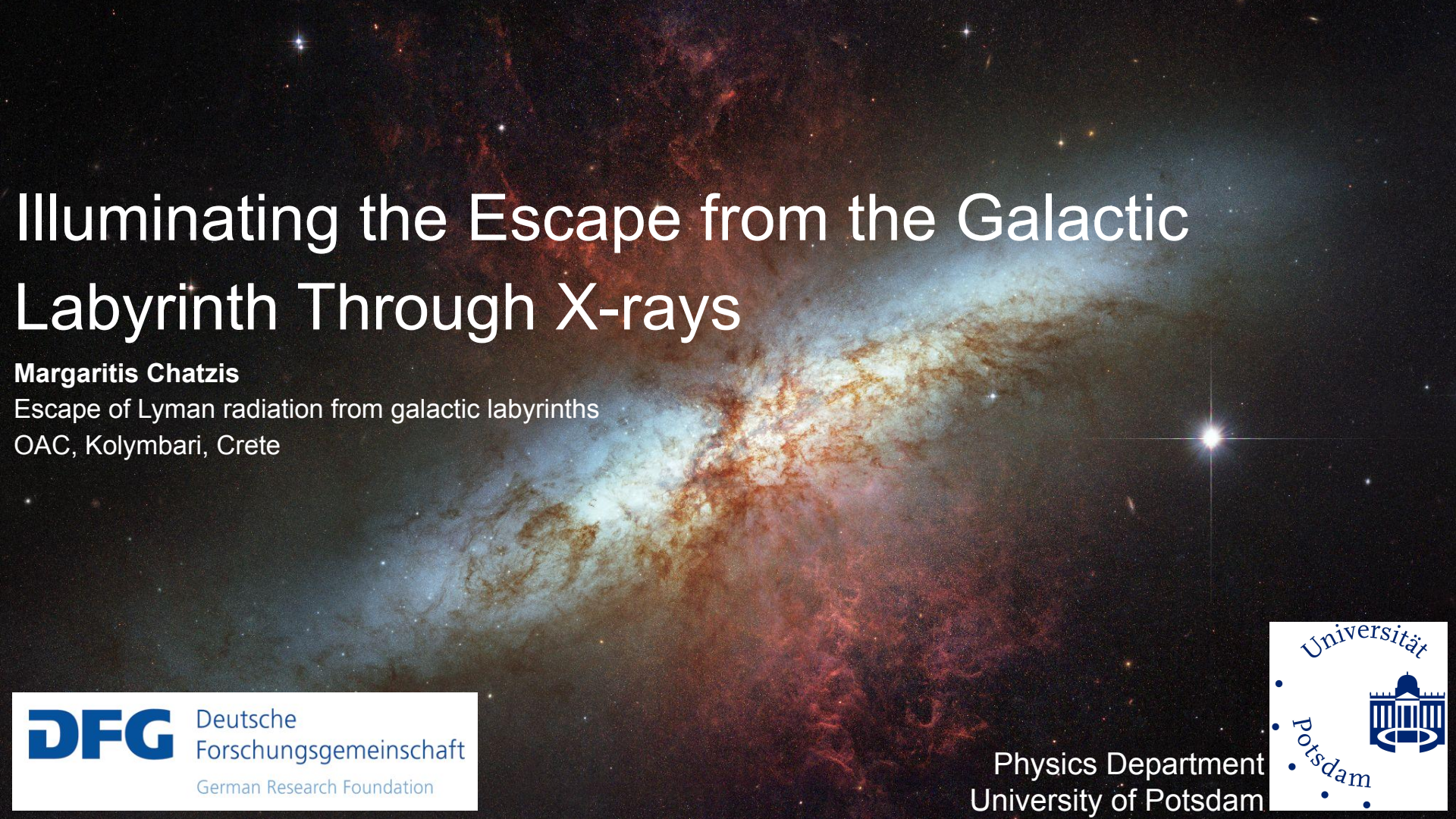

Illuminating the Escape from the Galactic Labyrinth Through X-rays

Margaritis Chatzis
Escape of Lyman radiation from galactic labyrinths
OAC, Kolymbari, Crete

DFG Deutsche Forschungsgemeinschaft
German Research Foundation

Physics Department
University of Potsdam

Universität Potsdam

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Bottom Line: X-rays in low-metallicity are too important to be overlooked

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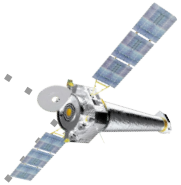

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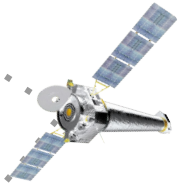

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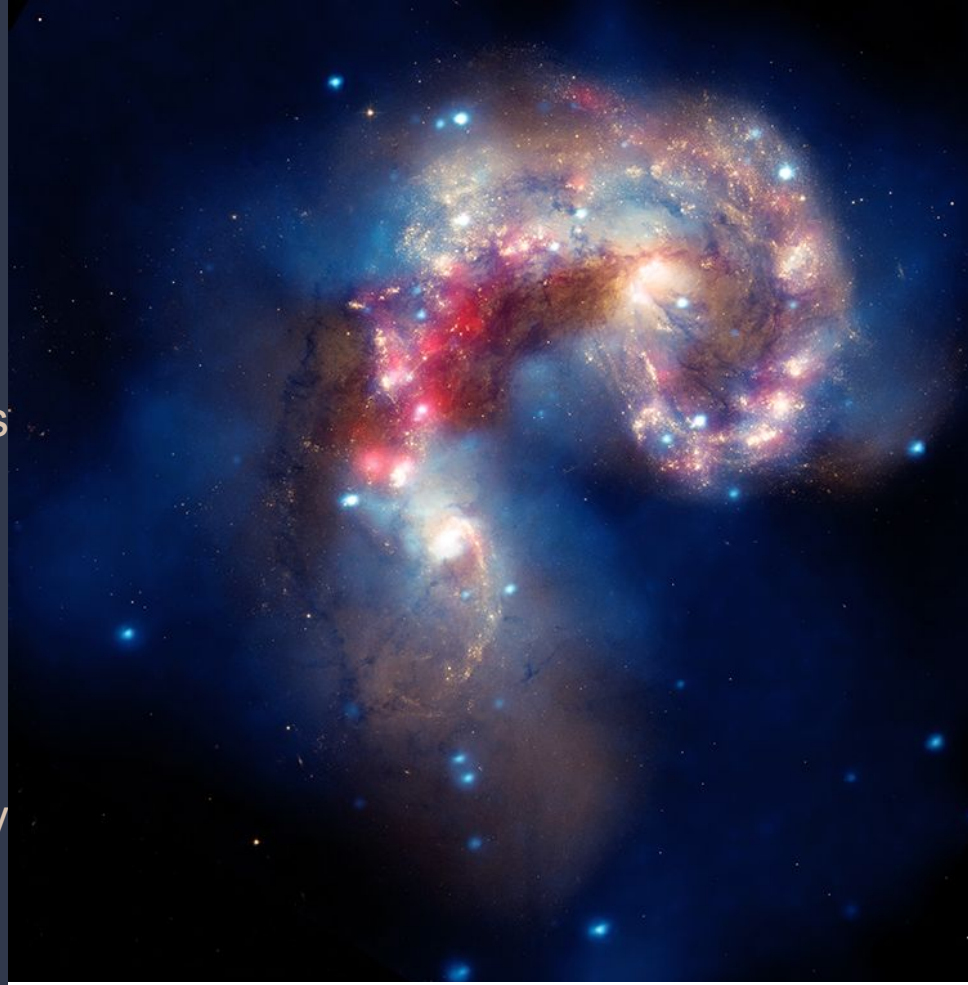
Ionizing Sources in Galaxies

A. Hot massive stars in clusters

B. Ultra luminous X-ray sources (ULX)
   - ➢ Binaries consisting of massive stars and compact objects (high-mass X-ray binaries)
   - ➢ Luminosities ≥ 10^{39} erg·s^{-1}

C. Diffuse X-ray emission
   - ➢ Extended emission filling the galaxy
   - ➢ Collisionally ionized plasma



Antennae Galaxies. Blue: X-rays, Gold: Optical, Red: Infrared. Credit: NASA

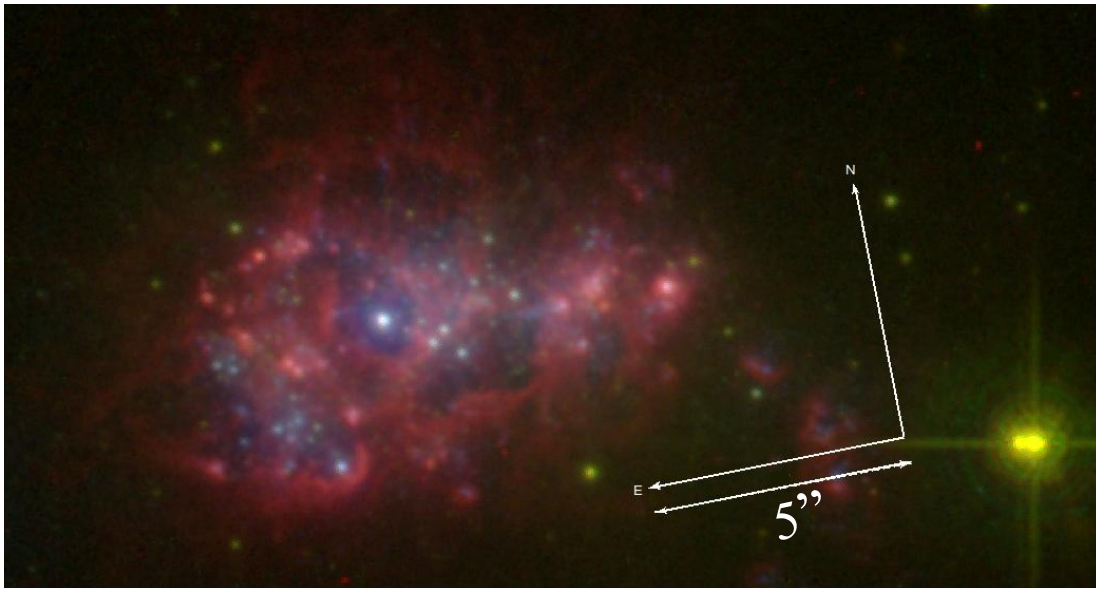
ESO 338-4 | Blue Compact Dwarf Galaxy with HST

- Also goes by the name of:
  - Tololo 1924-416
  - ESO 338-IG04

- Blue compact dwarf galaxy.
  A proxy for high redshift Lyα emitters.

- Low metallicity of 12% solar or 12+log(O/H)=7.9

- Distance ~ (37.5-40) Mpc

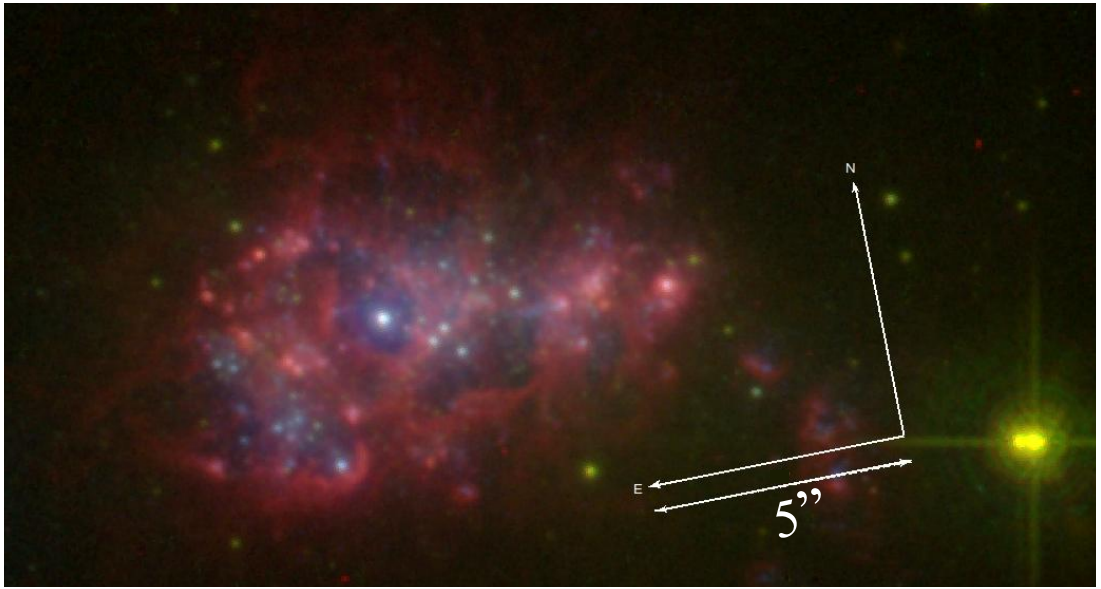


Red: FR656N
Green: F550M
Blue: F140LP

Bik et al. 2018, Lehmer et al. 2024

ESO 338-4 | Blue Compact Dwarf Galaxy with HST

- Vigorous starburst for the last ~ 40 Myr
- Star formation rate
  (SFR) ≈ (0.6-3.2)$M_{\odot} \cdot yr^{-1}$
- Total mass
  $M \approx 4 \cdot 10^{9} M_{\odot}$
- Comparison with Milky Way:
  - Total mass ≈ $10^{12} M_{\odot}$
  - SFR order of 1 $M_{\odot} \cdot yr^{-1}$



