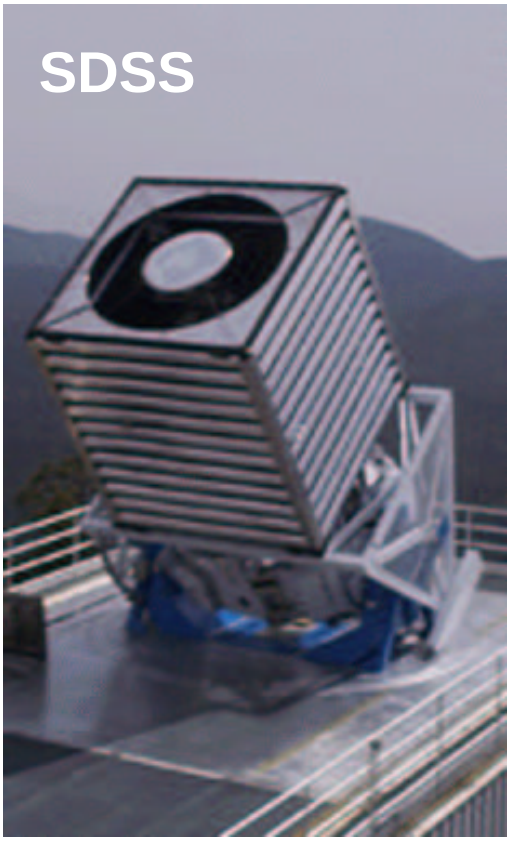
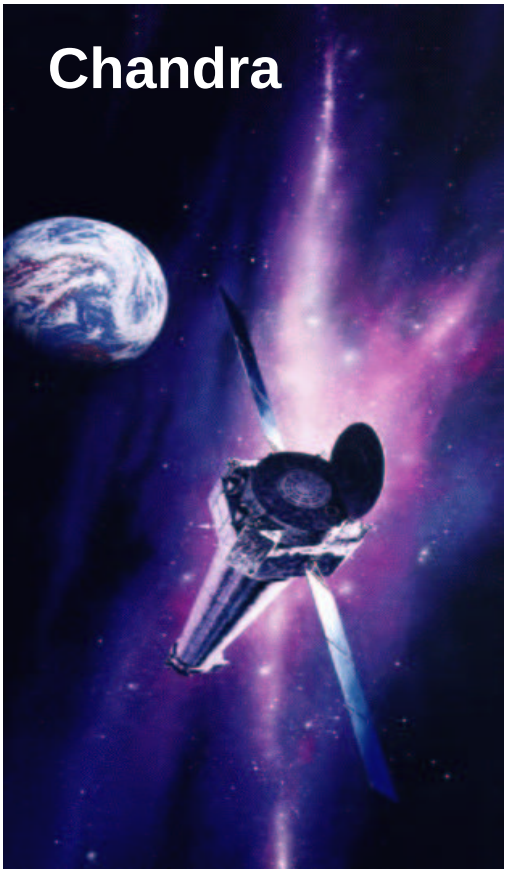
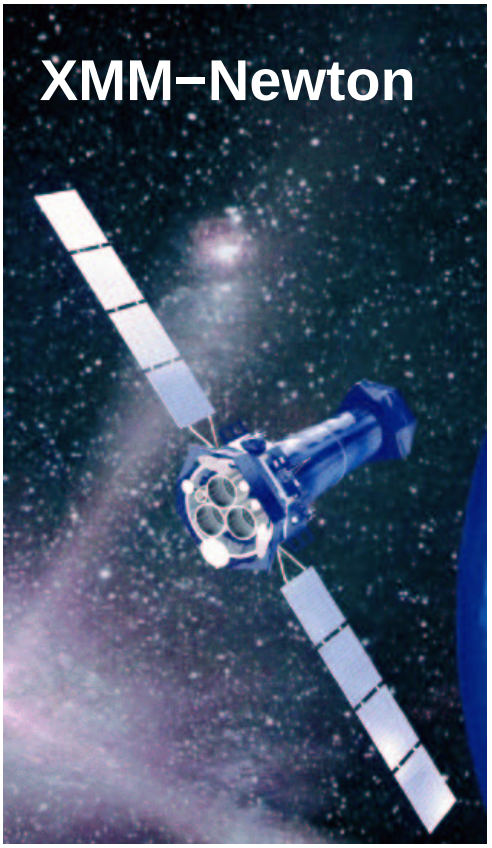
X−raying AGN Found and Missed by SDSS

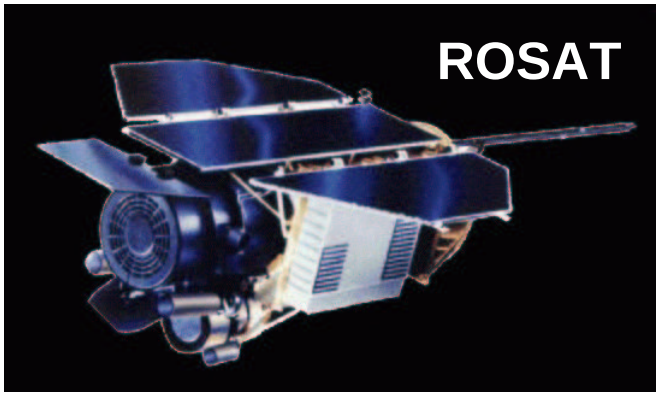
Niel Brandt (Penn State)

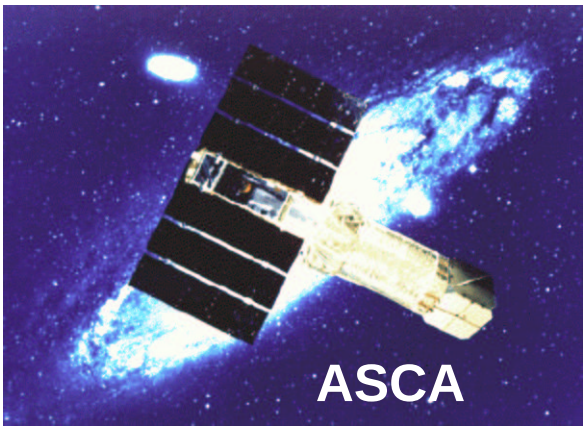






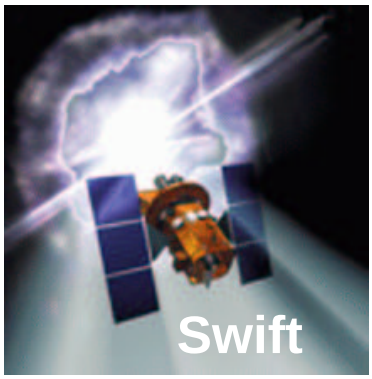
Past Mission Archives

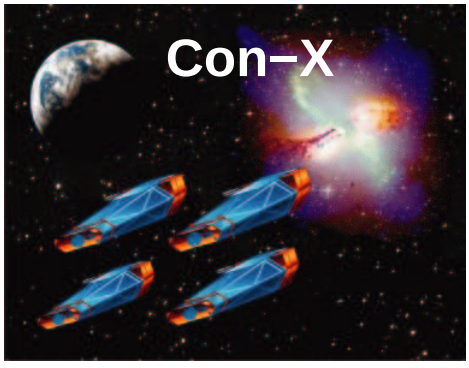




Also BeppoSAX

Future Missions





Also Astro−E2, XEUS, Gen−X

Utility of X−ray AGN Studies

X−ray emission nearly universal

Many (most?) AGN are strong X−ray emitters.

