ASTROSTAT-II

Development of Novel Statistical Tools for the Analysis of Astronomical Data

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What is ASTROSTAT-II ?

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The follow-up of ASTROSTAT-I !

ASTROSTAT-I Network

ASTROSTAT-I

- Image Analysis
- Classification
- Fitting complex data

Highlights of ASTROSTAT-I

- Source classification
  - Classification of galaxies (Stampoulis)
  - Classification of X-ray binaries (Maragkakis)
  - Supernova remnant classification (Kopsacheili)
  - Stellar spectral type classification

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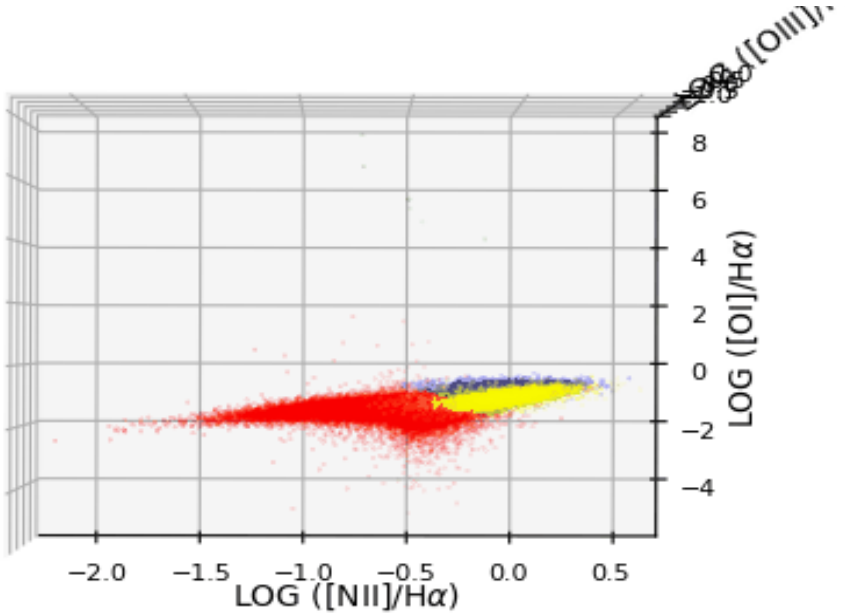
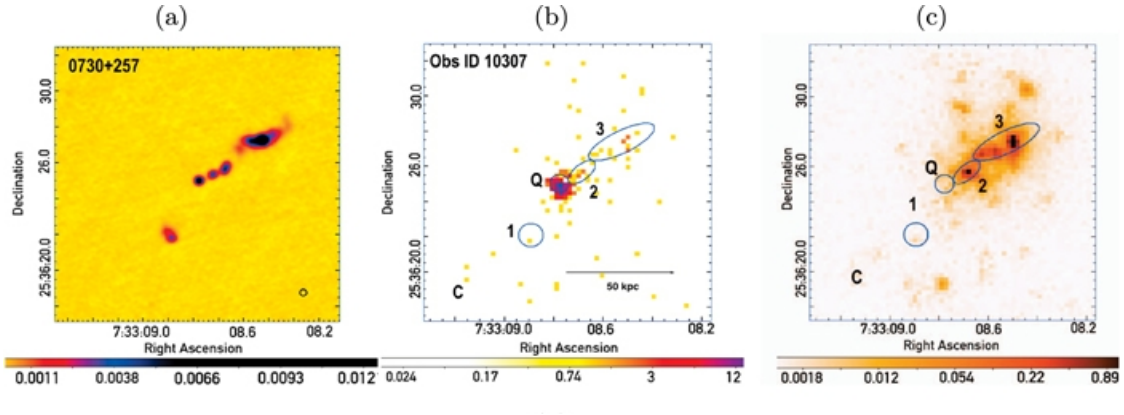
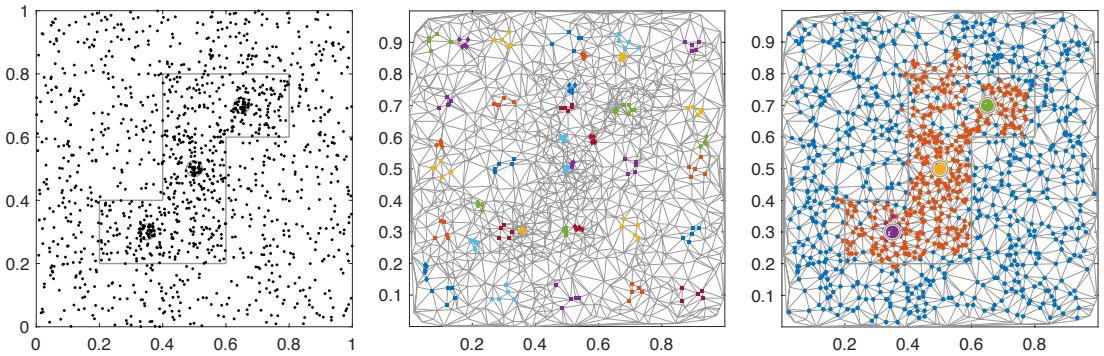


Highlights of ASTROSTAT-I

- Imaging analysis
  - LIRA (McKeough / Stein)
  - Seeded Region Growing in Poisson regime (Fan / Lee)



McKeough et al. 2016



Fan et al. In prep

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- Source classification
  - Classification of galaxies (Stampoulis)
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  - Stellar spectral type classification
- Imaging analysis
  - LIRA (McKeough / Stein)
  - Seeded Region Growing in Poisson regime (Fan / Lee)
- Fitting / inference
  - Interpolation of sparse multi-dimensional data (Fragos / Zevin)
  - SN cosmology (van Dyk / Mandel)

What is ASTROSTAT-II ?

Continuation and extension of
ASTROSTAT-I

ASTROSTAT-II Network

ASTROSTAT-II

- Source classification
- Imaging analysis
- Fitting / inference
- Timing

ASTROSTAT-II

- Source classification
  - Classification of X-ray binaries
  - Solar Region Classification
- Imaging analysis
  - Fine structure in galaxies
  - LIRA
  - Confused sources
- Fitting / inference
  - X-ray binary popualtion synthesis
  - Model uncertainties (DEM / CMD)
  - SN cosmology
- Timing
  - Variability in n-D
  - Detection + characterization of transients

