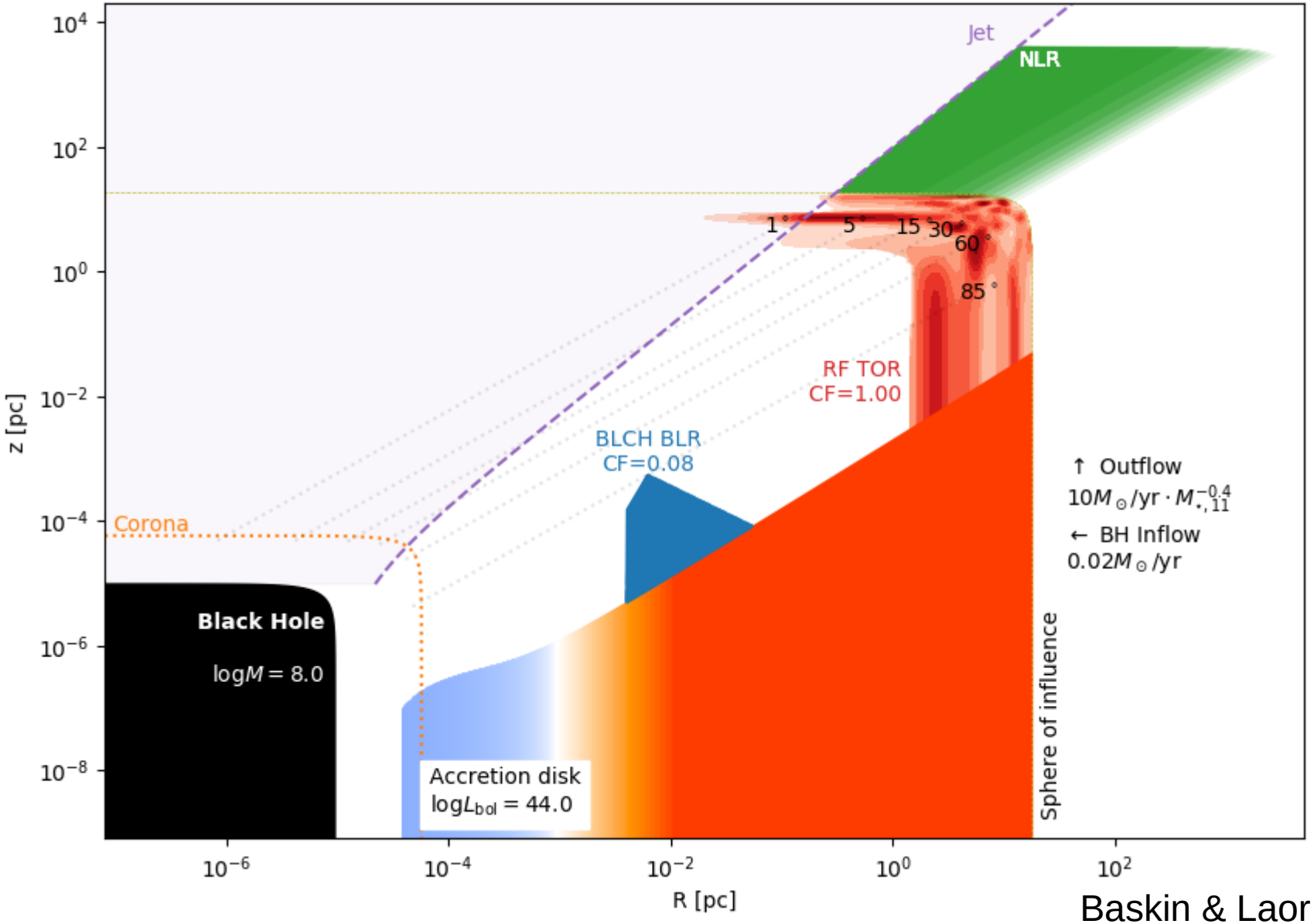
johannesbuchner.github.io/agnviz/



Baskin & Laor (2018)
Wada (2016)

Clumpy obscuration & occultation events

Collaborators

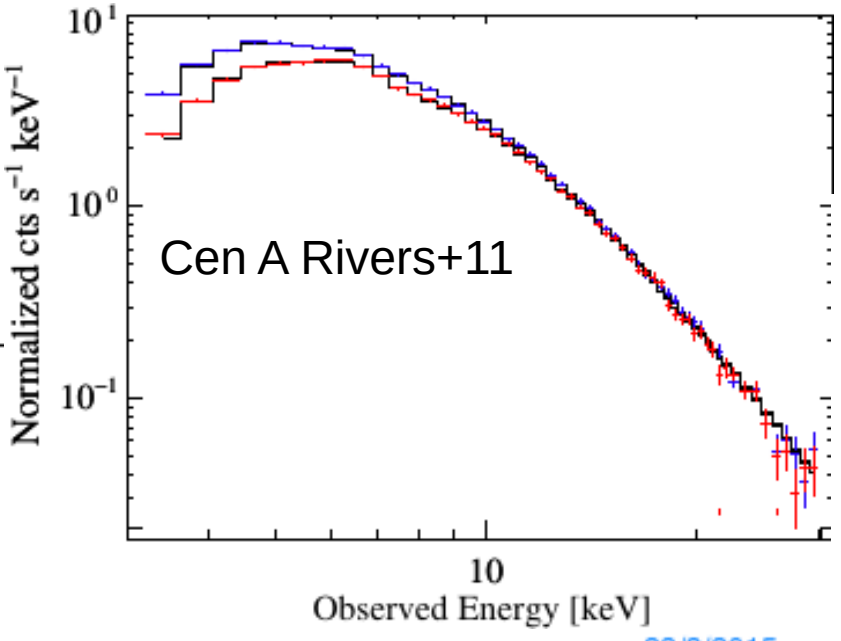
Murray Brightman,
Mislav Balokovic,
Franz Bauer,
Kirpal Nandra,
Keiichi Wada,
Robert Nikutta,
et altera

