Observations of the Nearby Sculptor Group Sd Galaxy NGC 7793 with the *Chandra* X-ray Observatory

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Outline

- Introduction
- Data Reduction
- Source Detection
- Results

Introduction

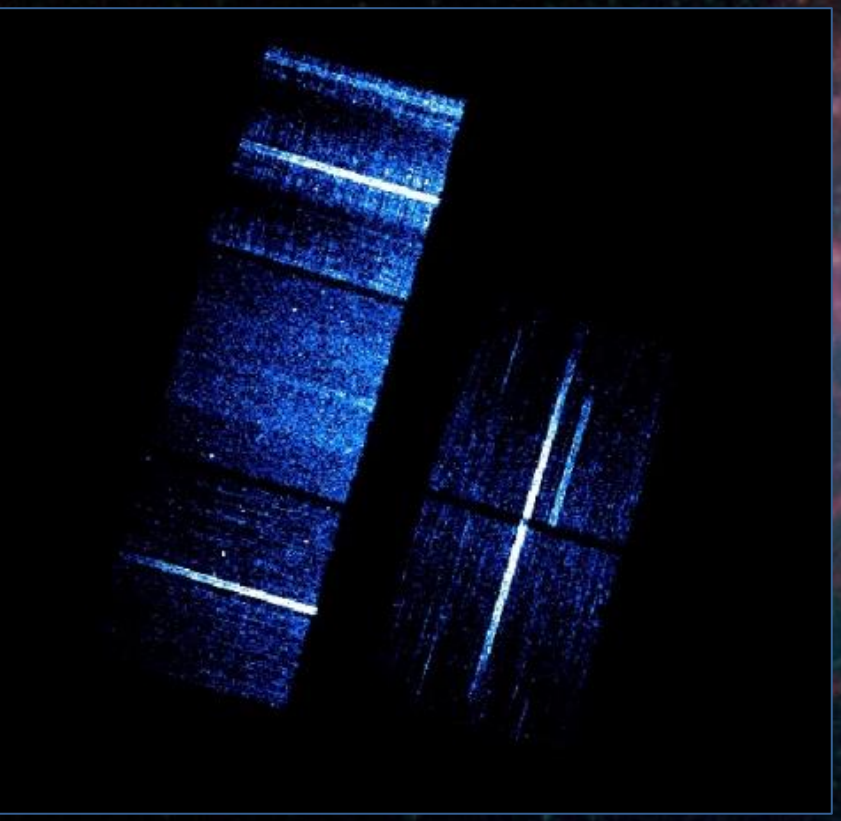
- NGC 7793
  - Diameter 9.2 arcmin
  - HI mass $9.1 \times 10^8 M_\odot$
  - Distance 3.91 Megaparsecs
  - Inclination 50°
- High star formation rate: 0.24 $M_\odot yr^{-1}$

Data Reduction

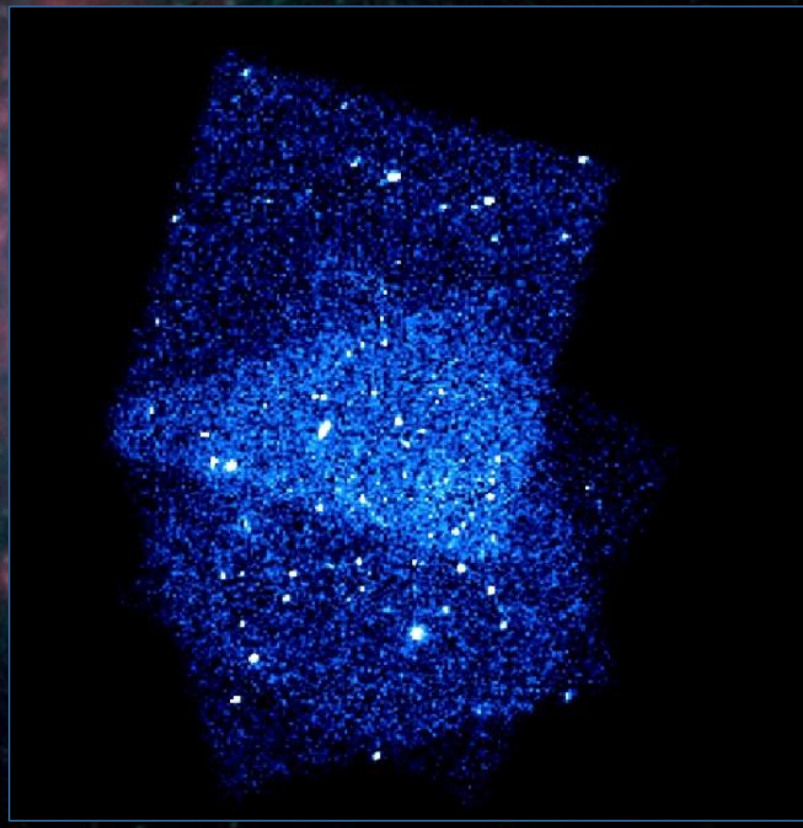
- cxc.harvard.edu
- Raw level = 1 event file → reprocessed level = 2 event file
  - chandra_repro flags bad pixels, applies gain, latest calibration, etc.
- Subtract background flares → get rid of high energy particle events in the detectors
- Merge observations