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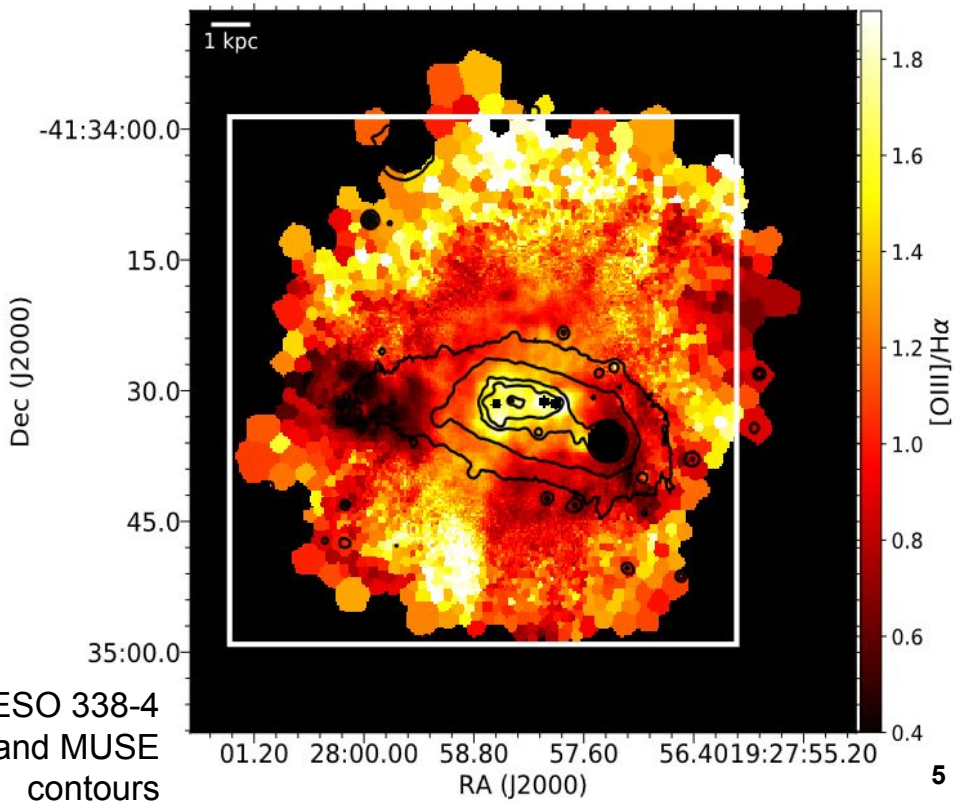
Bik et al. 2018, Lehmer et al. 2024

ESO 338-4 | Blue Compact Dwarf Galaxy with HST

- Large population of young (<10 Myr) super-star clusters with Wolf-Rayet features. Most massive of which cluster 23 (~$10^7 M_\odot$)

- Observed $L_{HeII} \approx 2 \cdot 10^{39}$ erg·s^{-1}. Considering both broad (star) and narrow (nebula) emission of the HeII 4686 line from MUSE data



Ionization map ESO 338-4
Black: I-Band MUSE contours

Bik et al. 2018

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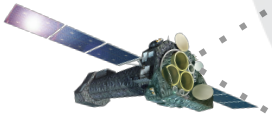

Chandra

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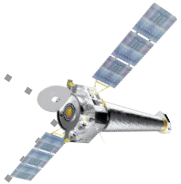

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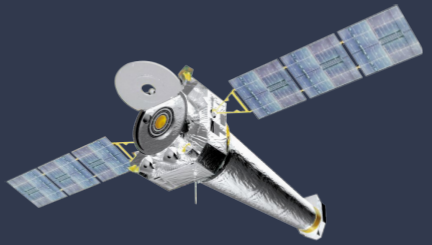
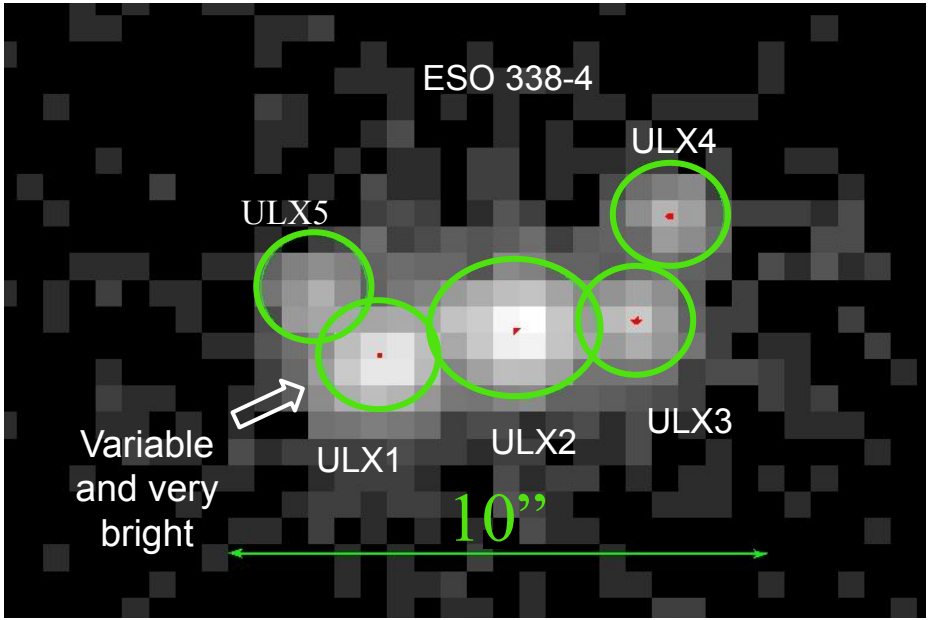
Chandra | Imaging of ESO 338-4



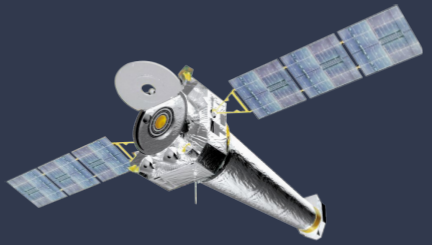
- General
  - 1 pixel ≈ 0.5”
  - Energies between 0.5-7 keV (~1.8-25 Å).
    BUT weak soft response.
  - Full Chandra FoV allows for astrometry with Gaia

- For ESO 338-4 Chandra:
  - **Detects 5 ULX!**
    1 very bright and variable.
  - **Detects local diffuse emission!**

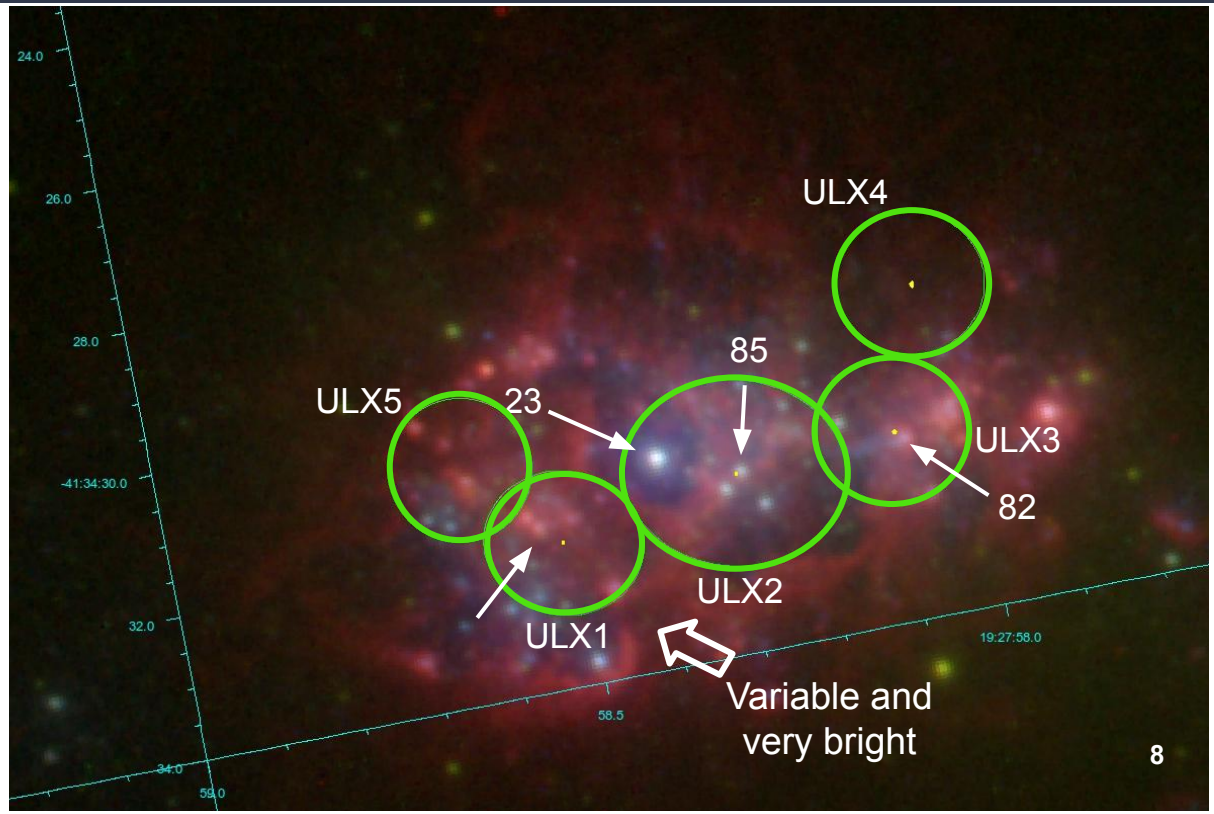


GREEN: ellipse enclosing 3σ of the photons associated with the source
RED: ULX location

Chandra | Optical Counterparts



- ULX - Super star cluster association for ULX2, 3, and possibly 5
- No XRB located at cluster 23!
- Nearest cluster for ULX1 is 0.3” equal to ≈ 0.2 kpc



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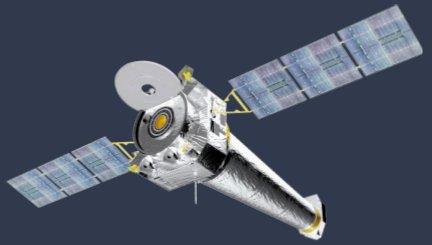

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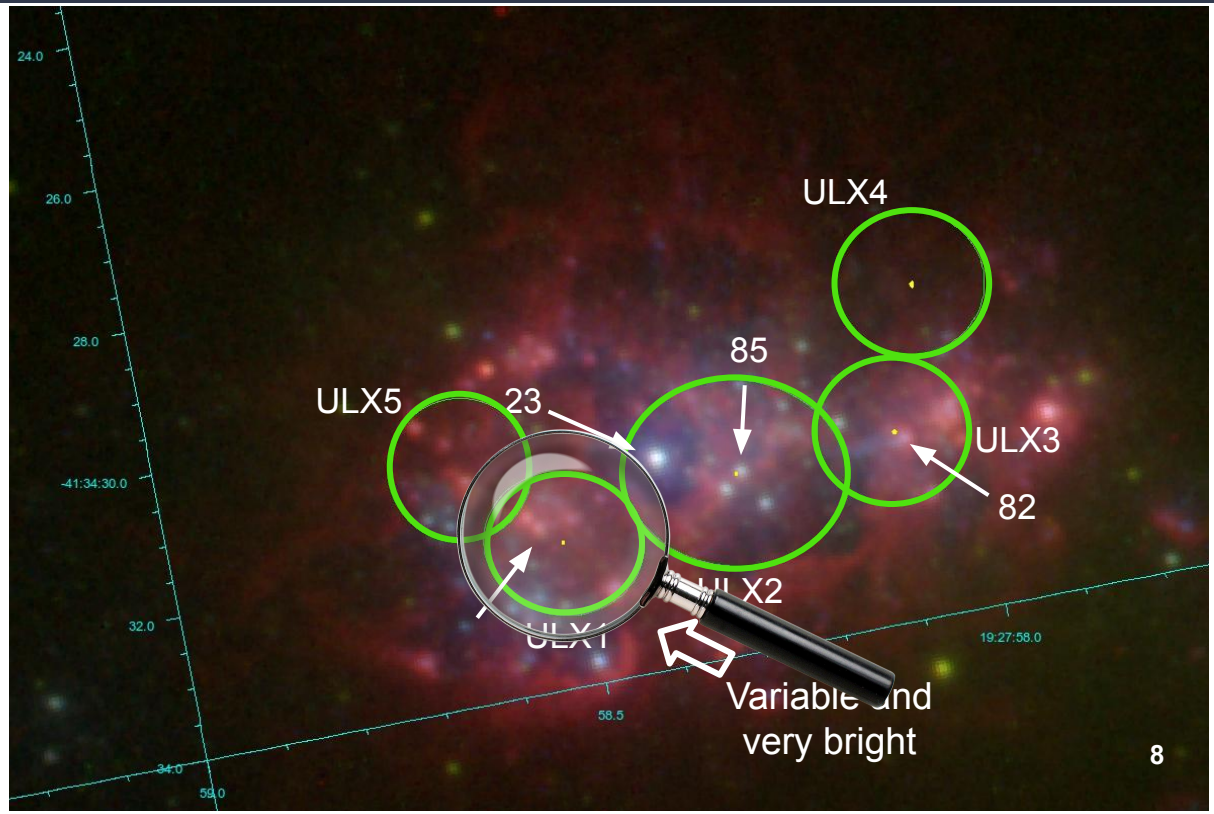