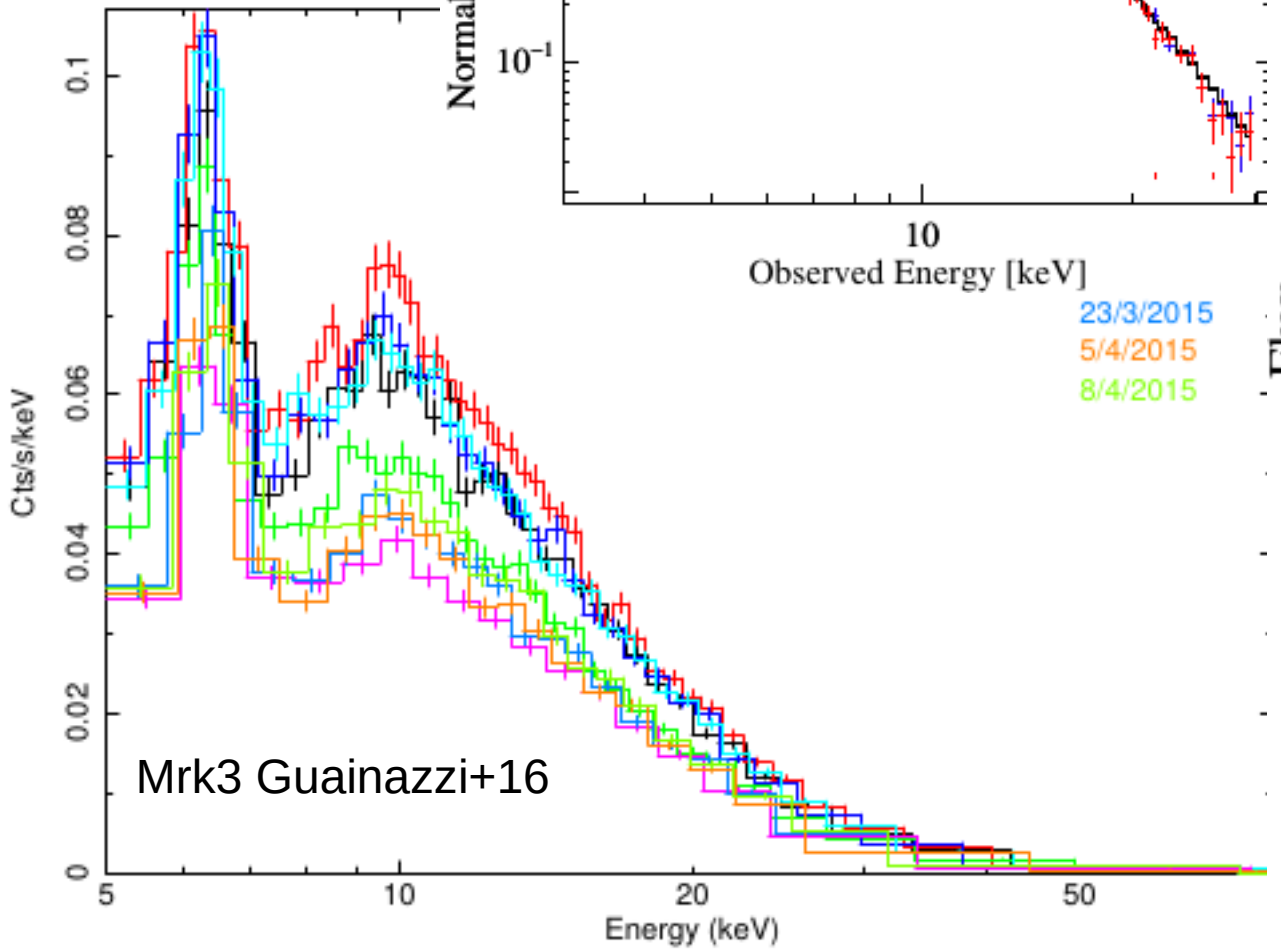
Johannes Buchner

http://astrost.at/istics

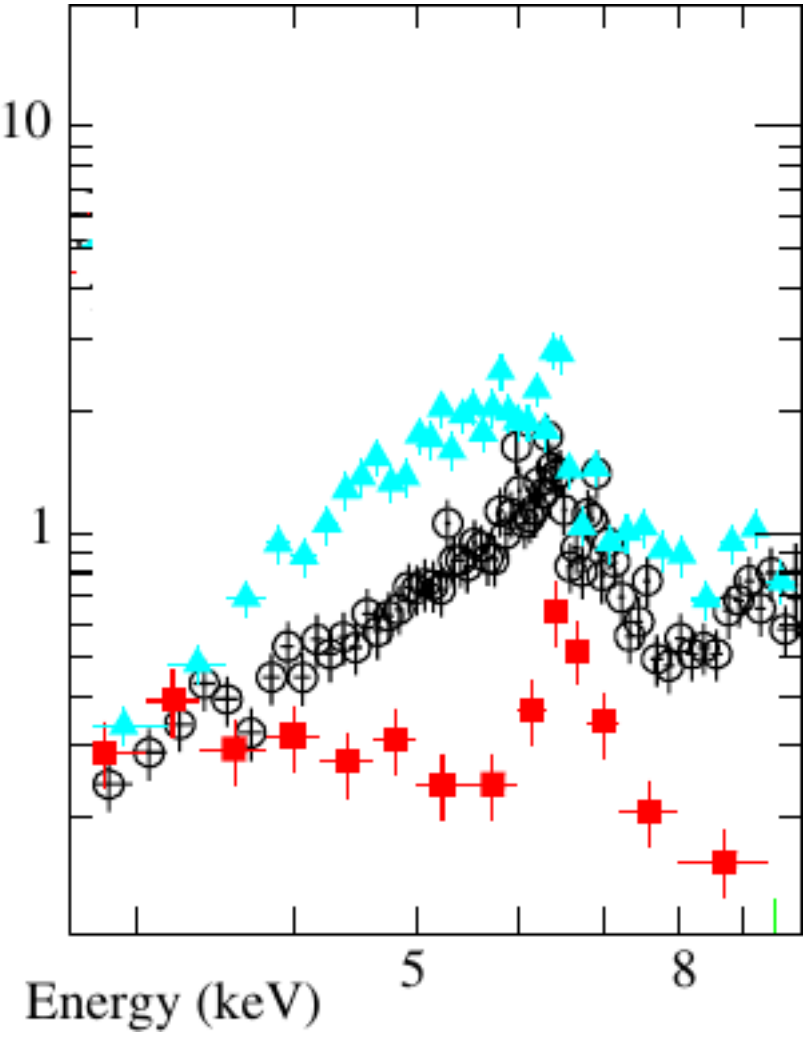
MPE

Column density changes



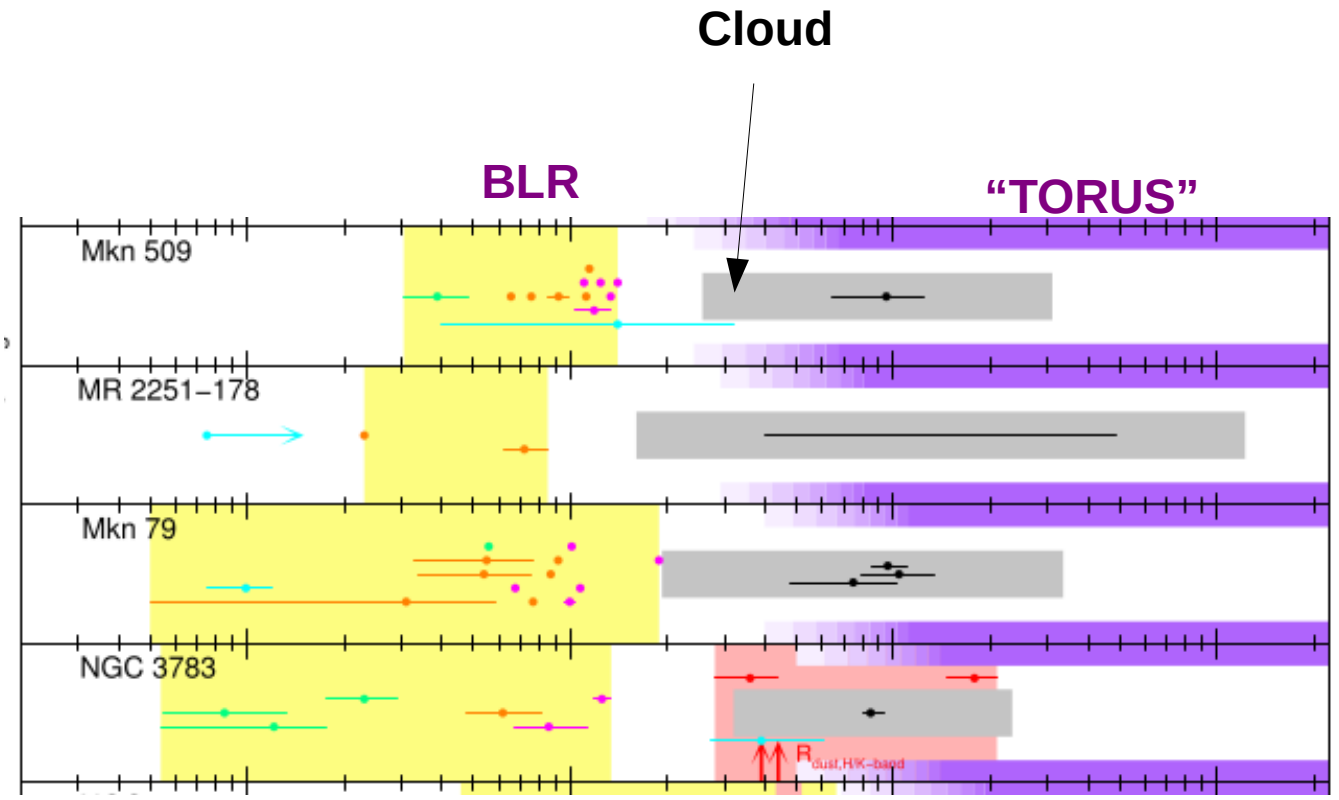


NGC 1365 Risaliti+05



Eclipse information

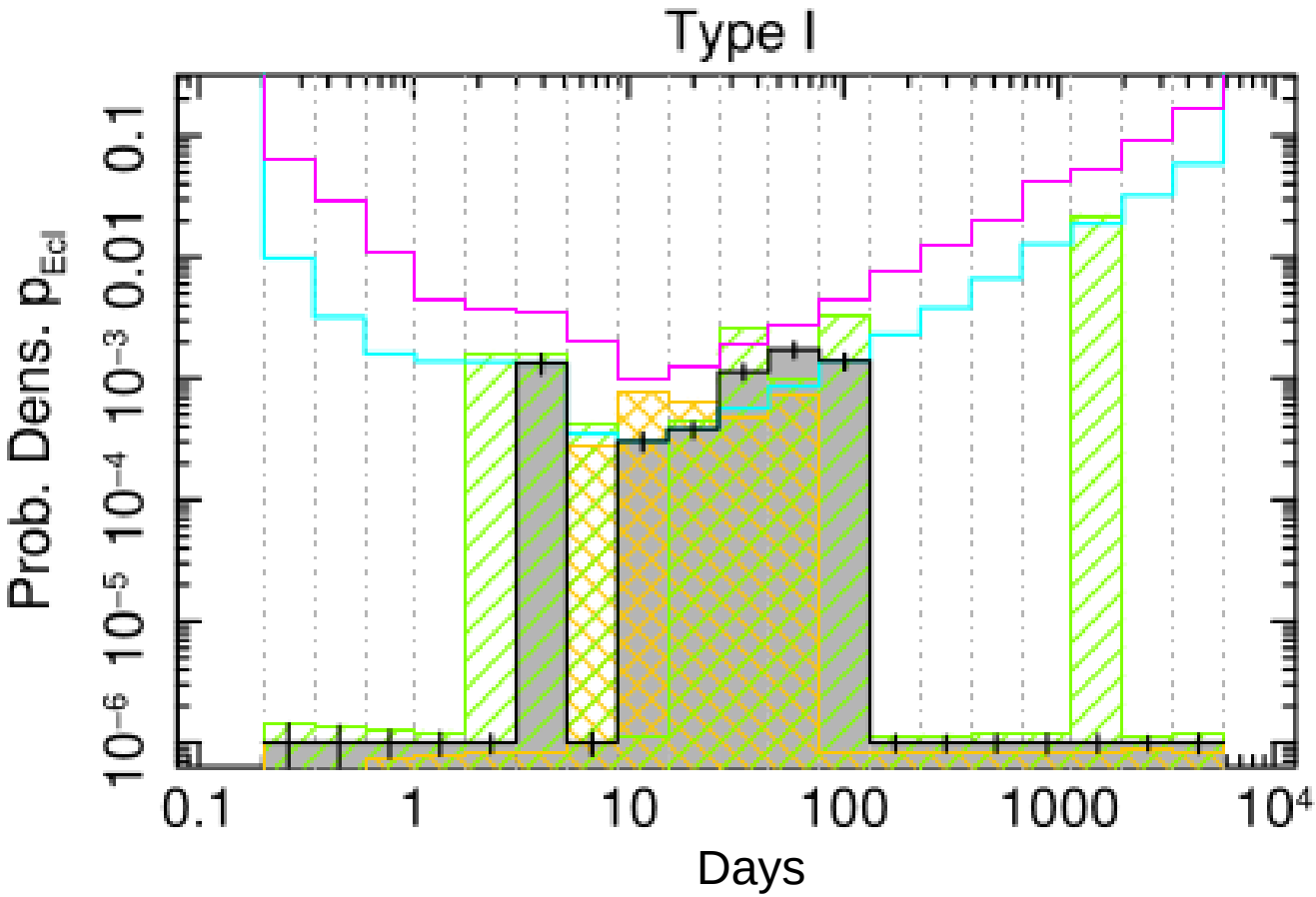
- N_H
- Ionisation
- → **Location**
- Duration
- → Size
- Frequency