Powerful way to find AGN

Minimize absn. bias and host−galaxy dilution

Highest density on sky − Chandra Deep Fields
find ~ 6000+ per sq. deg.

Effectively probe immediate black−hole environ. and larger scale environment.

SDSS Connections

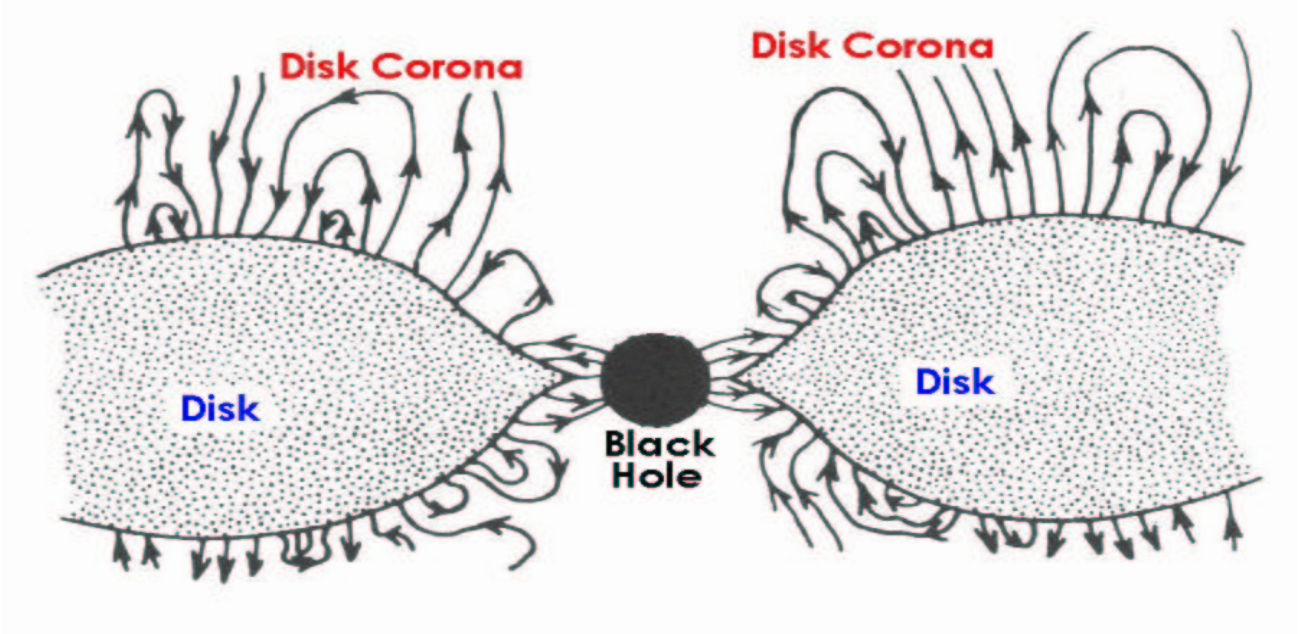
Powerful X−ray source identification "machine"

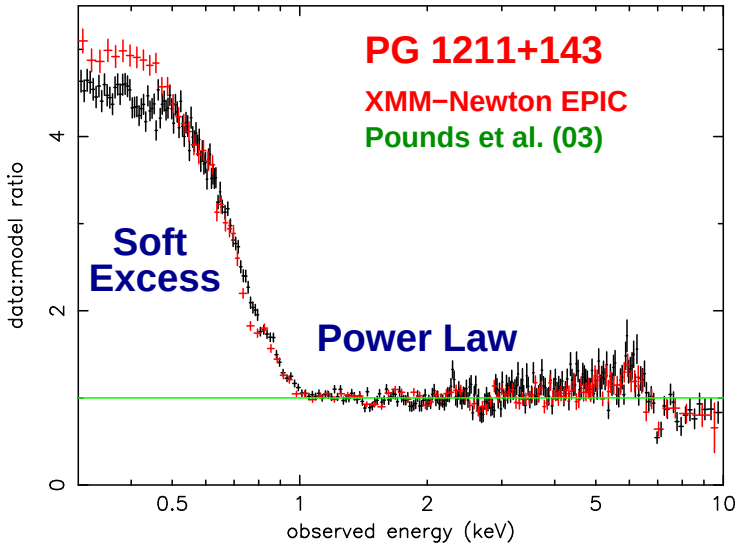
Large + well−defined samples for X−ray follow−up

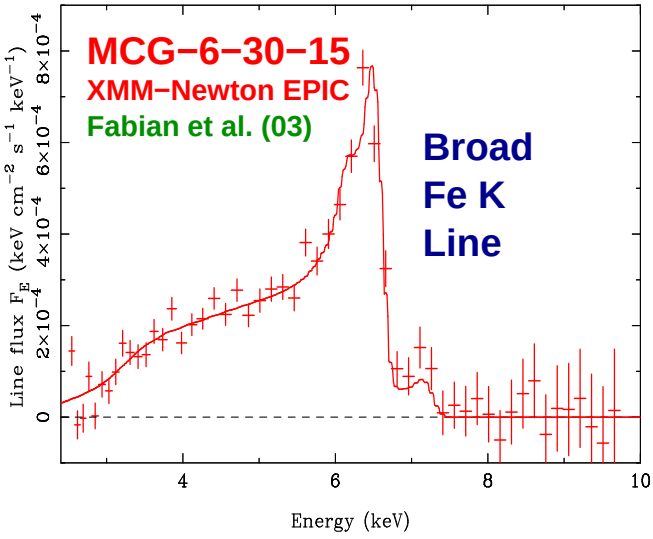
Reduced selection biases

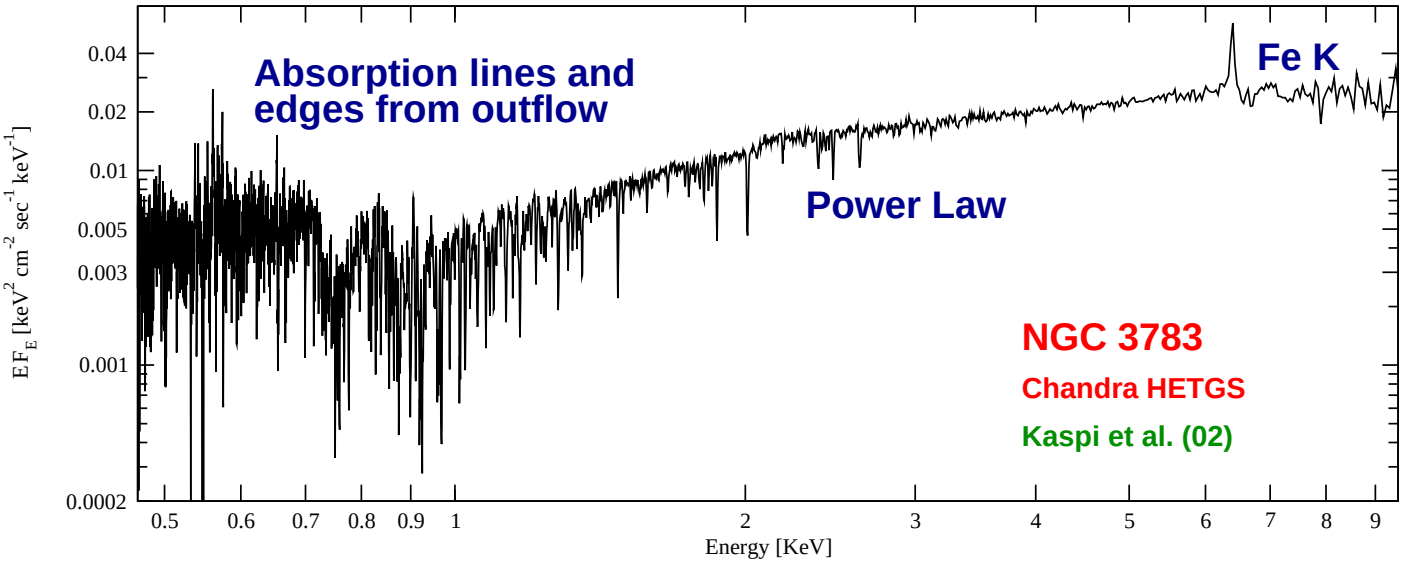
Immediately have good supporting spectrum + imaging.