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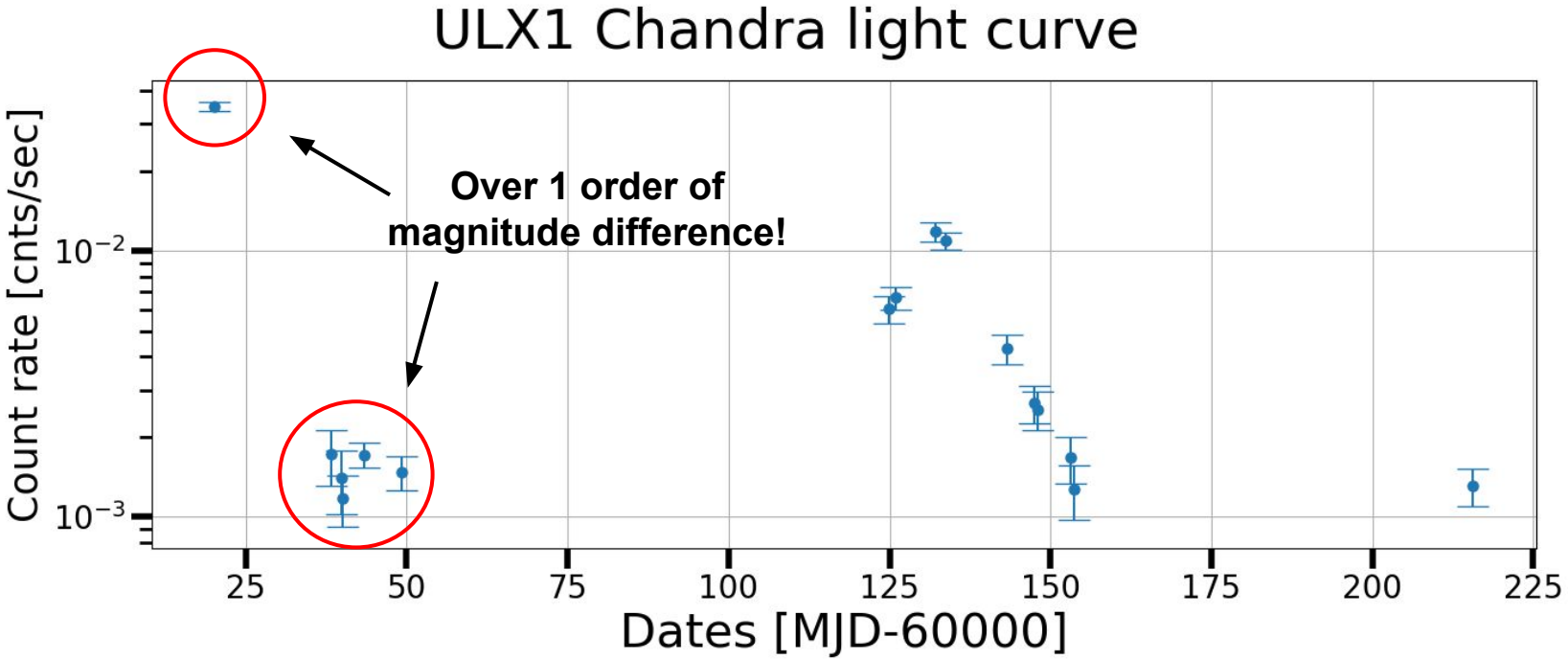
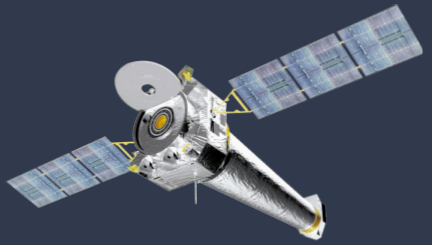


In our analysis we take the average.
BUT the true average might be higher!
Meaning a brighter than thought source.

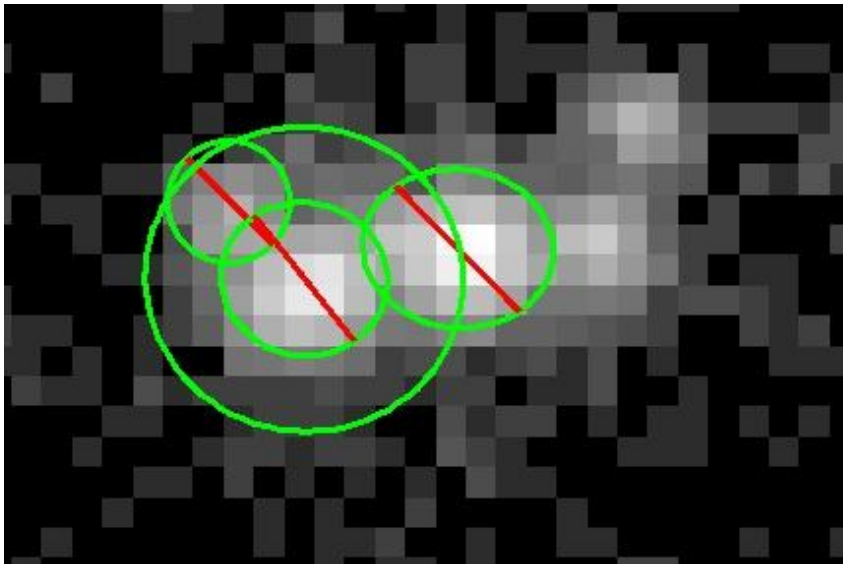
Chandra | Spectral Analysis



- Chandra allows us to fit models to both the ULX emission **AND** the *local* diffuse emission

- ULX@ model components:
  galactic absorption ✖
  intrinsic absorption ✖ ULX@ model

- Diffuse model components:
  galactic absorption ✖
  collisionally-ionized diffuse gas



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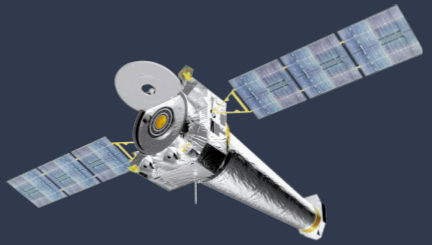
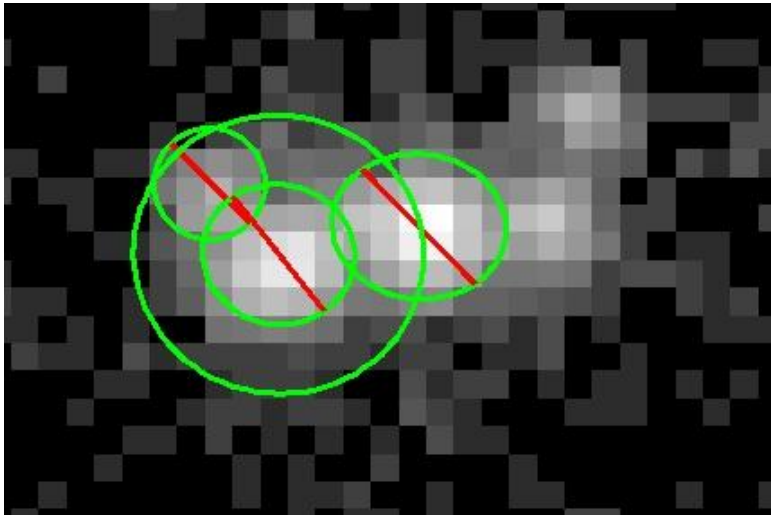


ULX1 model test cases:

- Powerlaw:
  Frequent first step in ULX analysis.

- 2 multicolor black-body disks:
  Approximates disk+corona

- Multicolor black-body disks with power-law dependence for disk temperature T(r):
  Description of “Broad” 1 component continuum spectra



All statistically viable.
We need XMM to choose!

Kaaret et al. 2017

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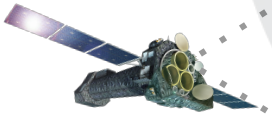

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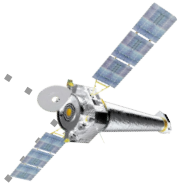

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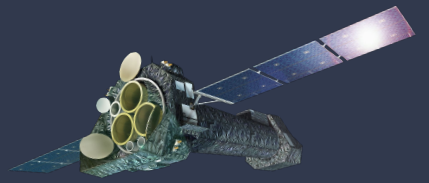
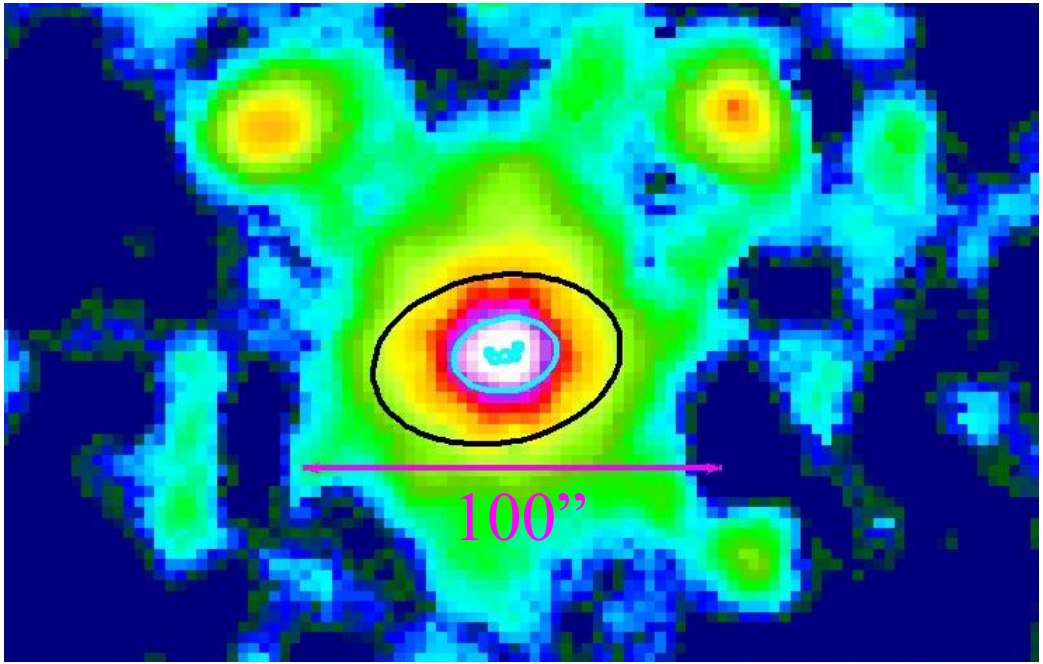
XMM-Newton | Imaging of ESO 338-4



- General
  - Image: EPIC cameras PN, MOS1, MOS2 merged and background corrected
  - Lower mirror resolution than Chandra → 5 ULX became blended
- For ESO 338-4 XMM-Newton:
  - **<u>Supplements Chandra below 1 keV</u>**
  - **<u>Detects galactic Halo!</u>**
    $L_X \approx 8.6 \cdot 10^{40}$ erg·s^{-1}
    and <kT> ≈ 2.5 keV



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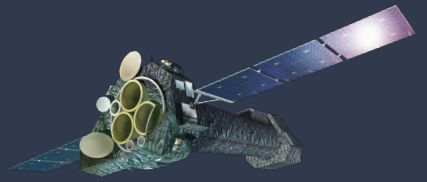
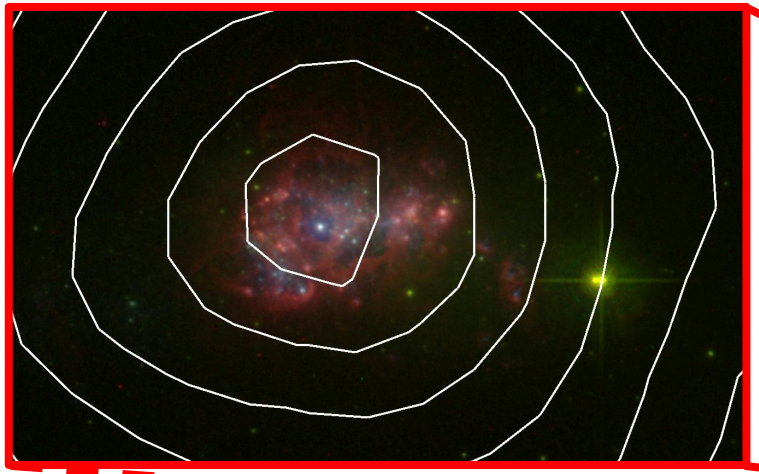
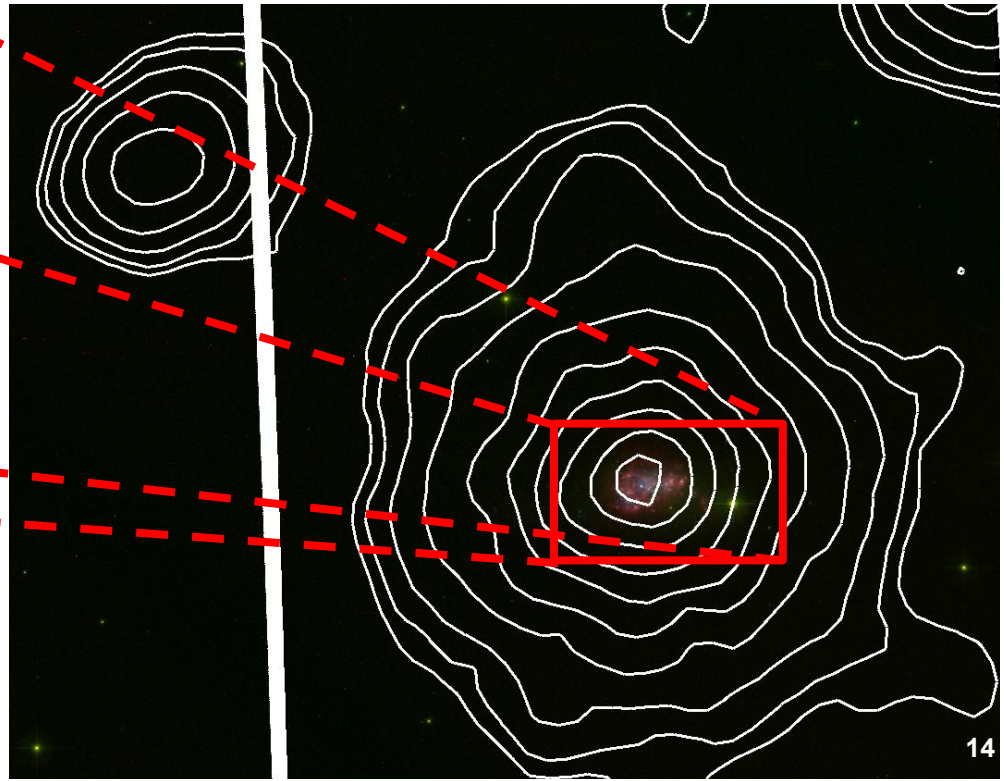






Galaxy Filled with diffuse X-rays beyond the optical extent!