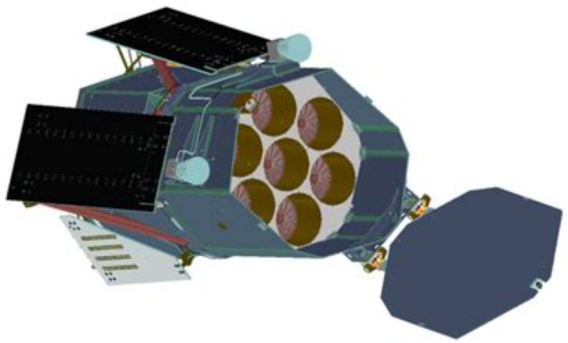
Markowitz+14

Eclipse information

- N_H
- Ionisation
- ➔ Location
- Duration
- ➔ Size
- **Frequency**



Markowitz+14, RXTE archive

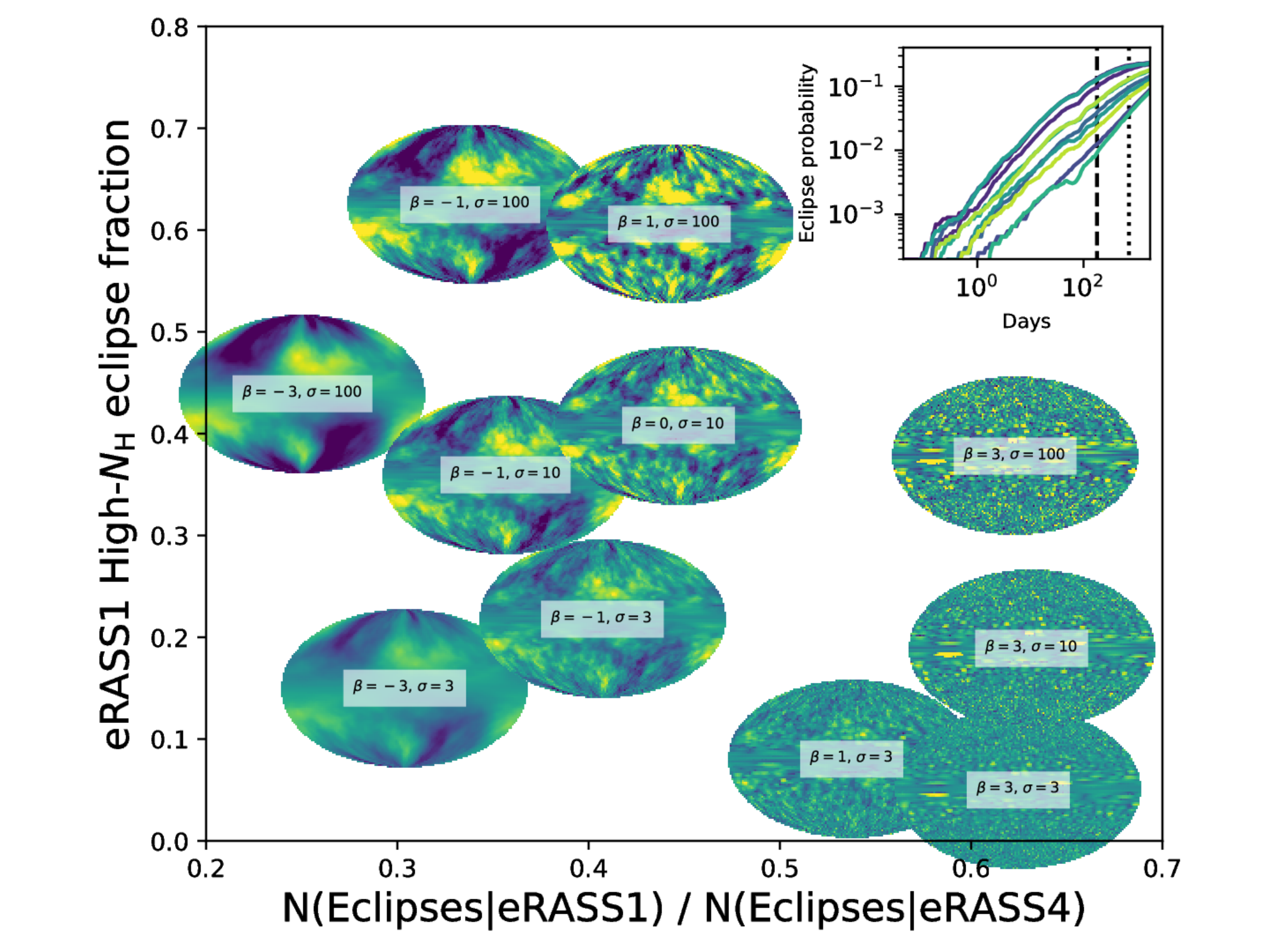


eROSITA

- X-ray survey
  - All-sky
  - Deepest soft-band
  - First hard-band
  - every 6 months
  - 8 times
- Science:
  - Cosmology with clusters
  - 3 Million AGN expected

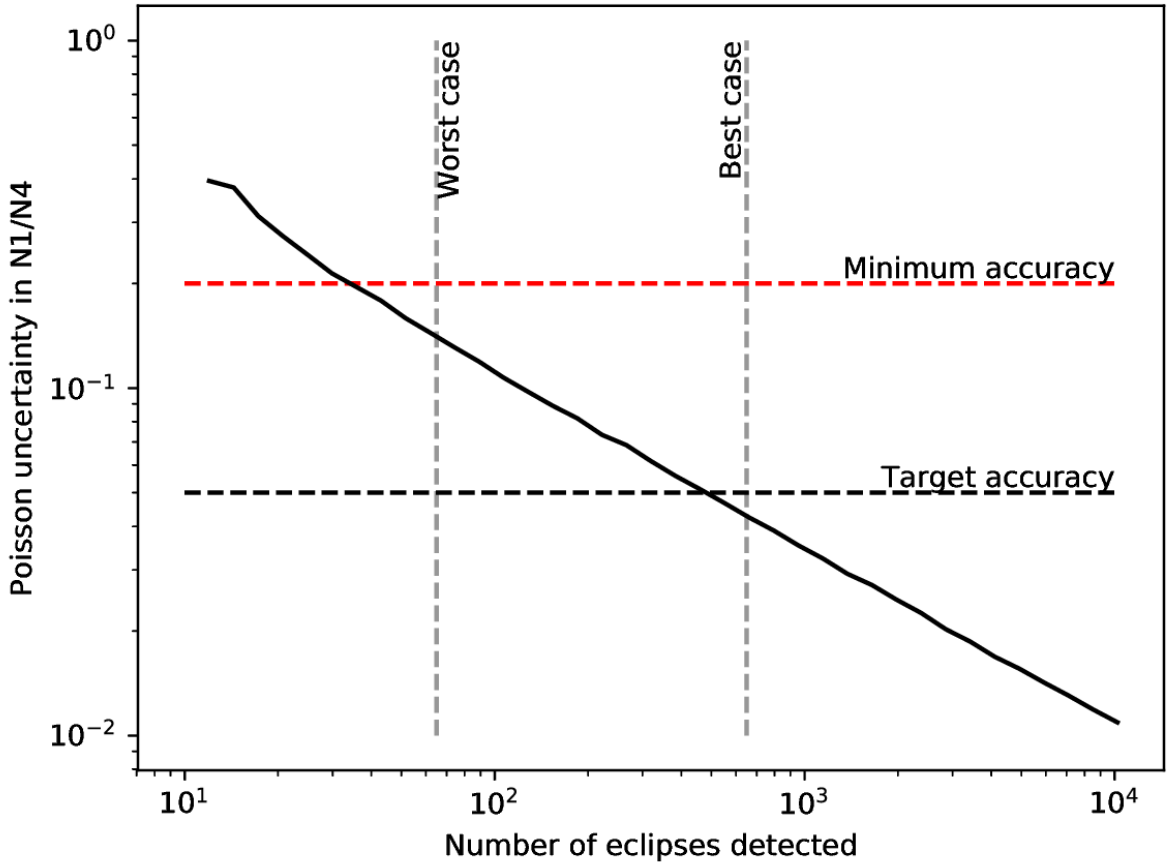
Launch: Friday 14:17

@eROSITA_SRG on twitter


eRASS1 High-N_H eclipse fraction
N(Eclipses|eRASS1) / N(Eclipses|eRASS4)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.2
0.3
0.4
0.5
0.6
0.7
$\beta = -1, \sigma = 100$
$\beta = 1, \sigma = 100$
$\beta = -3, \sigma = 100$
$\beta = 0, \sigma = 10$
$\beta = -1, \sigma = 10$
$\beta = 3, \sigma = 100$
$\beta = -1, \sigma = 3$
$\beta = 3, \sigma = 10$
$\beta = -3, \sigma = 3$
$\beta = 1, \sigma = 3$
$\beta = 3, \sigma = 3$
Eclipse probability
10^{-1}
10^{-2}
10^{-3}
10^{0}
10^{2}
Days

