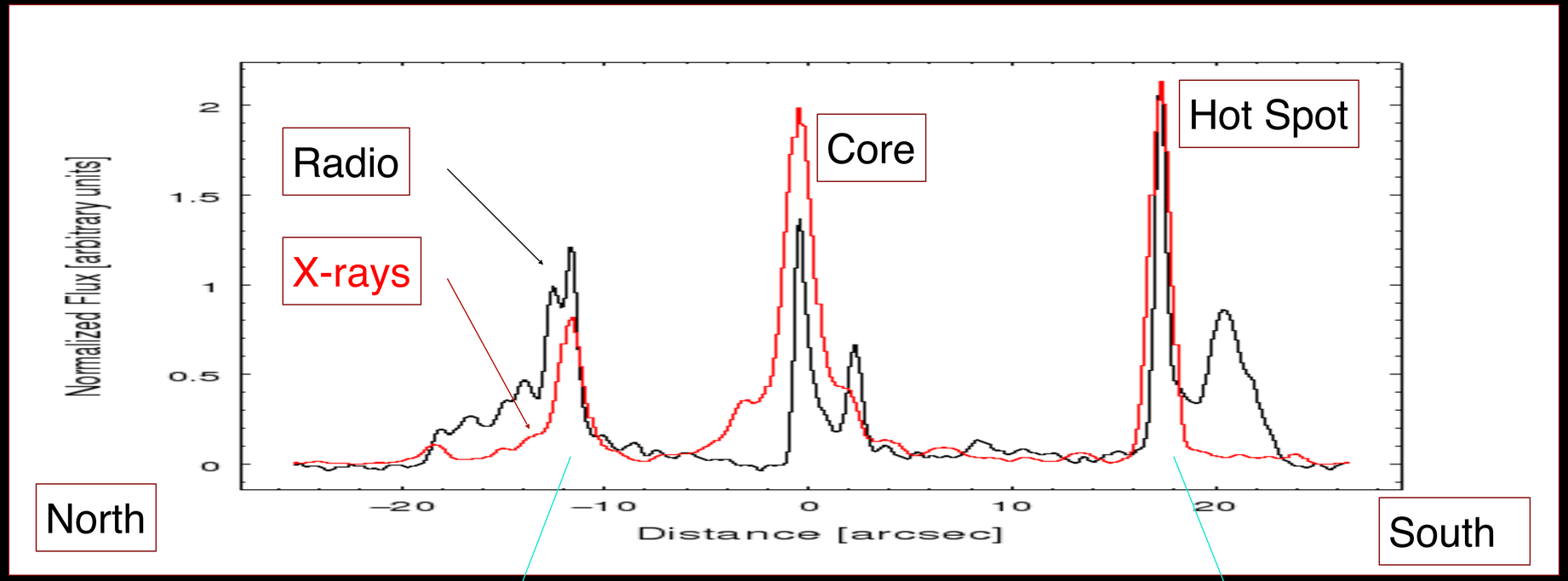
AGN L_X (2-10 keV) = 5 x10^{43} erg/s
Temp (ISM) = 0.5 keV

Radio:
Jet, knots, hotspots, lobes

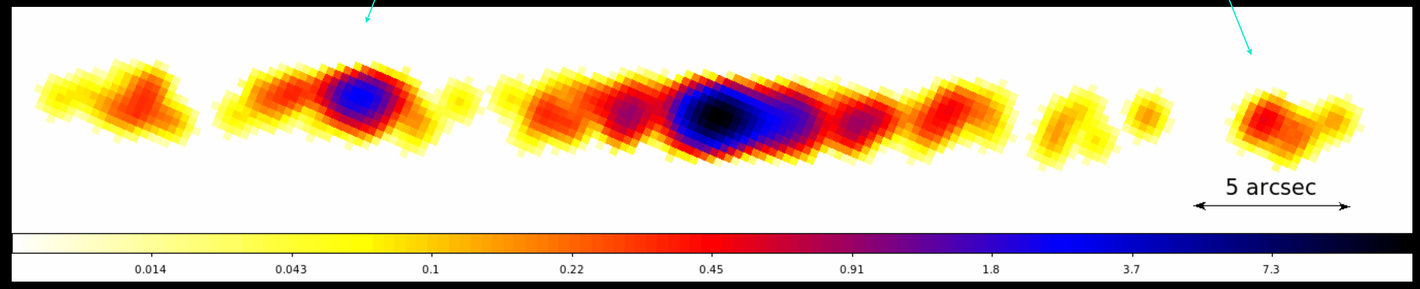
X-rays:
AGN nucleus, jet, knots, hot spots
diffuse structures