ASTROSTAT-II

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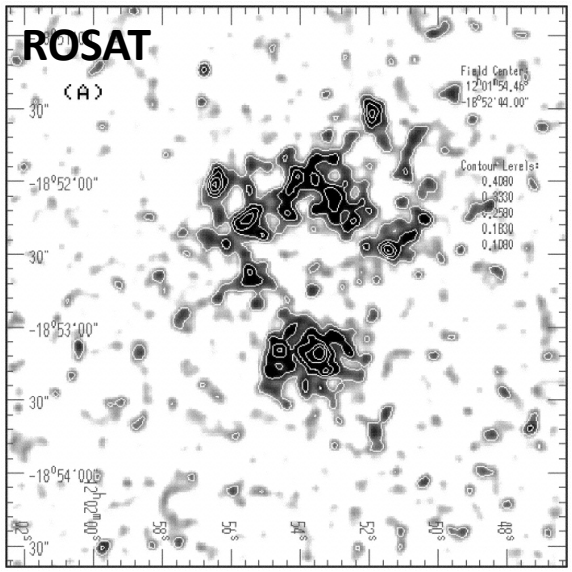
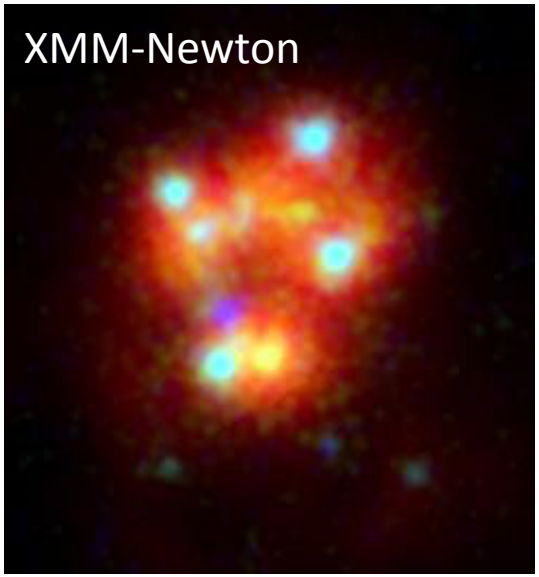
Imaging analysis

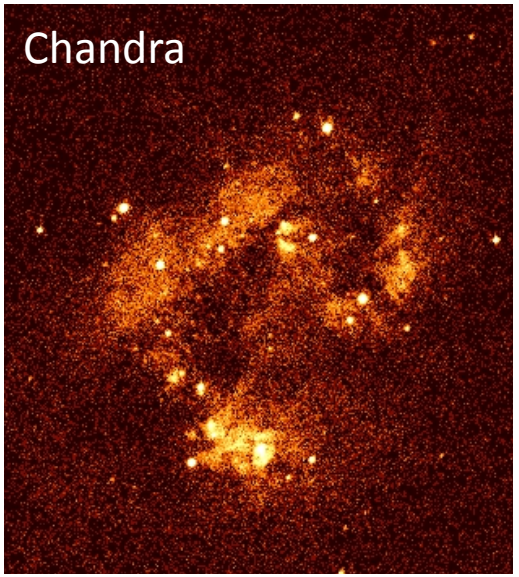
Wide range of quality (resolution, depth)

Observations = Real image * instrument response
(Point Spread Function)

Imaging analysis







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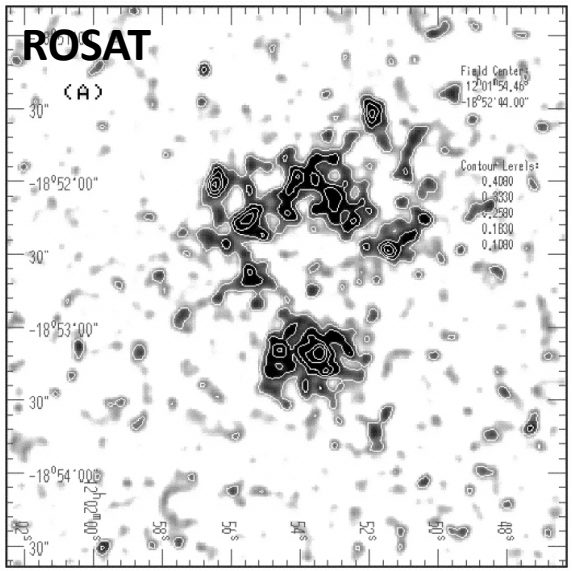
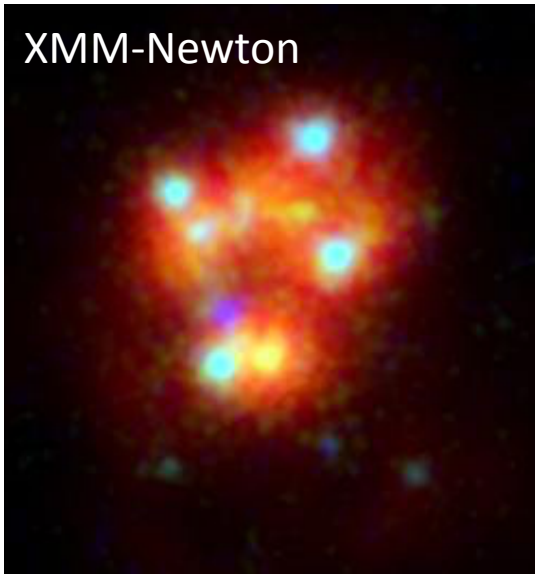
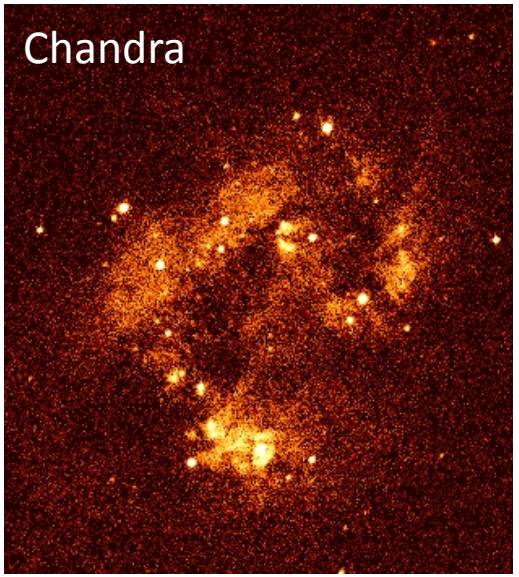
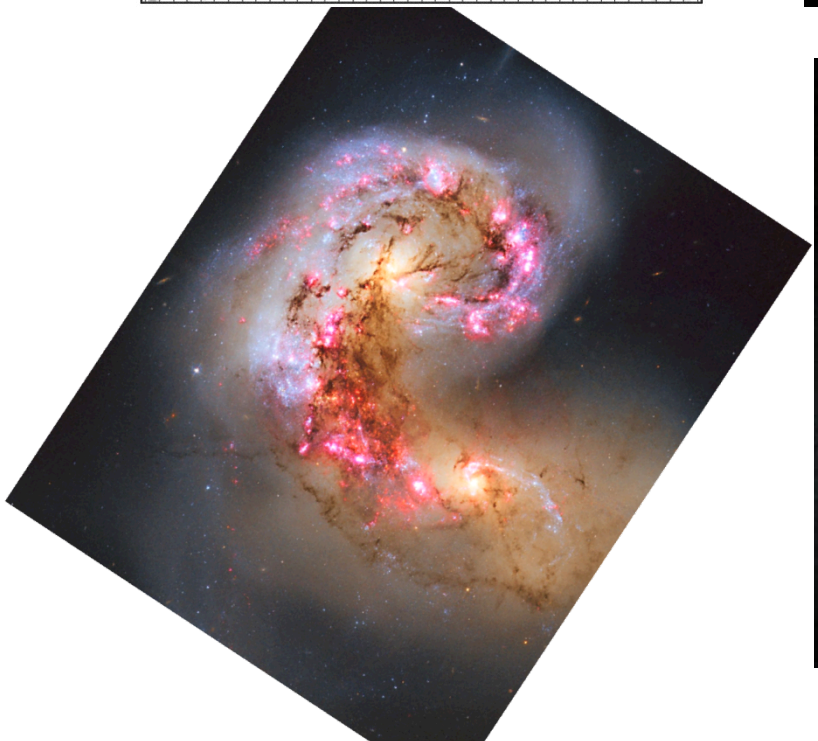
Multi-wavelength data