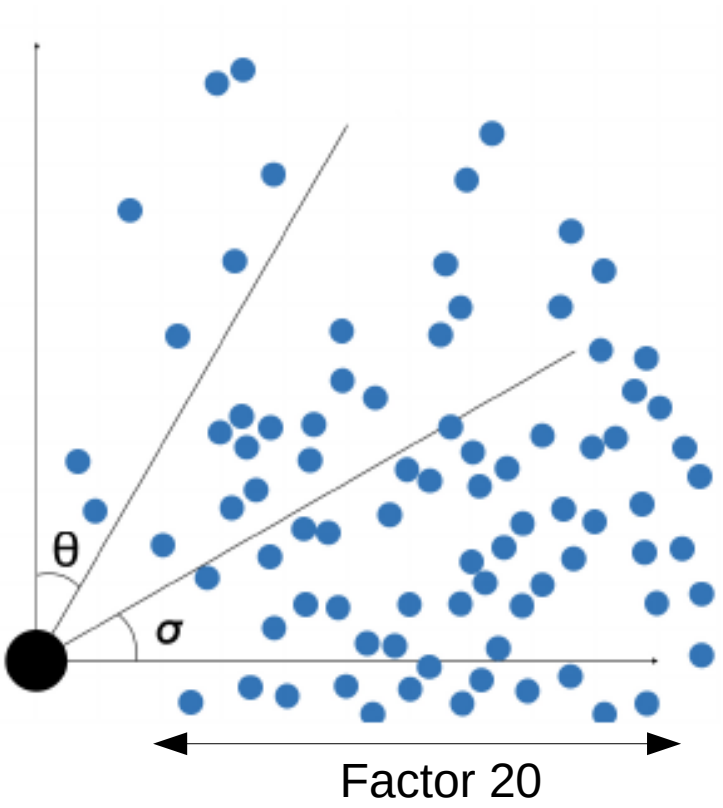
Eclipse events with eROSITA

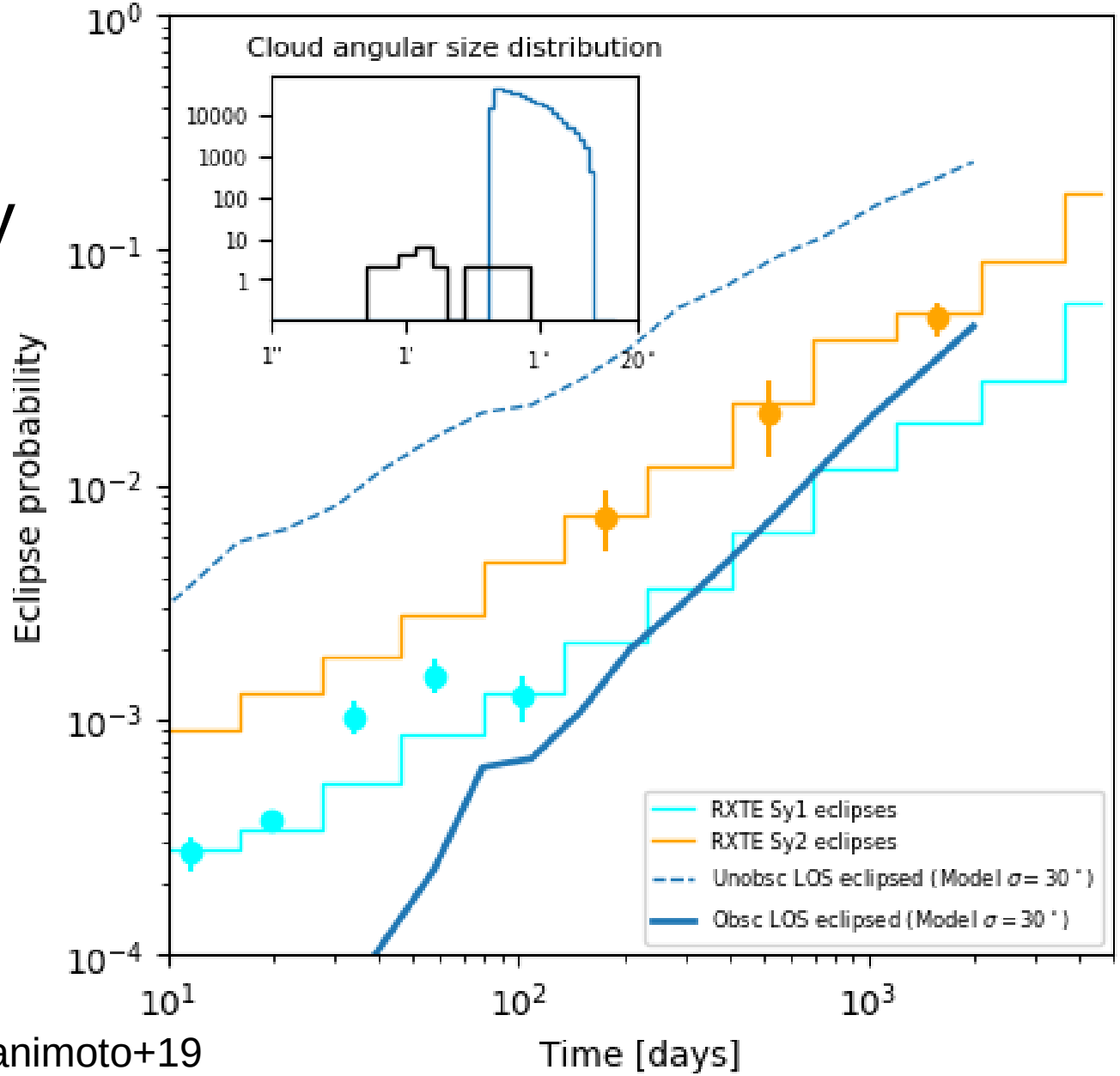
- Predictions:
- 340,000 extragalactic AGN in 6m catalogue
- 13,000 2-10keV detected
- 1-10% eclipses expected after 6 months, 50% sky