10 Contours from
10 to 1000 counts

XMM-Newton | Spectral Analysis Below 1keV

Chandra Modelling

+

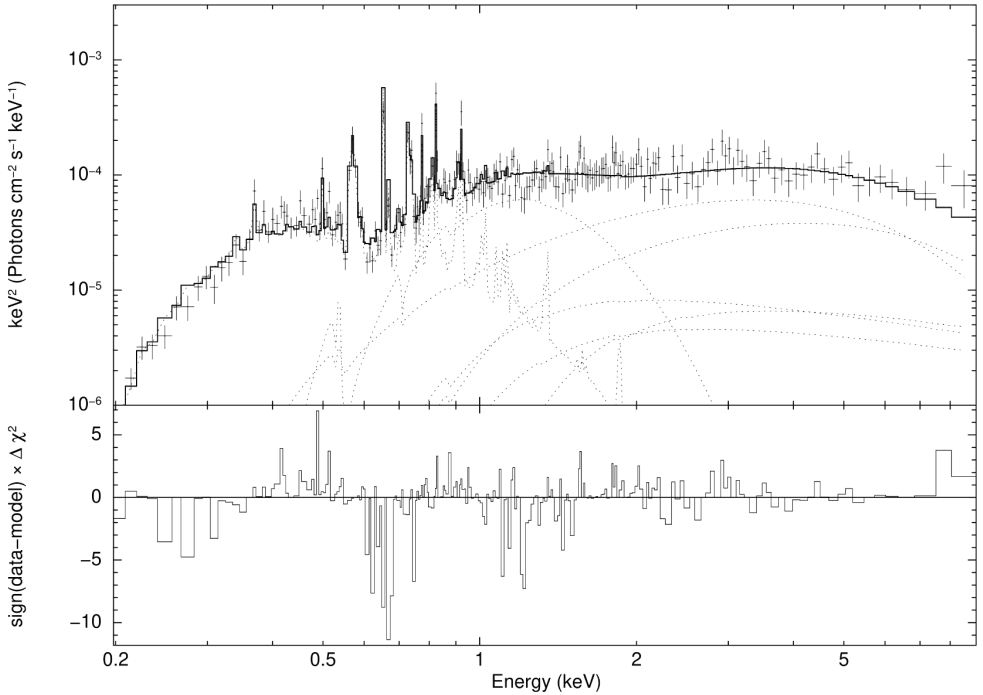
XMM info below 1 keV

+

XMM info on galactic halo

=

Construct a complex X-ray model of the galaxy



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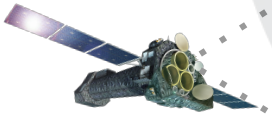

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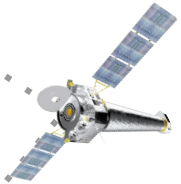

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Bottom Line: X-rays in low-metallicity are too important to be overlooked

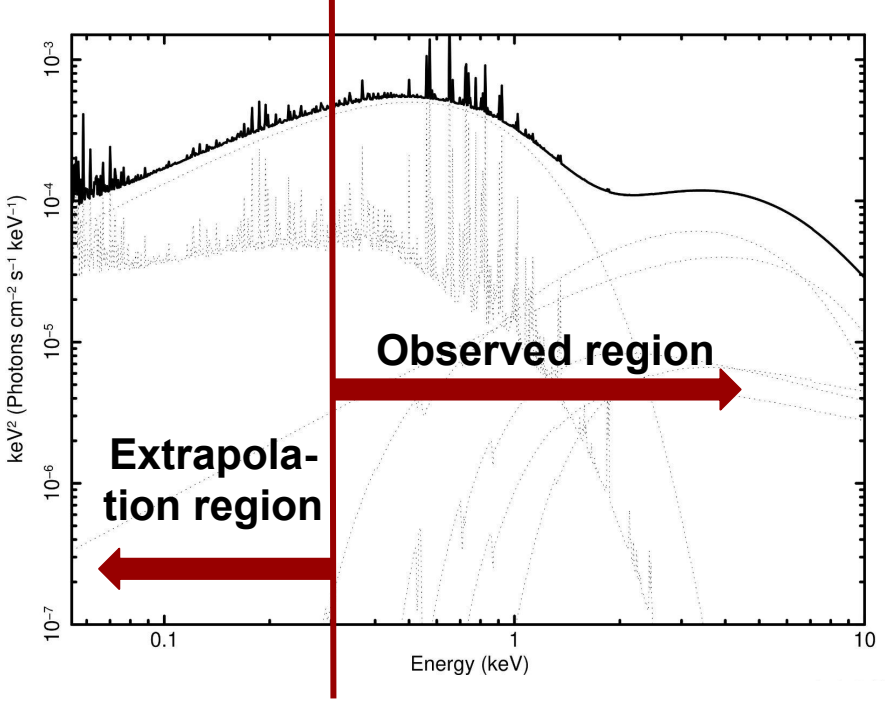
- Removing Galactic (and intrinsic) absorption we can estimate:

  $L_X^{0.054\text{-}0.25keV} \approx 0.24\ (1.1) \cdot 10^{41}$ erg·s^{-1} ➡

  Number of ionizing photons 3.2 (16)·10^{50} ph·s^{-1} ➡

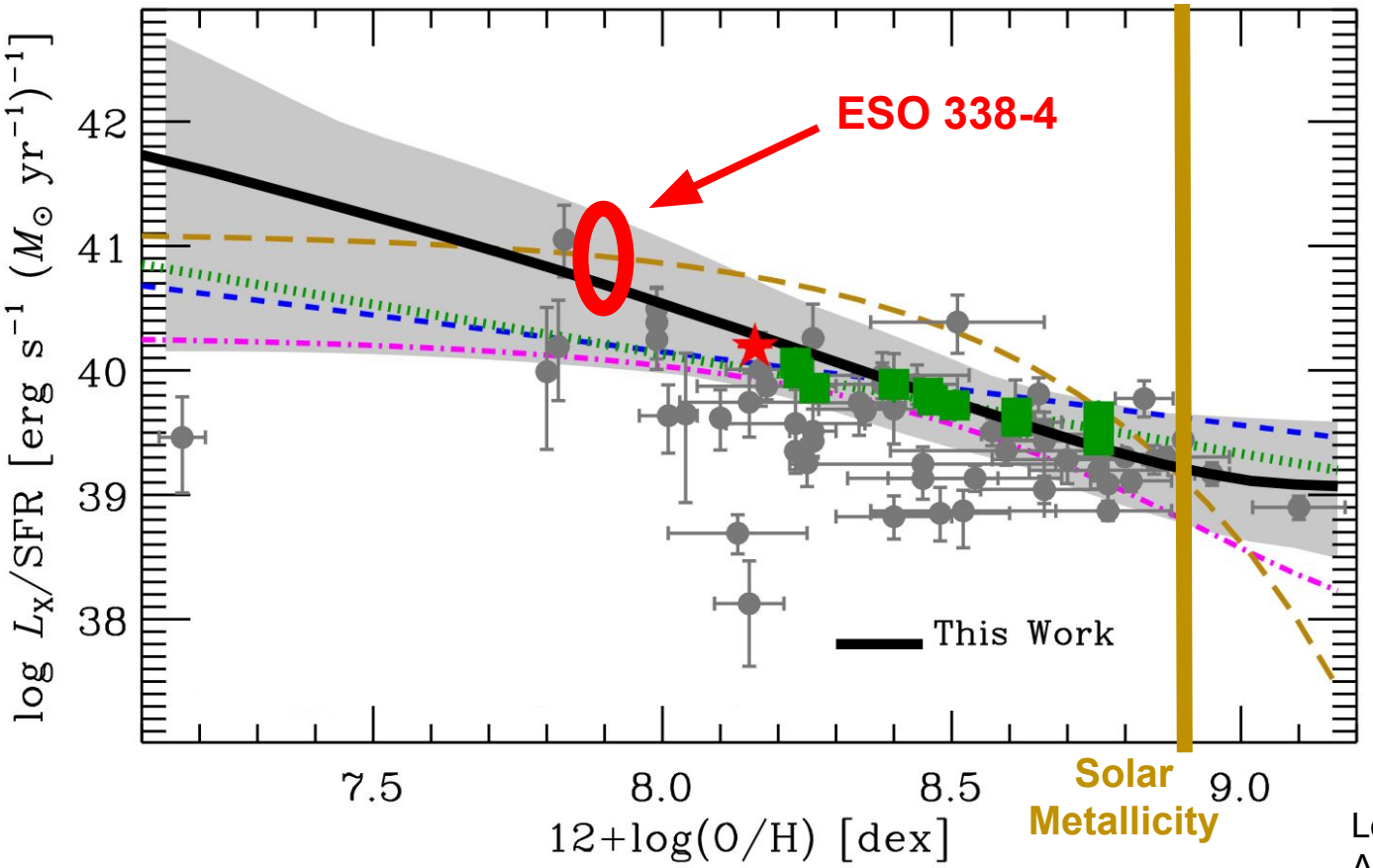
  Back-of-the-envelope estimate
  L_{HeII}=1.1 (5.4)·10^{39} erg·s^{-1}

- $L_{HeII}^{obs} \approx 2 \cdot 10^{39}$ erg·s^{-1}.
  Combined broad+narrow HeII 4686 emission from MUSE data.



Extrapolating our model to lower energies produces photons capable of ionizing HeII in the galaxy!

Ionizing Photon Flux | Extrapolating to HeII Edge



Lehmer et al. 2024,
Asplund et. al 2009

X-rays in Low-Metallicity Galaxies | L_X/SFR vs. Metallicity

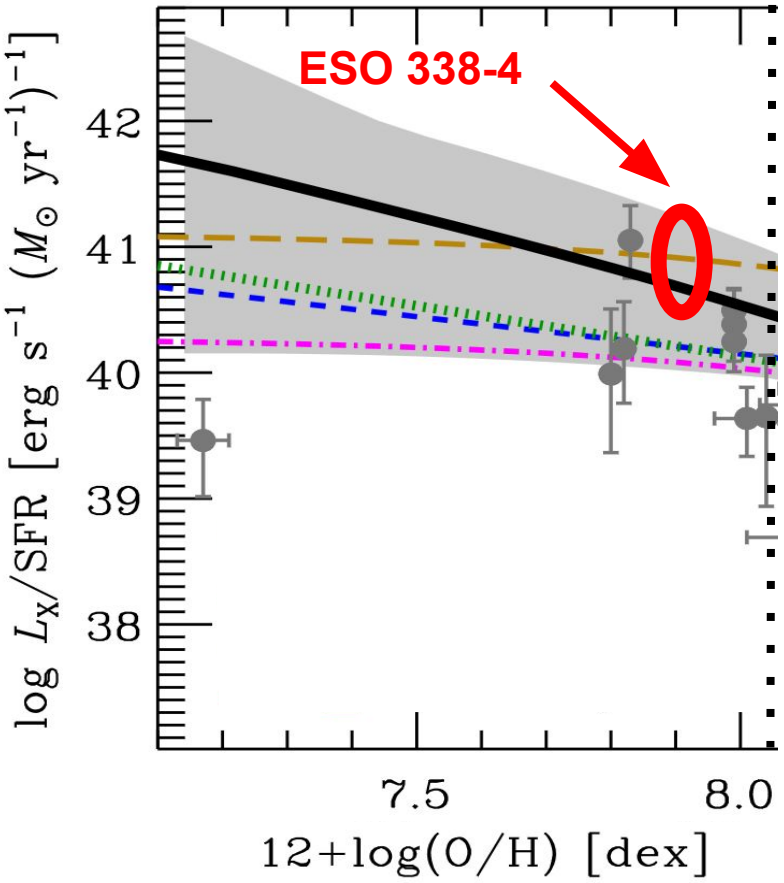
Generally:

- X-ray contents in low-metallicity galaxies higher than initially thought

For ESO 338-4:

- $L_X/SFR \approx (0.5\text{-}3.3)\cdot 10^{41}$ erg·s^{-1}/$M_\odot$·yr^{-1}. Above average!
- Values possibly are higher since ULX1 is variable.