Primary X−ray Emission Region + Observed Spectra





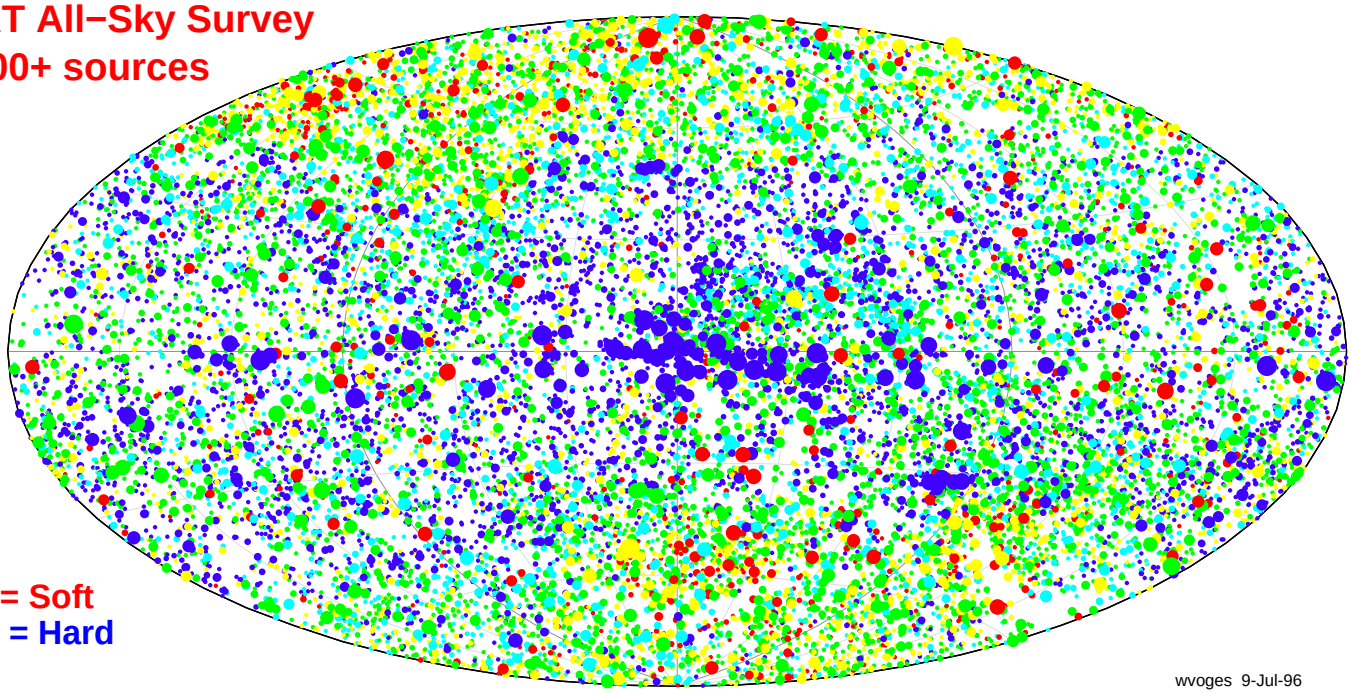




Also can have substantial jet−linked X−rays.

Bulk SDSS Follow−up of X−ray Sources

ROSAT All−Sky Survey
100,000+ sources

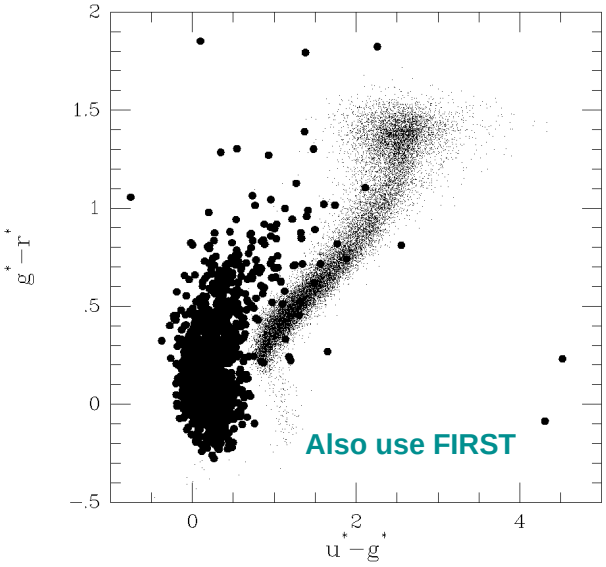


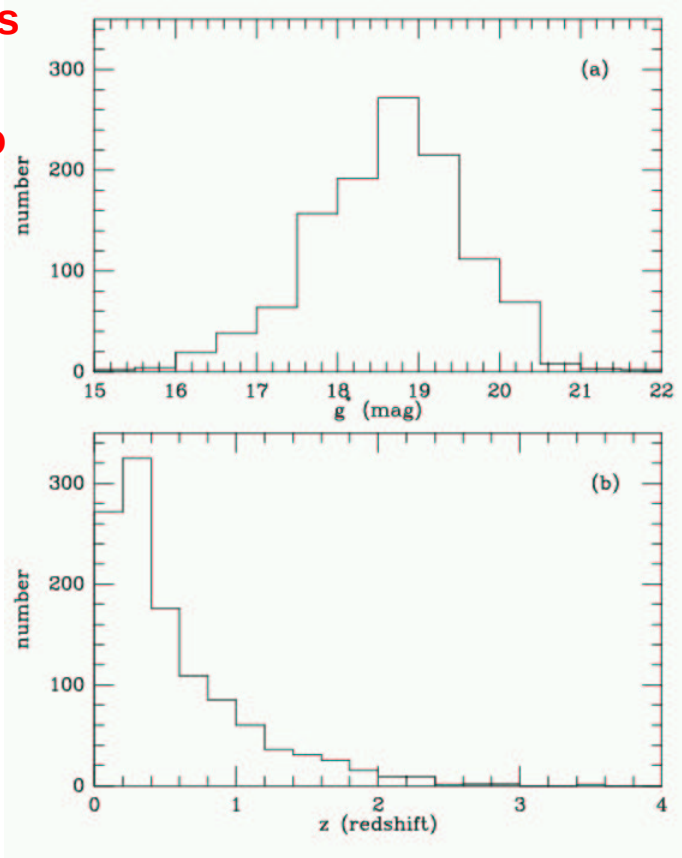
Red = Soft
Blue = Hard

wvoges 9-Jul-96

Previous Einstein+ROSAT samples have ~ 1000 IDs.

Anderson et al. (03) using SDSS to generate ~ 10,000 RASS IDs with high−quality, uniform data.