Simple Keplerian rotation model

- Spheres
- Orbits 11-1000y

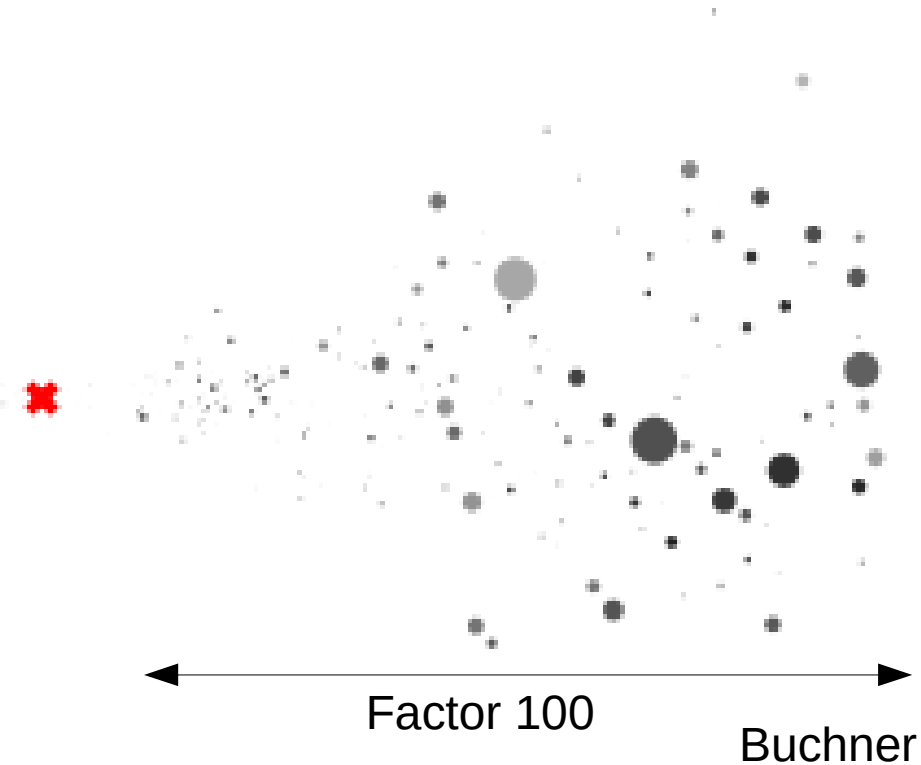


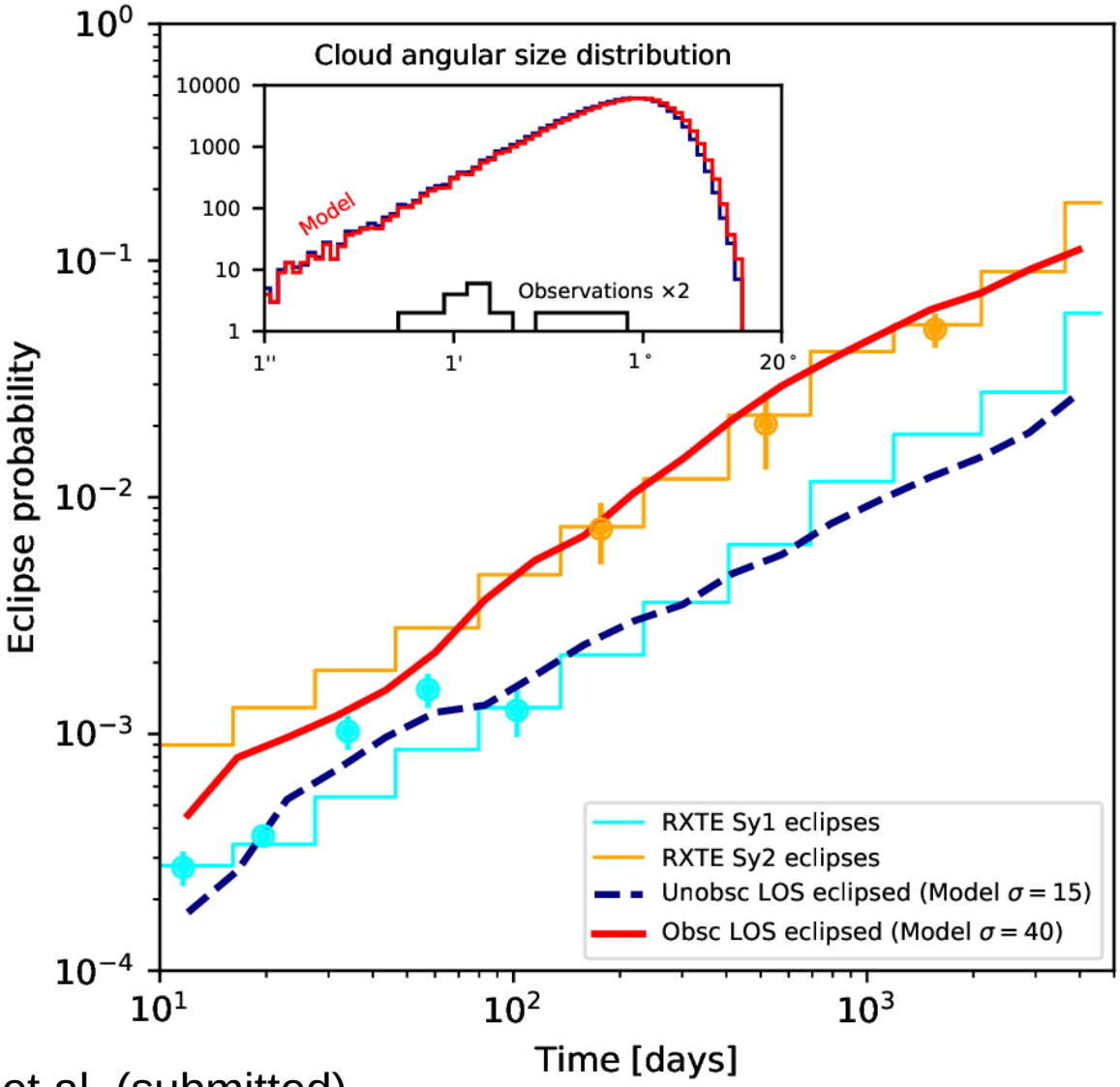


Tanimoto+19

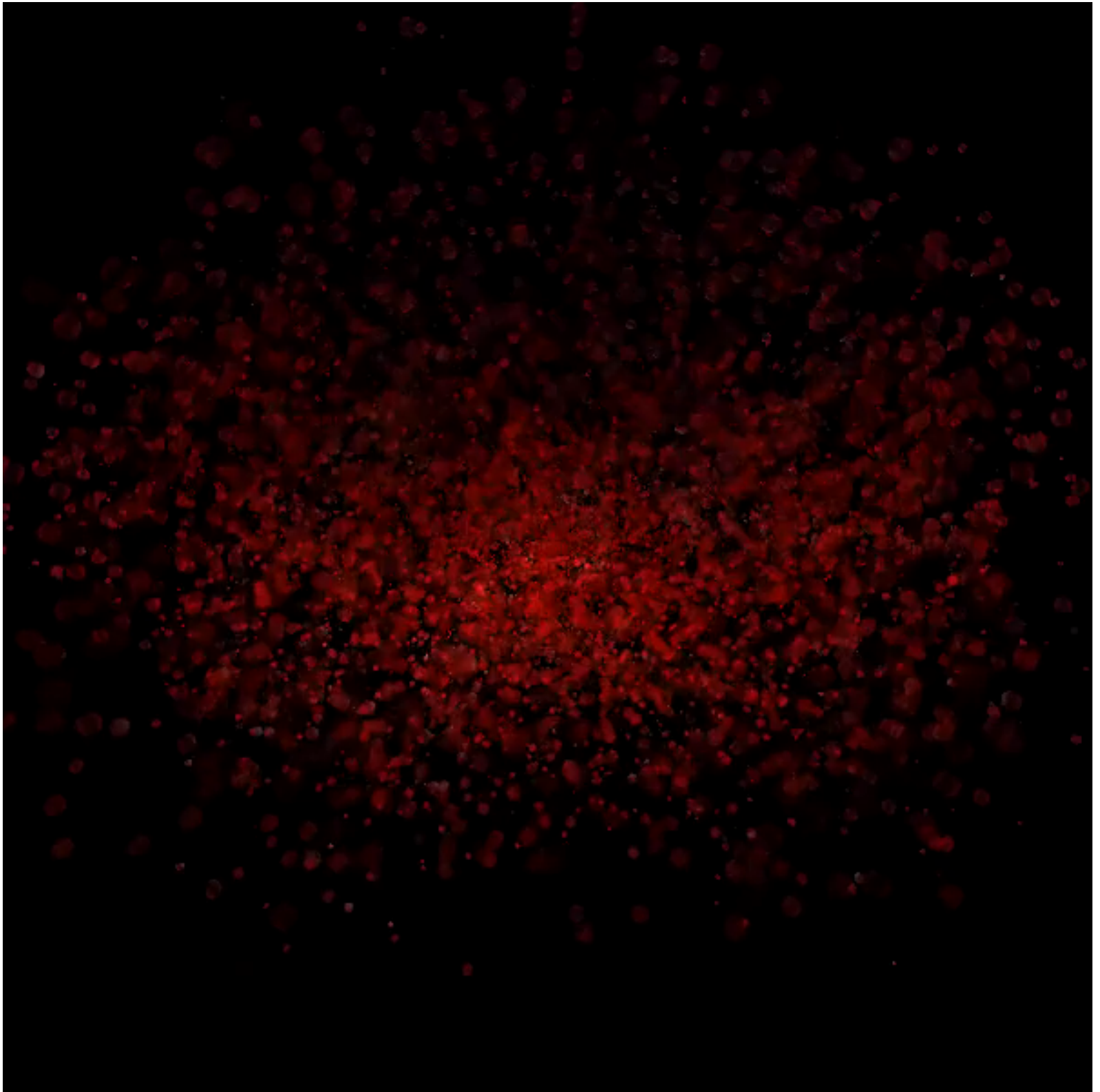
Matching Eclipse Frequencies

- Spheres scale with distance
- Wide size distribution



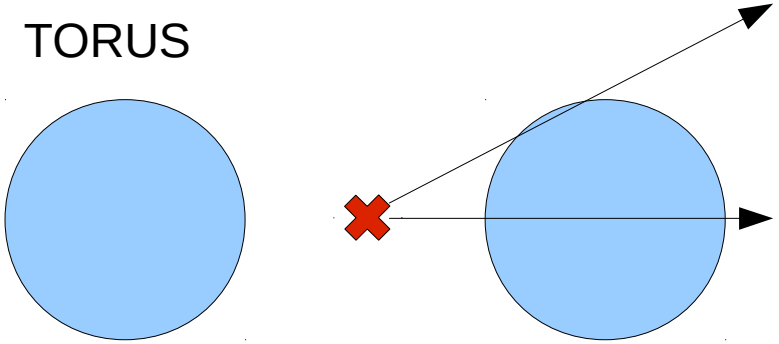


Buchner et al. (submitted)