Obs ID	Exposure (ks)	Start Date
13439	62.5	2011-12-25
14231	60.5	2011-08-13
14378	27.0	2011-12-30
3954	50.0	2003-09-06

Data Reduction

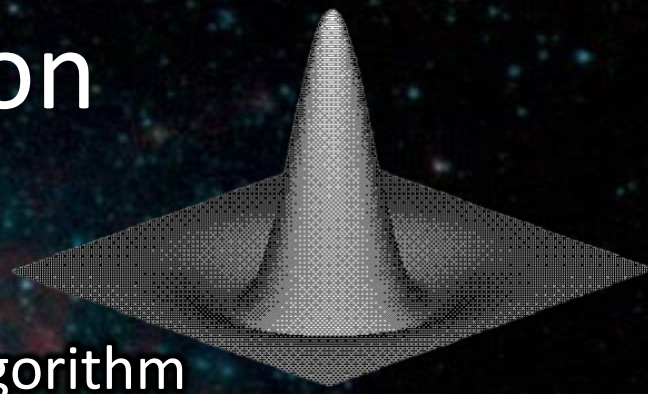


Raw image



Cleaned, merged image

Source Detection



- wavdetect tool
  - Wavelet-based source detection algorithm
    - » Mexican Hat wavelet
  - A local background is estimated around a putative source and a checking is done to see if the signal that is being seen in this pixel is significantly higher than expected
  - A hypothesis, that the observed signal can be obtained as a fluctuation from the background, is tested iteratively

Source Detection

Energy bands

- Broad band → 0.5 keV – 7 keV
- Soft band → 0.5 keV – 1.2 keV
- Hard band → 1.2 keV – 7 keV

C.f. Chandra sensitivity → 0.1 keV – 10 keV

Source Detection

- Hardness Ratio

$$\frac{H - S}{H + S}$$

H = number of counts in hard band (1.2 – 7 keV)

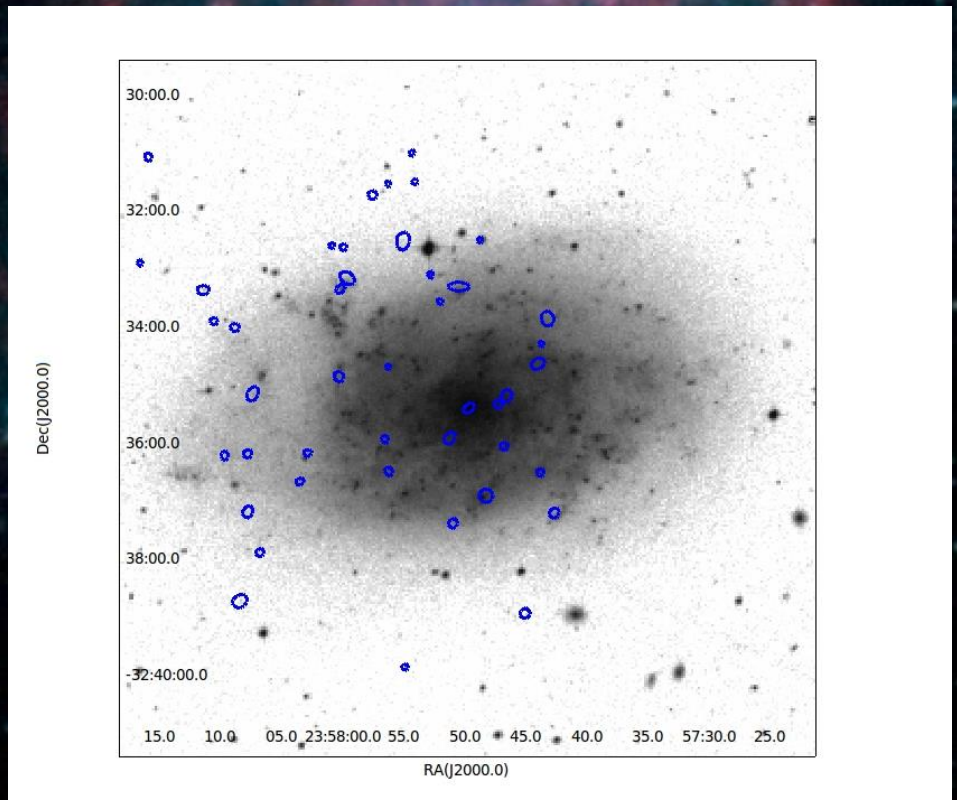
S = number of counts in soft band (0.5 – 1.2 keV)