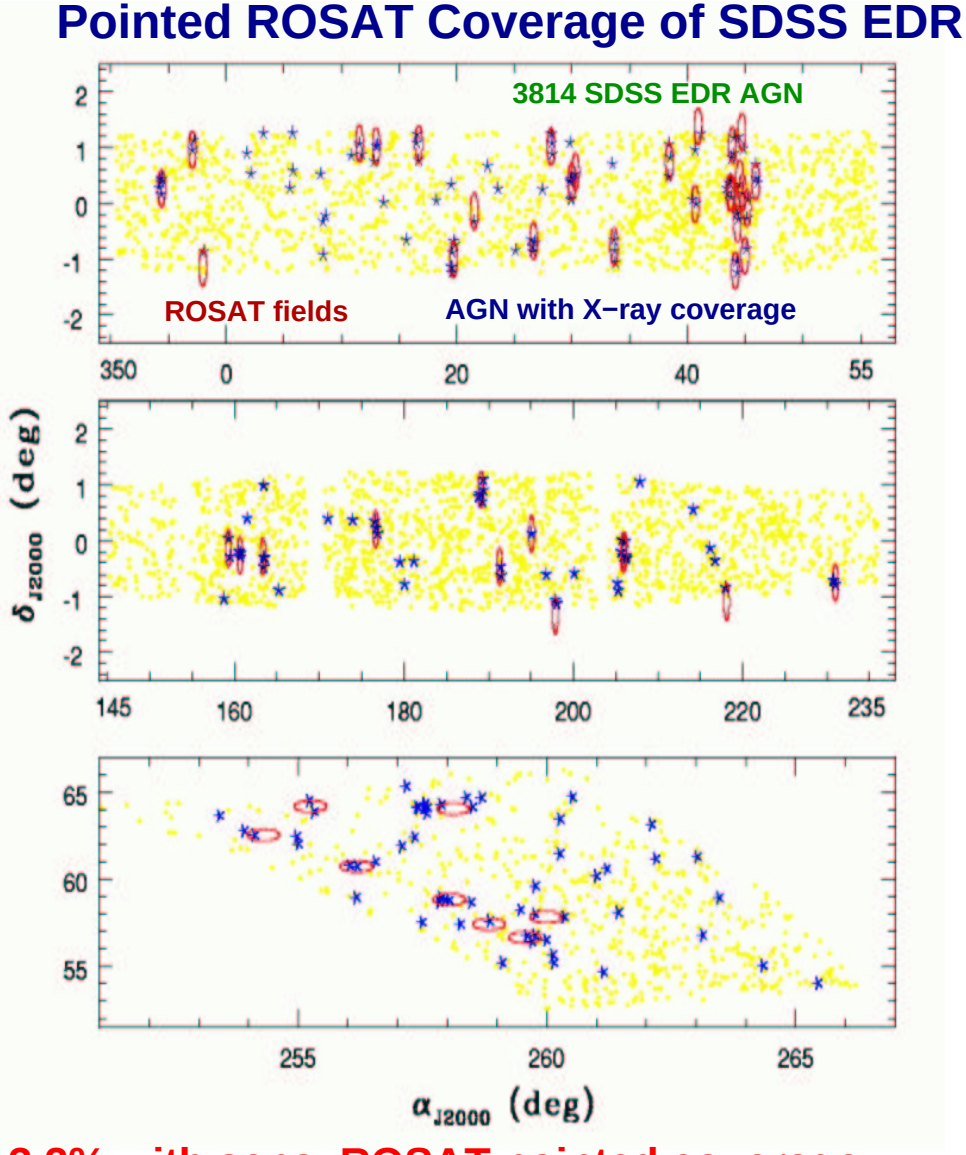
Currently ~ 1200 AGN, about 80% new.

Anderson et al. (03)

- **~ 964 broad−line AGN (including NLS1)**
- **~ 194 intermediate AGN**
- **~ 45 BL Lacs**