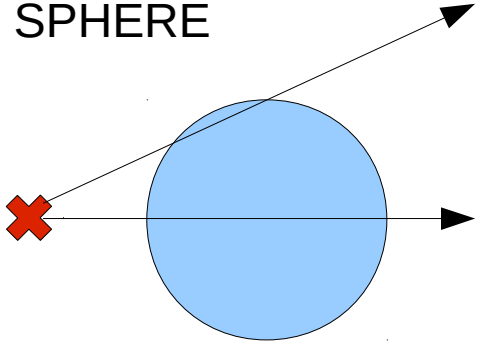


Covering factors

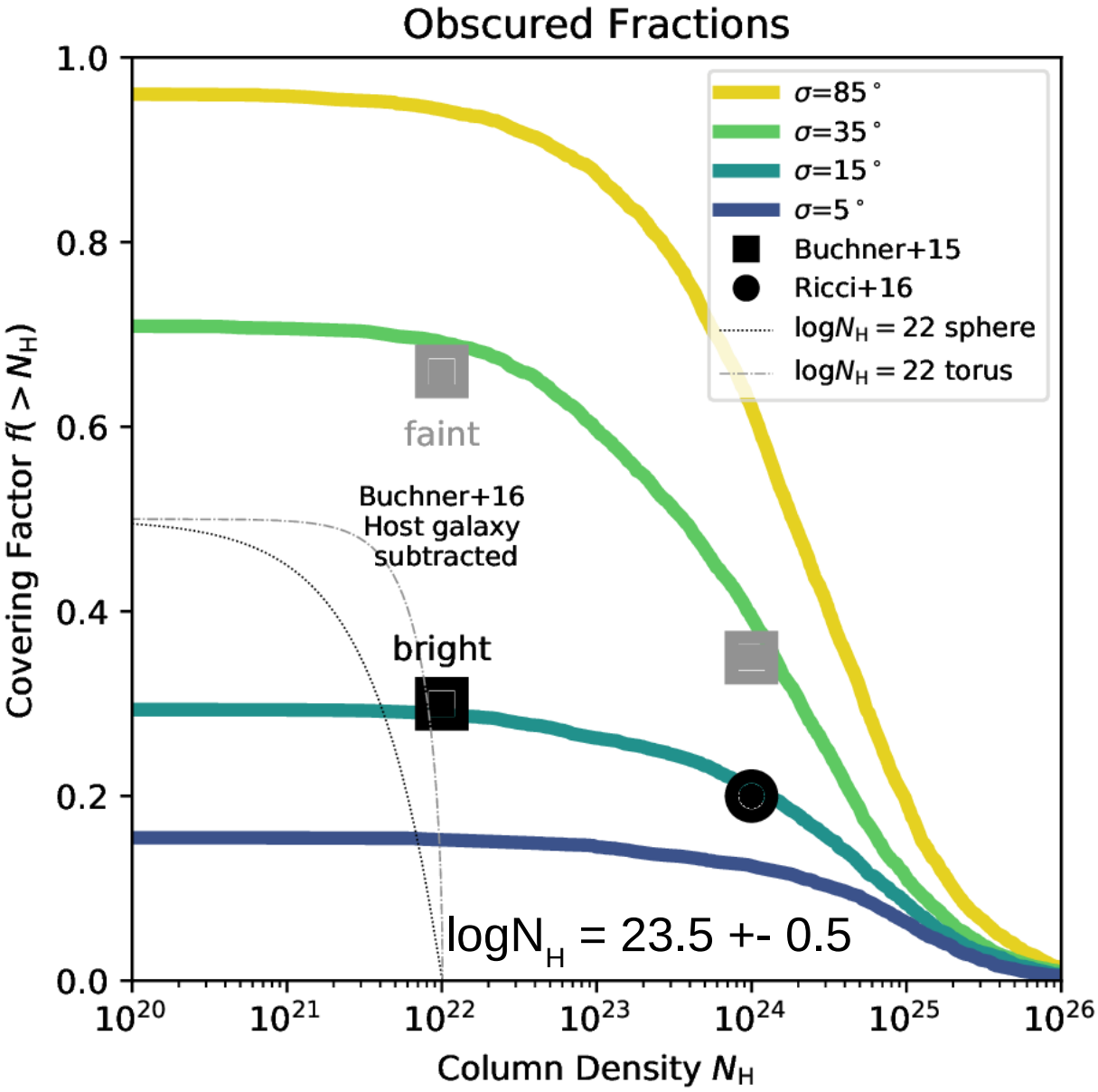
TORUS



SPHERE



N_H distribution 0.3dex wide



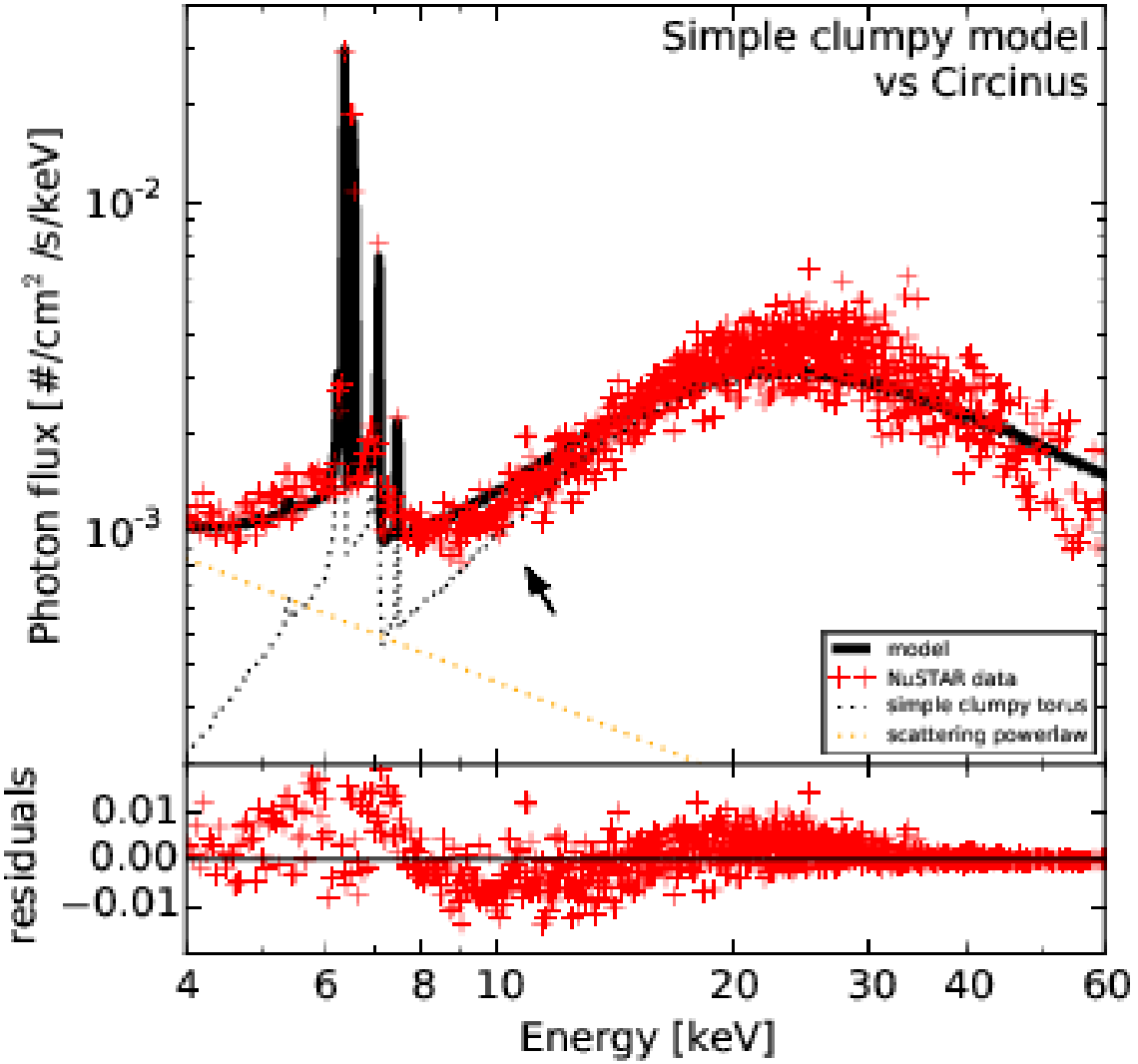
Buchner+15
Buchner+17a,b

Recap

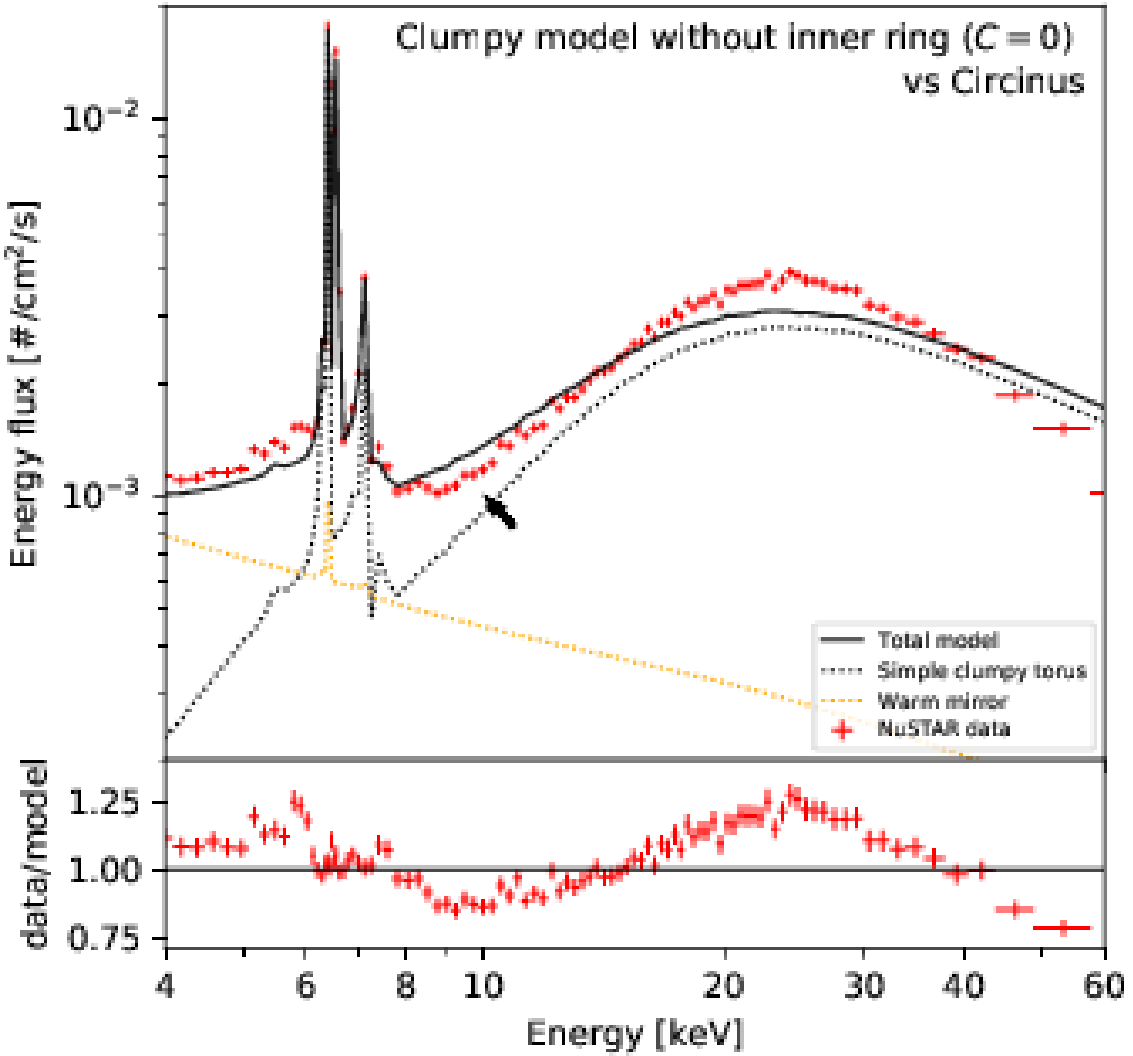
- Clumpy model geometry
  - Reproduces eclipse frequencies
  - Reproduces eclipse sizes
  - Reproduces N_H distribution
  - Consistent with CLUMPY IR models