Imaging analysis



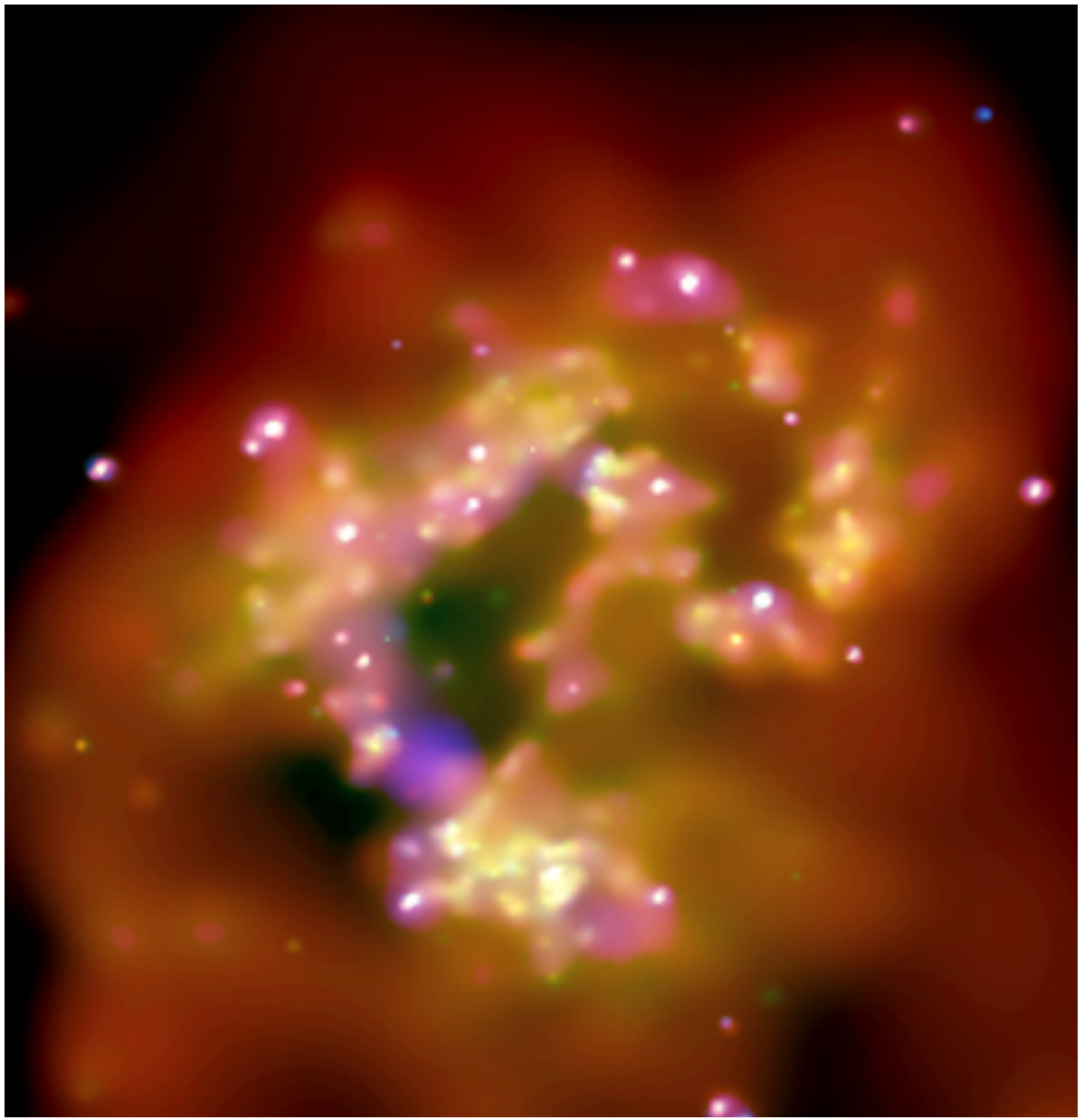






Imaging analysis

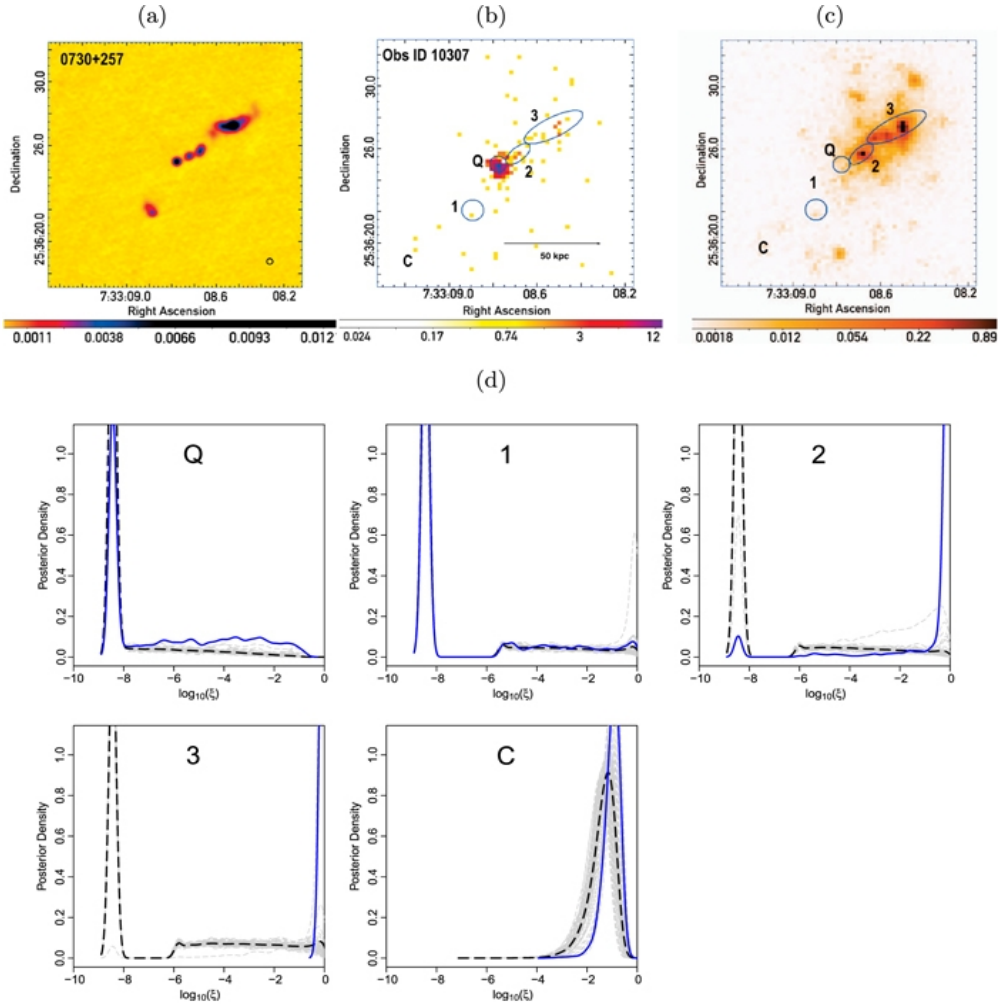
Multi-scale data



Imaging analysis

But we always want to squeeze out the most

- Detect structures

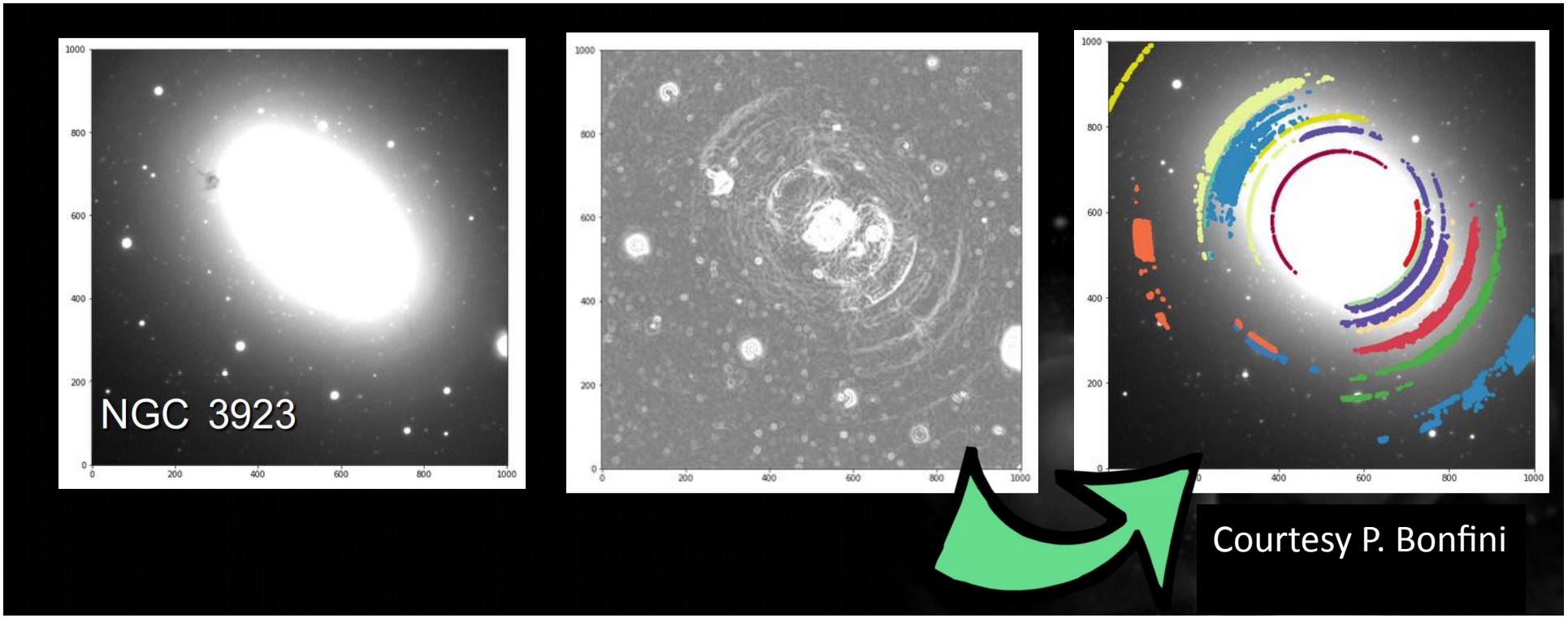