Siemiginowska et al 2012
Sobolewska, et al 2012

Tracing Jet-ISM Interactions



X-rays along the jet-line

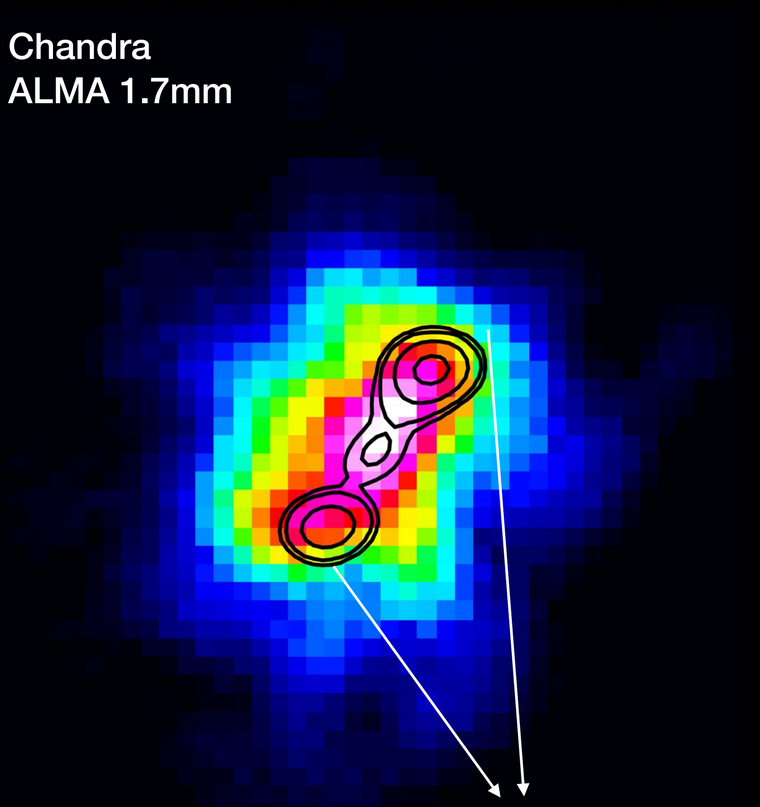


Siemiginowska et al 2012
Sobolewska, et al 2012

Type 2 Quasar PKS 0023-26 z=0.322

Jet Interactions with the ISM of the host galaxy

Chandra
ALMA 1.7mm



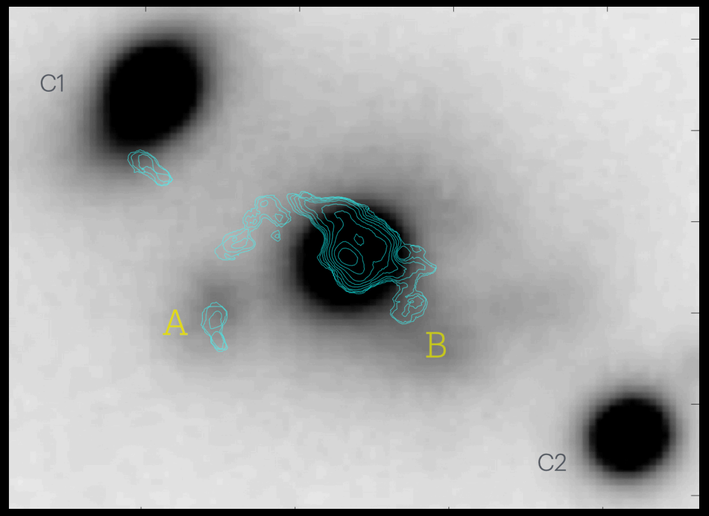