github.com/JohannesBuchner/xars/

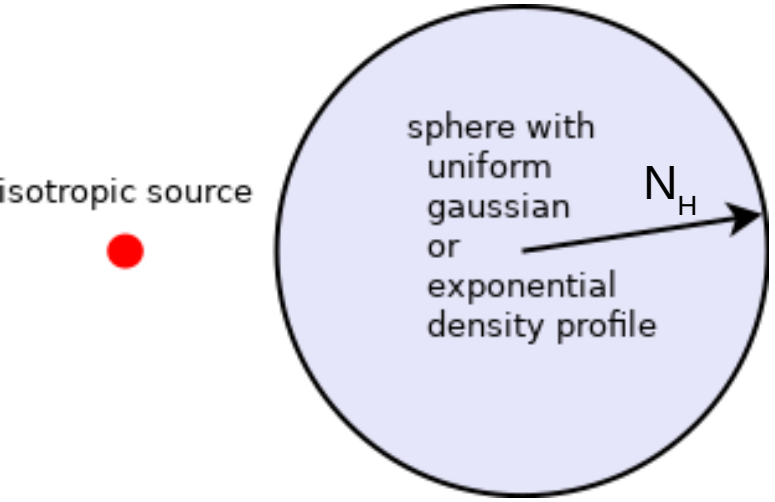
The problem

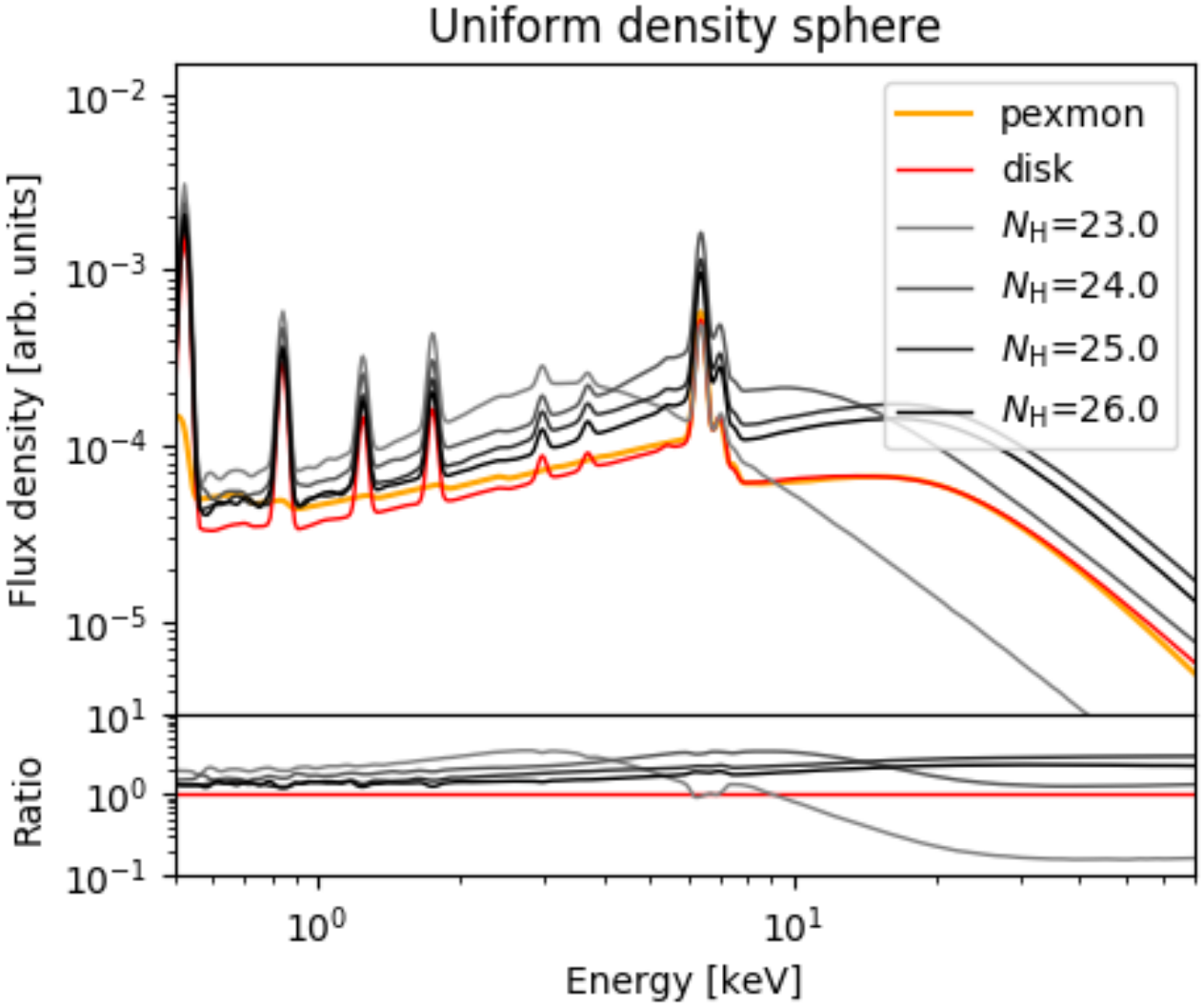

Simple clumpy model
vs Circinus
Photon flux [#/cm² /s/keV]
10⁻²
10⁻³
model
NuSTAR data
simple clumpy torus
scattering powerlaw
residuals
0.01
0.00
−0.01
4
6
8
10
20
30
40
60
Energy [keV]

The problem


Clumpy model without inner ring ($C = 0$)
vs Circinus
Energy flux [#/cm²/s]
10^{-2}
10^{-3}
Total model
Simple clumpy torus
Warm mirror
NuSTAR data
data/model
1.25
1.00
0.75
4
6
8
10
20
30
40
60
Energy [keV]