Bulk X−ray Follow−up of SDSS Sources

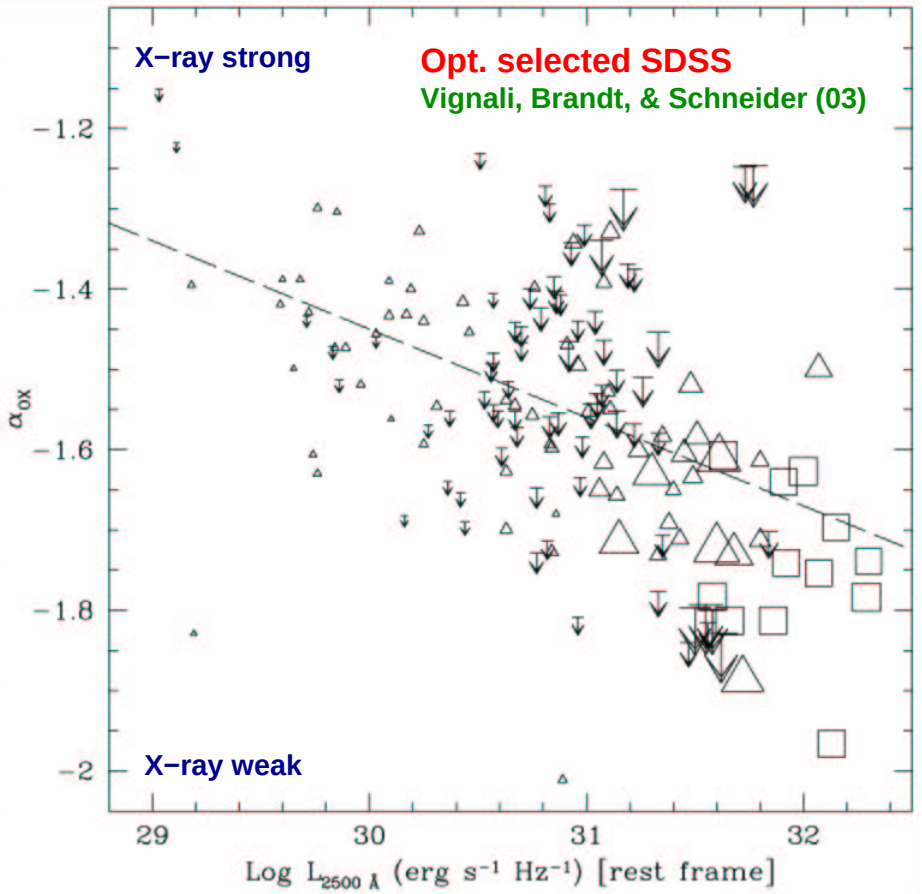
Pointed ROSAT Coverage of SDSS EDR

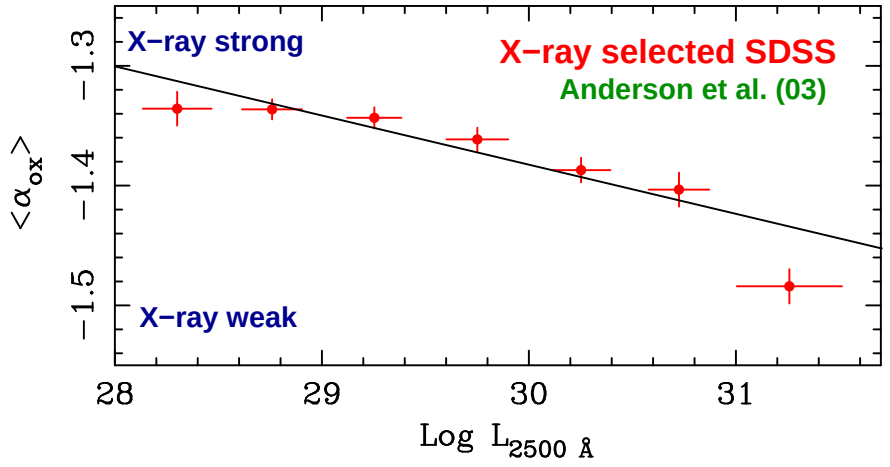


3.2% with sens. ROSAT pointed coverage

128 AGN with detections or upper limits

Ultimately 2600 with full SDSS

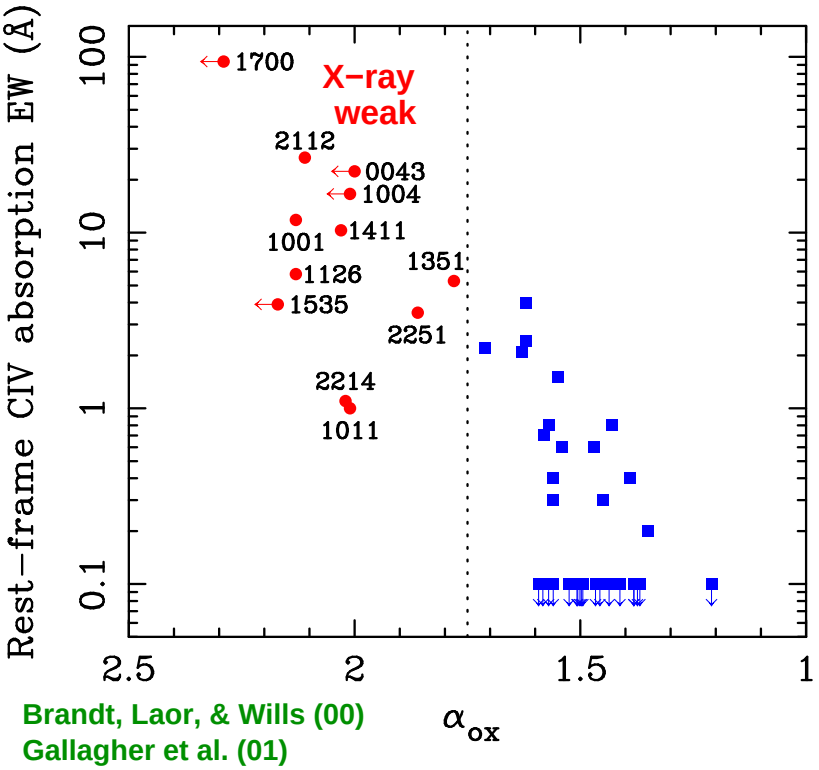




X−ray Weak Quasars and the SDSS

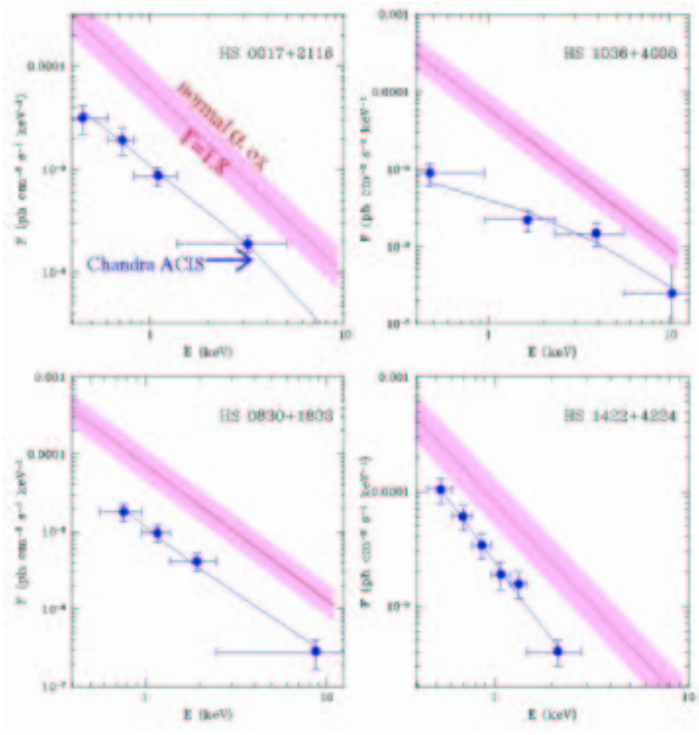
X−ray absorption? Missing corona? Extreme variability?

"Blue" X−ray weak AGN
Color−selected BQS sample
Obscuring outflows as main cause



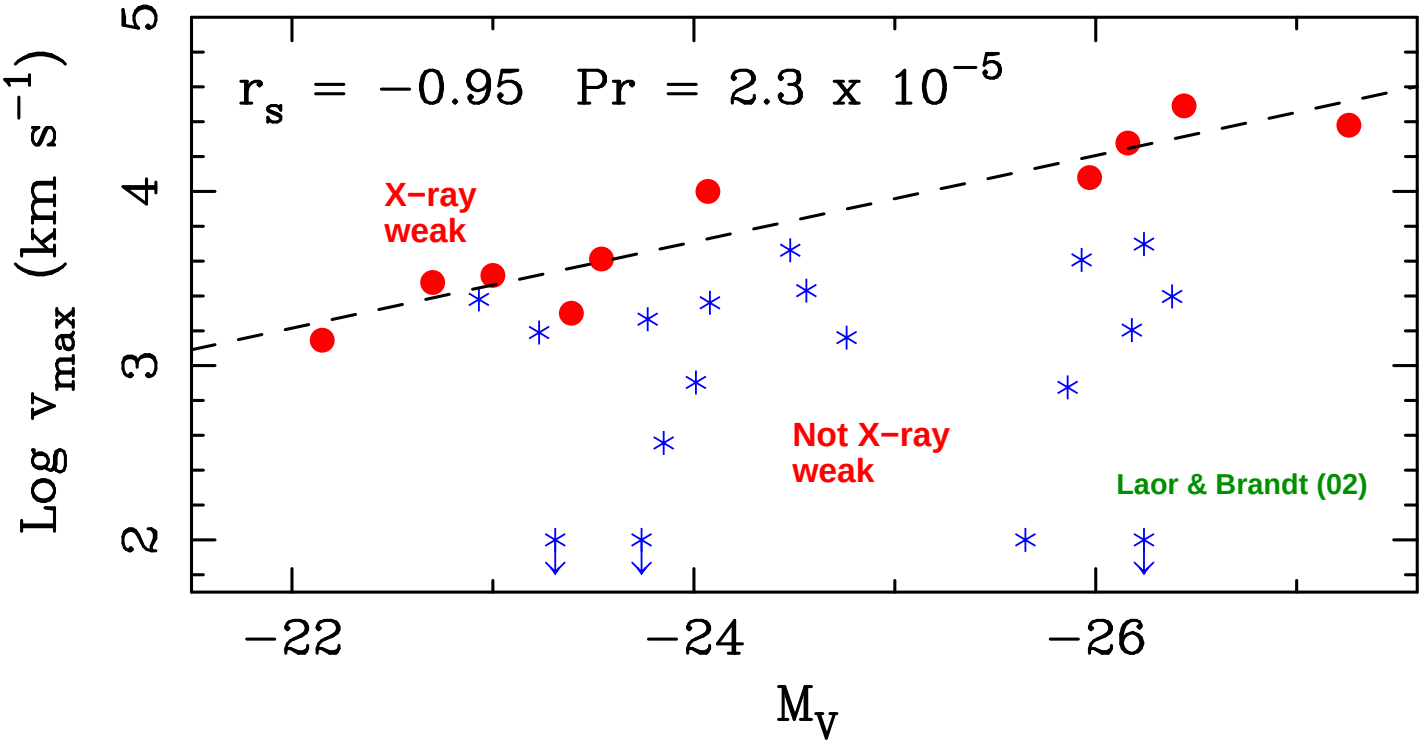
Brandt, Laor, & Wills (00)
Gallagher et al. (01)

"Somewhat redder" X−ray weak AGN
Grism−selected HQS sample
Missing coronae as main cause?