ESO 338-4: shows how low-metallicity galaxies can feature luminous X-ray sources contributing significantly to the radiative content of the galaxy

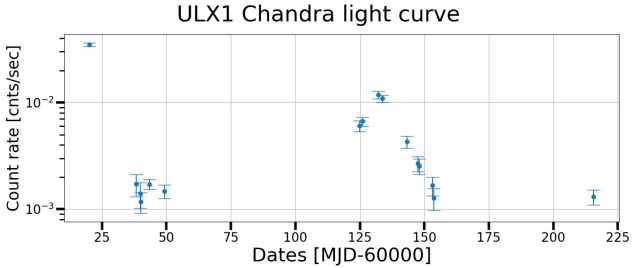


X-rays in Low-Metallicity Galaxies | L_X/SFR vs. Metallicity

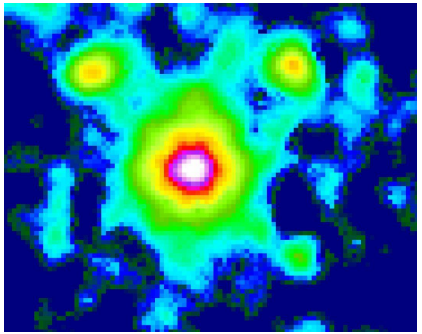
Estimate of HeII ionizing photons

- Number of photons between $(3.2\text{-}16)\cdot10^{50}$ ph·s^{-1}
- Expected luminosity $L_{HeII}=(1.1\text{-}5.4)\cdot10^{39}$ erg·s^{-1} . Comparable to observations.

ULX variability can lead to an even higher X-ray contribution



Galaxy filled with X-rays beyond the optical extent



X-rays in low-metallicity galaxies

- L_X/SFR≈$(0.5\text{-}3.3)\cdot10^{41}$ erg·s^{-1}/M$_\odot$·yr^{-1}
- Low-metallicity starburst galaxies feature a significant number of X-ray producing sources

Bottom Line | Summary

Estimate of HeII ionizing photons

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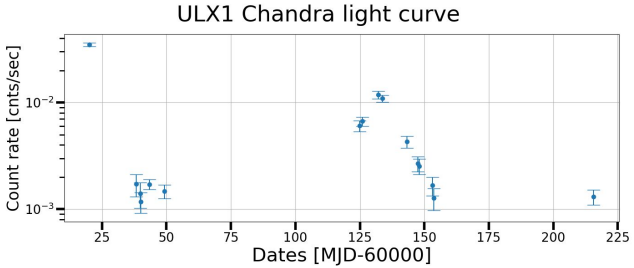
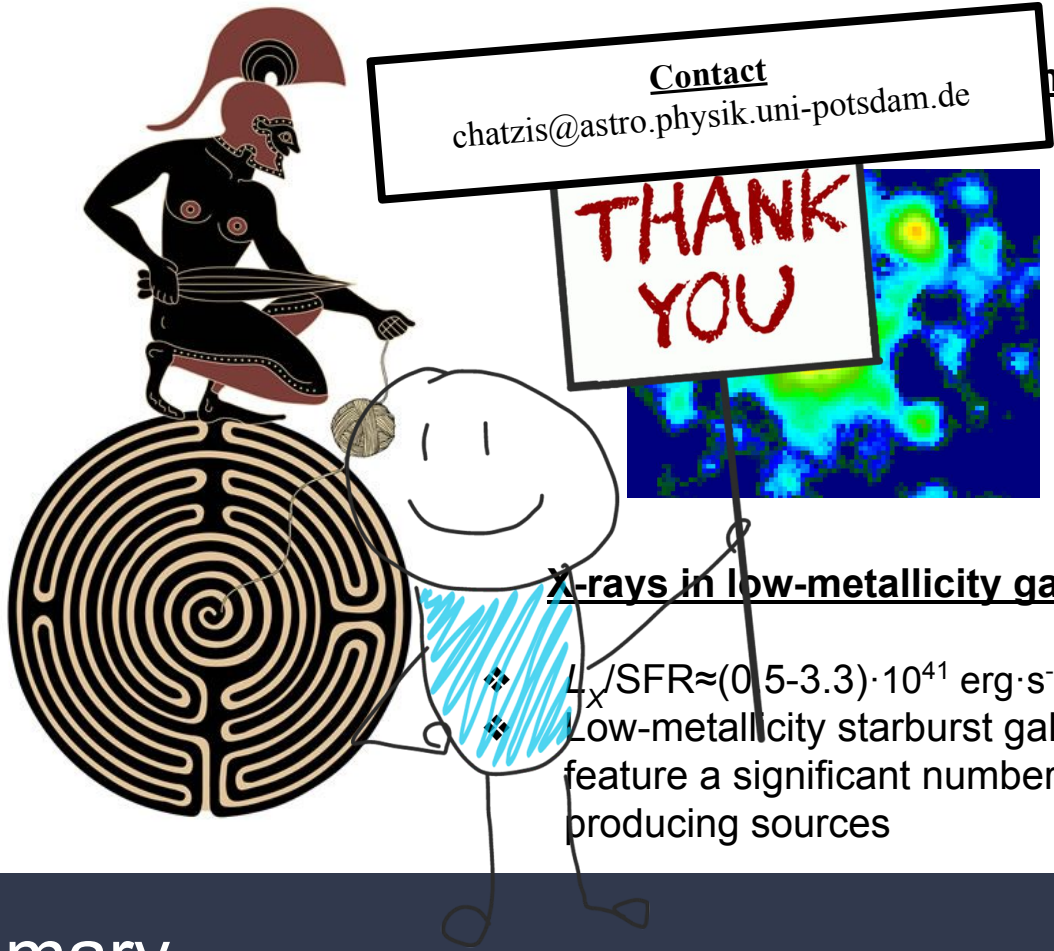


Contact
chatzis@astro.physik.uni-potsdam.de



nd the

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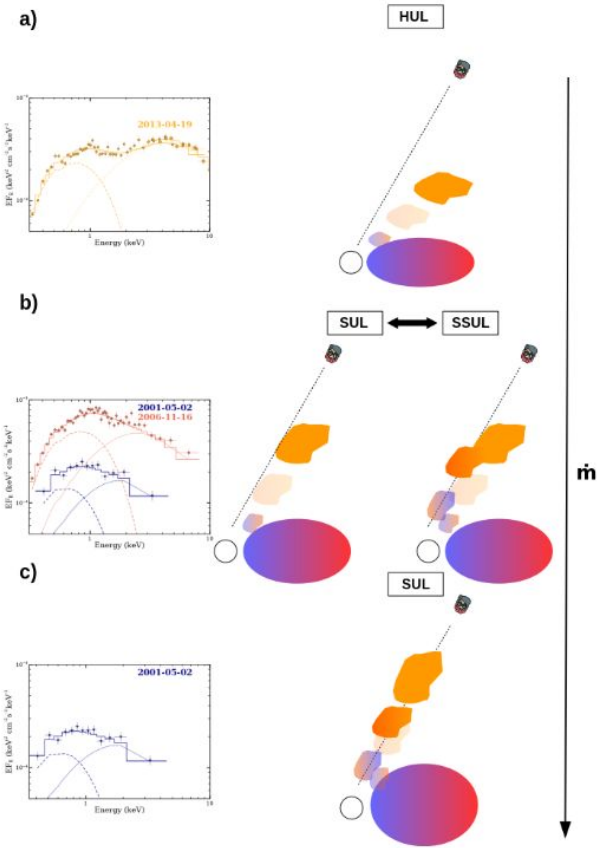
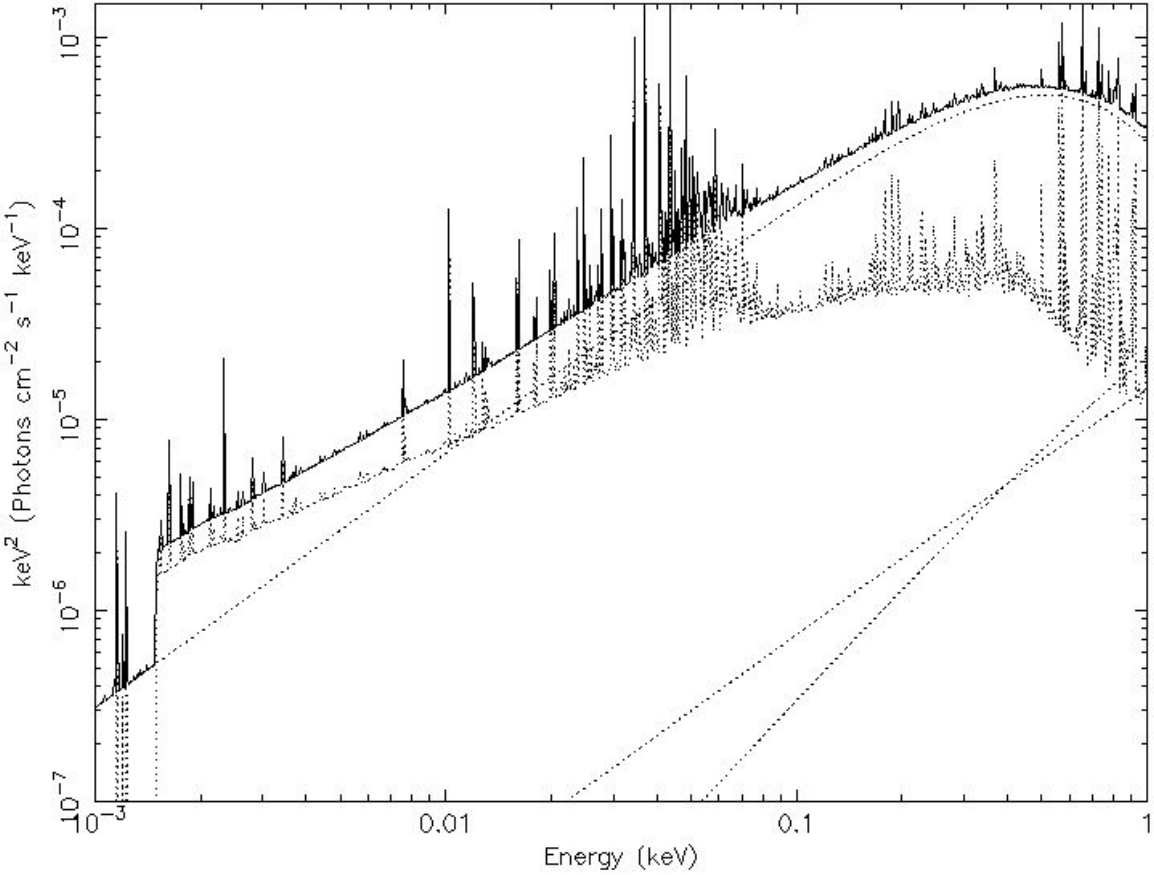
Bottom Line | Summary