McKeough et al. 2016

Imaging analysis

But we always want to squeeze out the most

- Bring out structures



Imaging analysis

But we always want to squeeze out the most

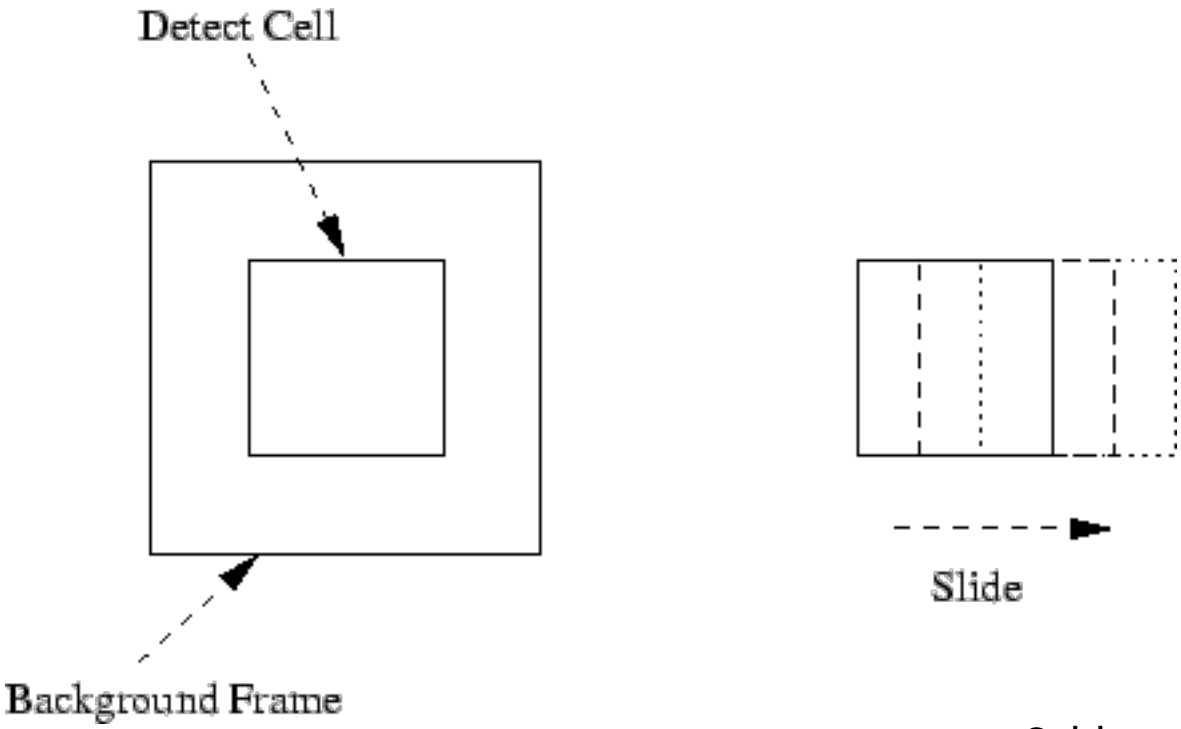
- Detect structures
- Bring out structures