RS Linear size: 4.7 kpc

Jet Power ~ a few 10^{46} erg/s

L_R (5GHz) = 1.3x 10^{44} erg/s

L_{Bol} = (2.5 - 4) x 10^{45} erg/s

Optical Image with CO density contours

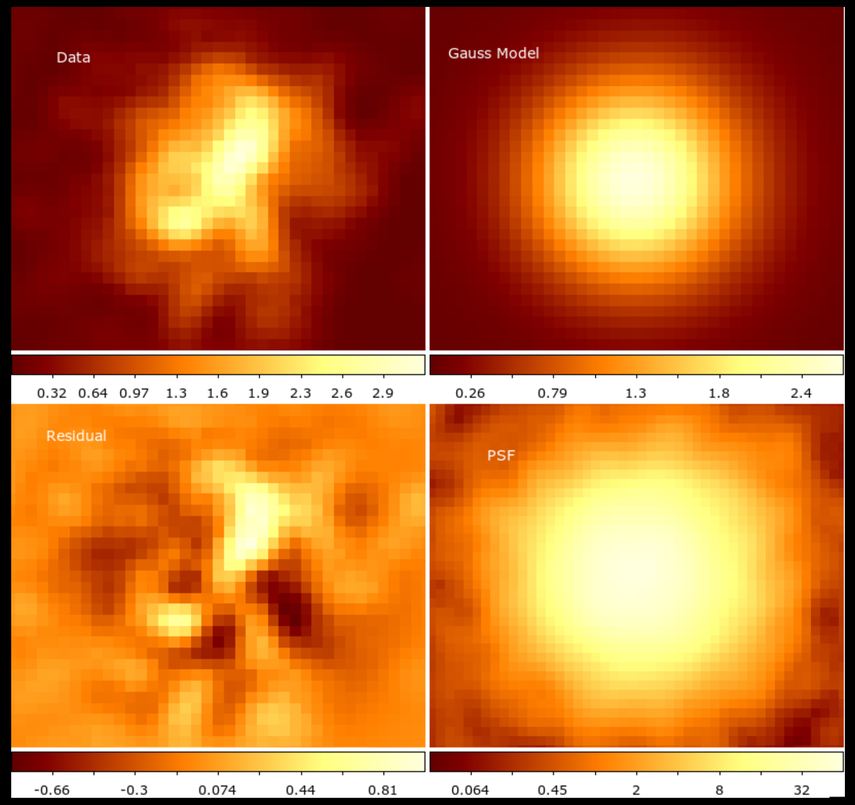


Morganti et al 2021

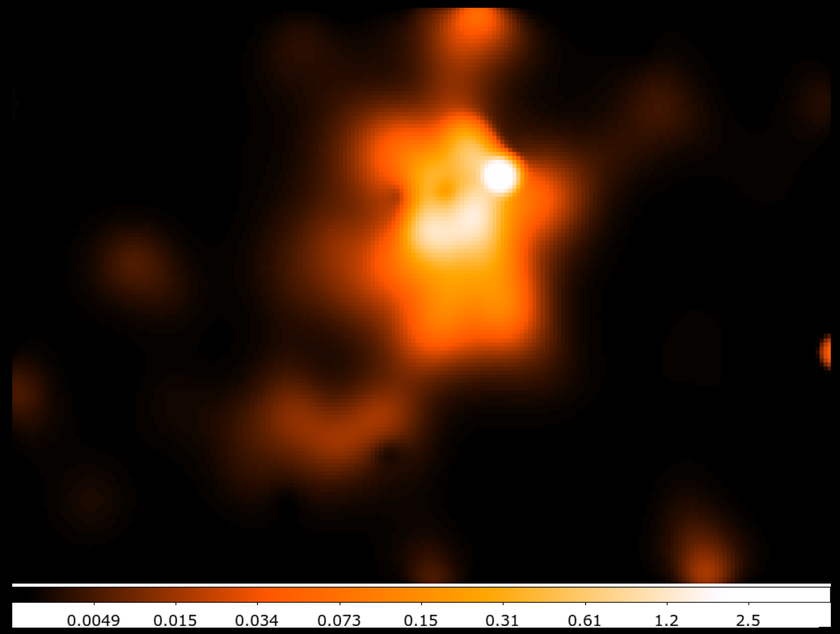
Type 2 Quasar PKS 0023-26 z=0.322

Chandra X-ray Image Analysis

Sherpa 2D model



