SKA and ATHENA

Gabriel W. Pratt
(SAp, CEA Saclay)

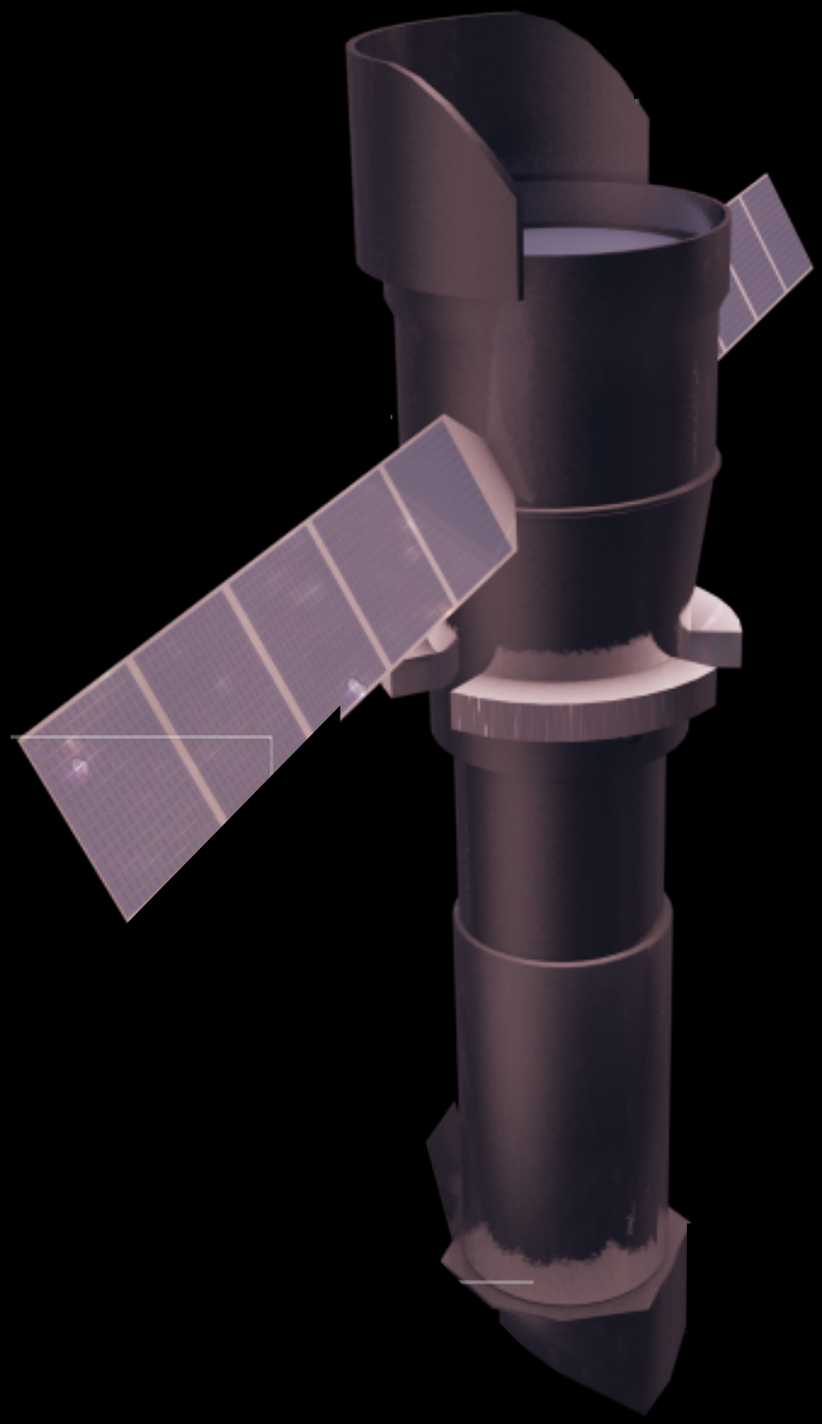
The hot and energetic Universe

The hot and energetic Universe

How does ordinary matter assemble into the large-scale structures we see today?

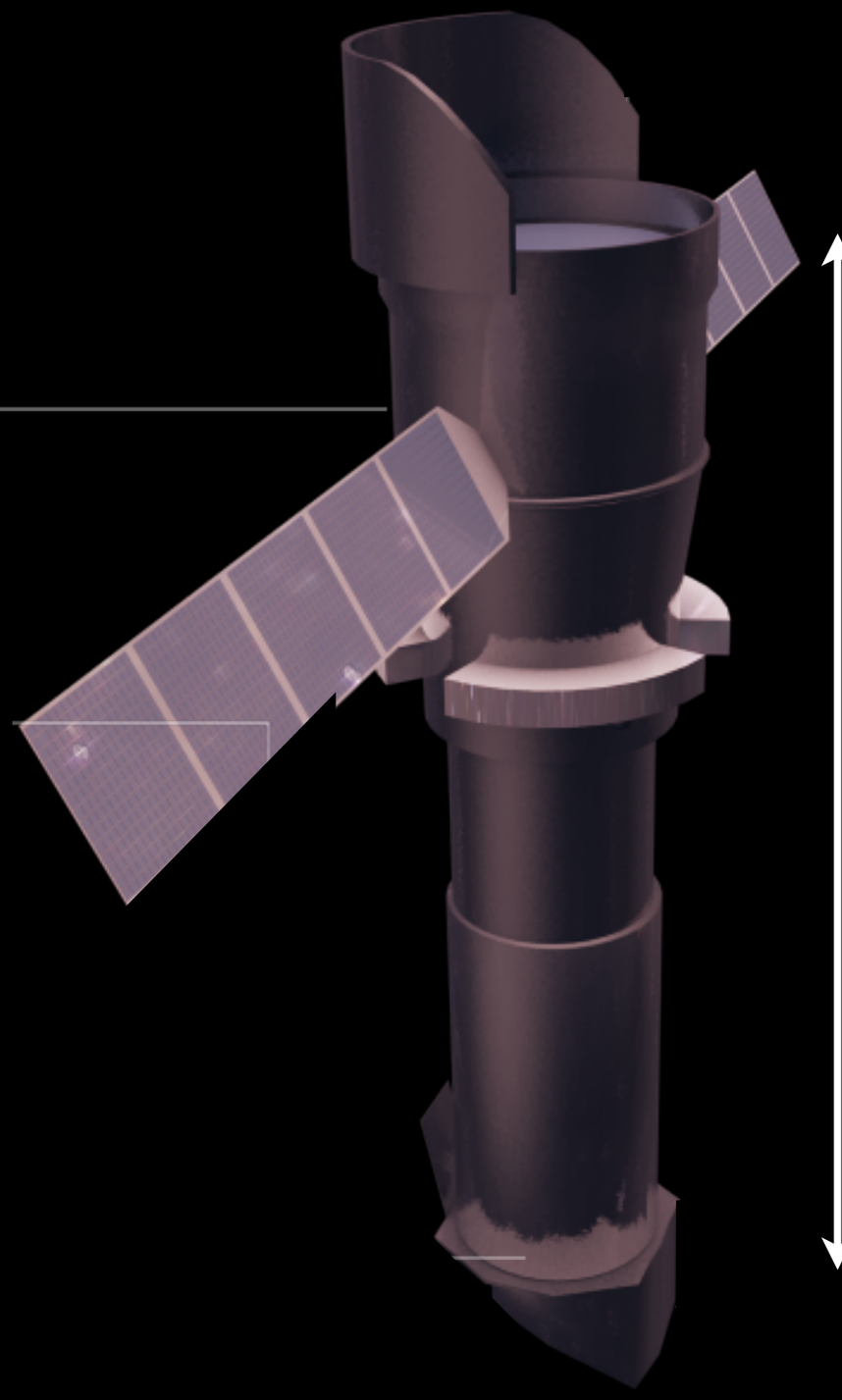
How do black holes grow and shape the Universe?

The Advanced Telescope for High ENergy Astrophysics



The Advanced Telescope for High ENergy Astrophysics

L2 orbit Ariane V
Mass < 5100 kg
Power 2500 W
5 year mission



12m

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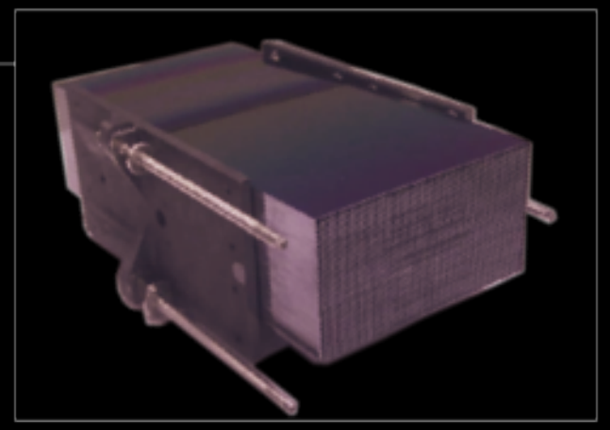
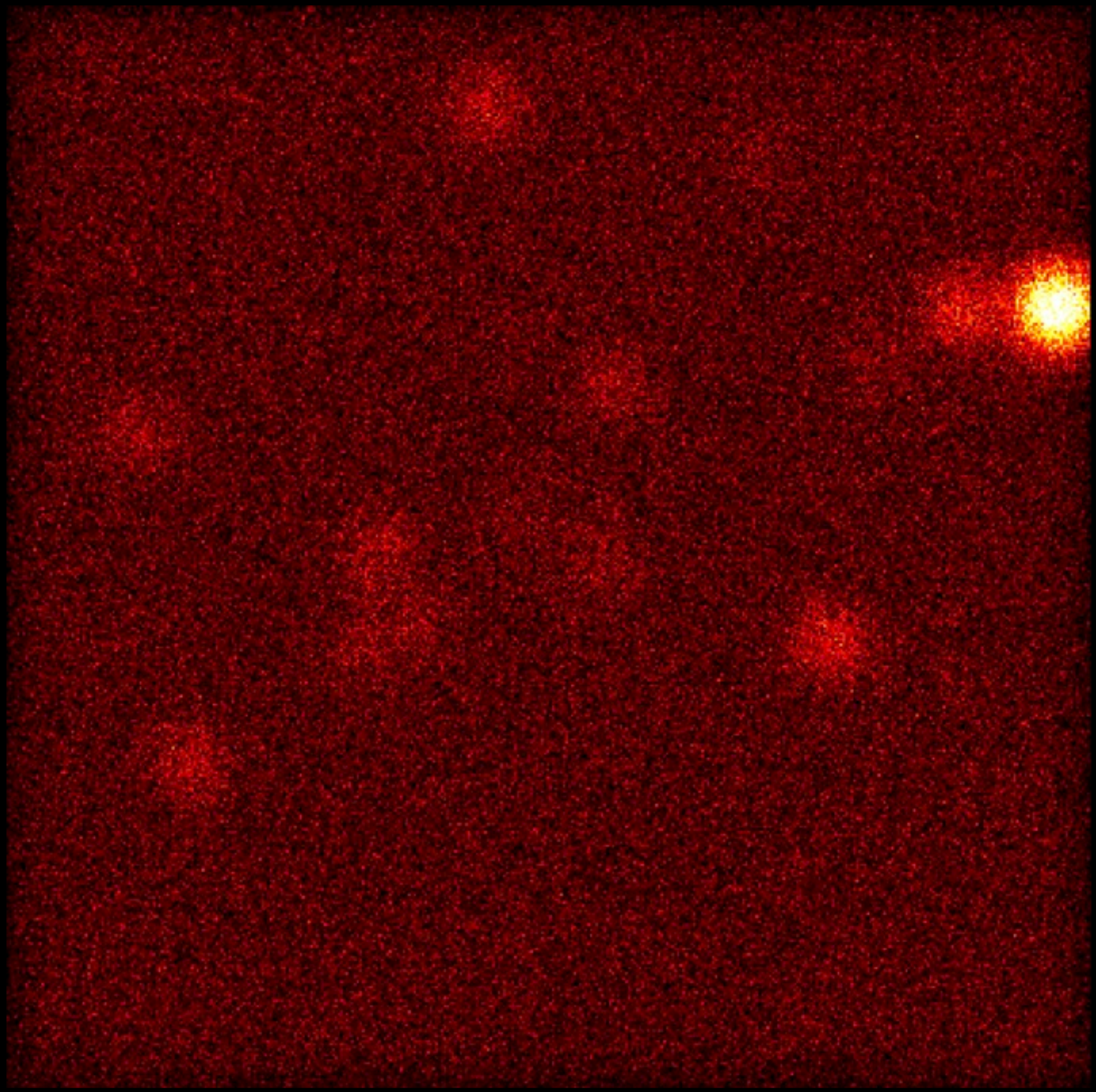
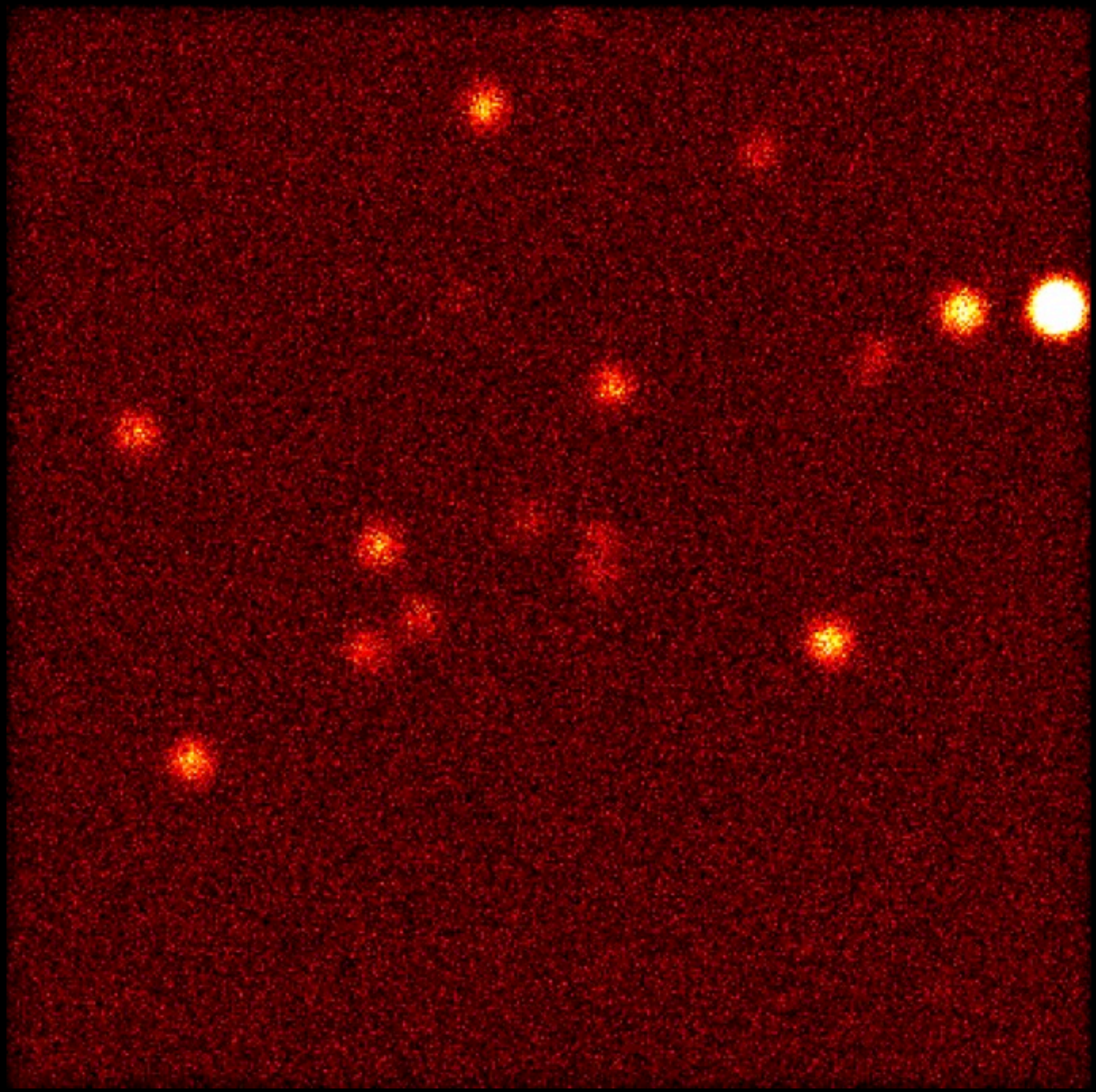


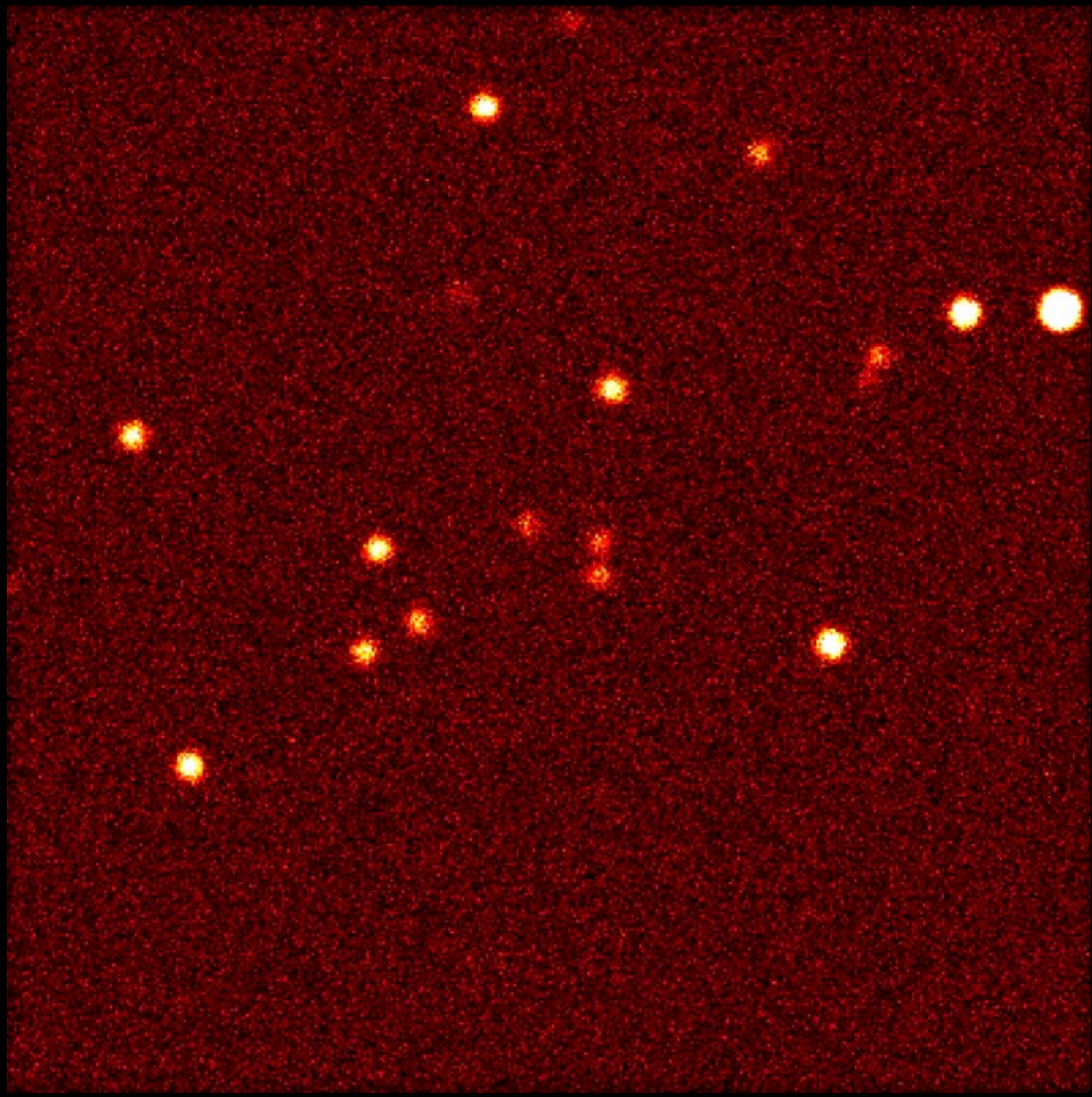
Silicon Pore Optics:
2 m^2 at 1 keV
5 arcsec HEW
Focal length: 12 m
Sensitivity: 3 10^{-17} erg cm^{-2} s^{-1}