- Find the faintest sources

- Resolve sources

Project I
Next generation of source detection

Celldetect (+Max. likelihood)



Calderwood et al. 2001

Project I
Next generation of source detection

Celldetect (+Max. likelihood)

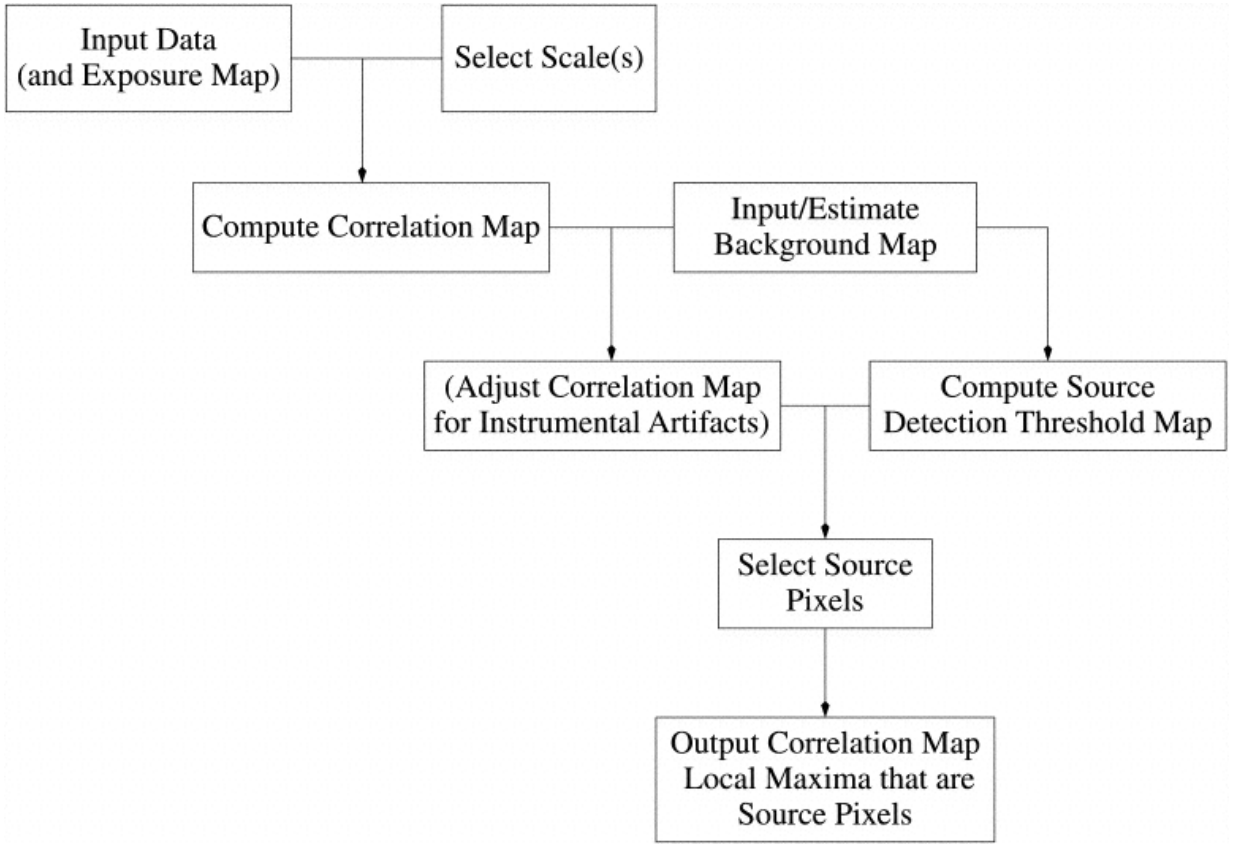
Wavelets

Convolve image with wavelet
Identify maxima → create source list

Project I
Next generation of source detection

Celldetect (+Max. likelihood)