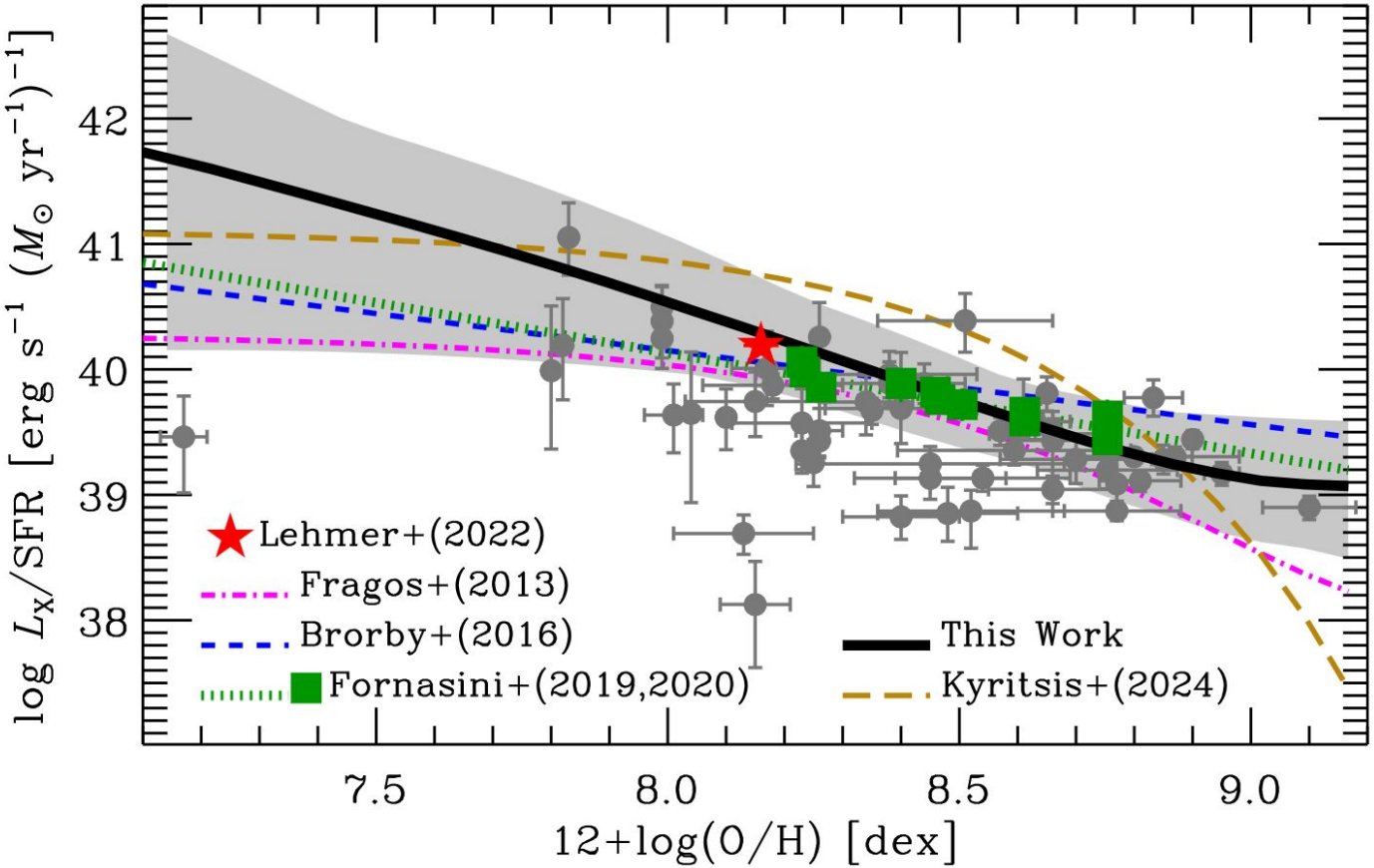
Backup Slides

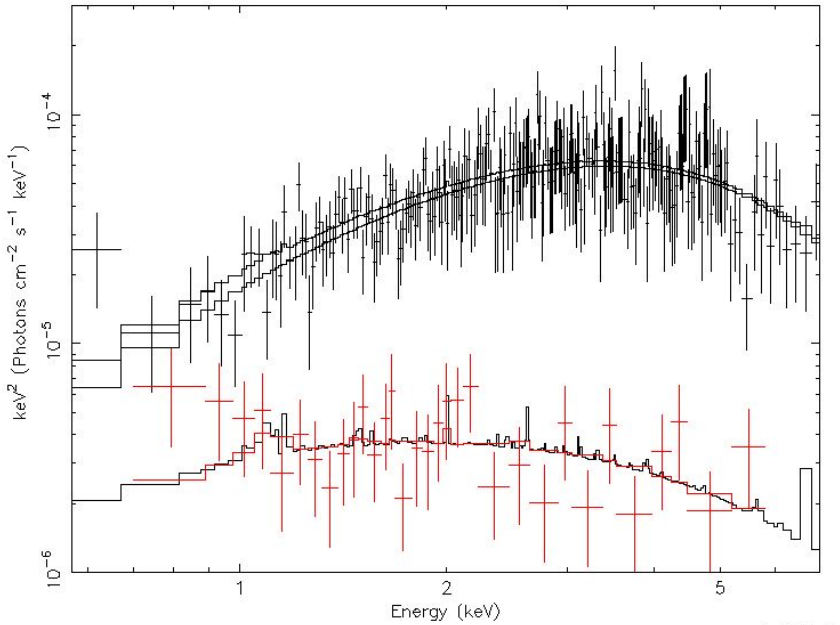


ULX Line of Sight problem



Model 1eV-1keV


log L_X/SFR [erg s^{-1} ($M_\odot$ yr^{-1})$^{-1}$]
42
41
40
39
38
7.5
8.0
8.5
9.0
12+log(O/H) [dex]
Lehmer+(2022)
Fragos+(2013)
Brorby+(2016)
Fornasini+(2019,2020)
This Work
Kyritsis+(2024)



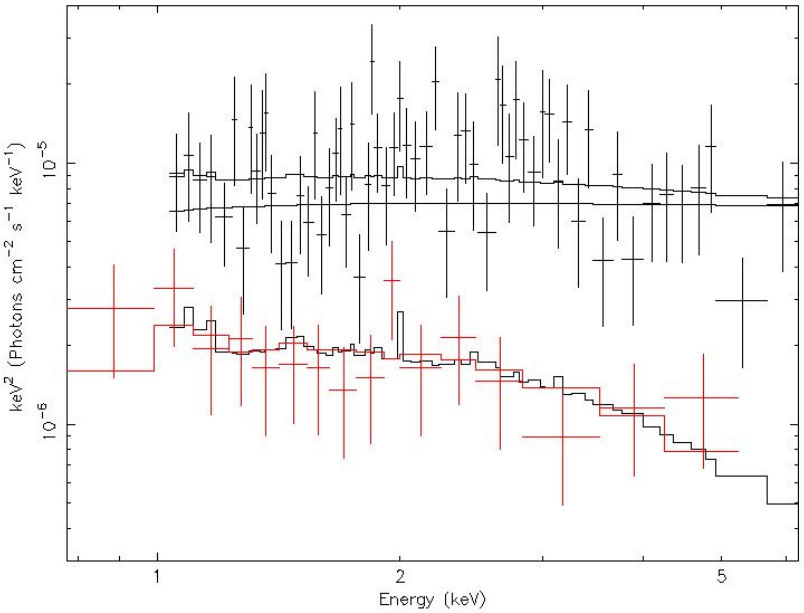

```
========================================================================
Model TBabs<1>*diskpbb<2> Source No.: 1   Active/On
Model Model Component  Parameter  Unit     Value
 par  comp
                            Data group: 1
   1    1   TBabs       nH         10^22    5.00000E-02  frozen
   2    2   diskpbb     Tin        keV      1.28402      +/-  9.72267E-02
   3    2   diskpbb     p                   1.00000      +/-  0.364494
   4    2   diskpbb     norm                5.66168E-03  +/-  3.51983E-03
                            Data group: 2
   5    1   TBabs       nH         10^22    5.00000E-02  = p1
   6    2   diskpbb     Tin        keV      1.28402      = p2
   7    2   diskpbb     p                   1.00000      = p3
   8    2   diskpbb     norm                0.0          frozen
------------------------------------------------------------------------

========================================================================
Model myback:TBabs<1>*apec<2> Source No.: 2   Active/On
Model Model Component  Parameter  Unit     Value
 par  comp
                            Data group: 1
   1    1   TBabs       nH         10^22    5.00000E-02  = p1
   2    2   apec        kT         keV      2.52922      +/-  0.401414
   3    2   apec        Abundanc            0.120000     frozen
   4    2   apec        Redshift            0.0          frozen
   5    2   apec        norm                1.41967E-05  +/-  1.59500E-06
                            Data group: 2
   6    1   TBabs       nH         10^22    5.00000E-02  = myback:p1
   7    2   apec        kT         keV      2.52922      = myback:p2
   8    2   apec        Abundanc            0.120000     = myback:p3
   9    2   apec        Redshift            0.0          = myback:p4
  10    2   apec        norm                1.41967E-05  = myback:p5
------------------------------------------------------------------------

Fit statistic  : C-Statistic                  193.45     using 239 bins, spectrum 1, group 1.
                 C-Statistic                   26.12     using 32 bins, spectrum 2, group 2.
Total fit statistic                          219.57     with 266 d.o.f.

Test statistic : Chi-Squared                 229.44     using 271 bins.
 Null hypothesis probability of 9.49e-01 with 266 degrees of freedom
```

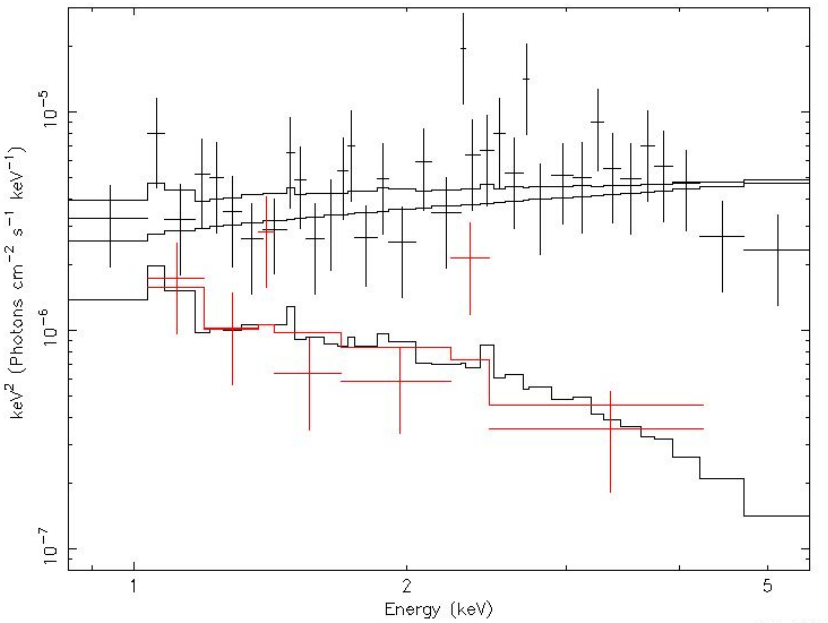
ULX2 Chandra spectrum




```
========================================================================
Model TBabs<1>*powerlaw<2>*TBabs<3> Source No.: 1   Active/On
Model Model Component  Parameter  Unit     Value
 par  comp
                            Data group: 1
   1    1   TBabs      nH          10^22    5.00000E-02  frozen
   2    2   powerlaw   PhoIndex             2.03657      +/-  0.158821
   3    2   powerlaw   norm                 7.33562E-06  +/-  1.07441E-06
   4    3   TBabs      nH          10^22    0.0          frozen
                            Data group: 2
   5    1   TBabs      nH          10^22    5.00000E-02  = p1
   6    2   powerlaw   PhoIndex             2.03657      = p2
   7    2   powerlaw   norm                 0.0          frozen
   8    3   TBabs      nH          10^22    0.0          = p4
------------------------------------------------------------------------

========================================================================
Model myback:TBabs<1>*apec<2> Source No.: 2   Active/On
Model Model Component  Parameter  Unit     Value
 par  comp
                            Data group: 1
   1    1   TBabs      nH          10^22    5.00000E-02  = p1
   2    2   apec       kT          keV      1.91041      +/-  0.339159
   3    2   apec       Abundanc             0.120000     frozen
   4    2   apec       Redshift             0.0          frozen
   5    2   apec       norm                 8.17166E-06  +/-  1.22987E-06
                            Data group: 2
   6    1   TBabs      nH          10^22    5.00000E-02  = myback:p1
   7    2   apec       kT          keV      1.91041      = myback:p2
   8    2   apec       Abundanc             0.120000     = myback:p3
   9    2   apec       Redshift             0.0          = myback:p4
  10    2   apec       norm                 8.17166E-06  = myback:p5
------------------------------------------------------------------------
```

ULX3 Chandra spectrum



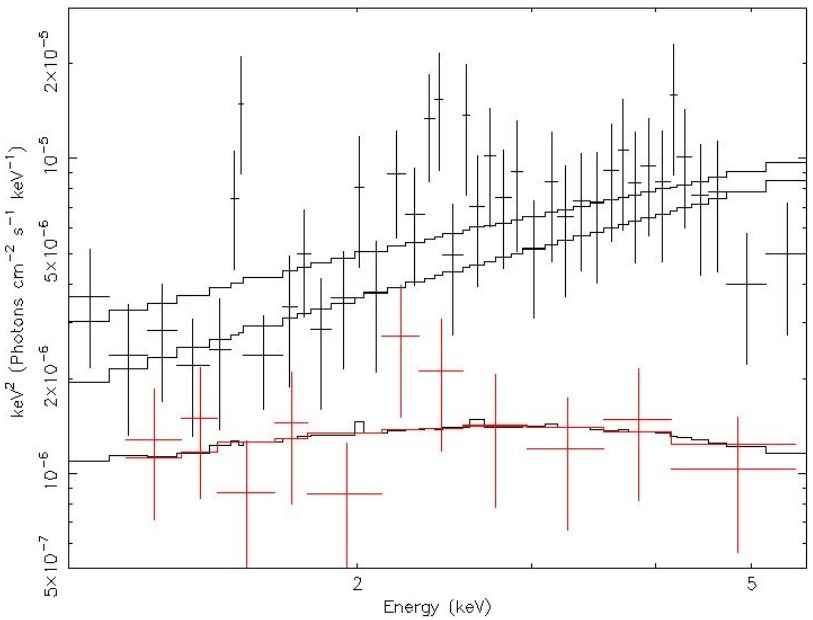

```
========================================================================
Model TBabs<1>*powerlaw<2>*TBabs<3> Source No.: 1   Active/On
Model Model Component  Parameter  Unit     Value
 par  comp
                            Data group: 1
   1    1   TBabs      nH          10^22    5.00000E-02  frozen
   2    2   powerlaw   PhoIndex             1.72779      +/-  0.230439
   3    2   powerlaw   norm                 3.04065E-06  +/-  6.71144E-07
   4    3   TBabs      nH          10^22    0.0          frozen
                            Data group: 2
   5    1   TBabs      nH          10^22    5.00000E-02  = p1
   6    2   powerlaw   PhoIndex             1.72779      = p2
   7    2   powerlaw   norm                 0.0          frozen
   8    3   TBabs      nH          10^22    0.0          = p4
```

```
========================================================================
Model myback:TBabs<1>*apec<2> Source No.: 2   Active/On
Model Model Component  Parameter  Unit     Value
 par  comp
                            Data group: 1
   1    1   TBabs      nH          10^22    5.00000E-02  = p1
   2    2   apec       kT          keV      1.33643      +/-  0.325570
   3    2   apec       Abundanc             0.120000     frozen
   4    2   apec       Redshift             0.0          frozen
   5    2   apec       norm                 4.75582E-06  +/-  1.11367E-06
                            Data group: 2
   6    1   TBabs      nH          10^22    5.00000E-02  = myback:p1
   7    2   apec       kT          keV      1.33643      = myback:p2
   8    2   apec       Abundanc             0.120000     = myback:p3
   9    2   apec       Redshift             0.0          = myback:p4
  10    2   apec       norm                 4.75582E-06  = myback:p5
```

```
Fit statistic  : C-Statistic                  36.22     using 36 bins, spectrum 1, group 1.
                 C-Statistic                   9.70     using 7 bins, spectrum 2, group 2.
Total fit statistic                          45.92     with 39 d.o.f.

Test statistic : Chi-Squared                 40.70     using 43 bins.
 Null hypothesis probability of 3.96e-01 with 39 degrees of freedom
```