10”



5”
(requirement)



3”
(goal)

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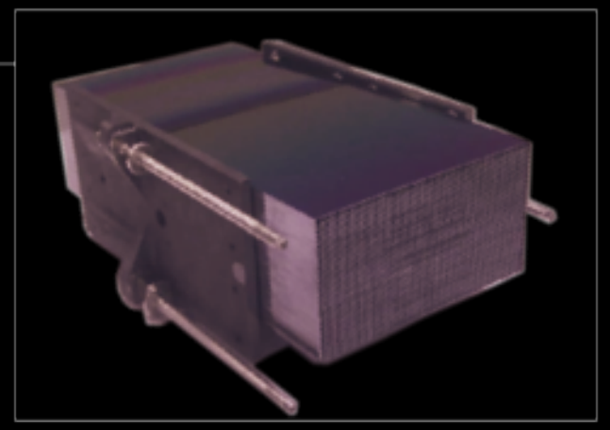

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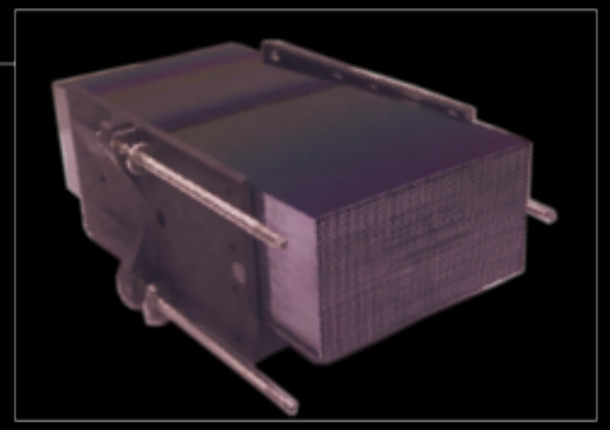

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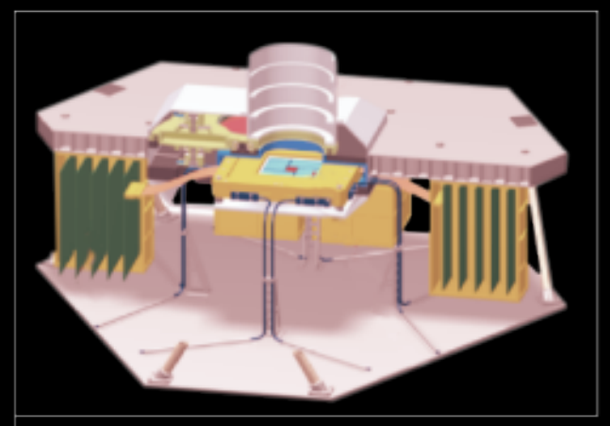

Wide Field Imager:
ΔE: 125 eV
Field of View: 40 arcmin
High countrate capability

Rau et al. 2013 arXiv1307.1709

40’
(requirement)

50’
(goal)

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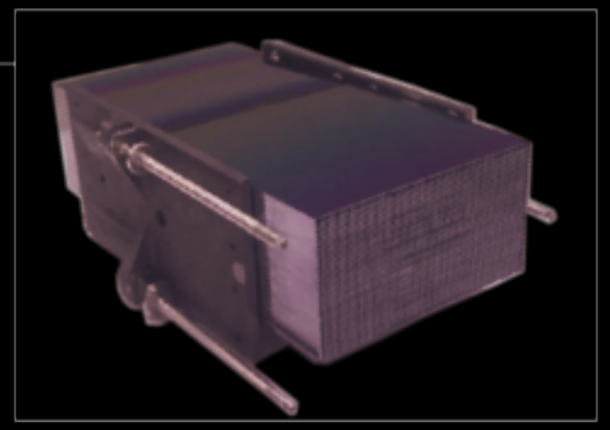

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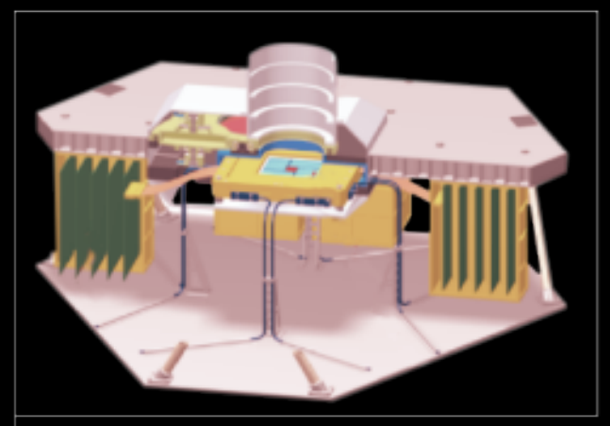

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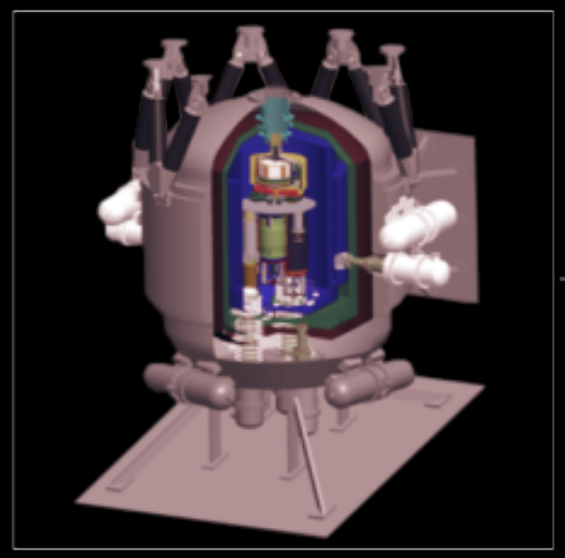

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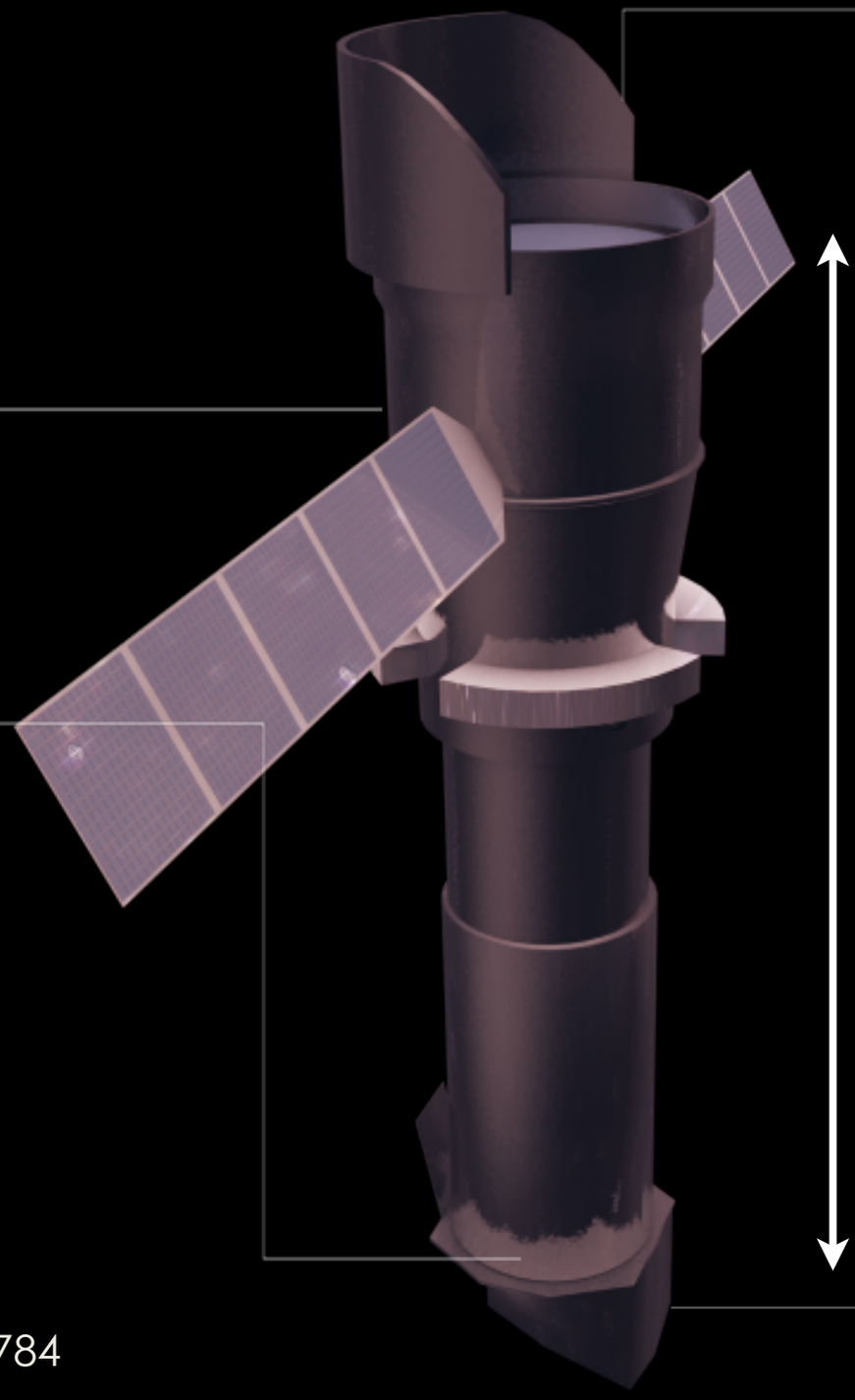

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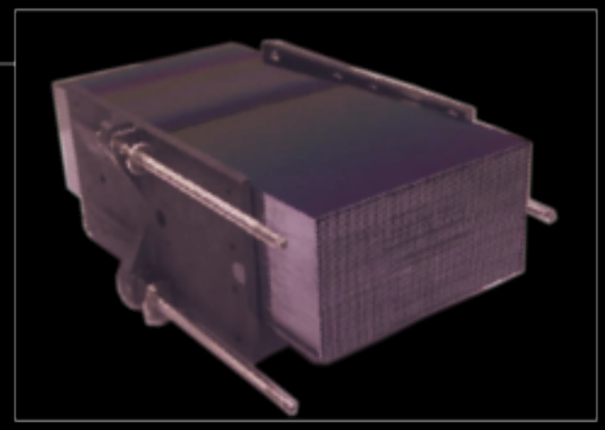

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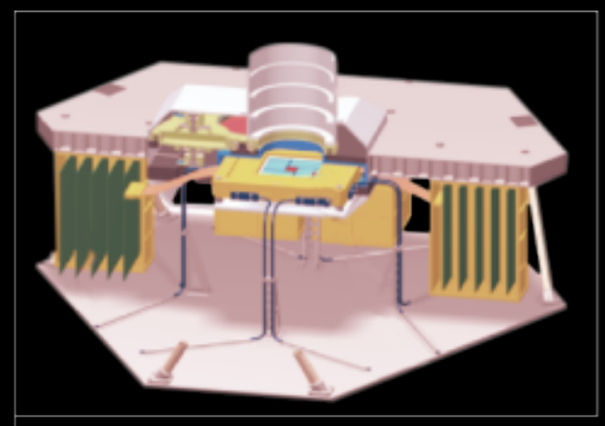

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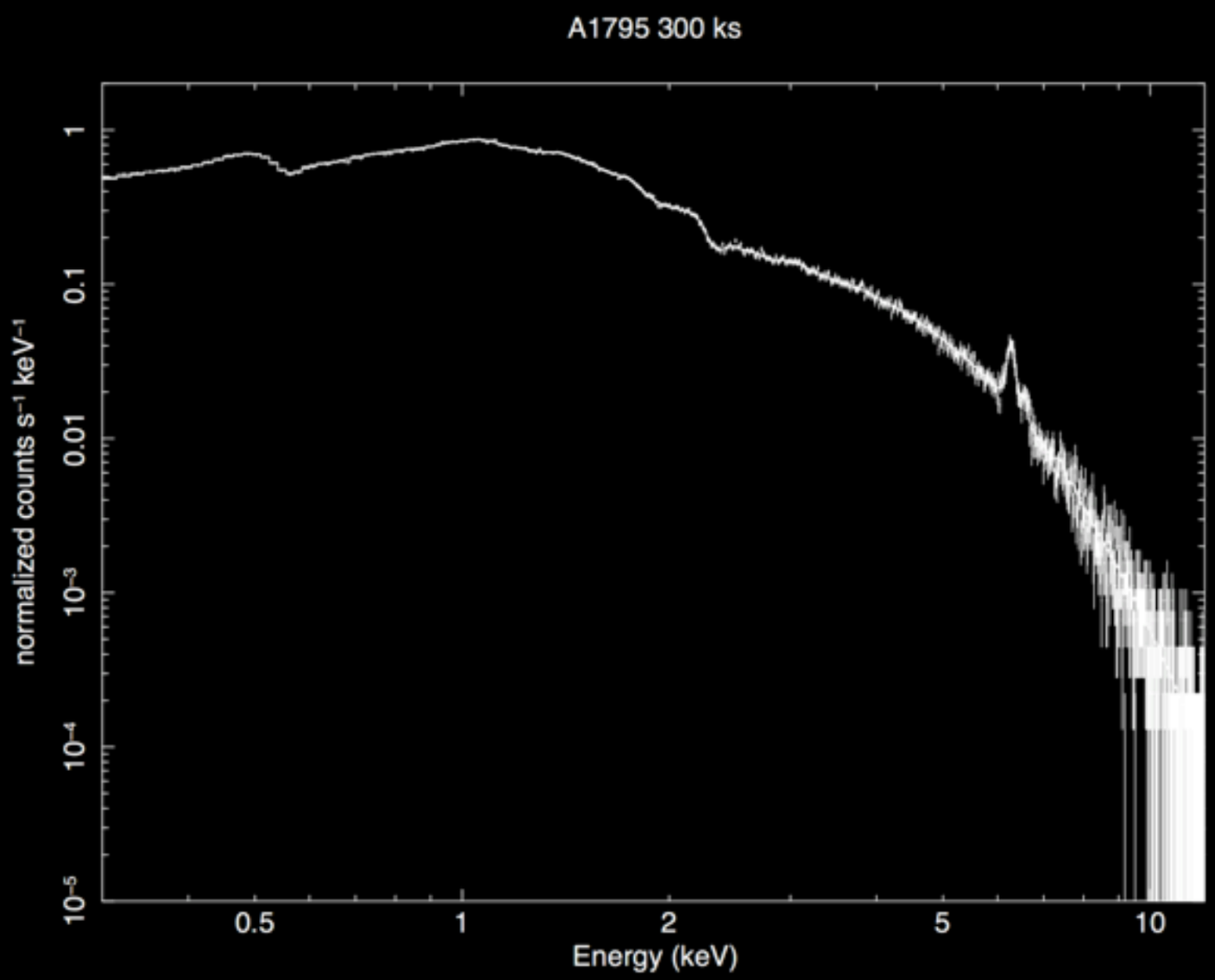
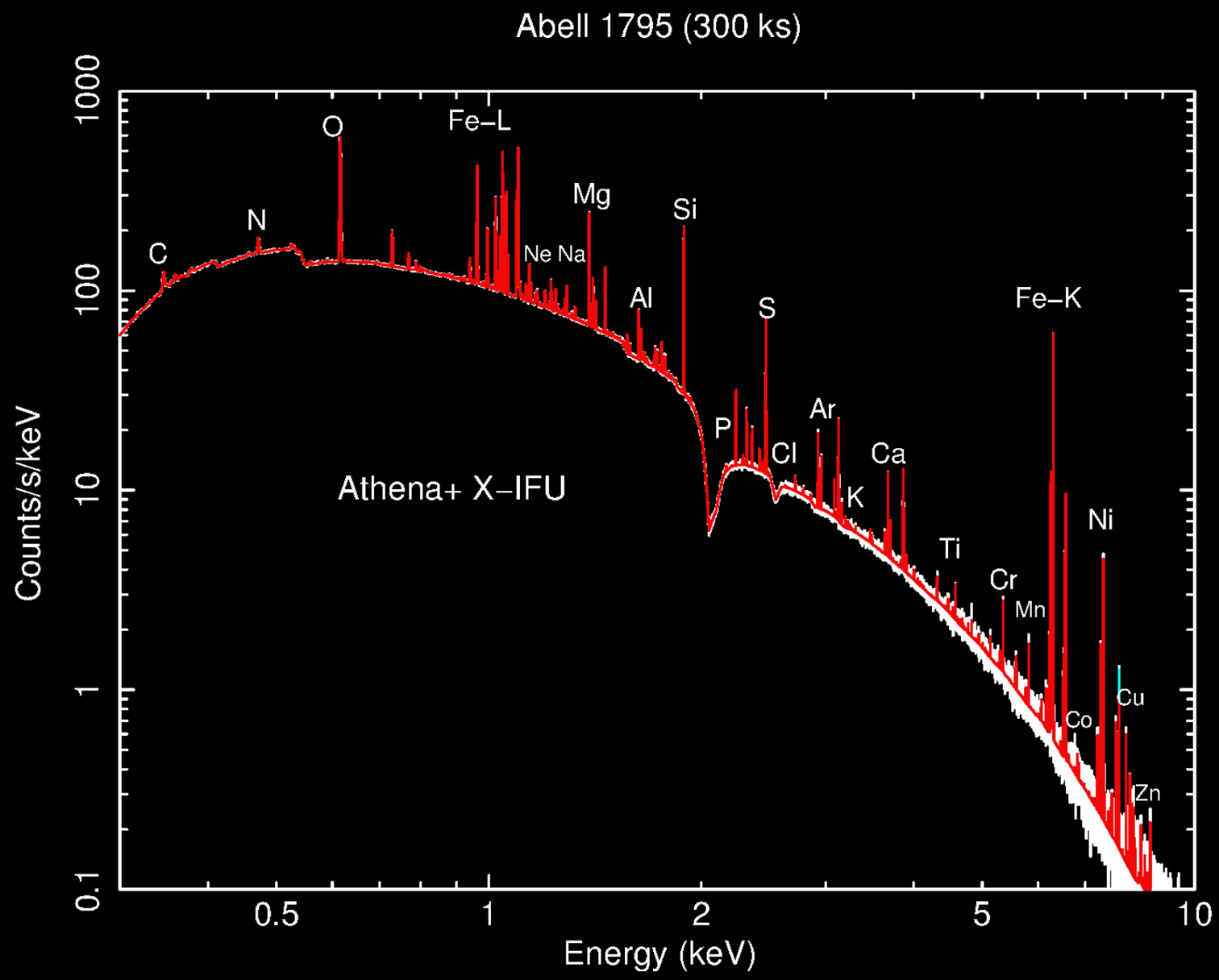
XIFU