Risaliti et al. (03)

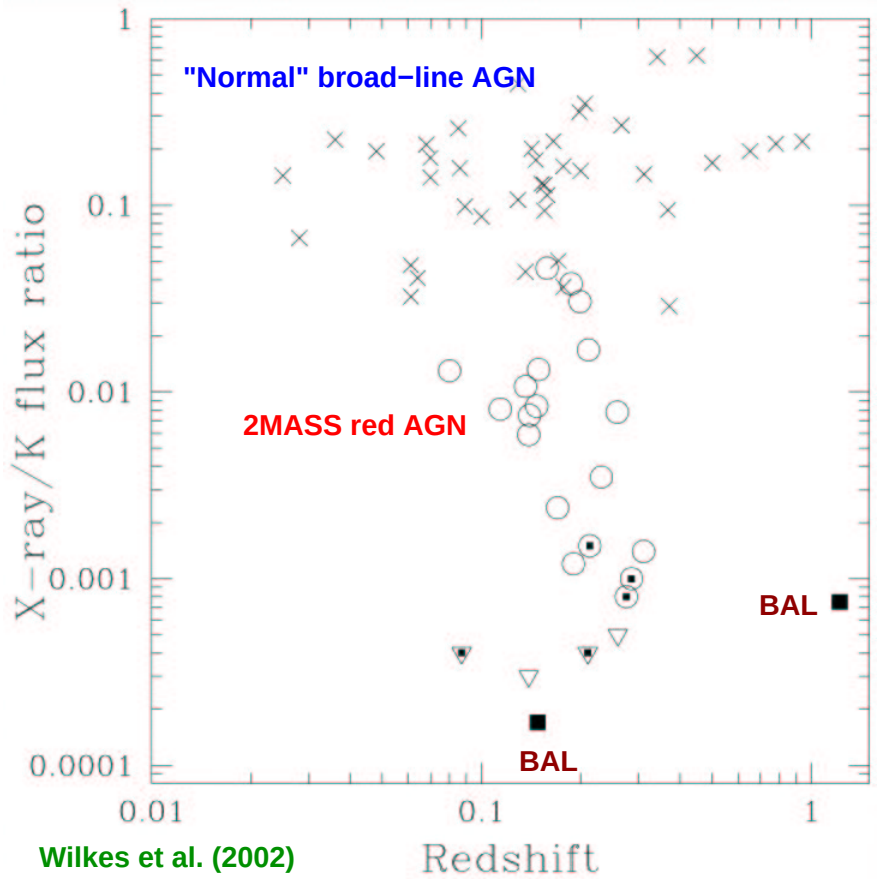
Luminosity dependence of AGN outflows?



Laor & Brandt (02)

Red AGN, X−rays, and the SDSS

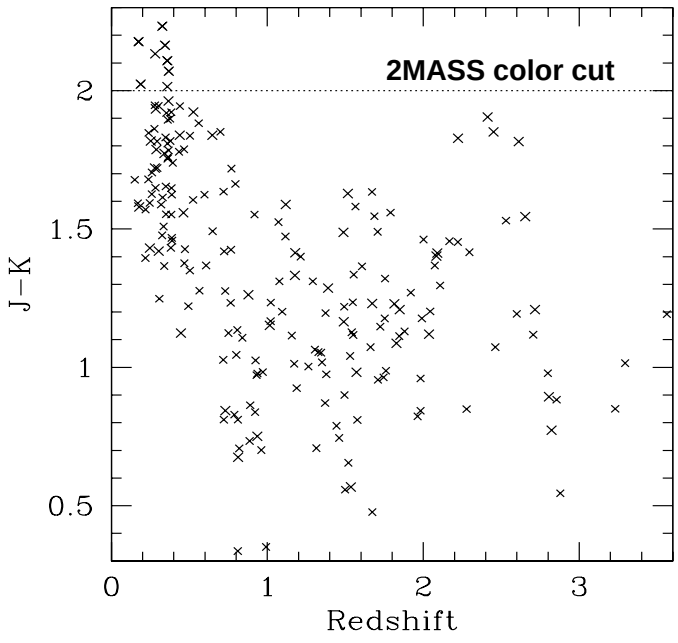
Chandra snapshots of 2MASS red AGN



Wilkes et al. (2002)

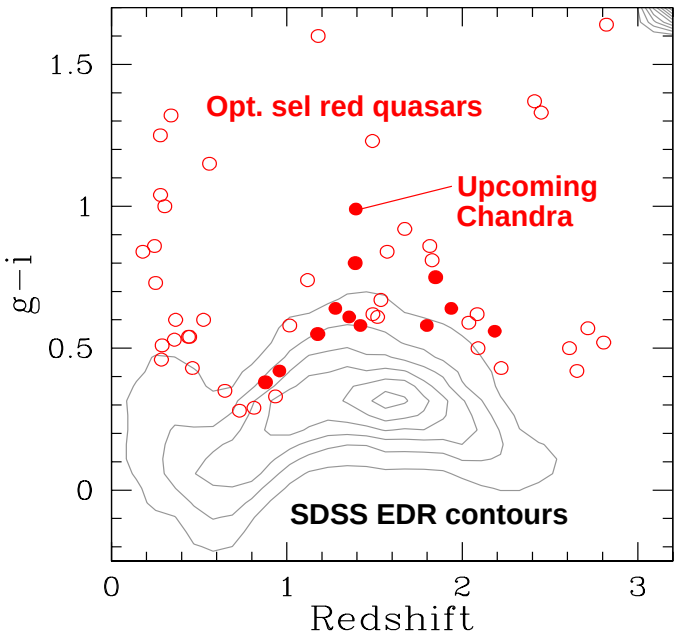
- J − K > 2 selection
- High space density
- Generally X−ray weak
- X−ray spectra hard, likely absn.
- Little relation between X−ray absorption and
  - NIR color
  - AGN class
  - Optical polarization