ULX4 Chandra spectrum



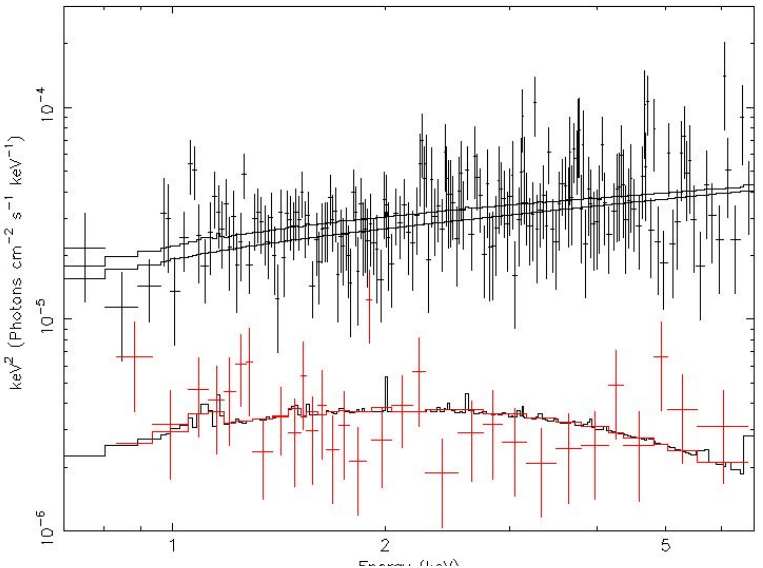

```
========================================================================
Model TBabs<1>*powerlaw<2>*TBabs<3> Source No.: 1   Active/On
Model Model Component  Parameter  Unit     Value
 par  comp
                            Data group: 1
   1    1   TBabs      nH         10^22    5.00000E-02  frozen
   2    2   powerlaw   PhoIndex             1.15369      +/-  0.237002
   3    2   powerlaw   norm                 2.04111E-06  +/-  5.24608E-07
   4    3   TBabs      nH         10^22    0.0          frozen
                            Data group: 2
   5    1   TBabs      nH         10^22    5.00000E-02  = p1
   6    2   powerlaw   PhoIndex             1.15369      = p2
   7    2   powerlaw   norm                 0.0          frozen
   8    3   TBabs      nH         10^22    0.0          = p4
------------------------------------------------------------------------

========================================================================
rce No.: 2   Active/Onapec<2> Sou
Model Model Component  Parameter  Unit     Value
 par  comp
                            Data group: 1
   1    1   TBabs      nH         10^22    5.00000E-02  = p1
   2    2   apec       kT         keV      4.05982      +/-  2.14117
   3    2   apec       Abundanc             0.120000     frozen
   4    2   apec       Redshift             0.0          frozen
   5    2   apec       norm                 4.34244E-06  +/-  9.45251E-07
                            Data group: 2
   6    1   TBabs      nH         10^22    5.00000E-02  = myback:p1
   7    2   apec       kT         keV      4.05982      = myback:p2
   8    2   apec       Abundanc             0.120000     = myback:p3
   9    2   apec       Redshift             0.0          = myback:p4
  10    2   apec       norm                 4.34244E-06  = myback:p5
------------------------------------------------------------------------

Fit statistic  : C-Statistic                   46.83     using 40 bins, spectrum 1, group 1.
                 C-Statistic                    5.26     using 11 bins, spectrum 2, group 2.
Total fit statistic                            52.09     with 47 d.o.f.

Test statistic : Chi-Squared                   49.77     using 51 bins.
 Null hypothesis probability of 3.64e-01 with 47 degrees of freedom
```

ULX5 Chandra spectrum

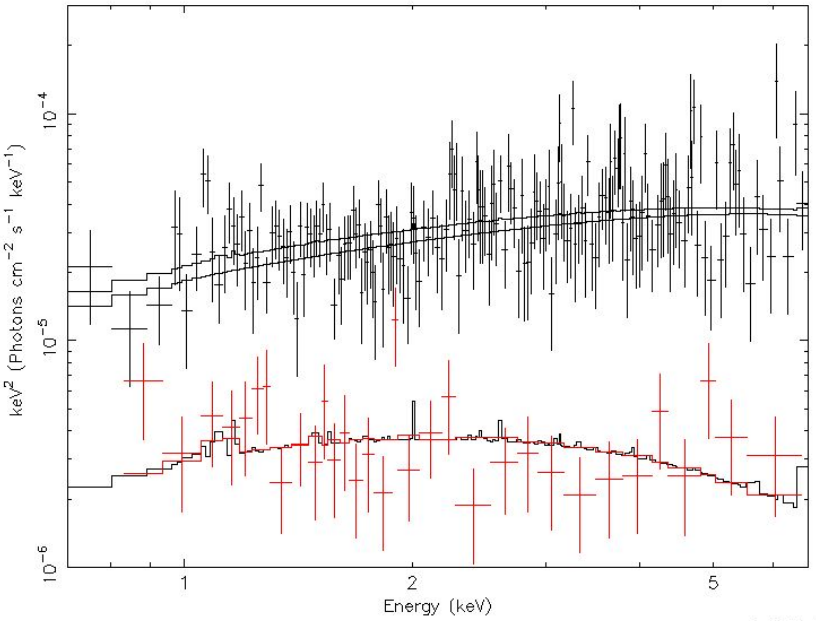



```
========================================================================
Model TBabs<1>*powerlaw<2> Source No.: 1   Active/On
Model Model Component  Parameter  Unit     Value
 par  comp
                          Data group: 1
   1    1   TBabs      nH         10^22    5.00000E-02  frozen
   2    2   powerlaw   PhoIndex            1.66833      +/-  6.26511E-02
   3    2   powerlaw   norm                2.17151E-05  +/-  1.37364E-06
                          Data group: 2
   4    1   TBabs      nH         10^22    5.00000E-02  = p1
   5    2   powerlaw   PhoIndex            1.66833      = p2
   6    2   powerlaw   norm                0.0          frozen
------------------------------------------------------------------------
```

```
========================================================================
Model myback:TBabs<1>*apec<2> Source No.: 2   Active/On
Model Model Component  Parameter  Unit     Value
 par  comp
                          Data group: 1
   1    1   TBabs      nH         10^22    5.00000E-02  = p1
   2    2   apec       kT         keV      2.99857      +/-  0.497500
   3    2   apec       Abundanc            0.120000     frozen
   4    2   apec       Redshift            0.0          frozen
   5    2   apec       norm                1.31291E-05  +/-  1.44064E-06
                          Data group: 2
   6    1   TBabs      nH         10^22    5.00000E-02  = myback:p1
   7    2   apec       kT         keV      2.99857      = myback:p2
   8    2   apec       Abundanc            0.120000     = myback:p3
   9    2   apec       Redshift            0.0          = myback:p4
  10    2   apec       norm                1.31291E-05  = myback:p5
------------------------------------------------------------------------
```

```
Fit statistic  : C-Statistic                196.07     using 182 bins, spectrum 1, group 1.
                 C-Statistic                 34.01     using 32 bins, spectrum 2, group 2.
Total fit statistic                         230.07     with 210 d.o.f.

Test statistic : Chi-Squared                224.18     using 214 bins.
 Null hypothesis probability of 2.39e-01 with 210 degrees of freedom
```



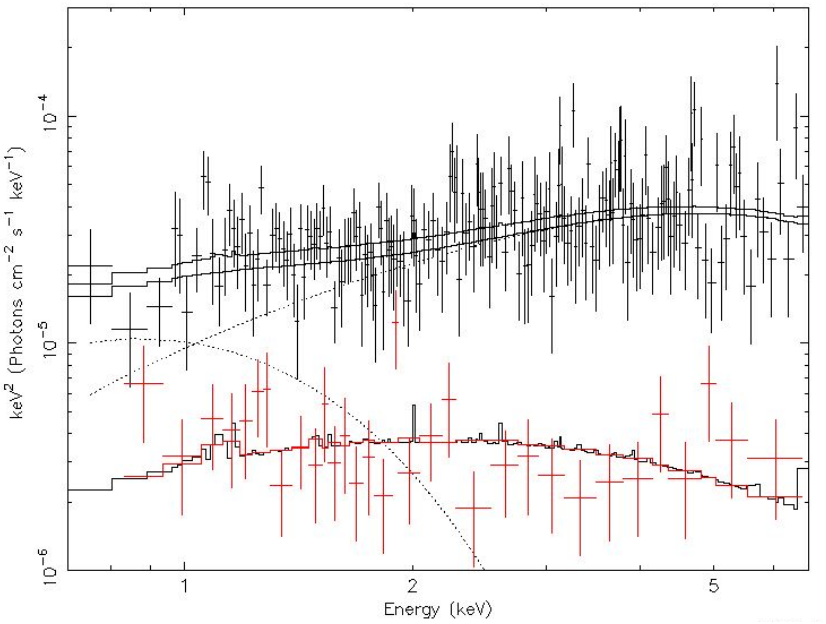

```
========================================================================
Model TBabs<1>*diskpbb<2> Source No.: 1   Active/On
Model Model Component  Parameter  Unit     Value
 par  comp
                            Data group: 1
   1    1   TBabs      nH         10^22    5.00000E-02  frozen
   2    2   diskpbb    Tin        keV      3.30124      +/-  1.55065
   3    2   diskpbb    p                   0.563637     +/-  2.38282E-02
   4    2   diskpbb    norm                2.06336E-05  +/-  4.11967E-05
                            Data group: 2
   5    1   TBabs      nH         10^22    5.00000E-02  = p1
   6    2   diskpbb    Tin        keV      3.30124      = p2
   7    2   diskpbb    p                   0.563637     = p3
   8    2   diskpbb    norm                0.0          frozen
------------------------------------------------------------------------

========================================================================
Model myback:TBabs<1>*apec<2> Source No.: 2   Active/On
Model Model Component  Parameter  Unit     Value
 par  comp
                            Data group: 1
   1    1   TBabs      nH         10^22    5.00000E-02  = p1
   2    2   apec       kT         keV      2.98110      +/-  0.492712
   3    2   apec       Abundanc            0.120000     frozen
   4    2   apec       Redshift            0.0          frozen
   5    2   apec       norm                1.31558E-05  +/-  1.44457E-06
                            Data group: 2
   6    1   TBabs      nH         10^22    5.00000E-02  = myback:p1
   7    2   apec       kT         keV      2.98110      = myback:p2
   8    2   apec       Abundanc            0.120000     = myback:p3
   9    2   apec       Redshift            0.0          = myback:p4
  10    2   apec       norm                1.31558E-05  = myback:p5
------------------------------------------------------------------------


Fit statistic  : C-Statistic                  195.98     using 182 bins, spectrum 1, group 1.
                 C-Statistic                   34.01     using 32 bins, spectrum 2, group 2.
Total fit statistic                          229.99     with 209 d.o.f.

Test statistic : Chi-Squared                 222.03     using 214 bins.
 Null hypothesis probability of 2.56e-01 with 209 degrees of freedom
```