But smaller field of view

XIFU



But smaller field of view

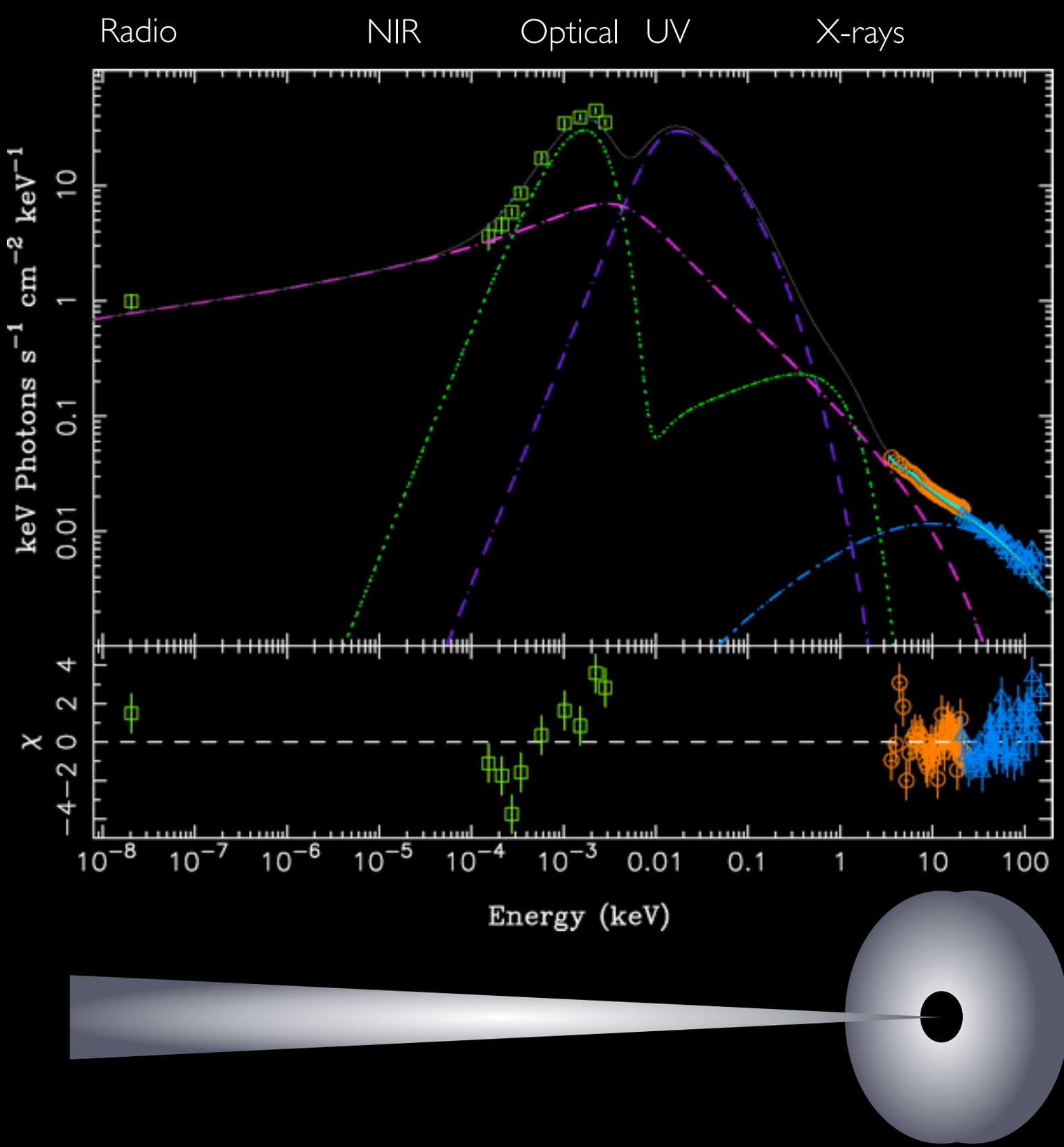
The hot and energetic Universe

The hot and energetic Universe

- Collecting area
- Spatial resolution
- Field of View (WFI)
- Spectral resolution (XIFU)
- (timing resolution [µs WFI])

Synergies with SKA and pathfinders (a few examples)