SDSS EDR quasars



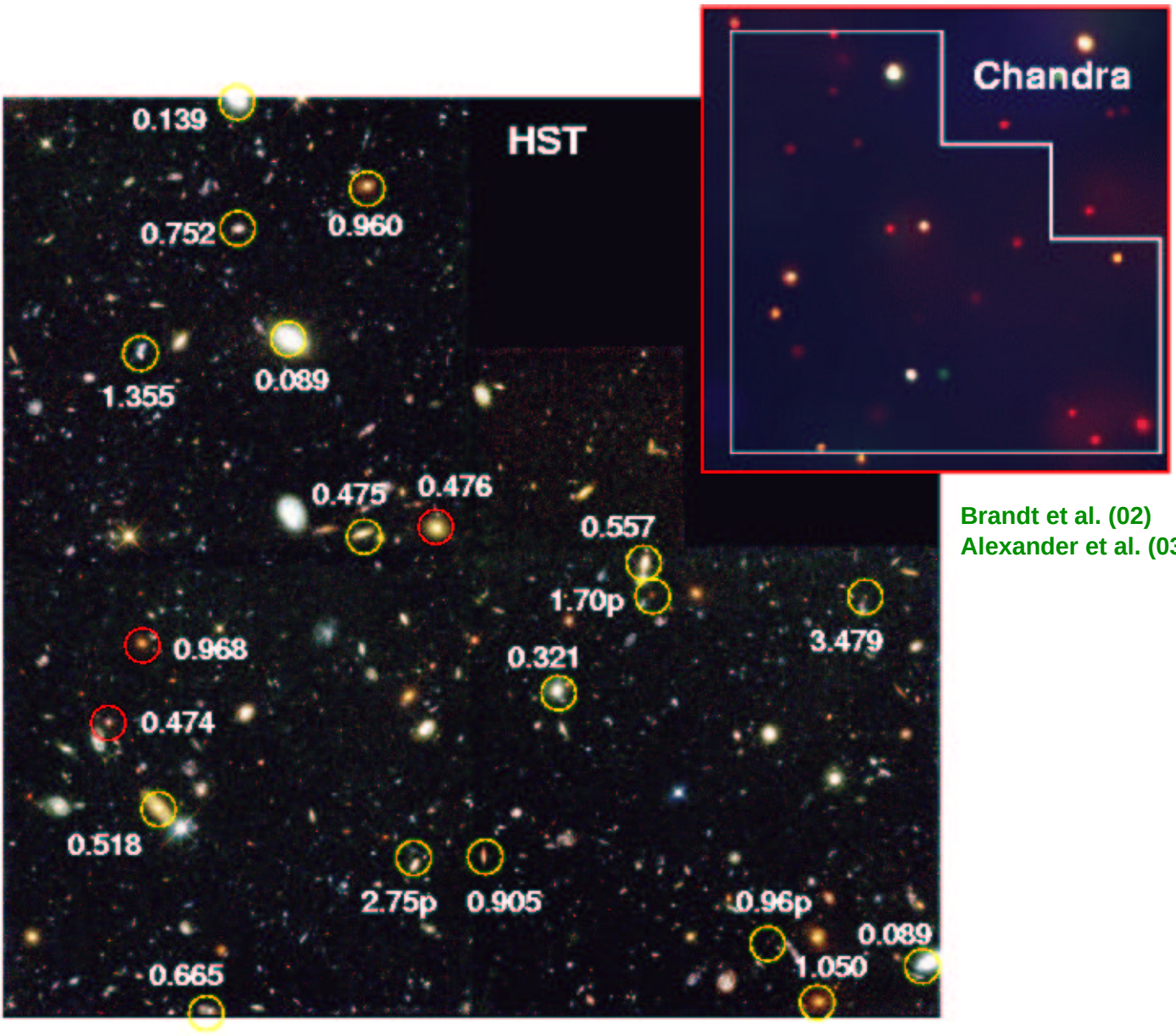
Richards et al. (2003)

Upcoming Chandra SDSS snapshots

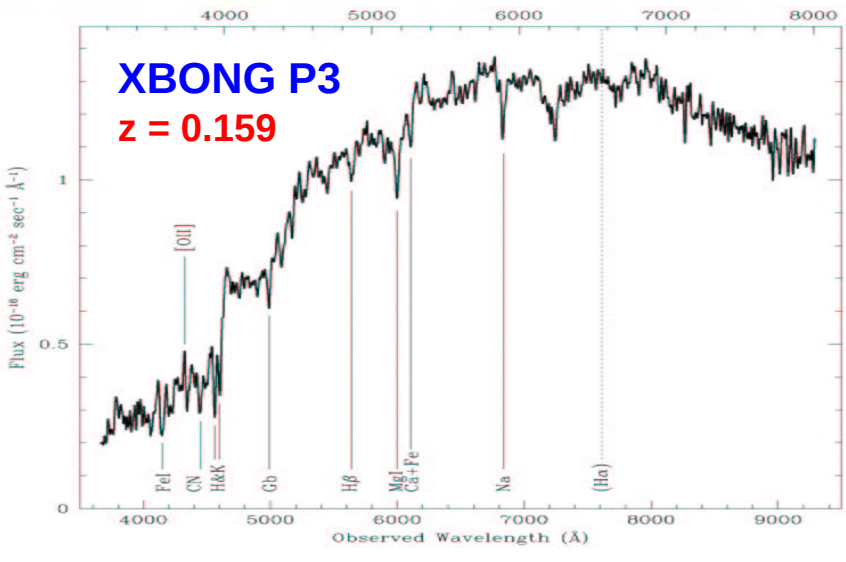


Richards et al. (2003)

Hard X−ray Selected AGN in SDSS Region



Brandt et al. (02)
Alexander et al. (03)



Comastri et al. (02)

Combine hard X−rays + SDSS

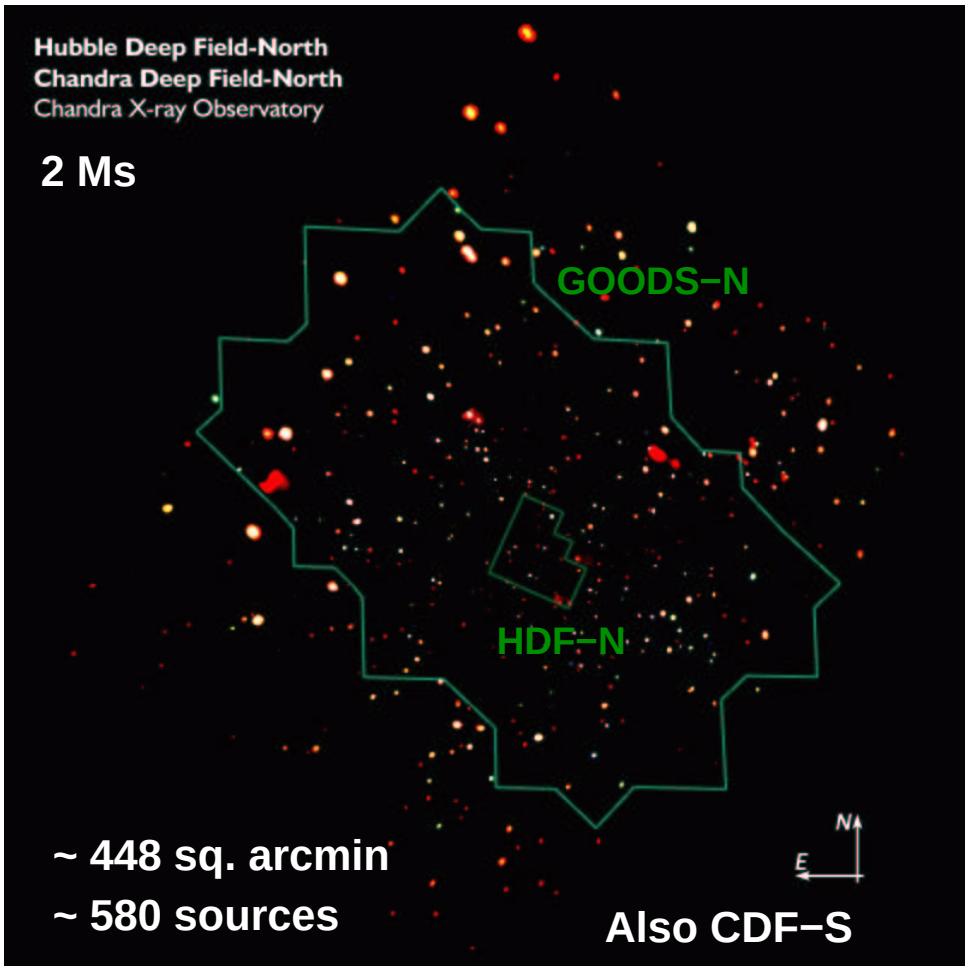
Find local examples for detailed follow−up, so can place within unified model.