- Positive hardness ratio ~ X-ray binary
- Negative hardness ratio ~ Supernova remnant

Results

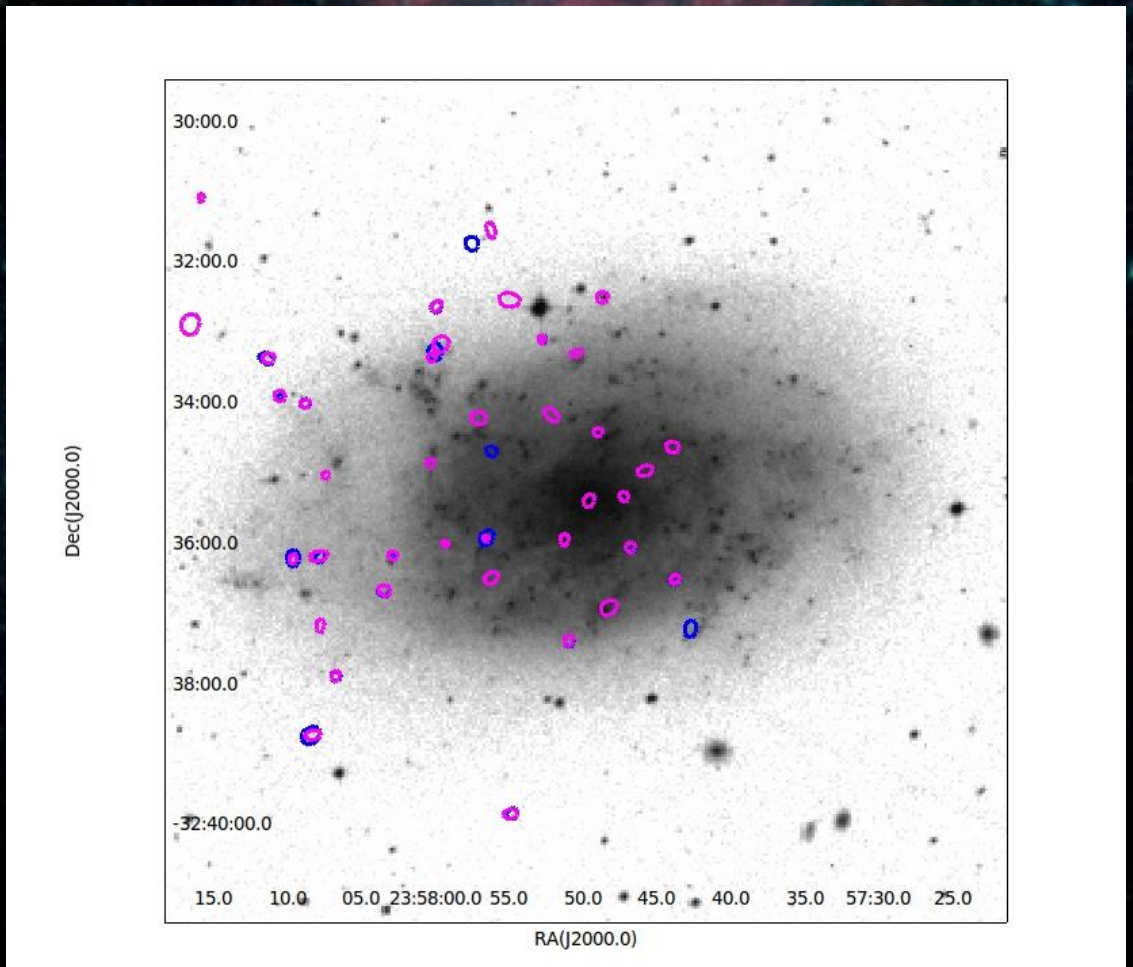
- 44 X-ray sources in total from 190,220 s exposure time

  c.f. 22 sources using 49,094 s exposure time in Pannuti et al. 2011



Results

- 39 soft (magenta), 21 hard (blue) X-ray sources
- 15 sources that emit in both hard and soft bands