Microquasars



preshock synchrotron

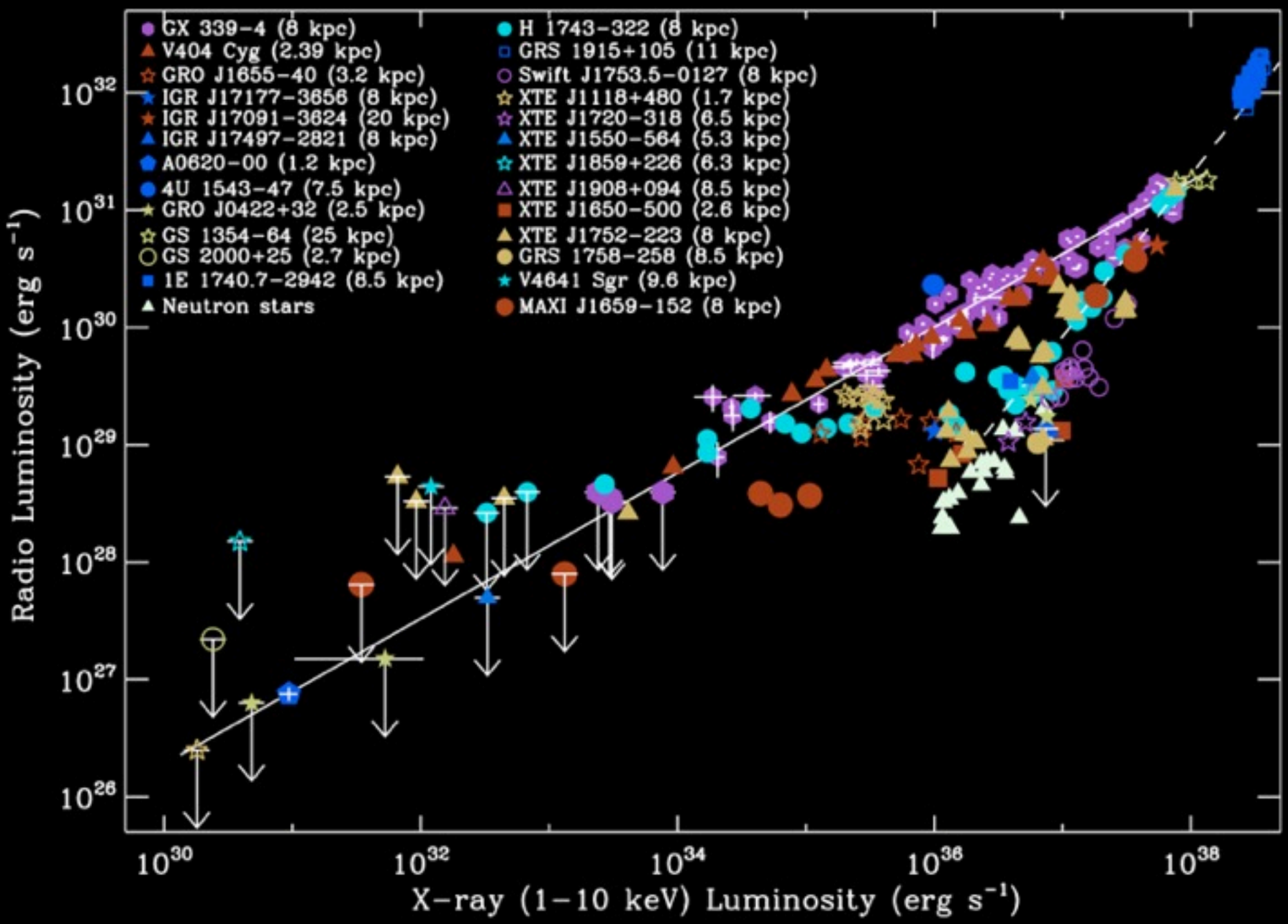
postshock synchrotron

SSC + disk external Compton

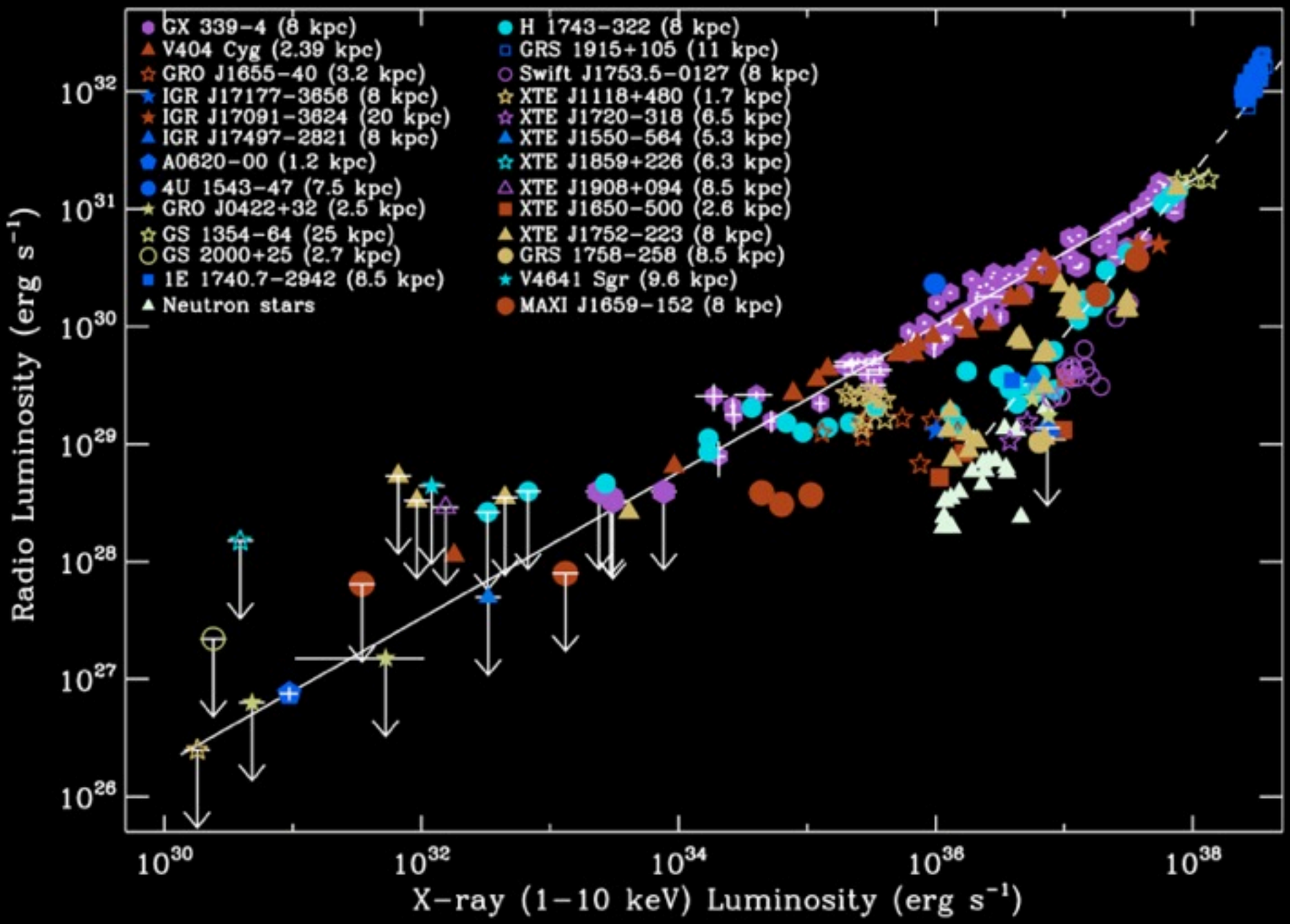
disk + companion star blackbody

Migliari et al 2007

Microquasars

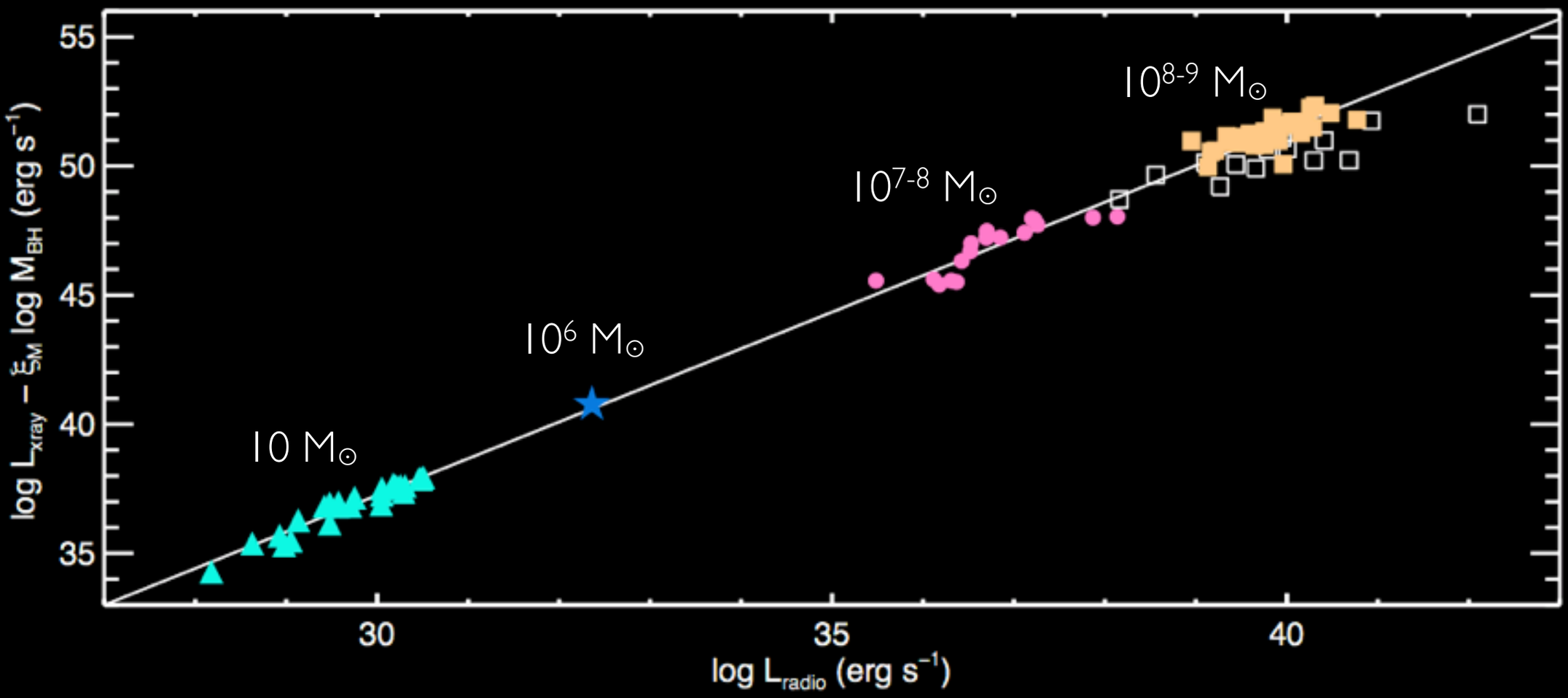


Microquasars



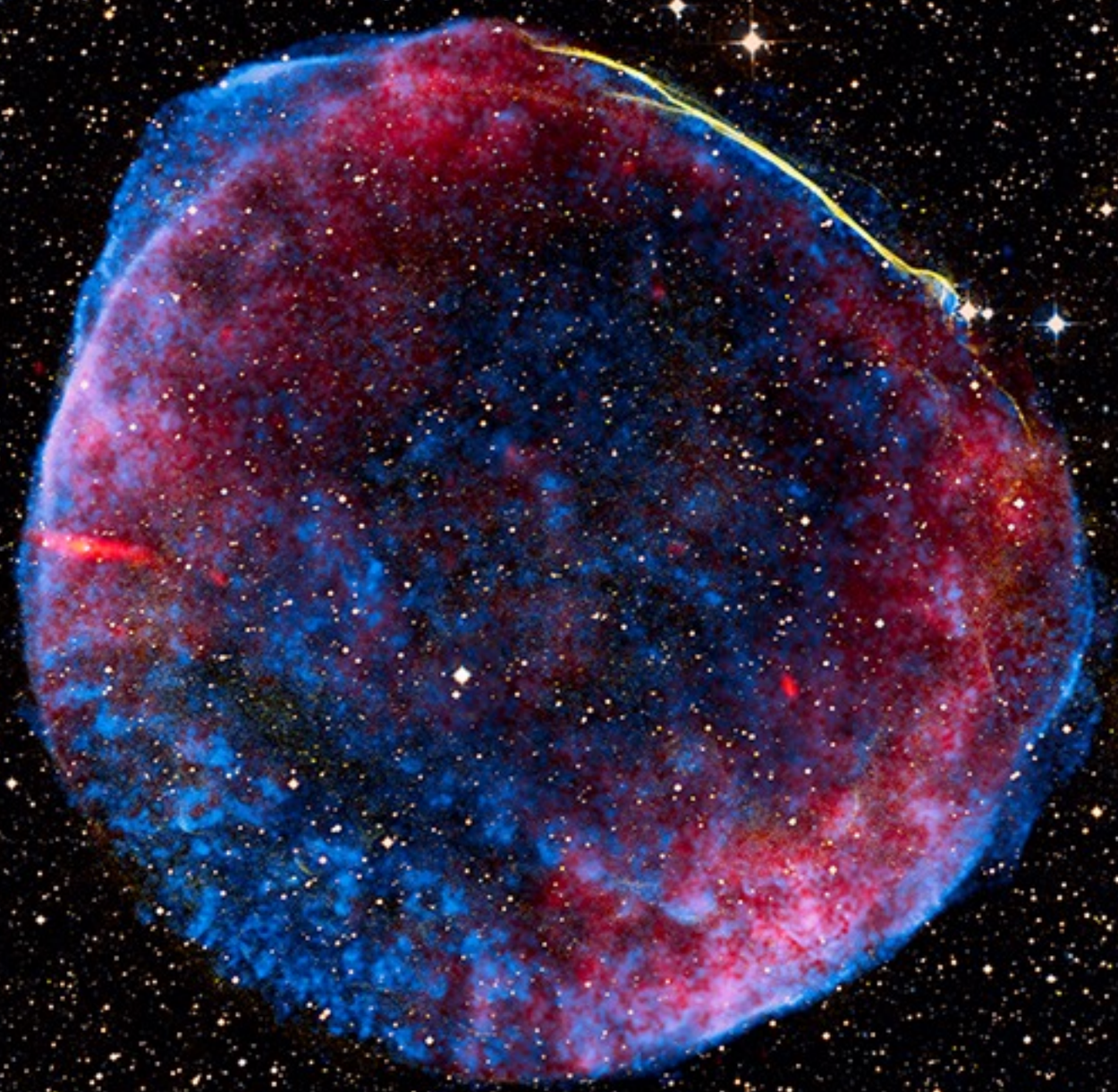
Corbel et al 2013

Black hole L_X-L_R fundamental plane



Plotkin et al 2012

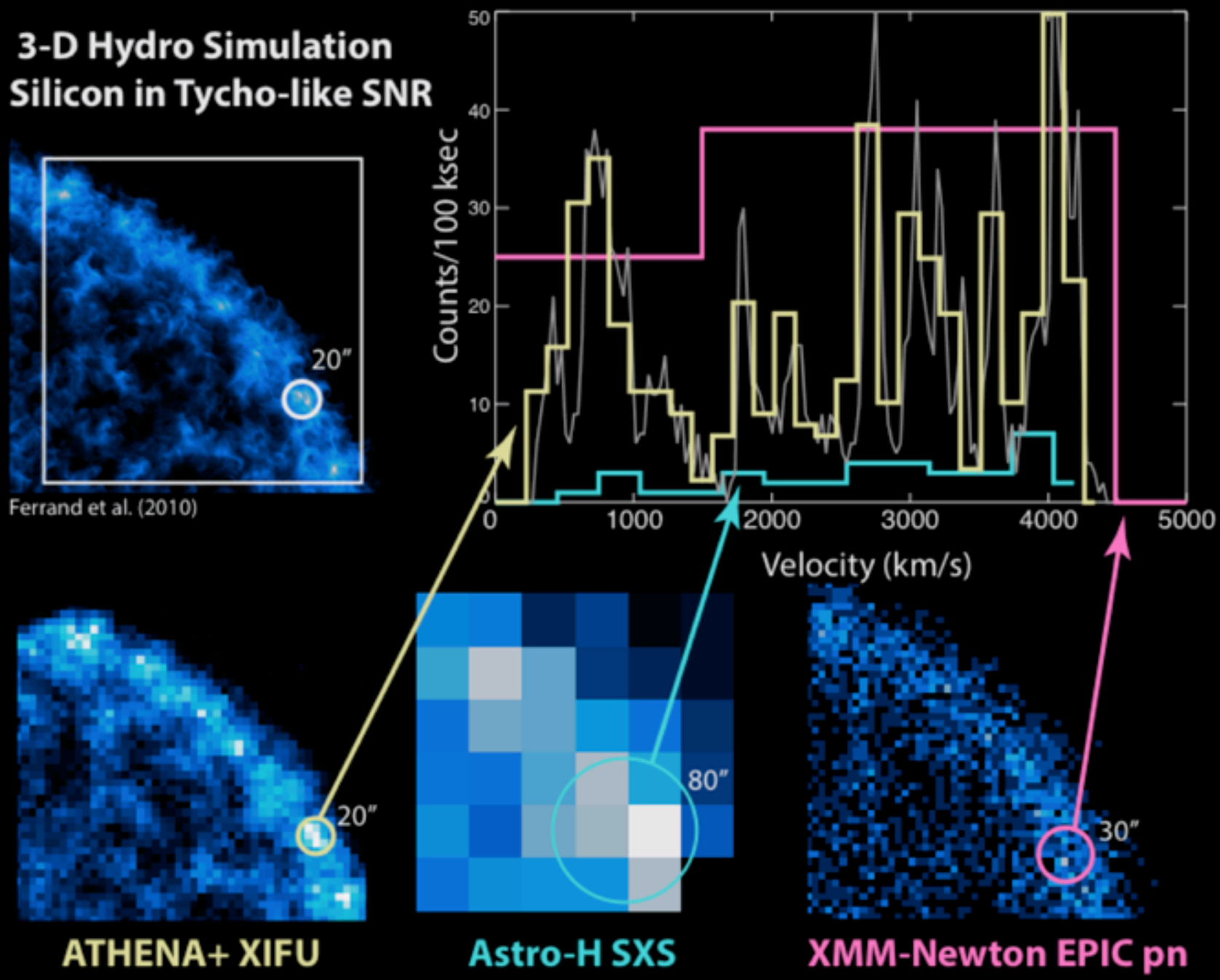
SN 1006



X-ray
Radio
optical

X-ray: NASA/CXC/Rutgers/G.Cassam-Chenaï, J.Hughes et al.; Radio: NRAO/AUI/NSF/GBT/VLA/ Dyer, Maddalena & Cornwell; Optical: Middlebury College/F.Winkler, NOAO/AURA/NSF/CTIO Schmidt & DSS

SN 1006


3-D Hydro Simulation
Silicon in Tycho-like SNR
20″
Ferrand et al. (2010)
Counts/100 ksec
50
40
30
20
10
0
0
1000
2000
3000
4000
5000
Velocity (km/s)
20″
80″
30″
ATHENA+ XIFU
Astro-H SXS
XMM-Newton EPIC pn

z = 1.0

gas temperature

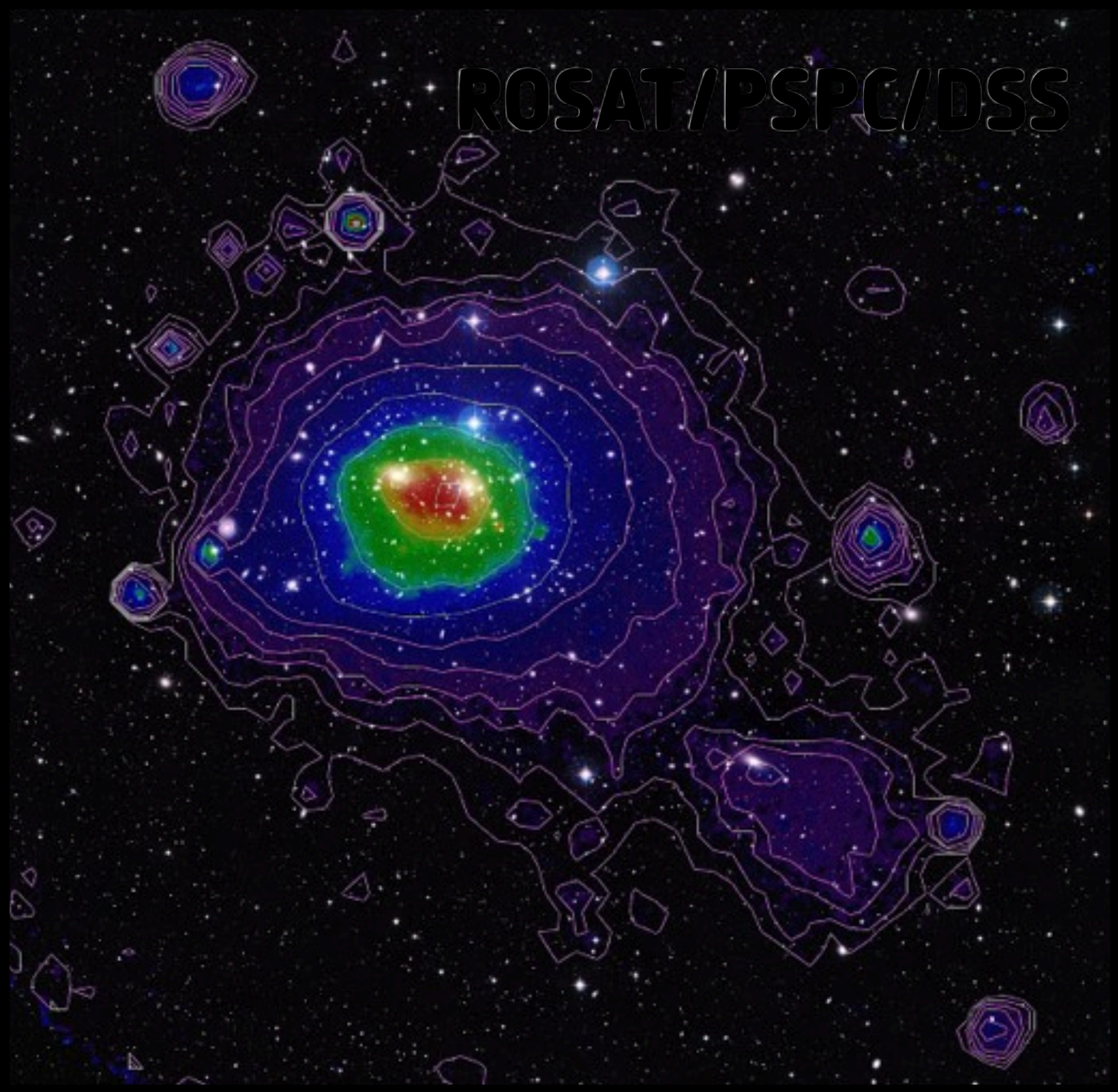
4 Mpc/h

gas density

dark matter density

Volker Springel

The halo-turbulence connection



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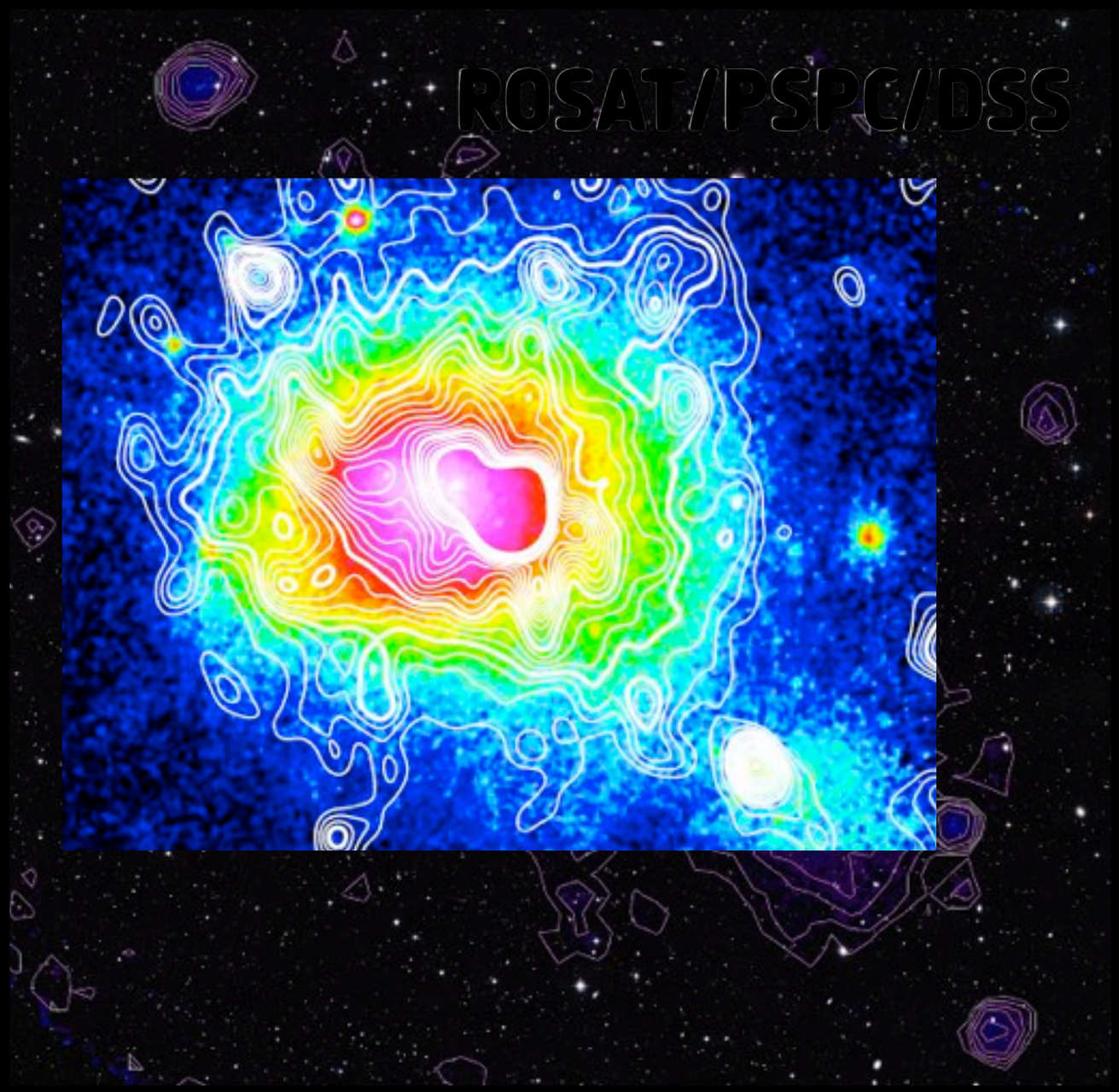

Brown & Rudnick 2010

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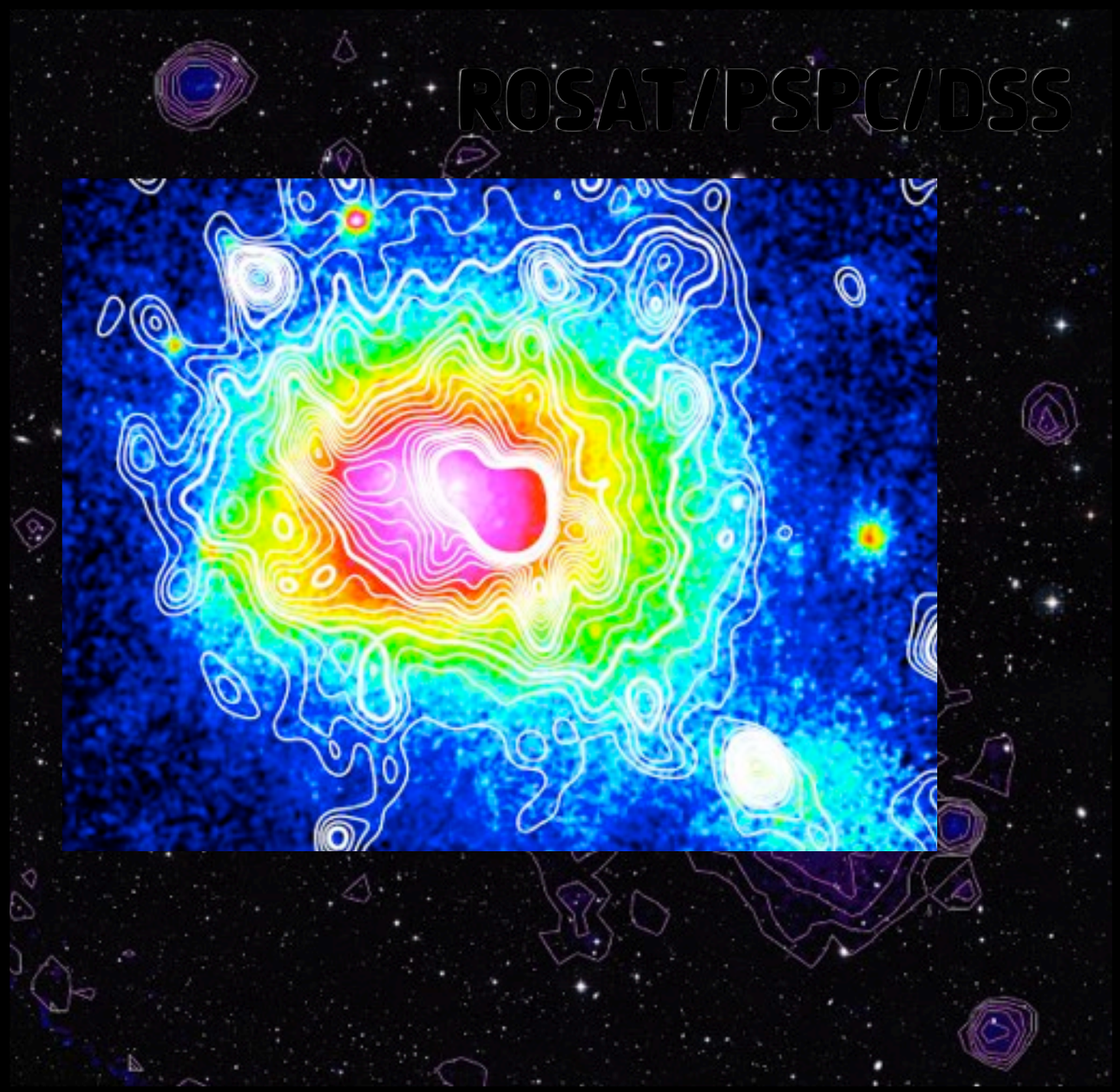
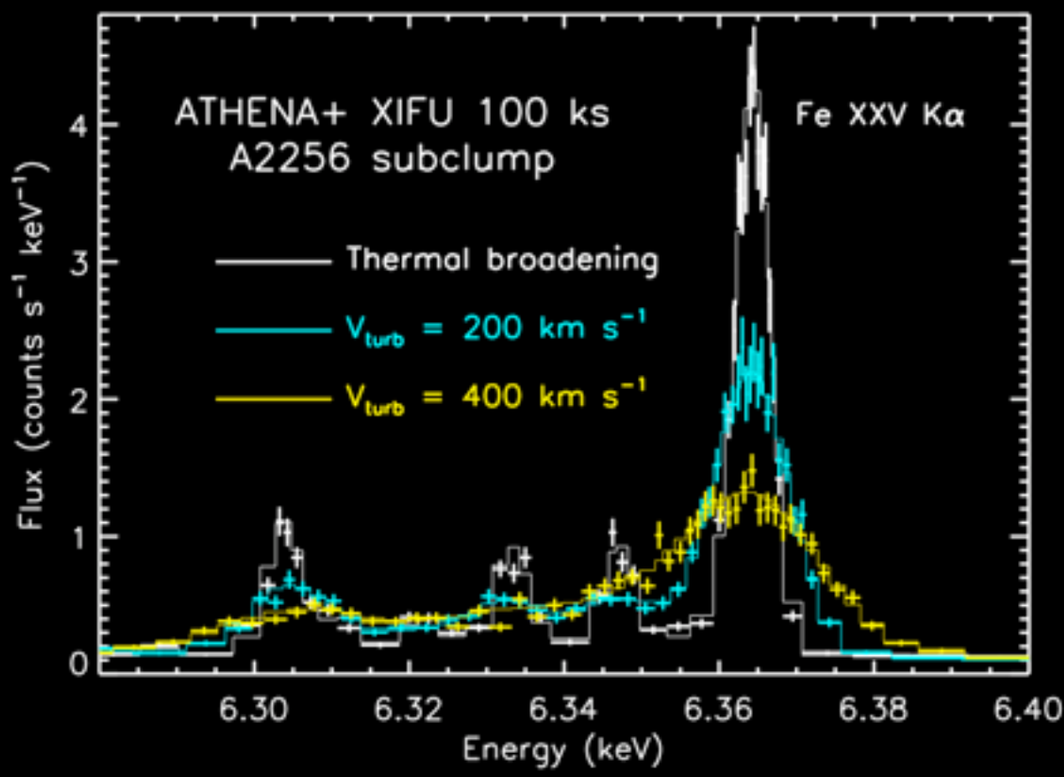
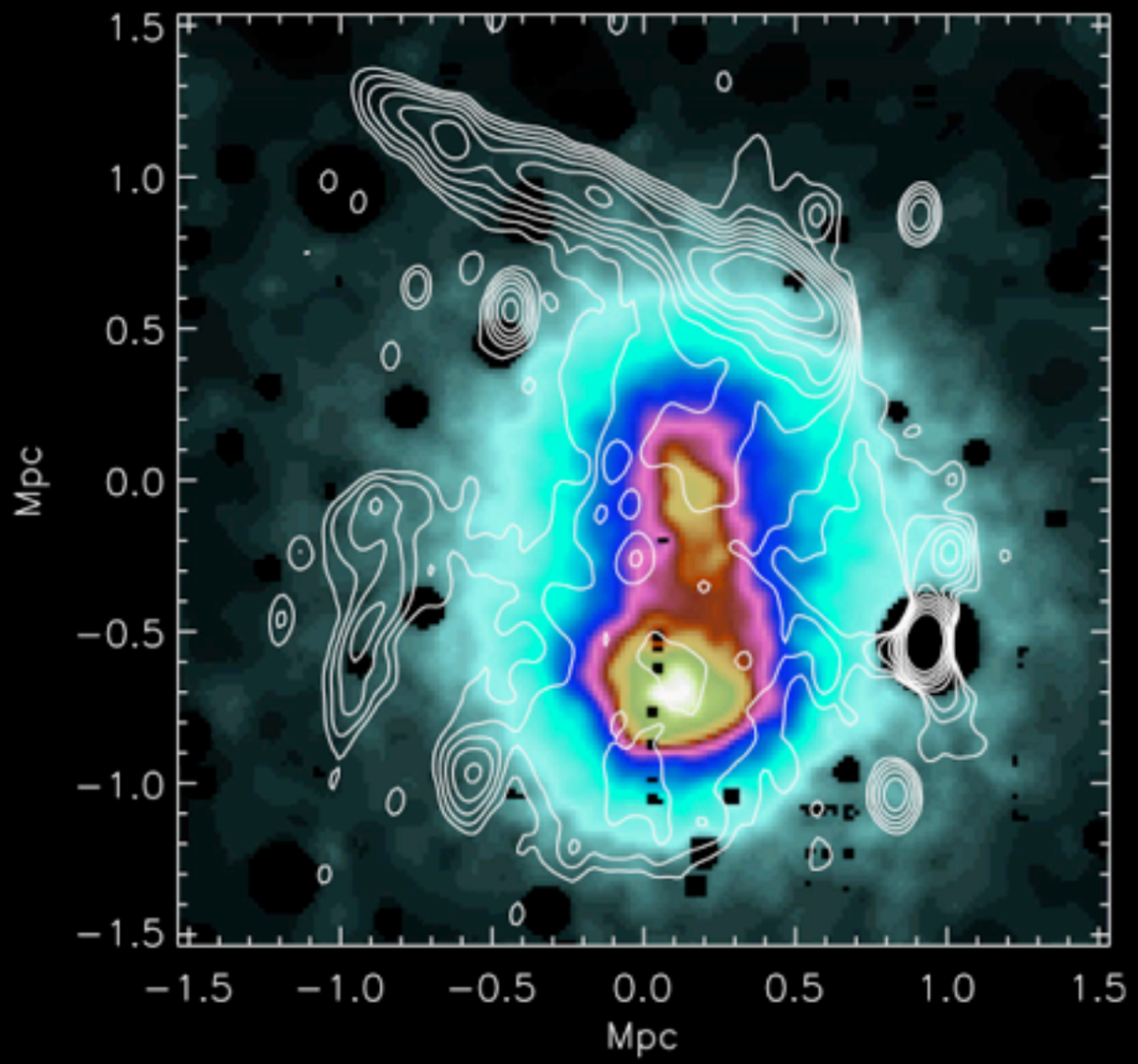