ULX1 Chandra spectrum | diskpbb



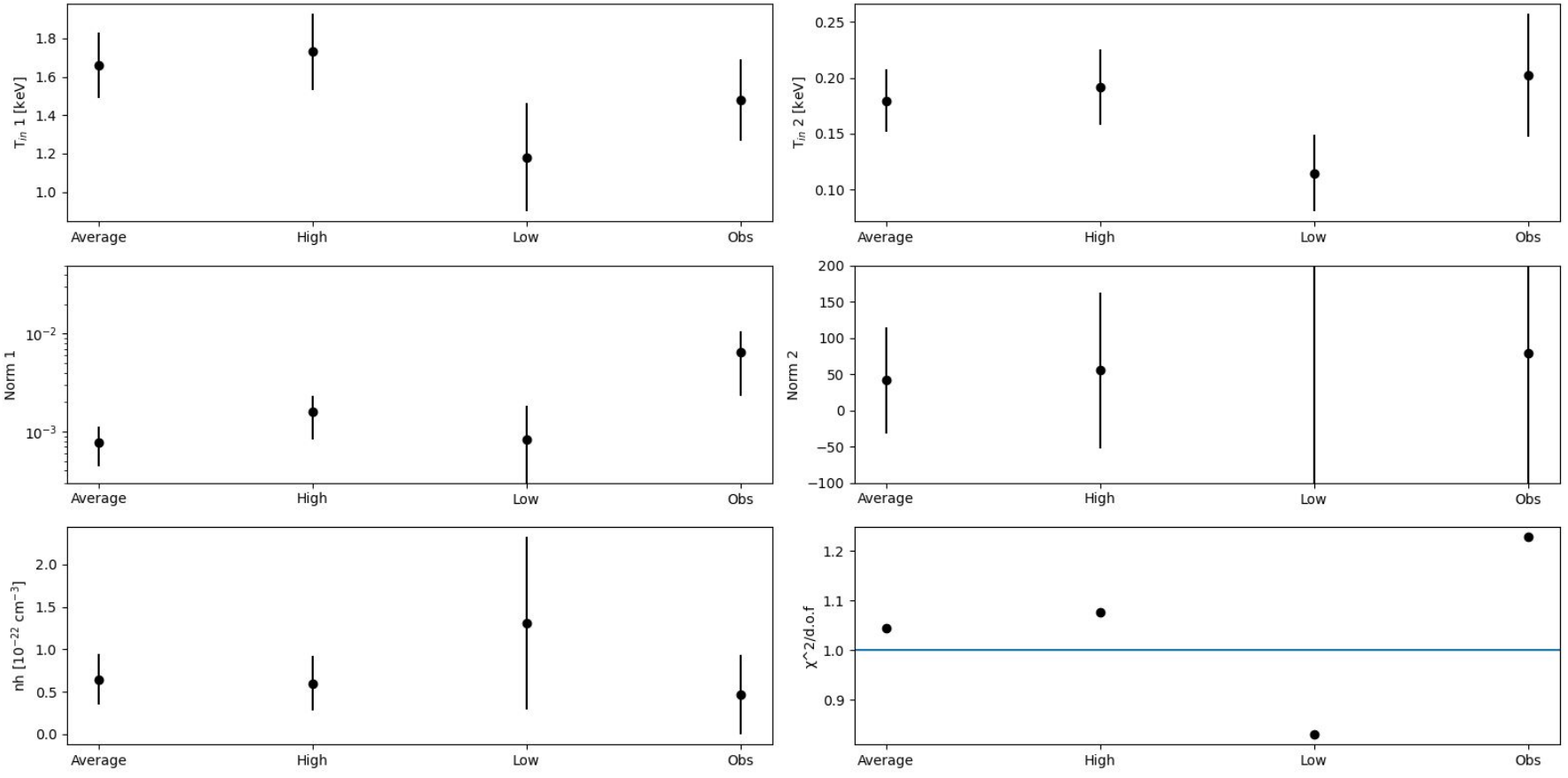

```
========================================================================
Model TBabs<1>(diskbb<2> + diskbb<3>) Source No.: 1   Active/On
Model Model Component  Parameter  Unit     Value
 par  comp
                            Data group: 1
   1    1   TBabs      nH          10^22    5.00000E-02  frozen
   2    2   diskbb     Tin         keV      2.00739      +/-  0.266872
   3    2   diskbb     norm                 3.42342E-04  +/-  1.71452E-04
   4    3   diskbb     Tin         keV      0.305195     +/-  9.38588E-02
   5    3   diskbb     norm                 0.220499     +/-  0.209532
                            Data group: 2
   6    1   TBabs      nH          10^22    5.00000E-02  = p1
   7    2   diskbb     Tin         keV      2.00739      = p2
   8    2   diskbb     norm                 0.0          frozen
   9    3   diskbb     Tin         keV      0.305195     = p4
  10    3   diskbb     norm                 0.0          frozen
```

```
========================================================================
Model myback:TBabs<1>*apec<2> Source No.: 2   Active/On
Model Model Component  Parameter  Unit     Value
 par  comp
                            Data group: 1
   1    1   TBabs      nH          10^22    5.00000E-02  = p1
   2    2   apec       kT          keV      2.99152      +/-  0.496177
   3    2   apec       Abundanc             0.120000     frozen
   4    2   apec       Redshift             0.0          frozen
   5    2   apec       norm                 1.31449E-05  +/-  1.44280E-06
                            Data group: 2
   6    1   TBabs      nH          10^22    5.00000E-02  = myback:p1
   7    2   apec       kT          keV      2.99152      = myback:p2
   8    2   apec       Abundanc             0.120000     = myback:p3
   9    2   apec       Redshift             0.0          = myback:p4
  10    2   apec       norm                 1.31449E-05  = myback:p5
```

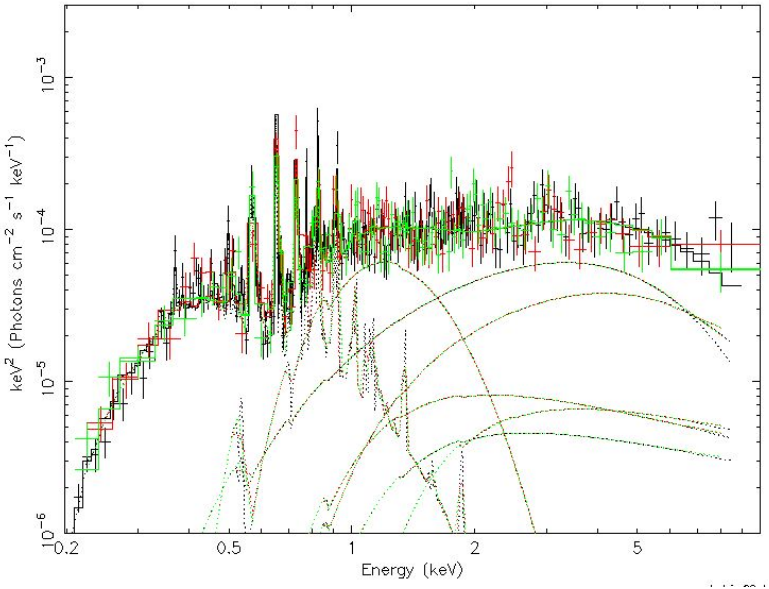
```
Fit statistic  : C-Statistic                192.89     using 182 bins, spectrum 1, group 1.
                 C-Statistic                 34.01     using 32 bins, spectrum 2, group 2.
Total fit statistic                         226.89     with 208 d.o.f.

Test statistic : Chi-Squared                216.81     using 214 bins.
 Null hypothesis probability of 3.23e-01 with 208 degrees of freedom
```

ULX1 Chandra spectrum | diskbb x2



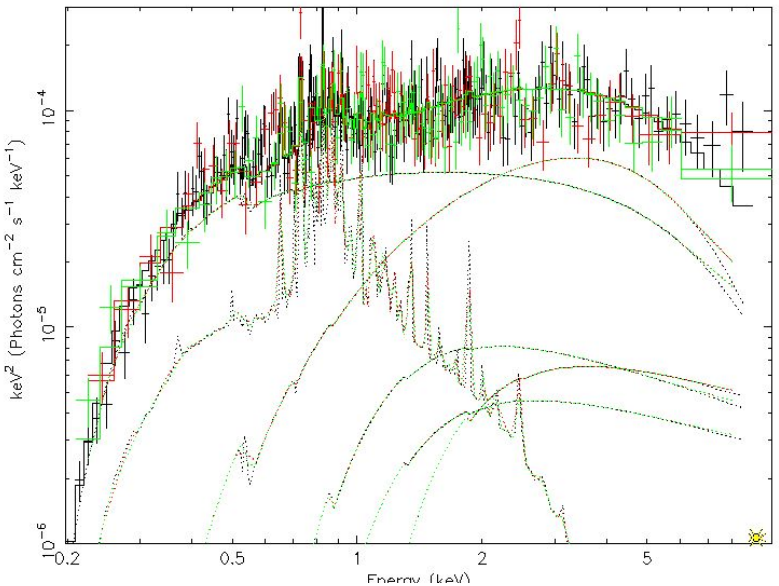
ULX 1 phase resolved



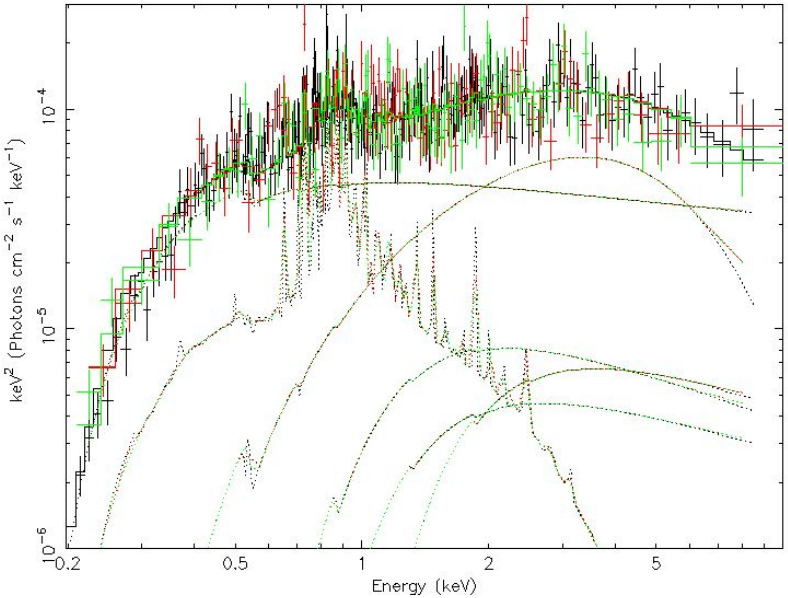
Data group: 1

1	1	TBabs	nH	10^22	5.00000E-02	frozen
2	2	powerlaw	PhoIndex		2.66056	frozen
3	2	powerlaw	norm		1.76334E-05	frozen
4	3	TBabs	nH	10^22	0.681092	frozen
5	4	powerlaw	PhoIndex		2.52484	frozen
6	4	powerlaw	norm		9.39465E-06	frozen
7	5	TBabs	nH	10^22	0.940129	frozen
8	6	powerlaw	PhoIndex		2.54888	frozen
9	6	powerlaw	norm		1.61767E-05	frozen
10	7	TBabs	nH	10^22	2.05995	frozen
11	8	TBabs	nH	10^22	0.100000	frozen
12	9	diskpbb	Tin	keV	1.24111	frozen
13	9	diskpbb	p		0.998445	frozen
14	9	diskpbb	norm		6.64760E-03	frozen
15	10	apec	kT	keV	0.261657	+/- 7.51062E-03
16	10	apec	Abundanc		0.120000	frozen
17	10	apec	Redshift		0.0	frozen
18	10	apec	norm		3.70009E-04	+/- 1.05408E-05
19	11	TBabs	nH	10^22	0.0	frozen
20	12	TBabs	nH	10^22	0.644734	frozen
21	13	diskbb	Tin	keV	1.66064	frozen
22	13	diskbb	norm		7.79879E-04	frozen
23	14	diskbb	Tin	keV	0.215439	+/- 9.26541E-03
24	14	diskbb	norm		34.4736	+/- 10.8341

XMM | ULX1 diskbb+diskbb



1	1	TBabs	nH	10^22	5.00000E-02	frozen
2	2	powerlaw	PhoIndex		2.66056	frozen
3	2	powerlaw	norm		1.76334E-05	frozen
4	3	TBabs	nH	10^22	0.681092	frozen
5	4	powerlaw	PhoIndex		2.52484	frozen
6	4	powerlaw	norm		9.39465E-06	frozen
7	5	TBabs	nH	10^22	0.940129	frozen
8	6	powerlaw	PhoIndex		2.54888	frozen
9	6	powerlaw	norm		1.61767E-05	frozen
10	7	TBabs	nH	10^22	2.05995	frozen
11	8	TBabs	nH	10^22	0.100000	frozen
12	9	diskpbb	Tin	keV	1.24111	frozen
13	9	diskpbb	p		0.998445	frozen
14	9	diskpbb	norm		6.64760E-03	frozen
15	10	apec	kT	keV	0.657269	+/- 3.85747E-02
16	10	apec	Abundanc		0.120000	frozen
17	10	apec	Redshift		0.0	frozen
18	10	apec	norm		9.48959E-05	+/- 8.56775E-06
19	11	TBabs	nH	10^22	0.0	frozen
20	12	TBabs	nH	10^22	0.0	frozen
21	13	diskpbb	Tin	keV	1.58017	+/- 0.229900
p			0.500000	+/-	1.65486E-02	
23	13	diskpbb	norm		3.30790E-04	+/- 2.27963E-04



1	1	TBabs	nH	10^22	5.00000E-02	frozen
2	2	powerlaw	PhoIndex		2.66056	frozen
werlaw	norm			1.76334E-05	frozen	
4	3	TBabs	nH	10^22	0.681092	frozen
5	4	powerlaw	PhoIndex		2.52484	frozen
6	4	powerlaw	norm		9.39465E-06	frozen
7	5	TBabs	nH	10^22	0.940129	frozen
8	6	powerlaw	PhoIndex		2.54888	frozen
9	6	powerlaw	norm		1.61767E-05	frozen
10	7	TBabs	nH	10^22	2.05995	frozen
11	8	TBabs	nH	10^22	0.100000	frozen
12	9	diskpbb	Tin	keV	1.24111	frozen
13	9	diskpbb	p		0.998445	frozen
14	9	diskpbb	norm		6.64760E-03	frozen
15	10	apec	kT	keV	0.734476	+/- 3.46371E-02
16	10	apec	Abundanc		0.120000	frozen
17	10	apec	Redshift		0.0	frozen
18	10	apec	norm		9.50966E-05	+/- 8.20752E-06
19	11	TBabs	nH	10^22	0.0	frozen
20	12	TBabs	nH	10^22	8.87545E-06	frozen
21	13	powerlaw	PhoIndex		2.20118	+/- 3.82283E-02
22	13	powerlaw	norm		5.20183E-05	+/- 2.16700E-06

XMM | ULX1 powerlaw