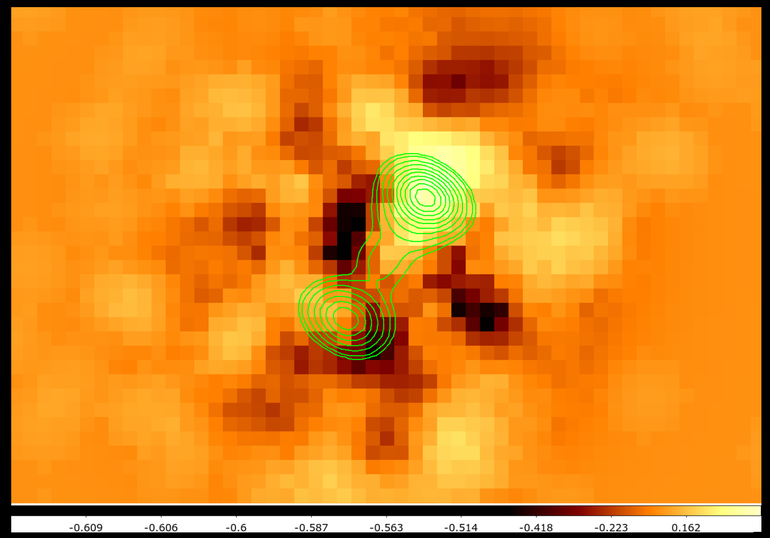
Jolideco - deconvolution



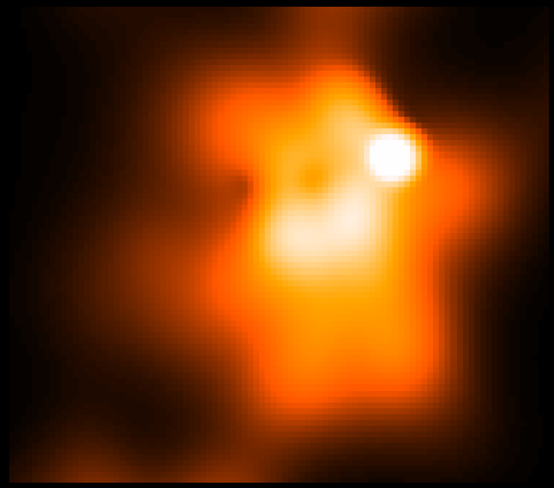
Type 2 Quasar PKS 0023-26 z=0.322

Chandra X-ray Image Analysis

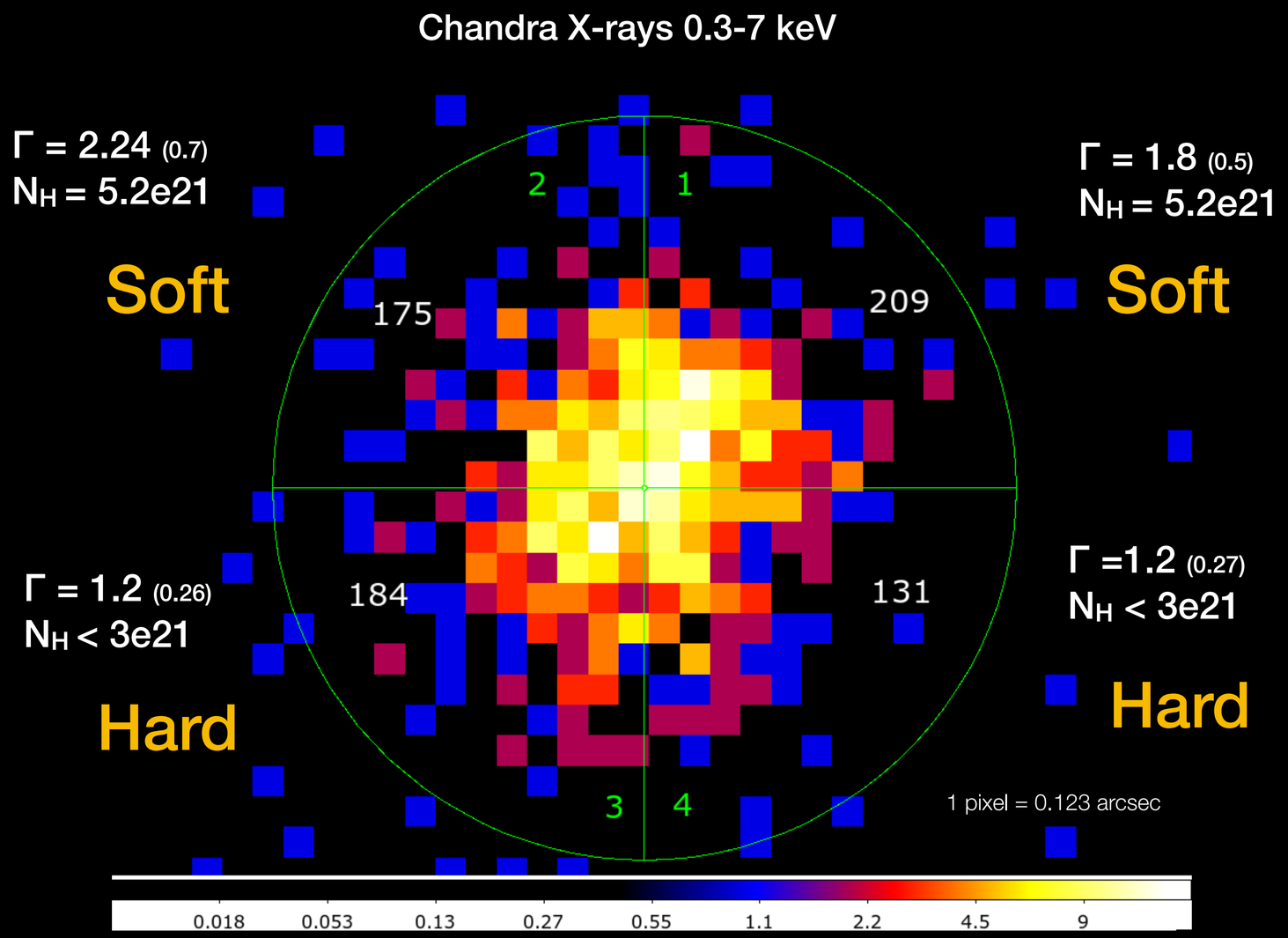
Sherpa 2D model - Residuals



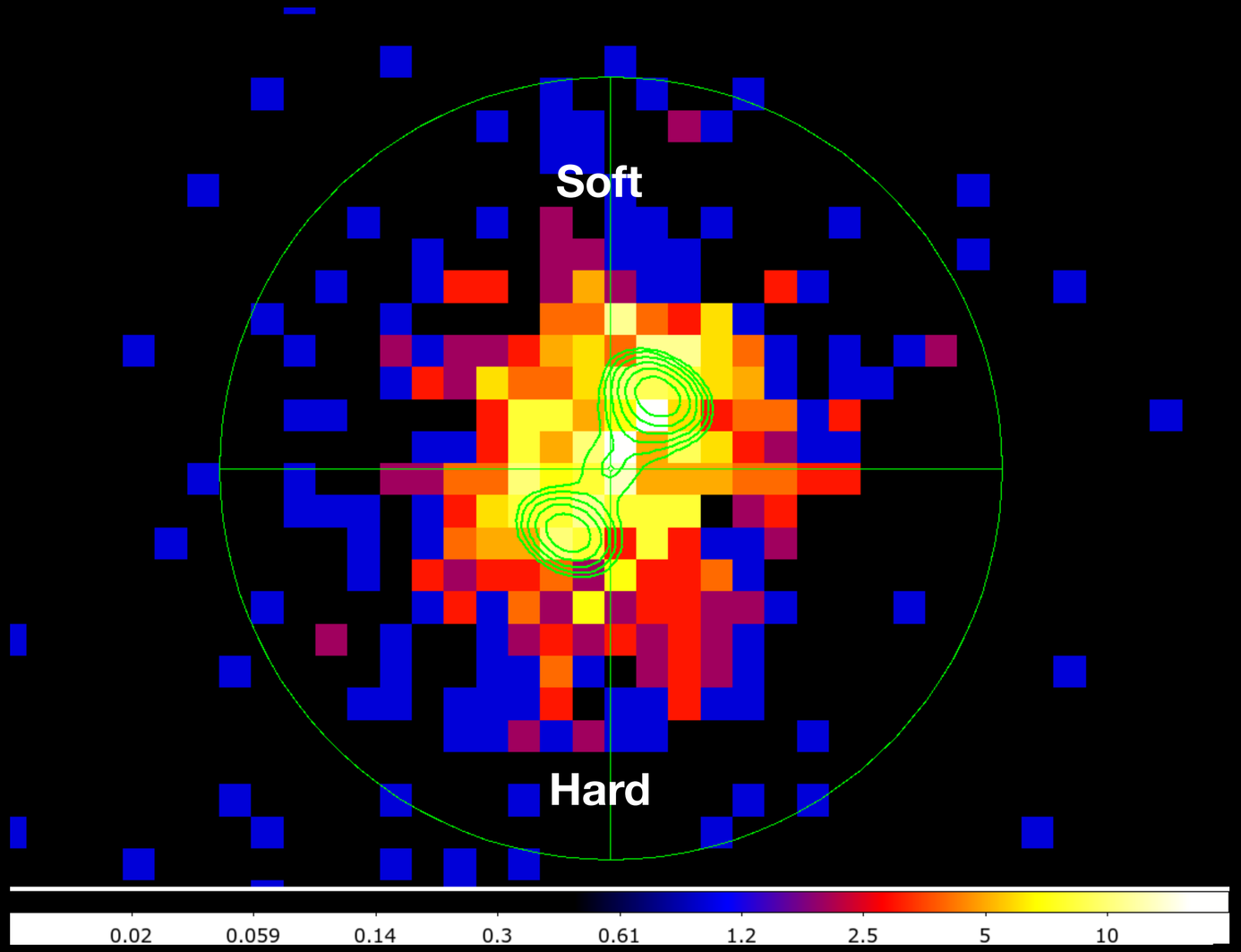
Jolideco - deconvolution



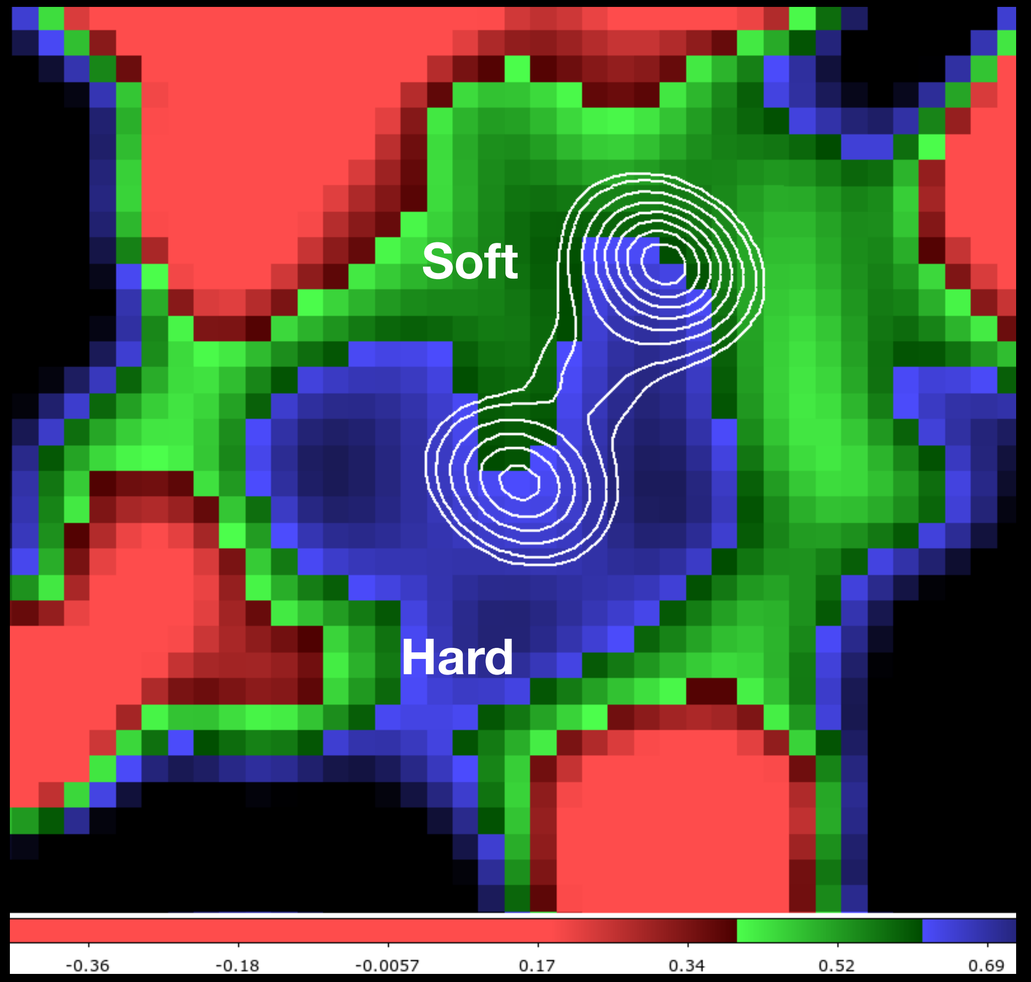