Brown & Rudnick 2010

Shock acceleration in relics



Ogrean et al 2013

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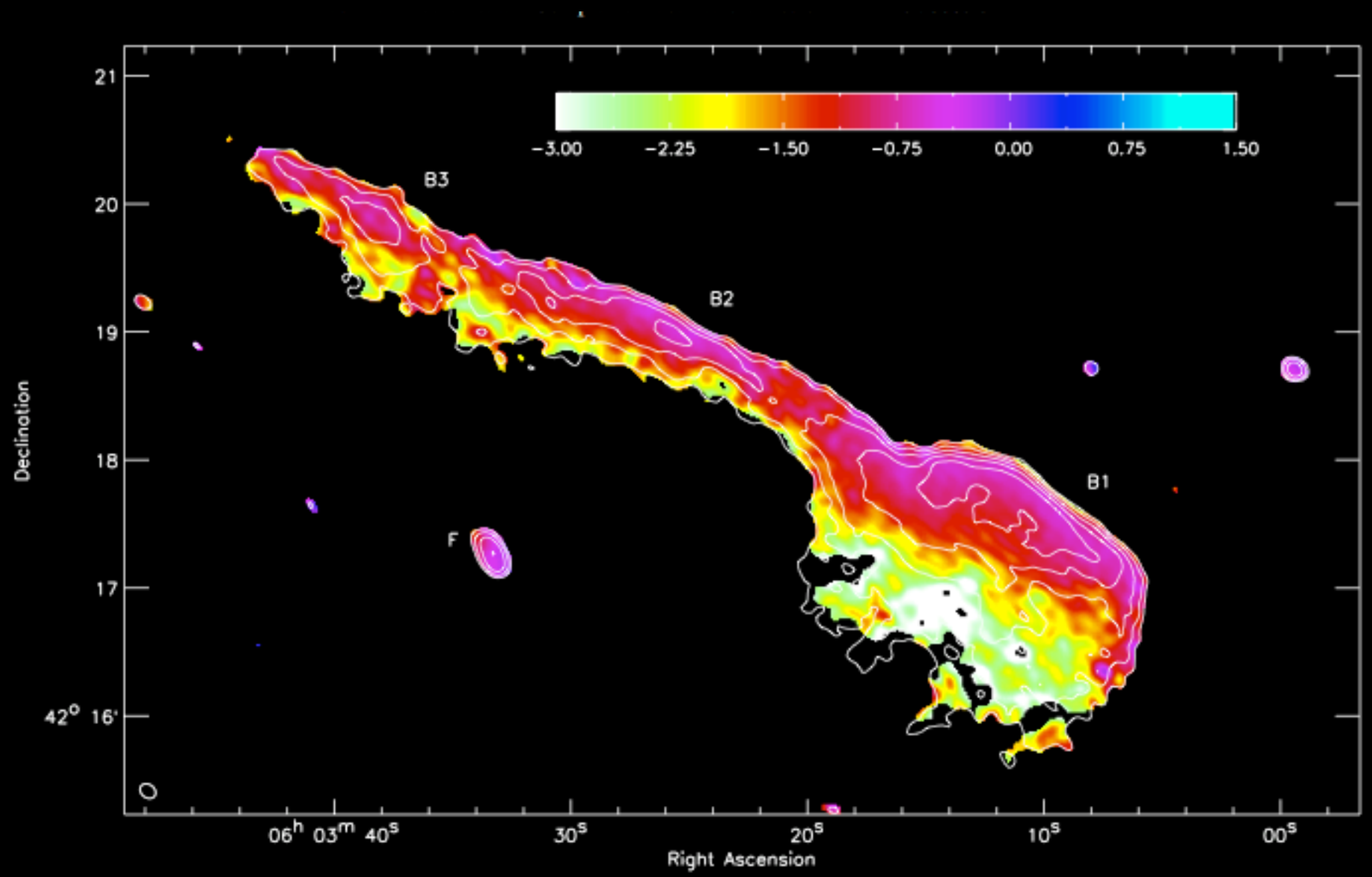
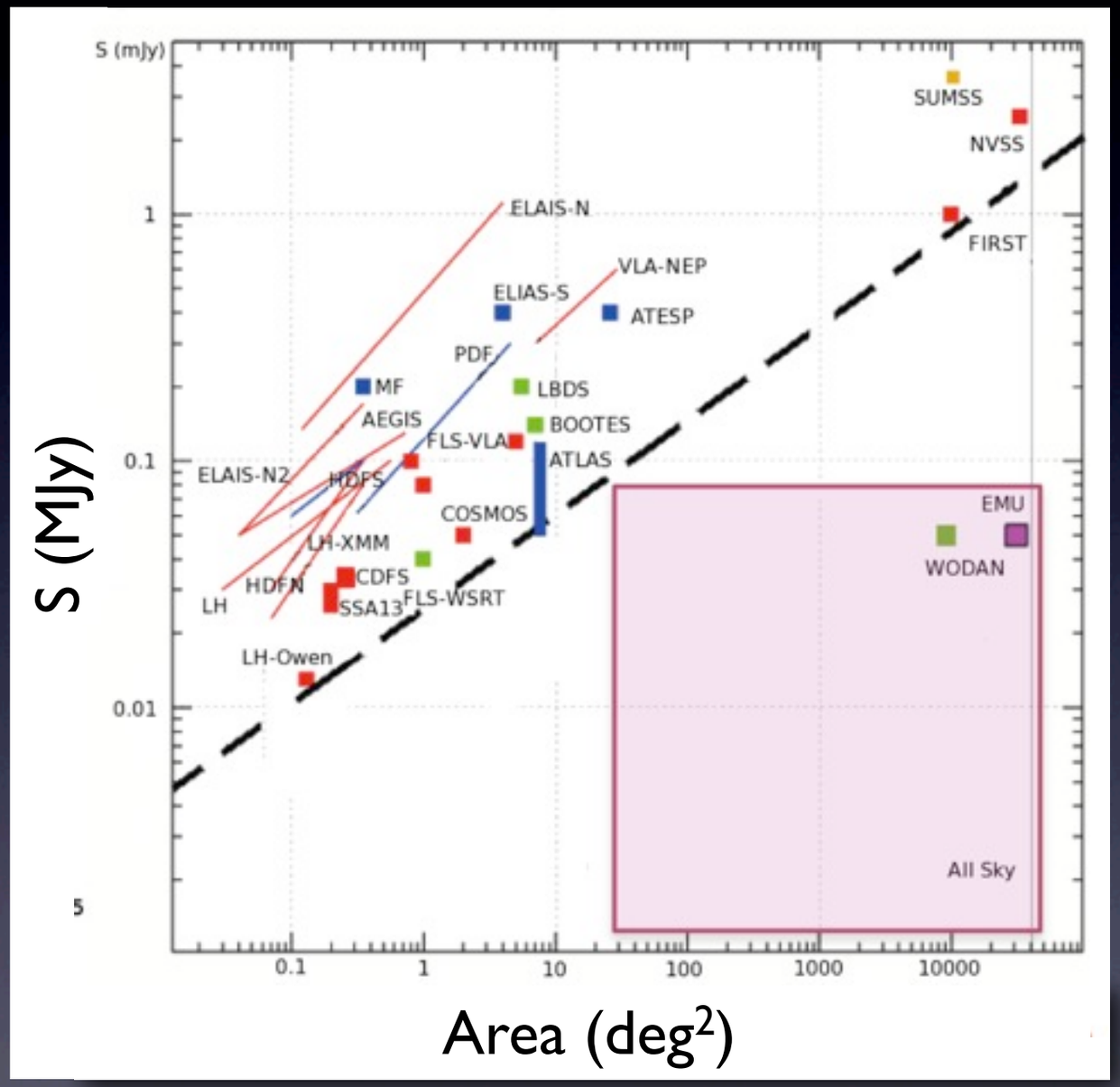


van Weeren et al 2012 (WSRT/GMRT)

Some upcoming radio surveys

Population studies



Survey	Details	Cluster Science
ASKAP-EMU	Southern continuum survey, 1.4GHz, 10”, 10μJy	Haloes, relics, tailed galaxies
WODAN	Northern continuum survey, 1.4GHz, 6”, 10μJy	Haloes, relics, tailed galaxies
LOFAR	Northern sky, 30-240 MHz, 10”	Haloes, relics
MWA	Southern sky, 80-300 MHz, 2.7’, 8-9 mJy	Haloes, relics

Adapted from Norris et al 2012

AGN-ICM interaction

MS0735.6+7421 a z=0.22;
NASA, ESA, and B. McNamara

M84 a z=0.0034
C. Jones

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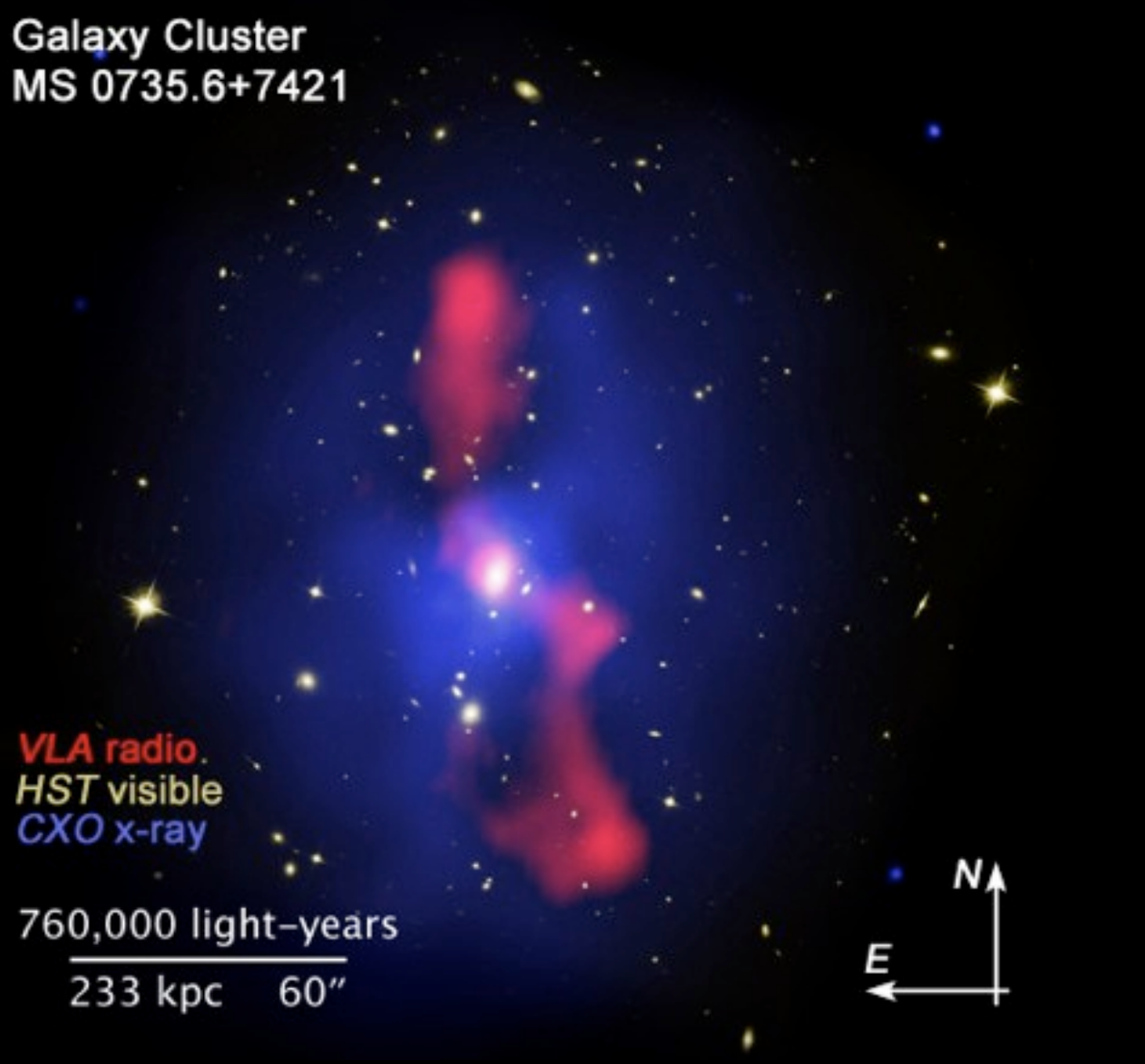