Wavelets



Freeman et al. 2001

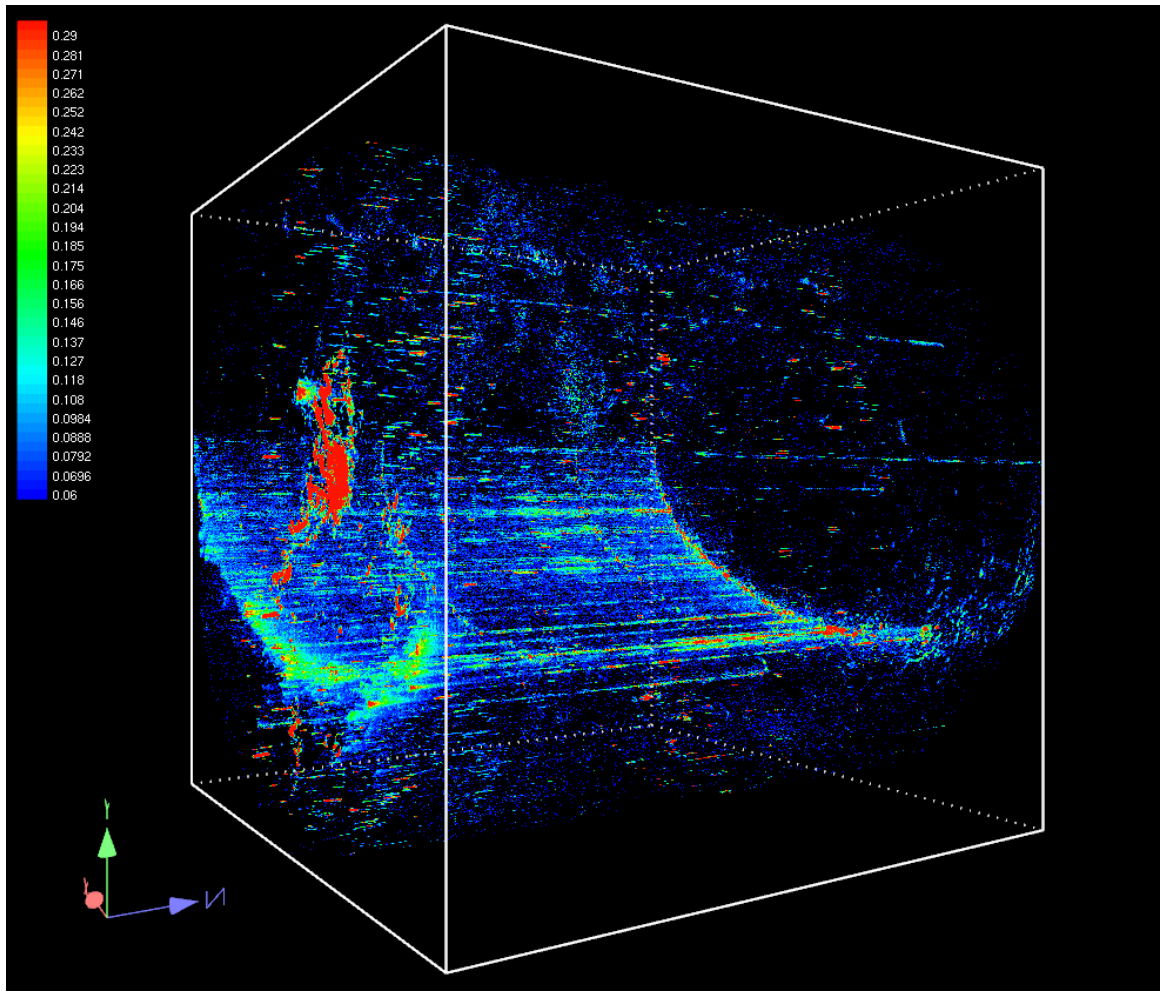
Next generation of source detection

Limitations of wavdetect

- detection significance
- detection efficiency
- application on multiple datasets