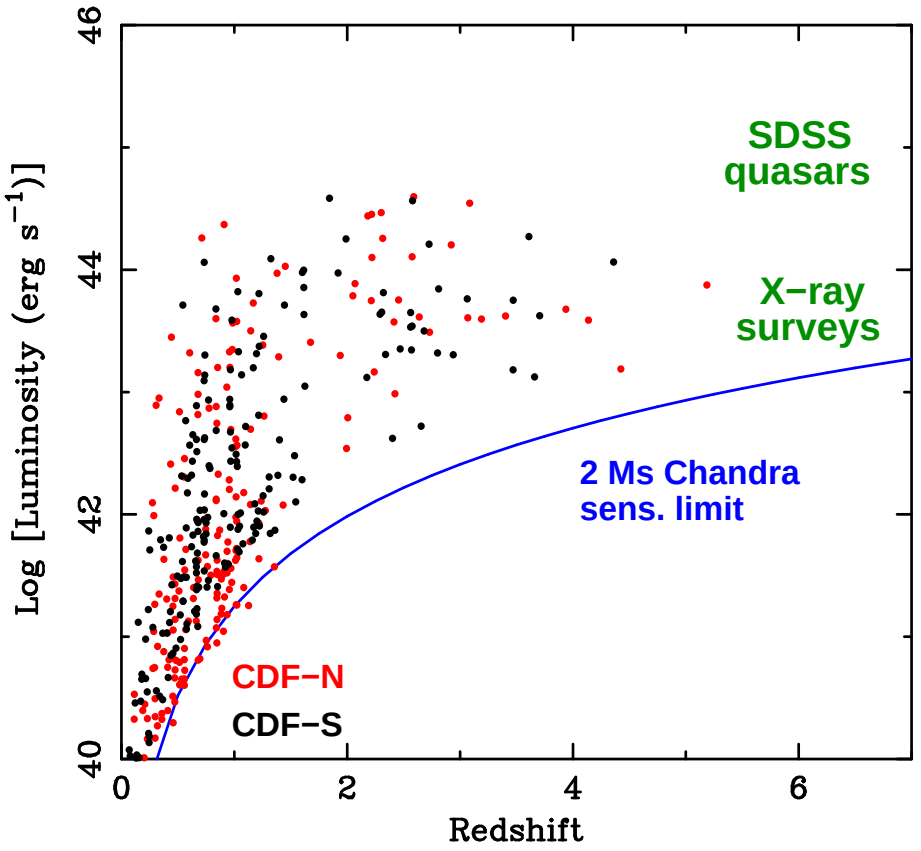
SDSS may "accidentally" observe 200+ of them.

Understand SDSS AGN selection effectiveness better.

Swift coming too; about 400 AGN in 10−150 keV band.

High−Redshift AGN Demography from SDSS and Deep X−ray Surveys





Deep X−ray surveys probe z > 4 AGN more than 30 times less luminous than SDSS.

More numerous + representative.

Minimal absorption bias.

Constrain sky density with follow−up and Lyman break.

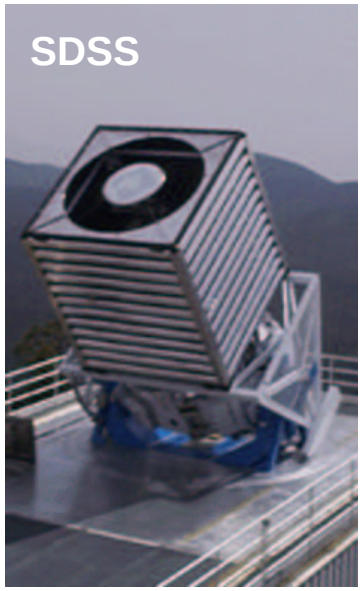
No more than ~ 8 AGN at z > 4 per field.

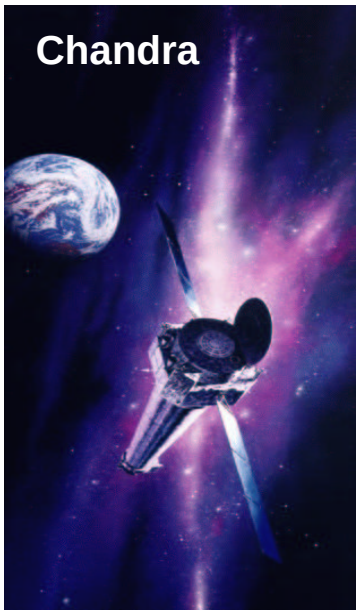
Alexander et al. (01), Barger et al. (03), Cristiani et al. (03), Koekemoer et al. (03)

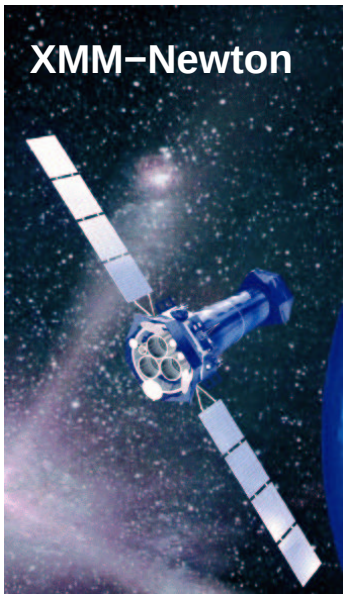
Contribution to z ~ 6 reionization small.

Better source statistics needed. E−CDF−S.

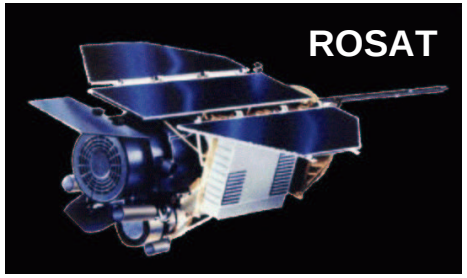
Future X−ray + SDSS Prospects

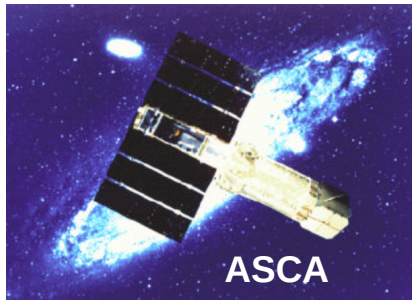






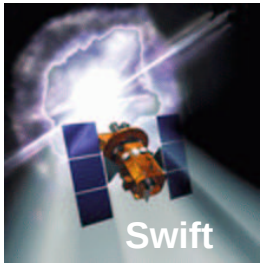
Past Mission Archives

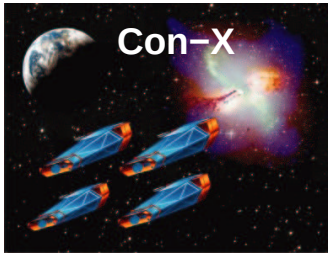




Also BeppoSAX

Future Missions





Also Astro−E2, XEUS, Gen−X

Many other great X−ray projects...

- Narrow−Line Seyfert 1s
- Double−peaked line emitters
- C IV blueshift−selected quasars
- LLAGNs
- Poststarburst quasars
- High−redshift quasars + blazars
- "No−line" quasars
- Intrinsically red quasars
- Type 2 quasars
- Unusual BALQSOs

Lots more too.