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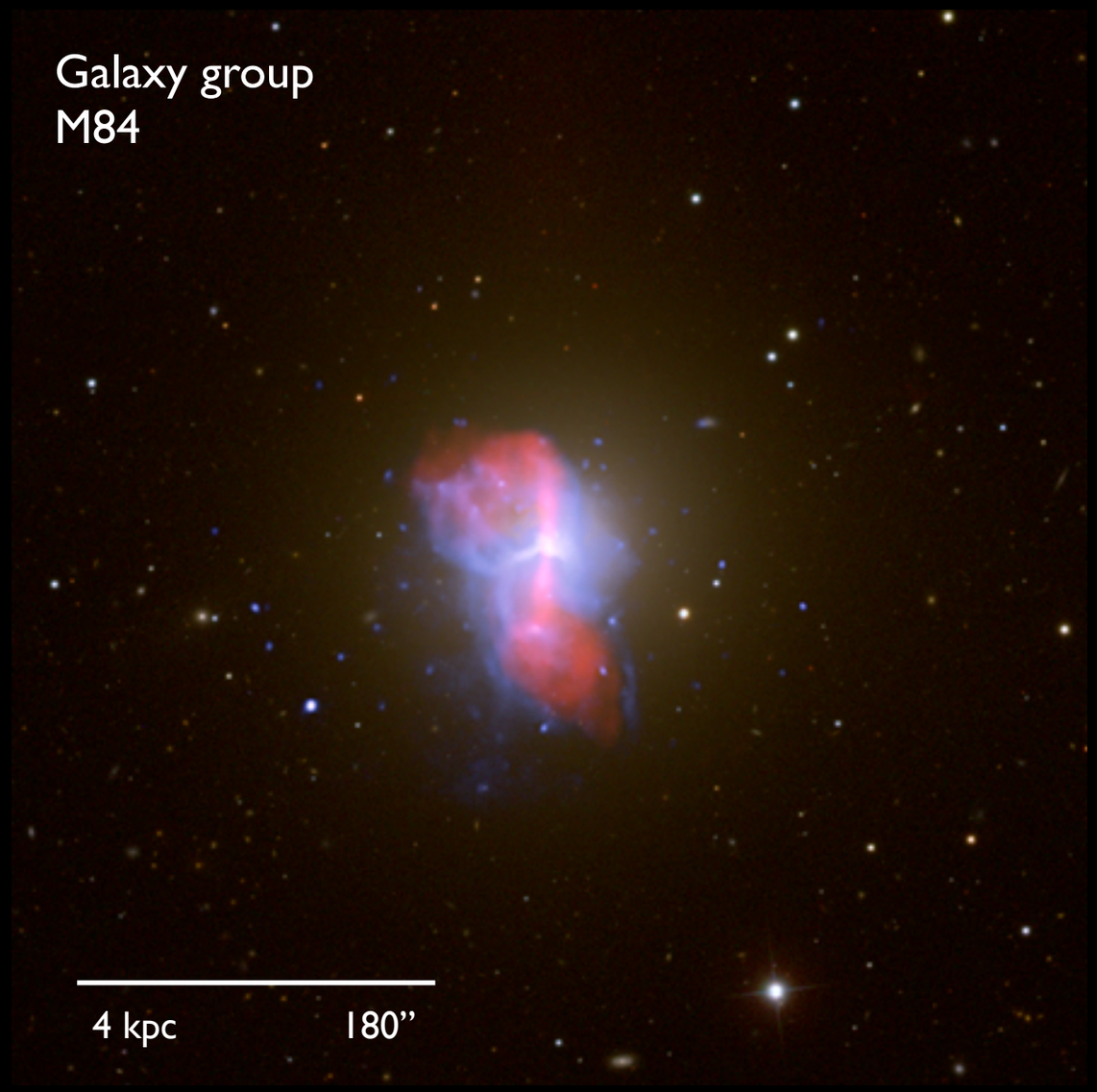
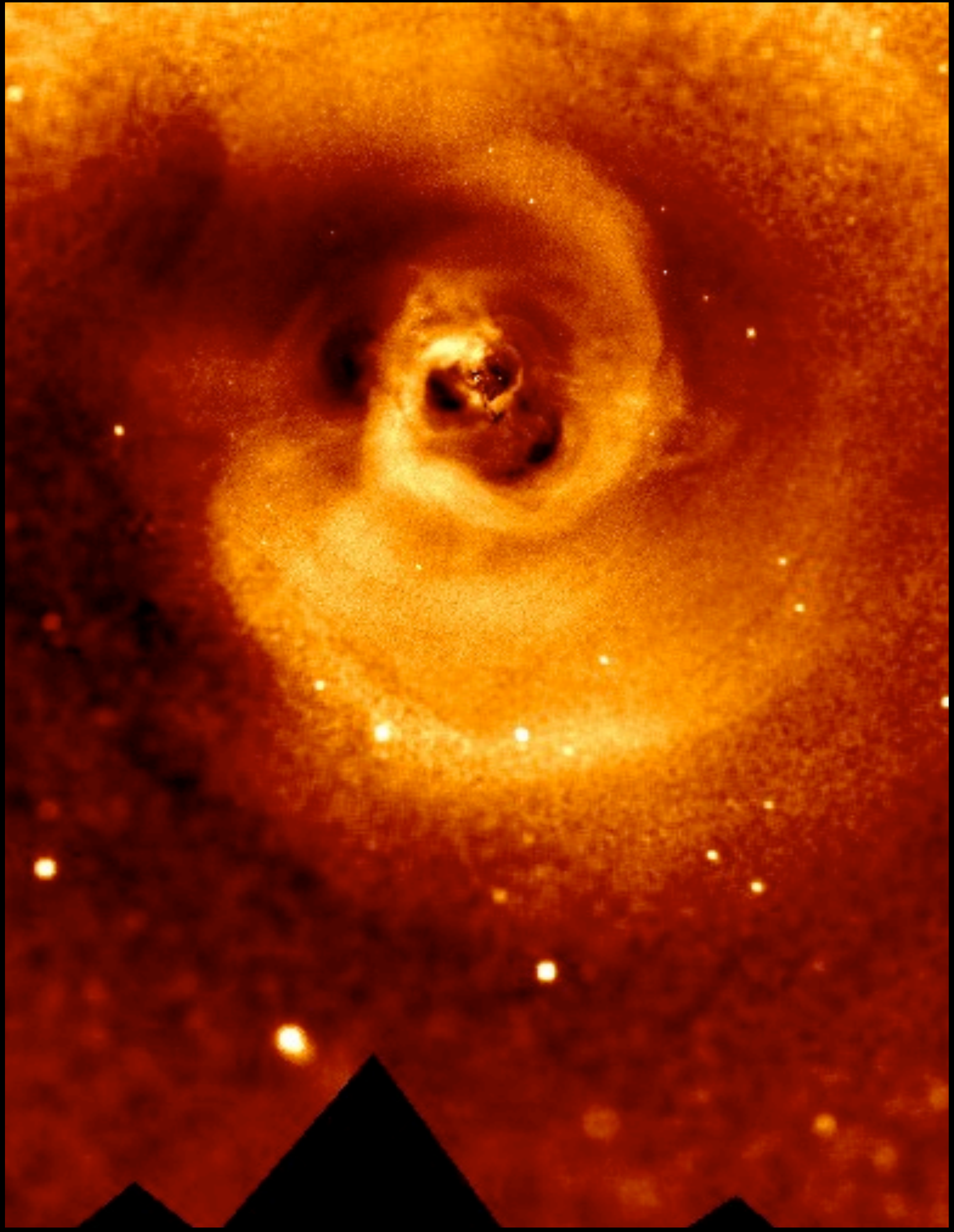


M84 a z=0.0034
C. Jones

Conclusions

- **Athena represents a quantum leap forward in X-ray astronomy**
  - Unprecedented combination of spatial and spectral resolution
- **Strong physical connections between radio and X-ray emission**
  - For many different astrophysical sources
- Many synergies between Athena and SKA and pathfinders
- L2 CFP out; proposal due 15 April 2014
- Launch 2028



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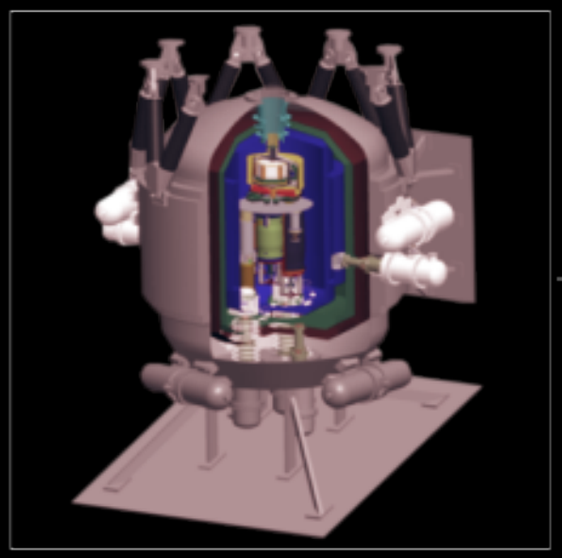

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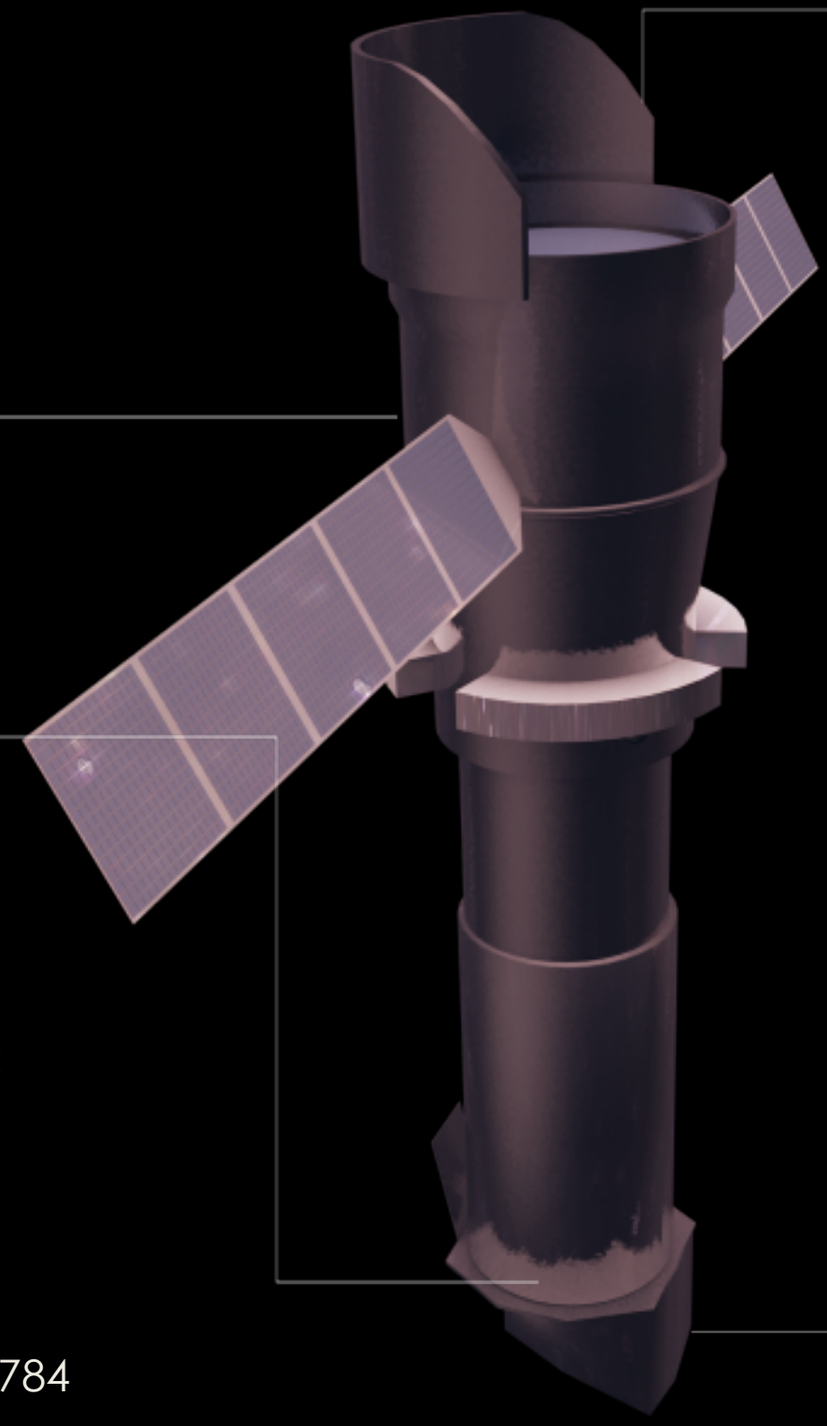
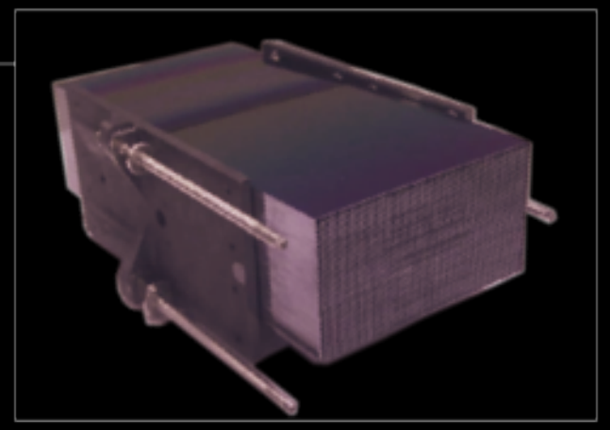
Barret et al., 2013 arXiv:1308.6784





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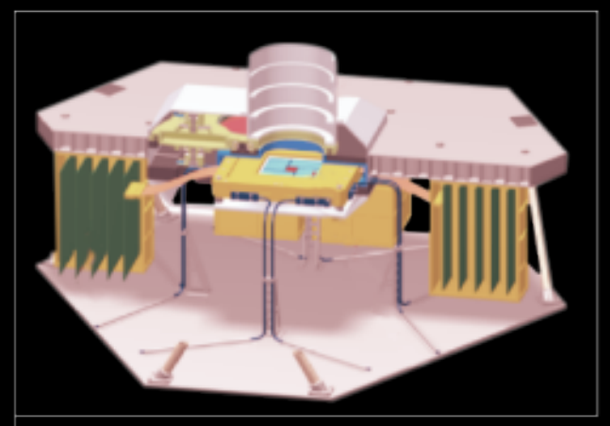

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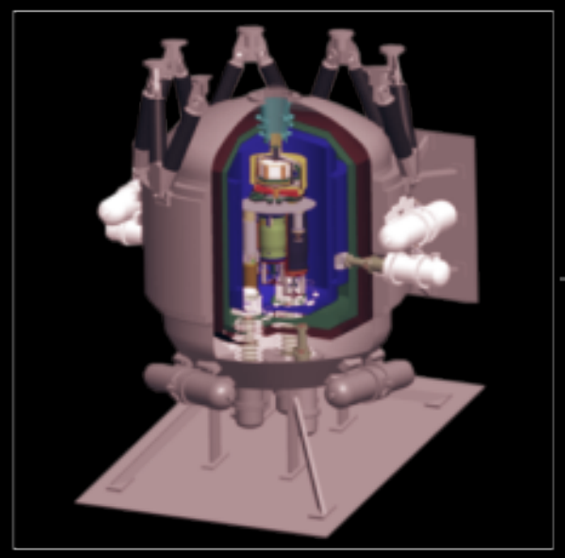

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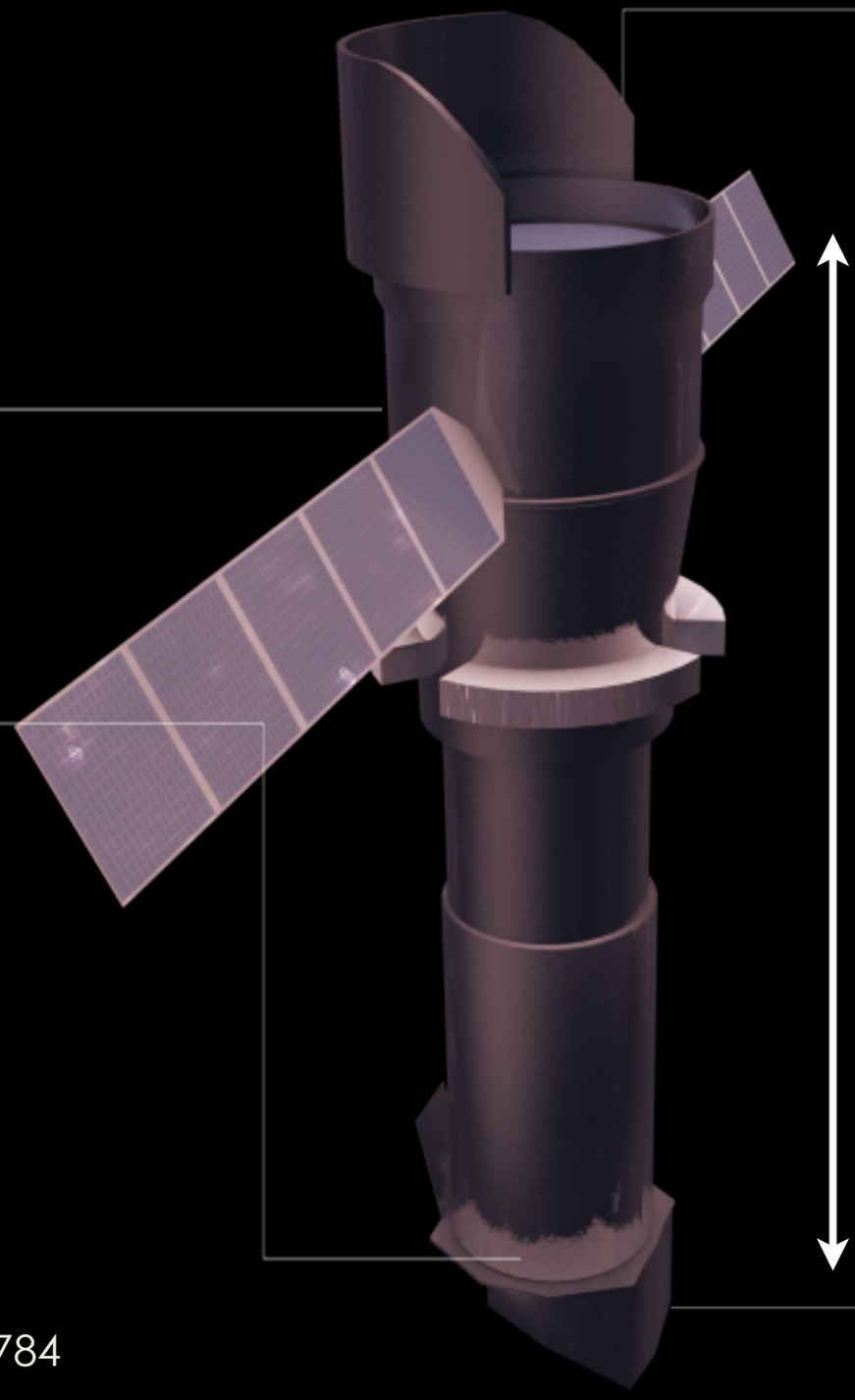

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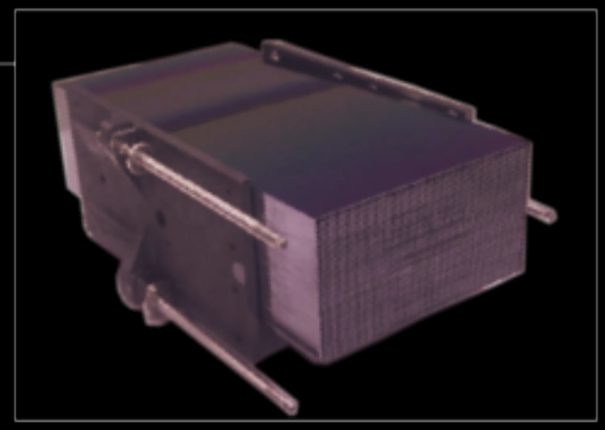

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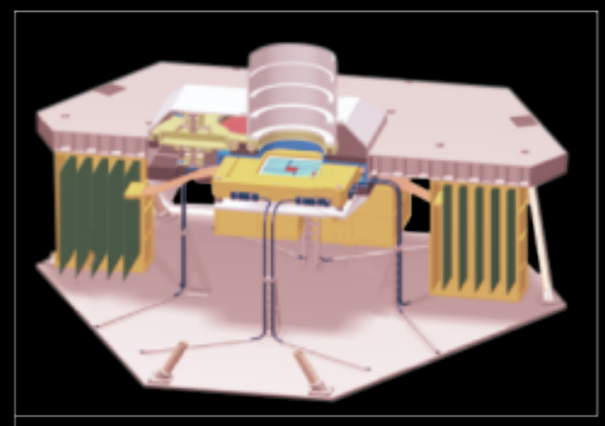