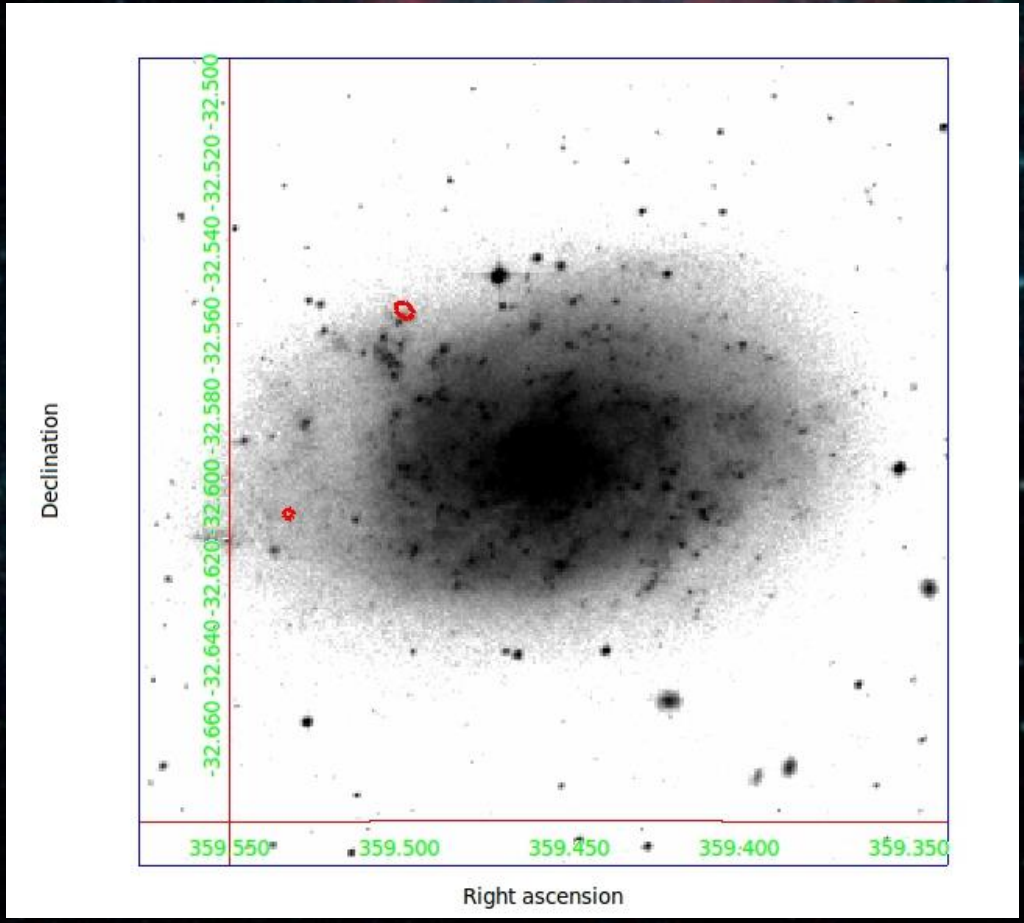


Results

SNR candidate	Hardness ratio	X-ray binary candidate	Hardness ratio
CXOU J235743.8-323635	0.11	CXOU J235752.8-323310	-0.53
CXOU J235746.8-323608	0.64	CXOU J235756.5-323559	-0.53
CXOU J235751.0-323727	0.98	CXOU J235802.9-323614	-0.37
CXOU J235754.8-323954	0.14	CXOU J235803.5-323644	-0.02
CXOU J235806.7-323757	0.93	CXOU J235807.8-323615	-0.01
CXOU J235808.4-323848	0.63	CXOU J235808.8-323404	-0.37
CXOU J235809.6-323616	0.11	CXOU J235810.5-323359	-0.25
CXOU J235811.4-323326	0.10		

Results

- At least 2 variable sources using the tool ‘glvary’



Future Work

- Check for more variable sources
- Obtain spectral fitting for some bright sources
- Compare with Spitzer data

References

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Questions?