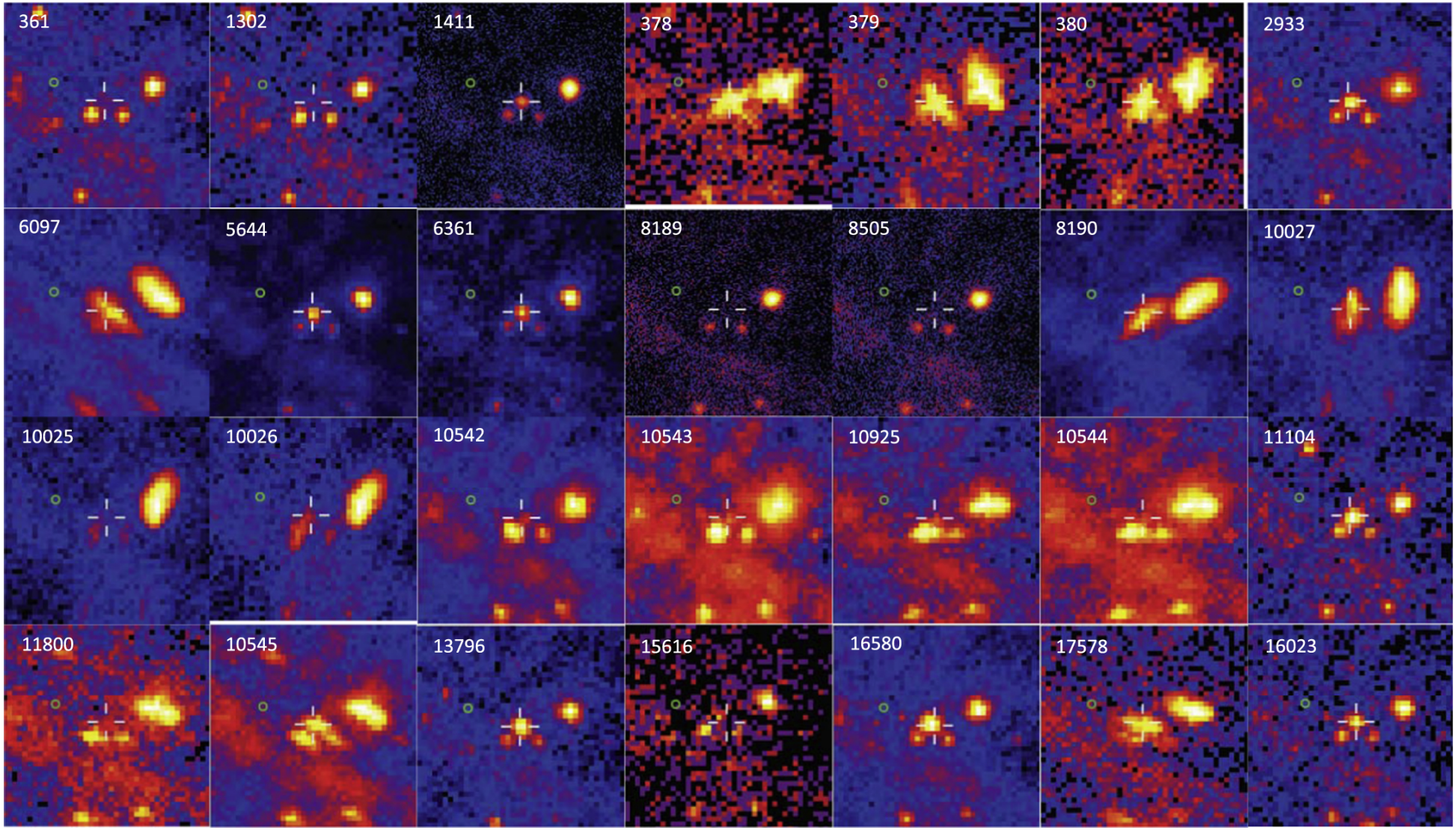
Next generation of source detection

Multi-dimensional – multi-scale detection



https://www.atnf.csiro.au/research/WALLABY/3Dvis.html

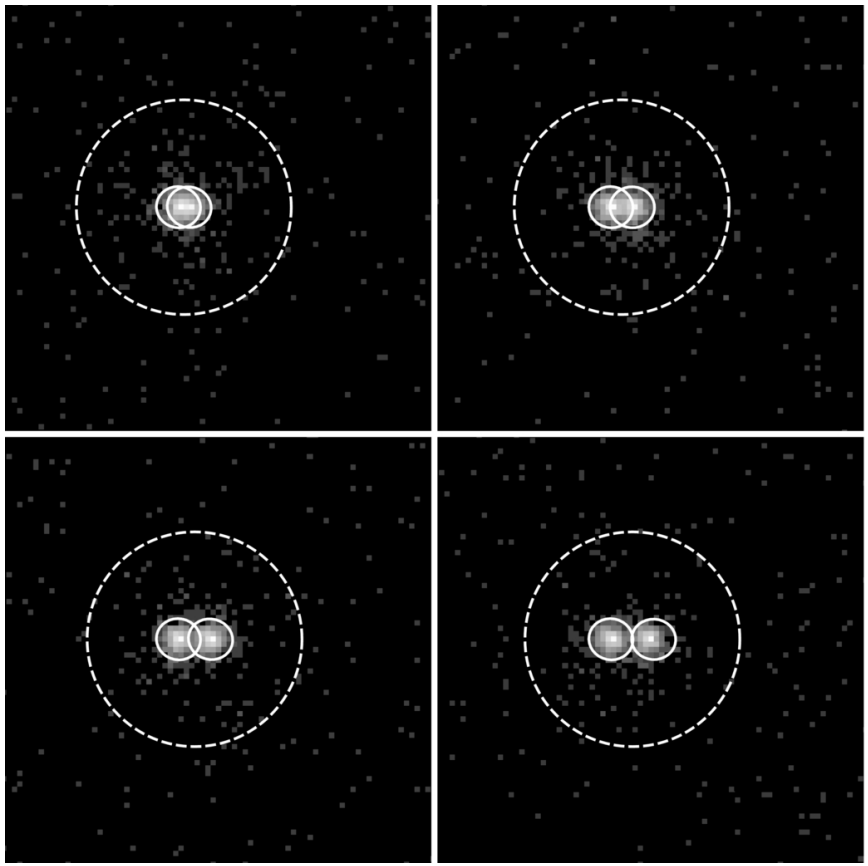
Project II
Source confusion



Brightman et al. 2016

Source confusion

2D joint fit of two sources

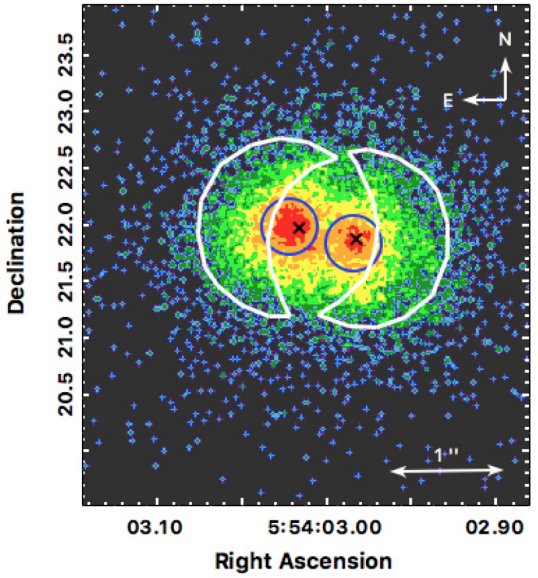


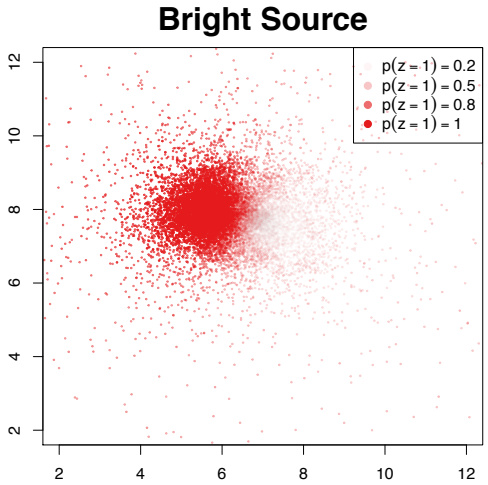
Primini & Kashyap 2014

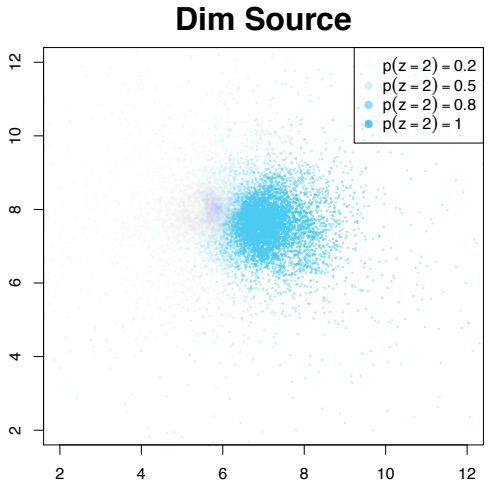
Source confusion

2D joint fit of two sources

3D spectro-spatial (David Jones)
tempo-spatial (Luis Campos)







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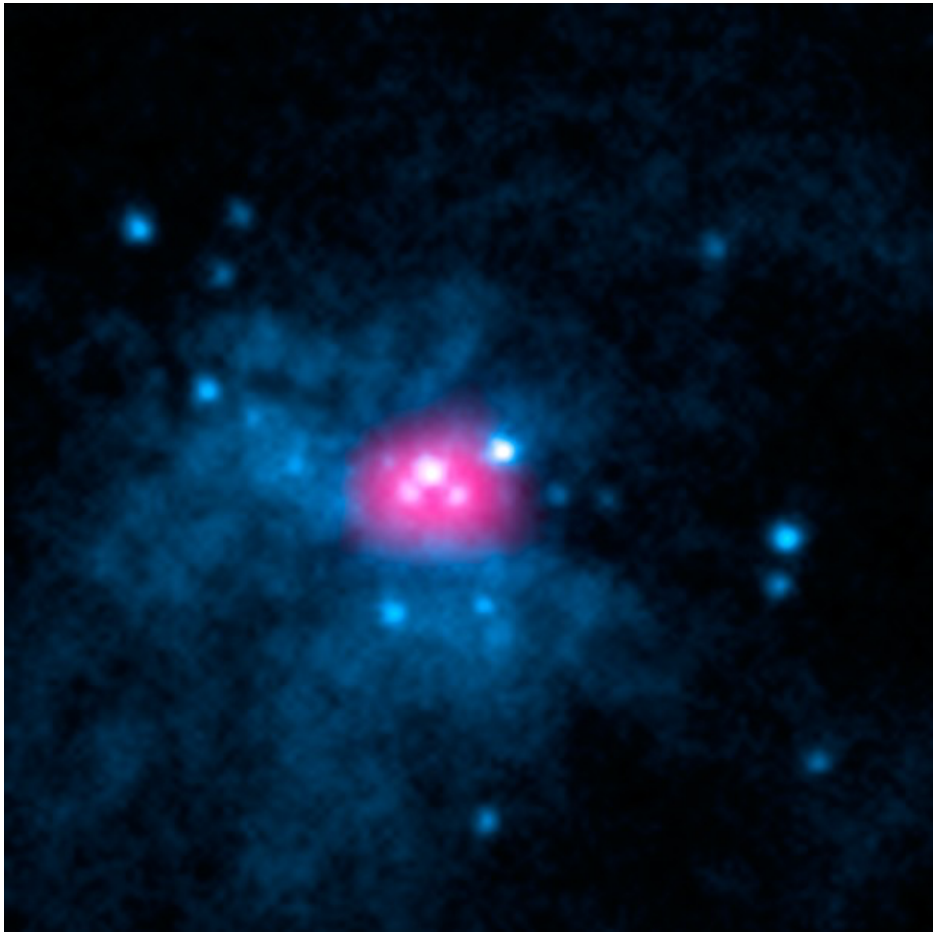