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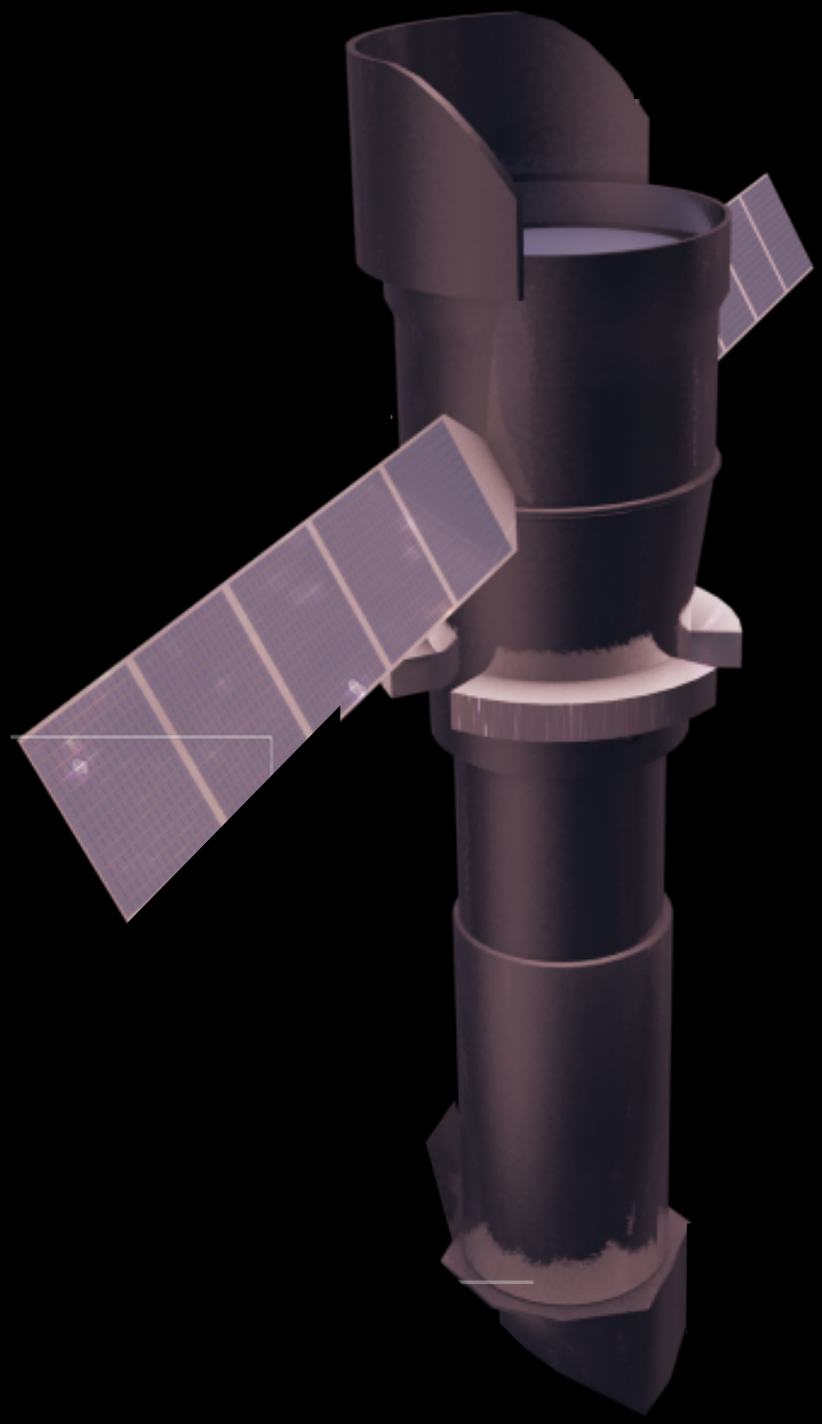

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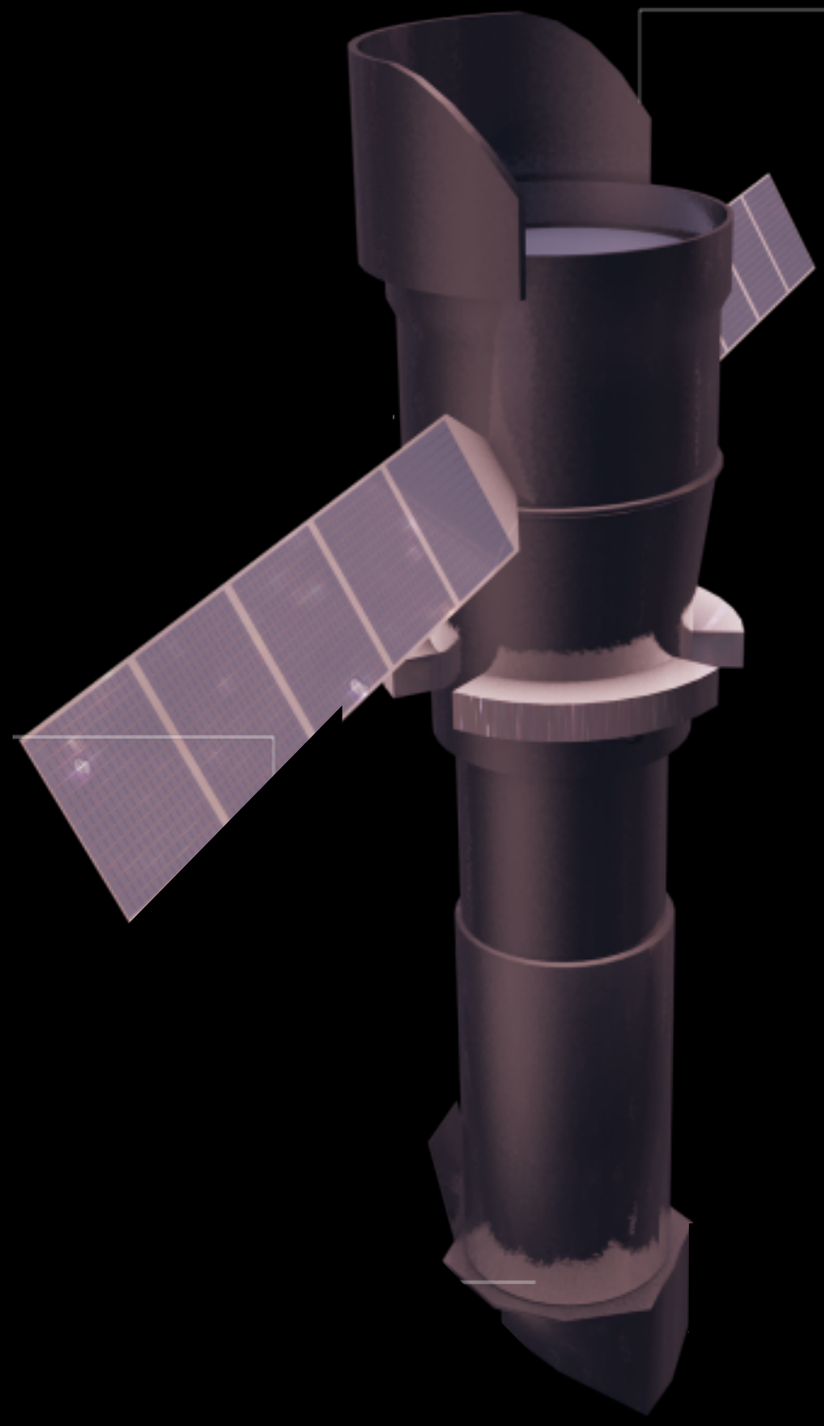

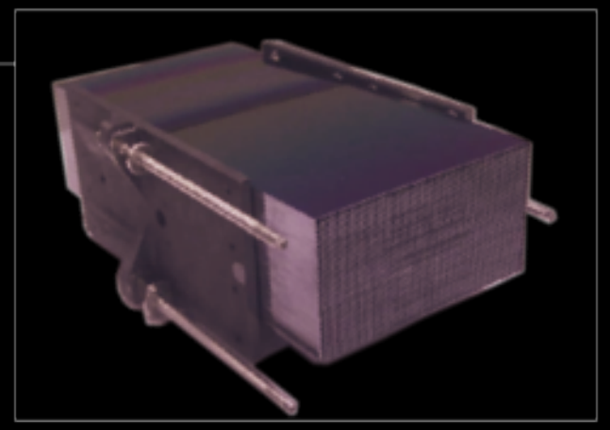

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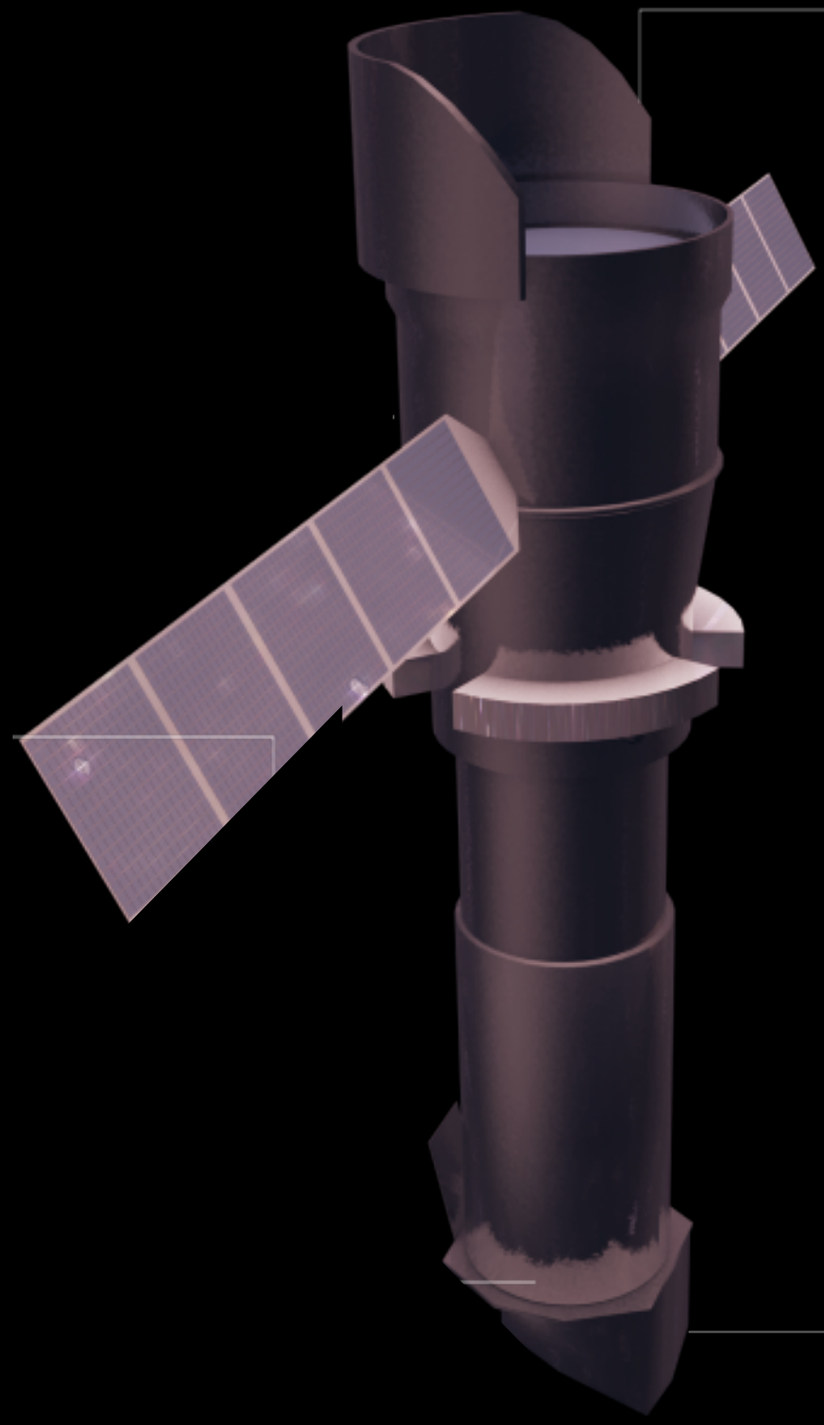
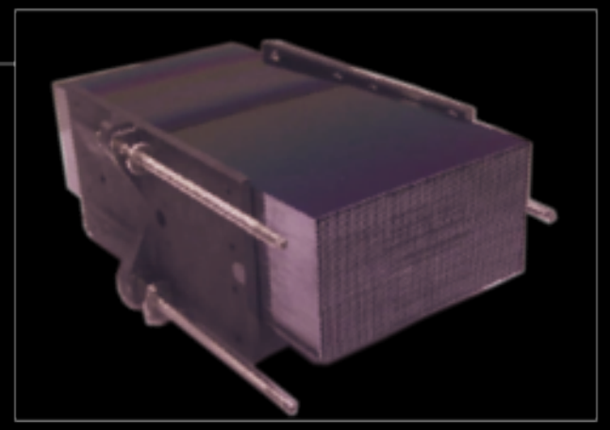
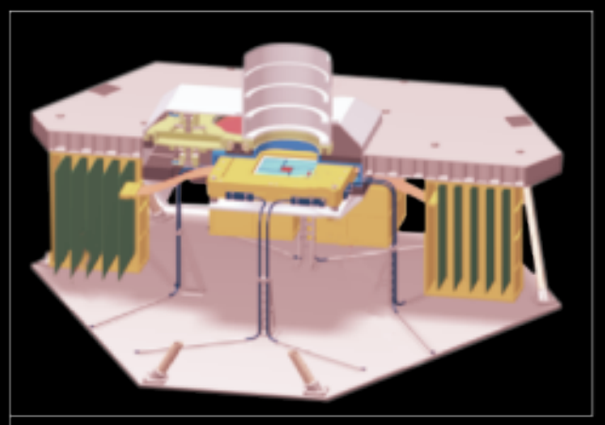




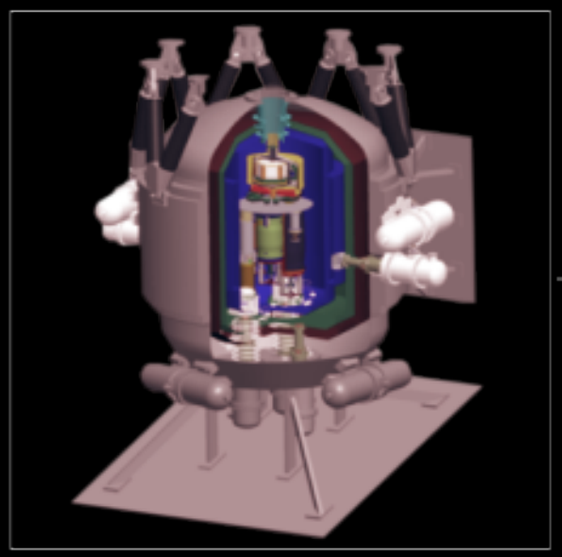
Silicon Pore Optics:
2 m^2 at 1 keV
5 arcsec HEW
Focal length: 12 m
Sensitivity: 3 10^{-17} erg cm^{-2} s^{-1}



Wide Field Imager:
ΔE: 125 eV
Field of View: 40 arcmin
High countrate capability

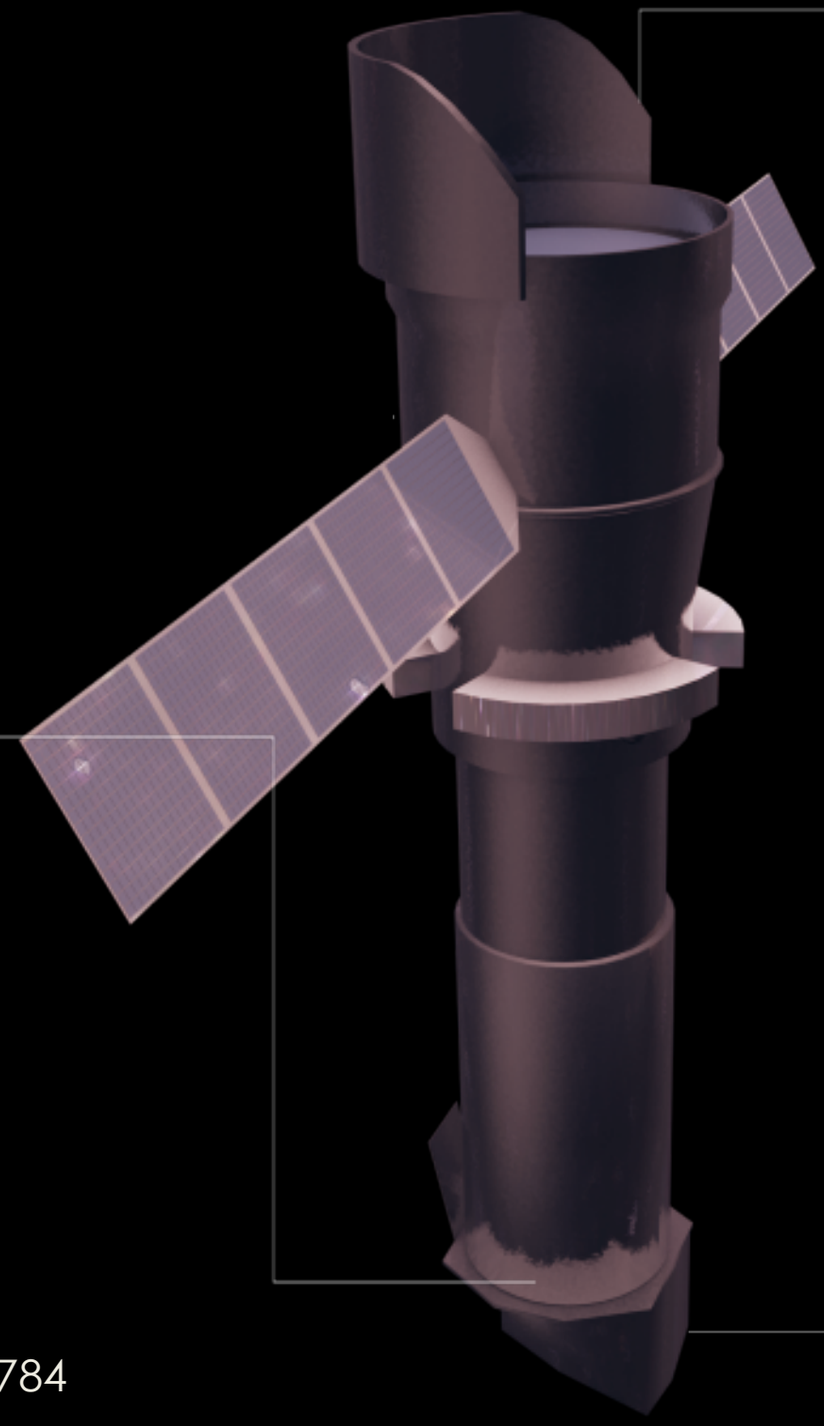
Rau et al. 2013 arXiv1307.1709

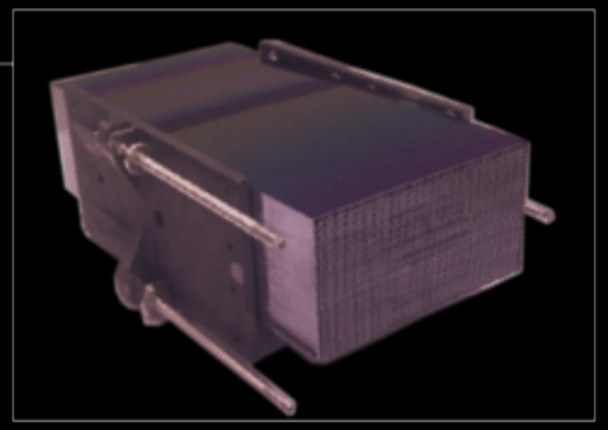
The Advanced Telescope for High ENergy Astrophysics