Type 2 Quasar PKS 0023-26 z=0.322



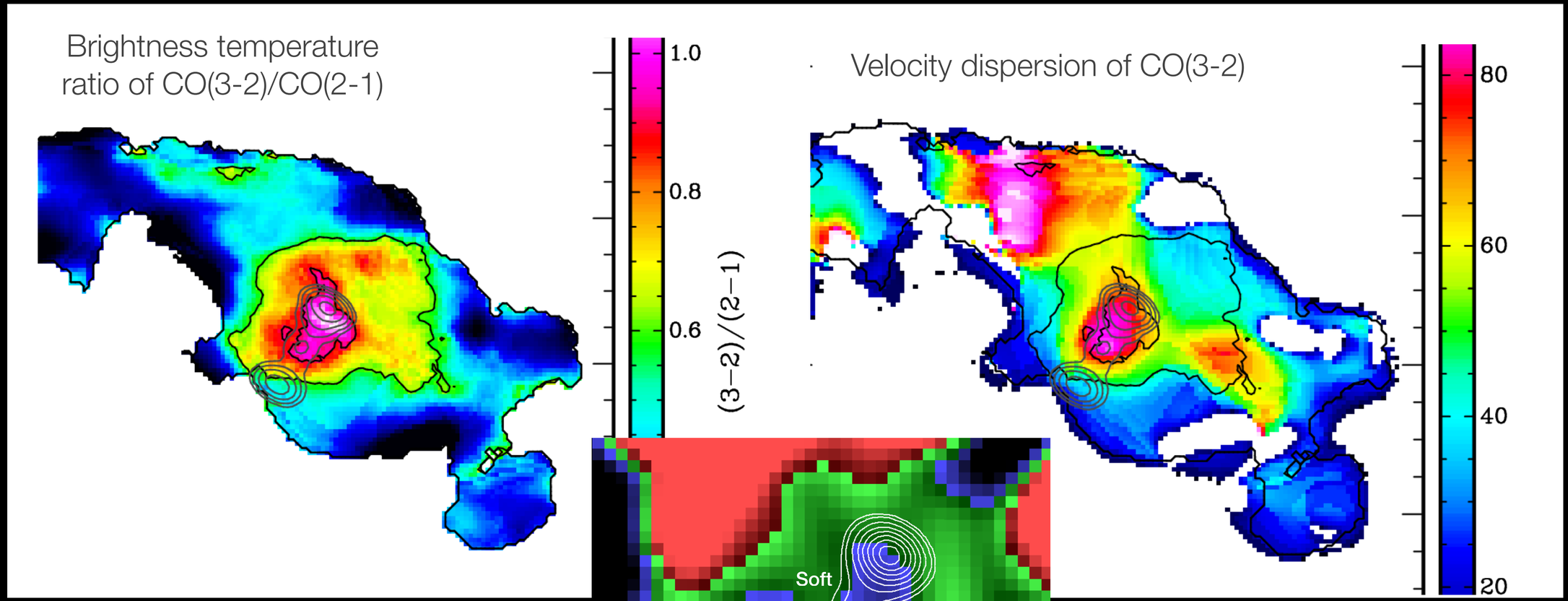
Type 2 Quasar PKS 0023-26 z=0.322



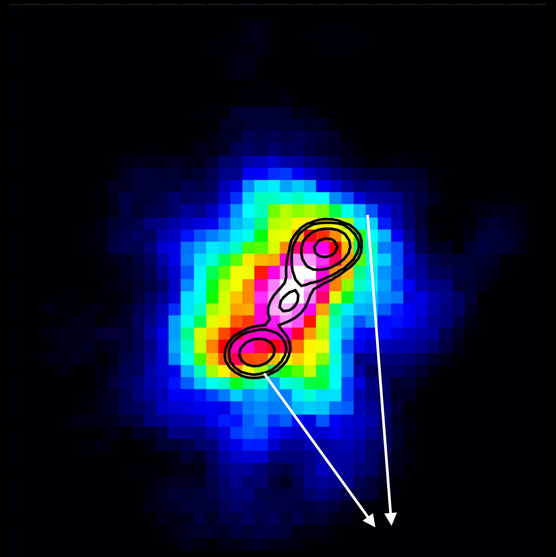
Hardness Ratio H-S/H+S



Type 2 Quasar PKS 0023-26 z=0.322



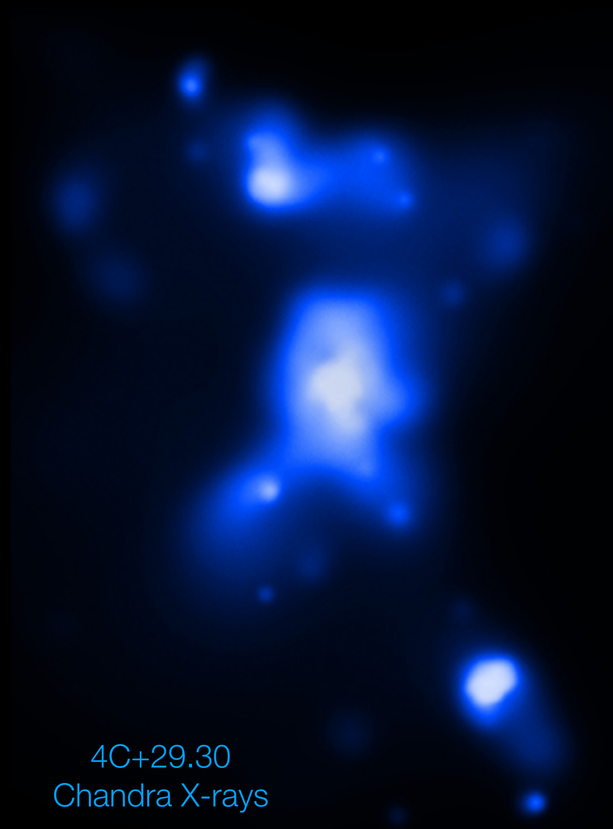
Jet-ISM Interactions in PKS0023-36



RS Linear size: 4.7 kpc

- Jet Power ~ a few 10^{46} erg/s
- X-ray luminosity of the thermal gas: $L_{X(0.5\text{-}2\ keV)} \sim 10^{43}$ erg/s
- X-ray elongation in the same direction as radio emission
- highest velocity of molecular gas in the core region
- high velocity dispersion and distribution of the gas wrapping around the radio lobes on kpc-scales
- CO transitions indicate high excitation temperatures of molecular gas (or optically thin conditions)
- jet compresses and heats up the gas

Summary



4C+29.30
Chandra X-rays

- High angular resolution of Chandra gives unprecedented views on the evolving jets impact on the ISM
- Different X-ray radiation process in young radio sources
- Tracing jet interactions and impact on ISM
- Important data for understanding feedback process
- Studies require deep high resolution X-ray observations and need for future X-ray missions

Thank you to everyone involved in different aspects of the Chandra projects over the past 25

X-rays/Radio:

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Clive Tadhunter (Sheffield)

Thank you Chandra!