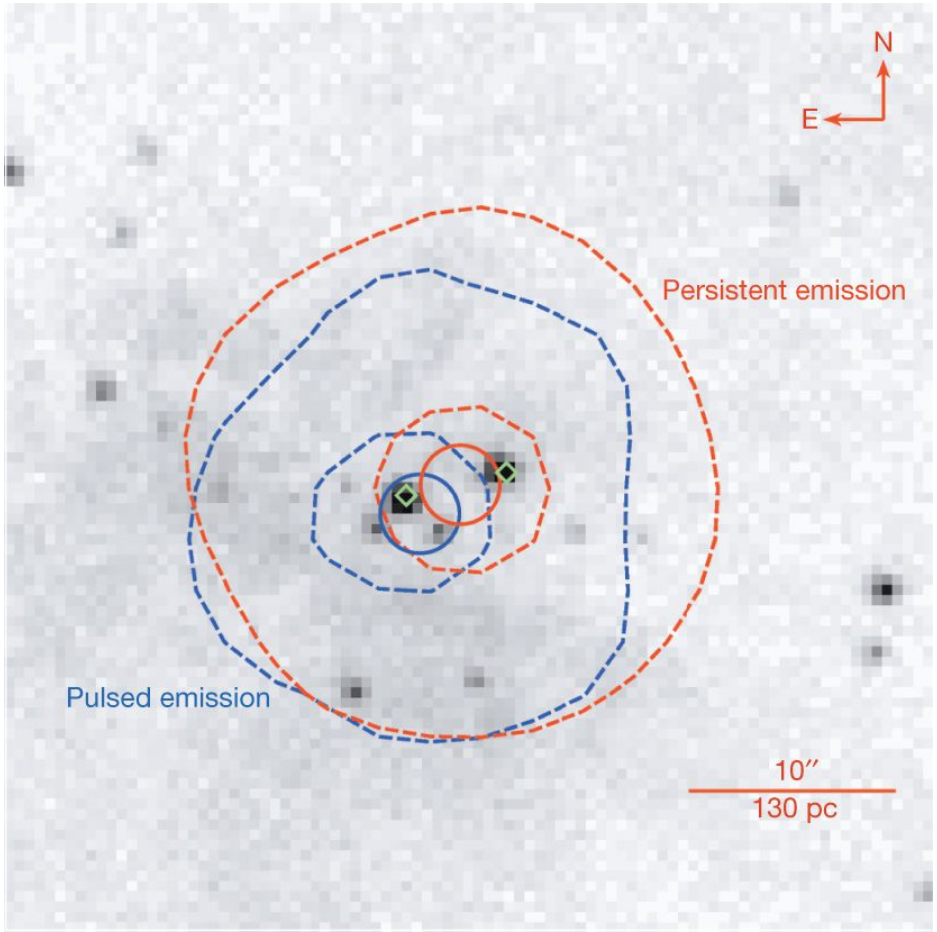

Bachetti et a.l 2014

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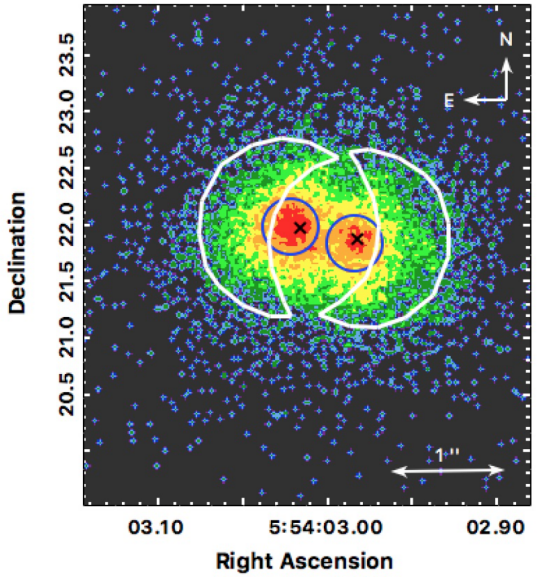
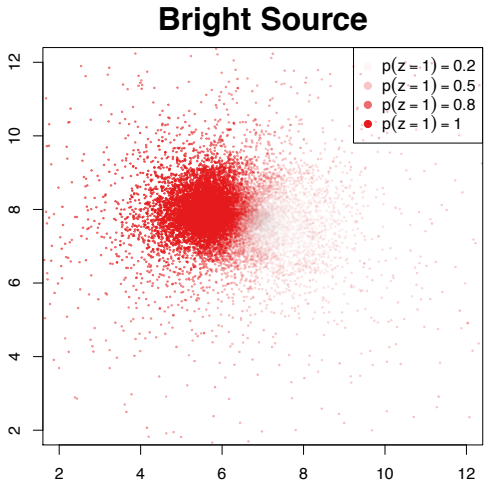
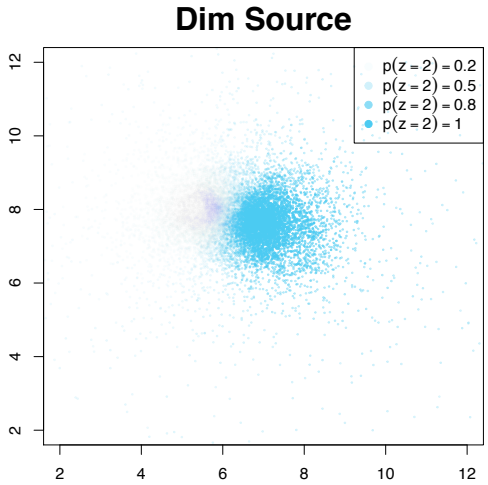
Next step:
4D spectro-tempo-spatial (???)







Looking ahead

X-ray telescopes

eROSITA, XRISM, ATHENA, Lynx, FORCE/HEXP

Optical surveys: LSST

Will require advanced source detection and source characterization methods