X-ray Integral Field Unit:
ΔE: 2.5 eV
Field of View: 5 arcmin
Operating temp: 50 mk

Barret et al., 2013 arXiv:1308.6784





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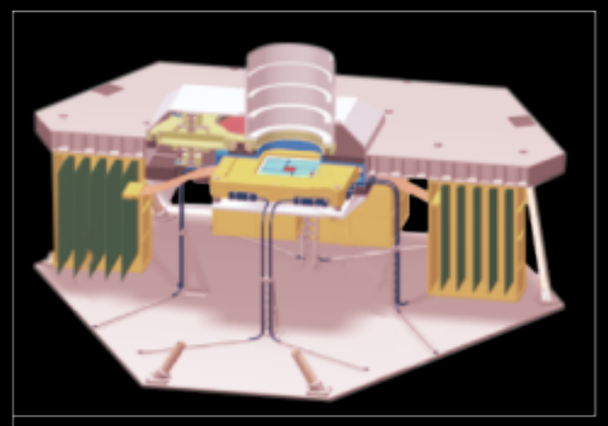

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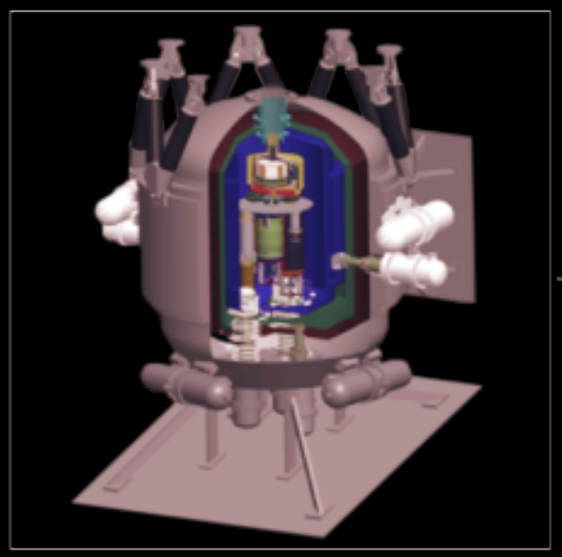

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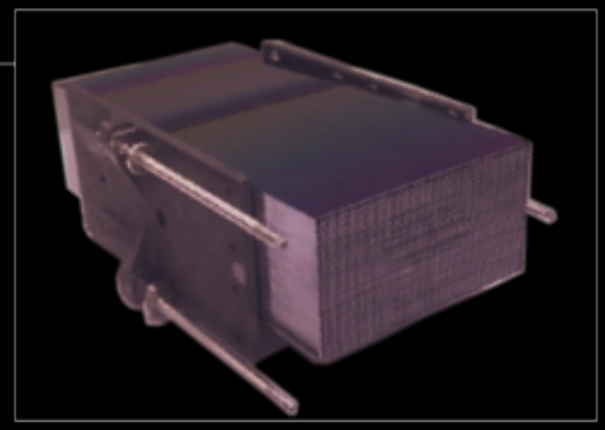
Barret et al., 2013 arXiv:1308.6784

12m



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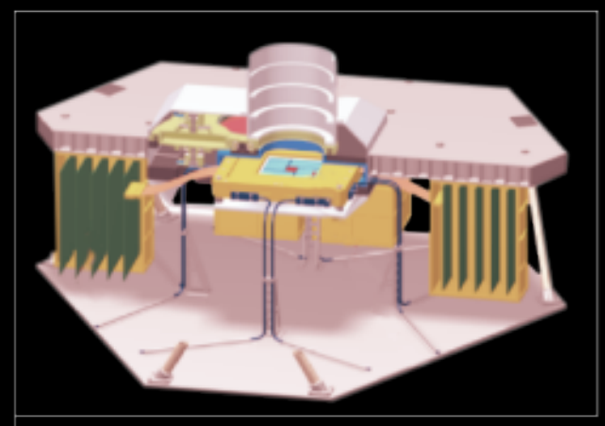

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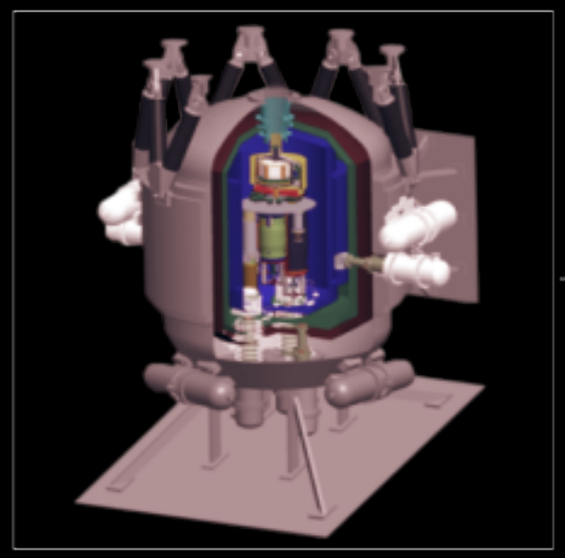
The Advanced Telescope for High ENergy Astrophysics

L2 orbit Ariane V
Mass < 5100 kg
Power 2500 W
5 year mission



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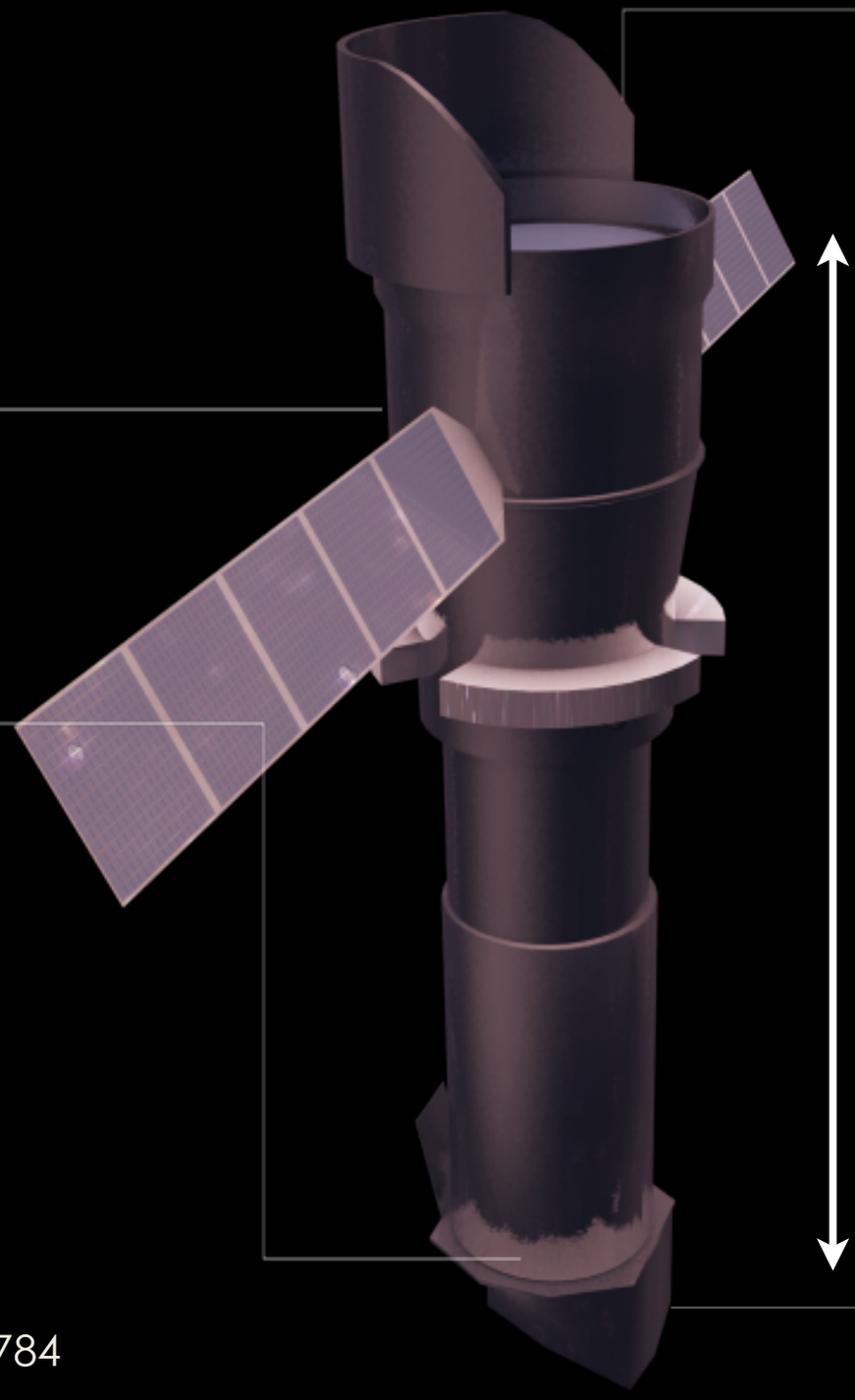

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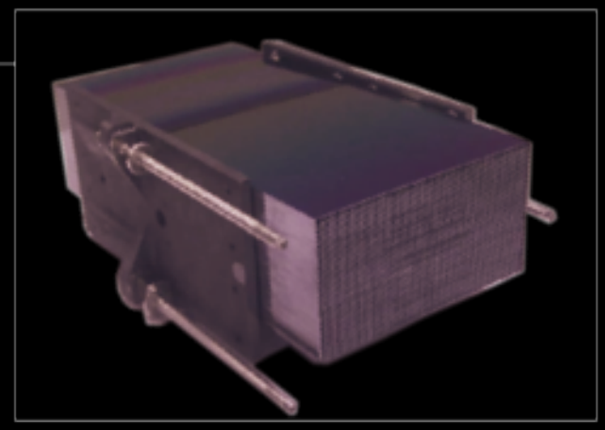

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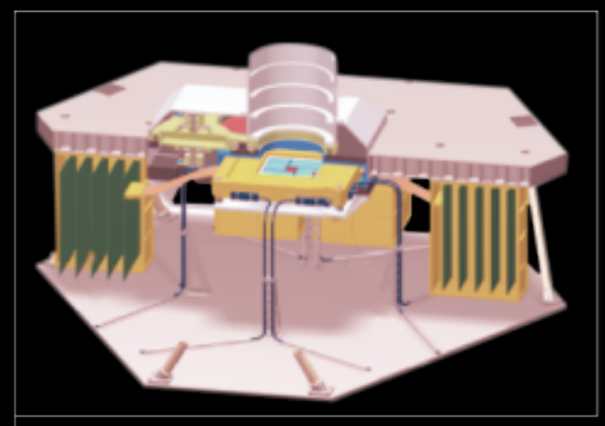

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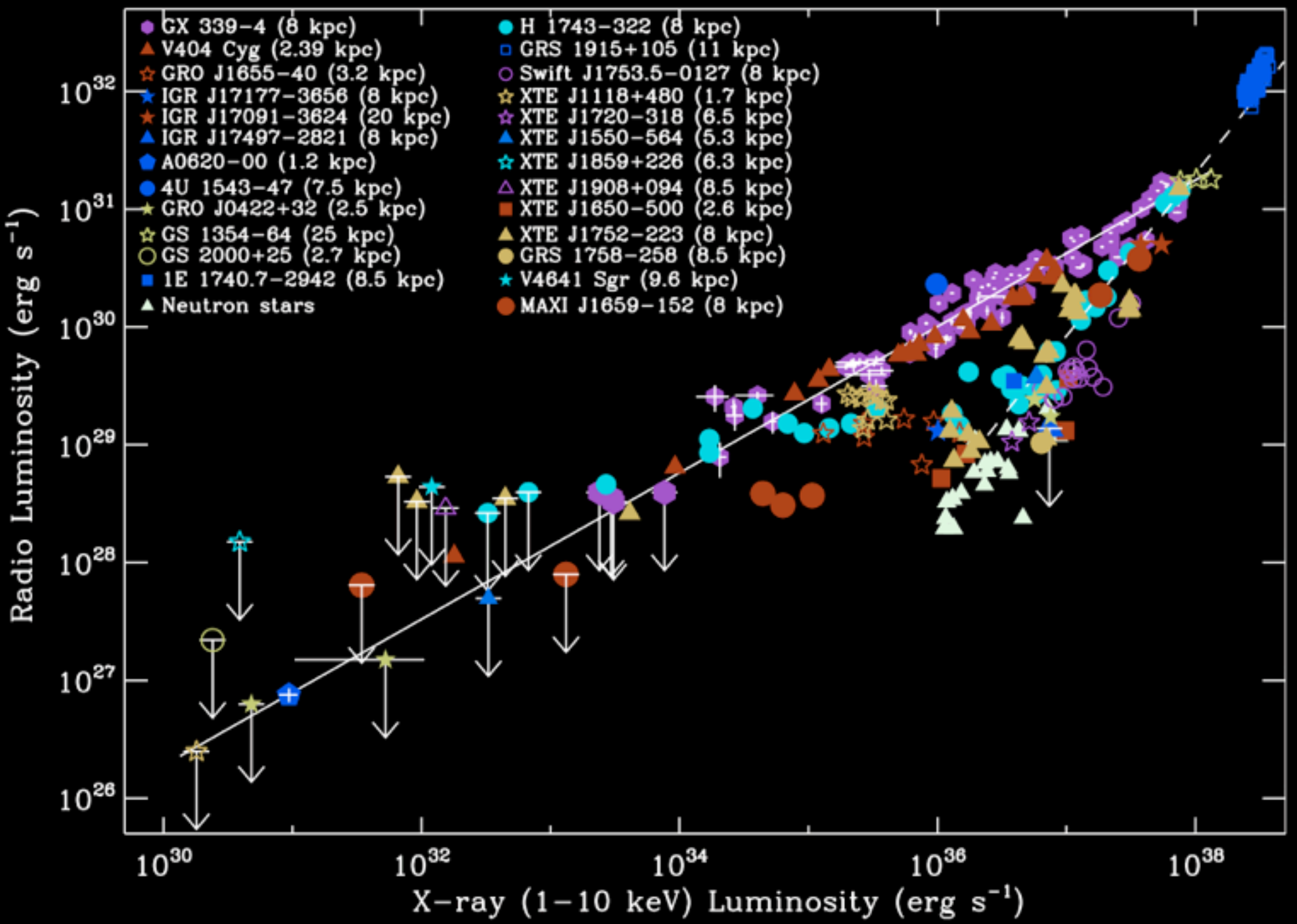
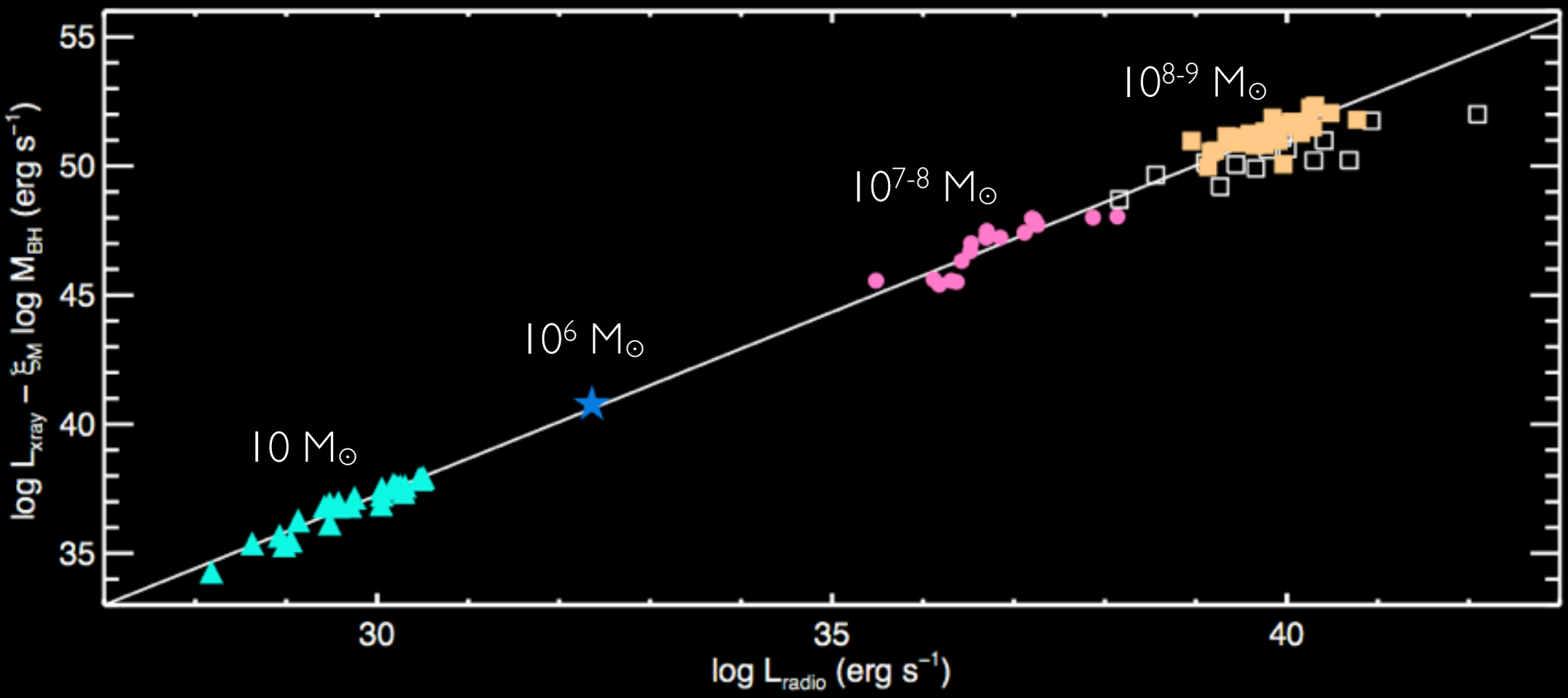
Microquasars



Corbel et al 2013

Black hole L_X-L_R fundamental plane



Plotkin et al 2012