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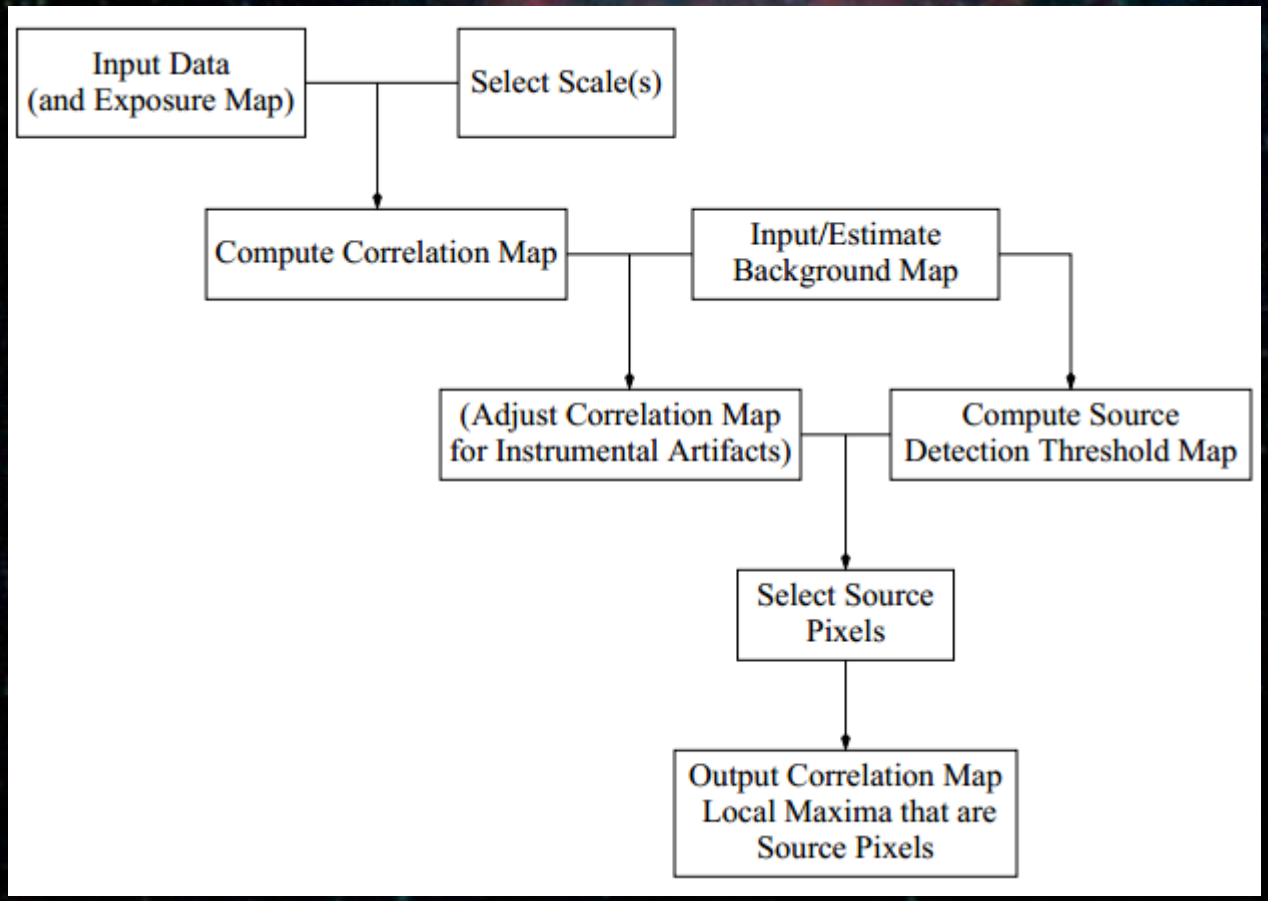
Additional Slide 1

$$W_m\left(\frac{x}{\sigma_x}, \frac{y}{\sigma_y}\right) = \frac{1}{2\pi\sigma_x\sigma_y} W_m\left(\frac{x}{\sigma_x}, \frac{y}{\sigma_y}\right)$$



Additional Slide 2

- *Chandra* X-ray Observatory
  - Best angular resolution in X-ray: 0.492” per pixel
  - Front and back-illuminated detectors → spectroscopic as well as photometric analyses
  - Sophisticated data analysis framework → Chandra Interactive Analysis of Observations (CIAO) package
  - Datasets available in public domain

Additional Slide 3

- Why study nearby galaxies in X-ray?
  - X-ray binaries (XRBs) and supernova remnants (SNRs) → stellar evolution
  - Observational difficulties in our own galaxy
    - Significant absorption along 5 degrees galactic line of sight
    - Considerable uncertainties in distances
  - Broadening the sample by studying these objects in galaxies of diverse masses, metallicities, star formation histories and morphological types