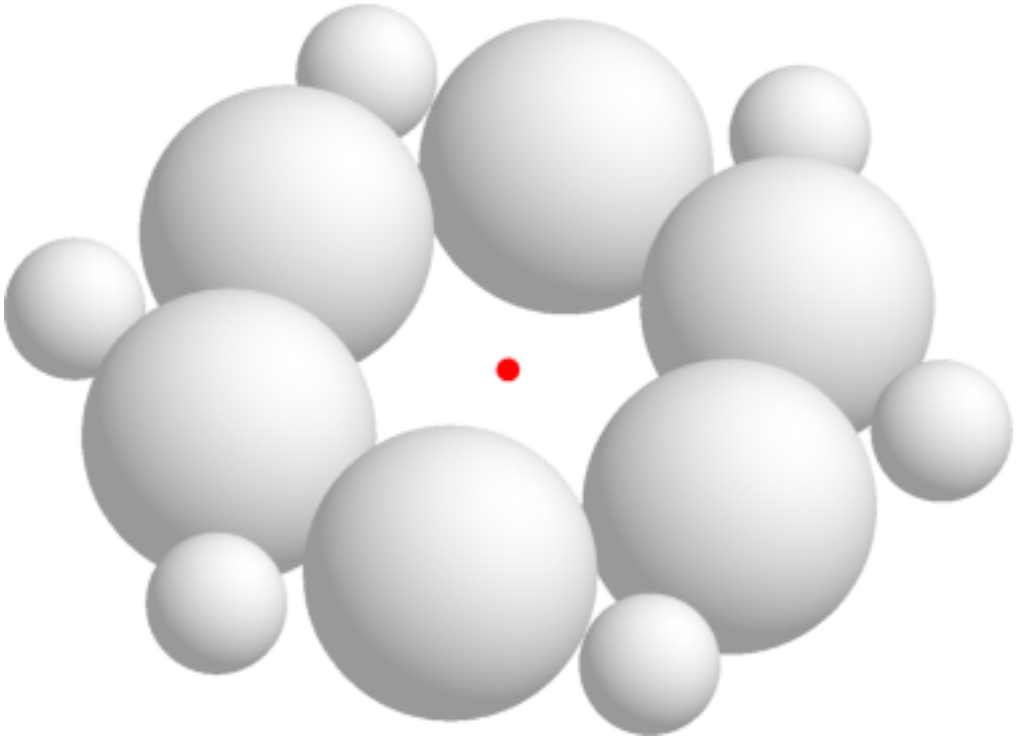
Compton Hump Primer

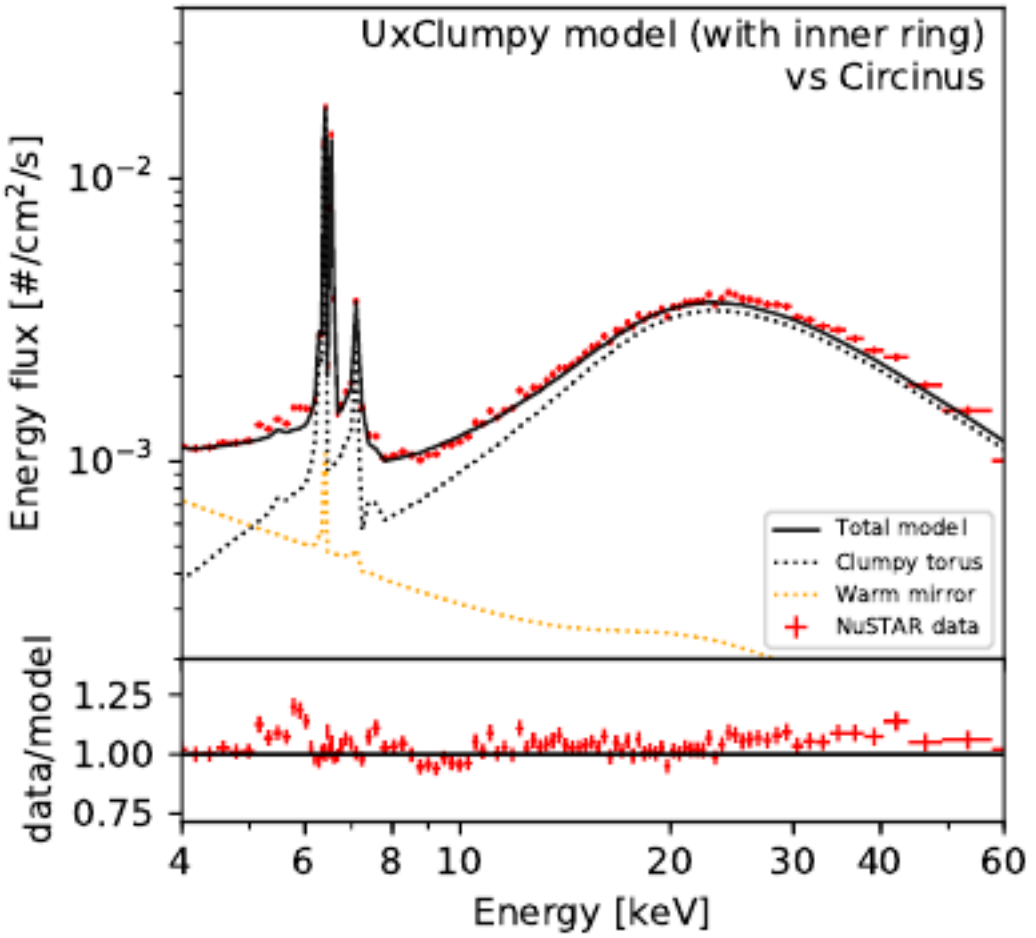


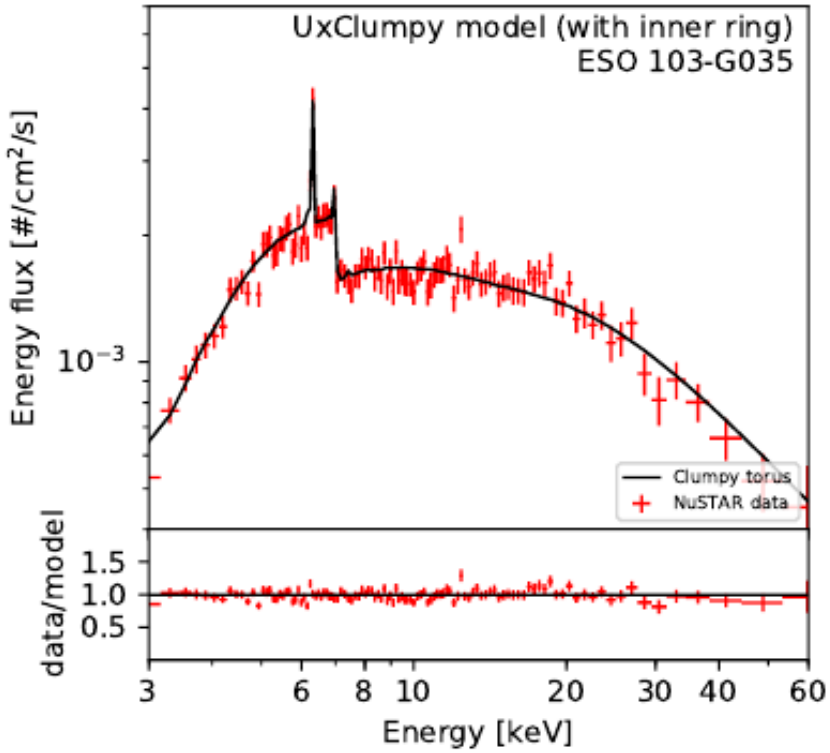


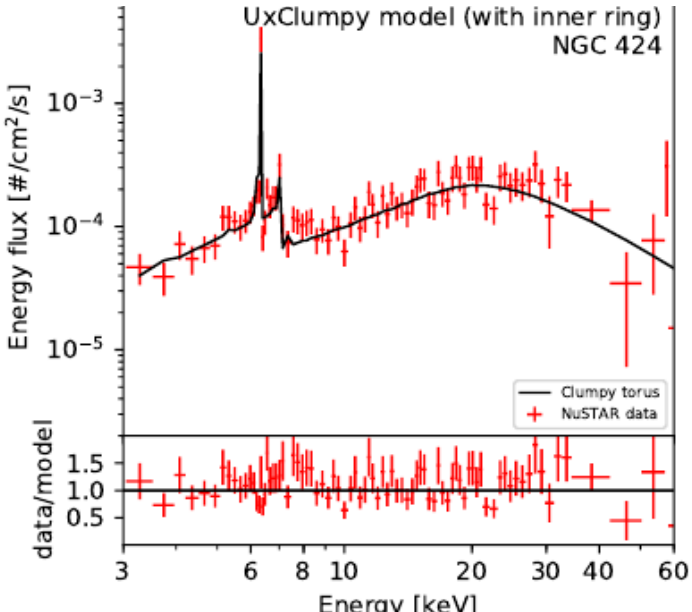
Compton-hump contains imprints of geometry and density of reflector

Also: Nandra&George (1994)



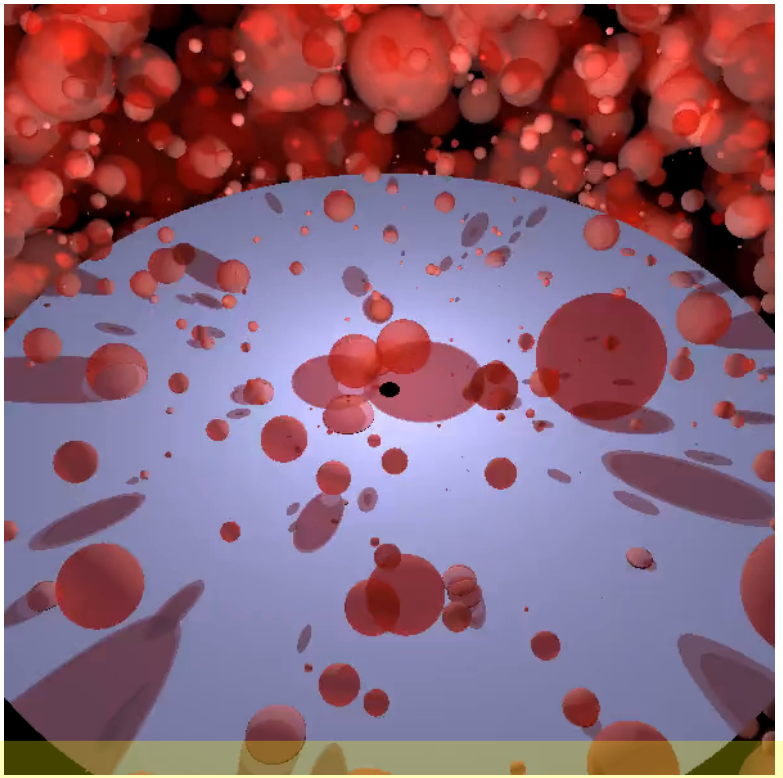

UxClumpy model (with inner ring)
vs Circinus
Energy flux [#/cm²/s]
Total model
Clumpy torus
Warm mirror
NuSTAR data
data/model
Energy [keV]


UxClumpy model (with inner ring)
ESO 103-G035
Energy flux [#/cm²/s]
Clumpy torus
NuSTAR data
data/model
Energy [keV]


UxClumpy model (with inner ring)
NGC 424
Energy flux [#/cm²/s]
Clumpy torus
NuSTAR data
data/model
Energy [keV]

Lessons learnt

- UXCLUMPY
  - Reproduces N_H distribution
  - Eclipse event frequency
  - X-ray spectra of various AGN
- Clouds need diversity of
  - column density, small sizes (1”), distances
  - CTK cannot be modeled as mixture of CTN clouds
  - need large, inner CTK surface
- Obscurer granularity with eROSITA

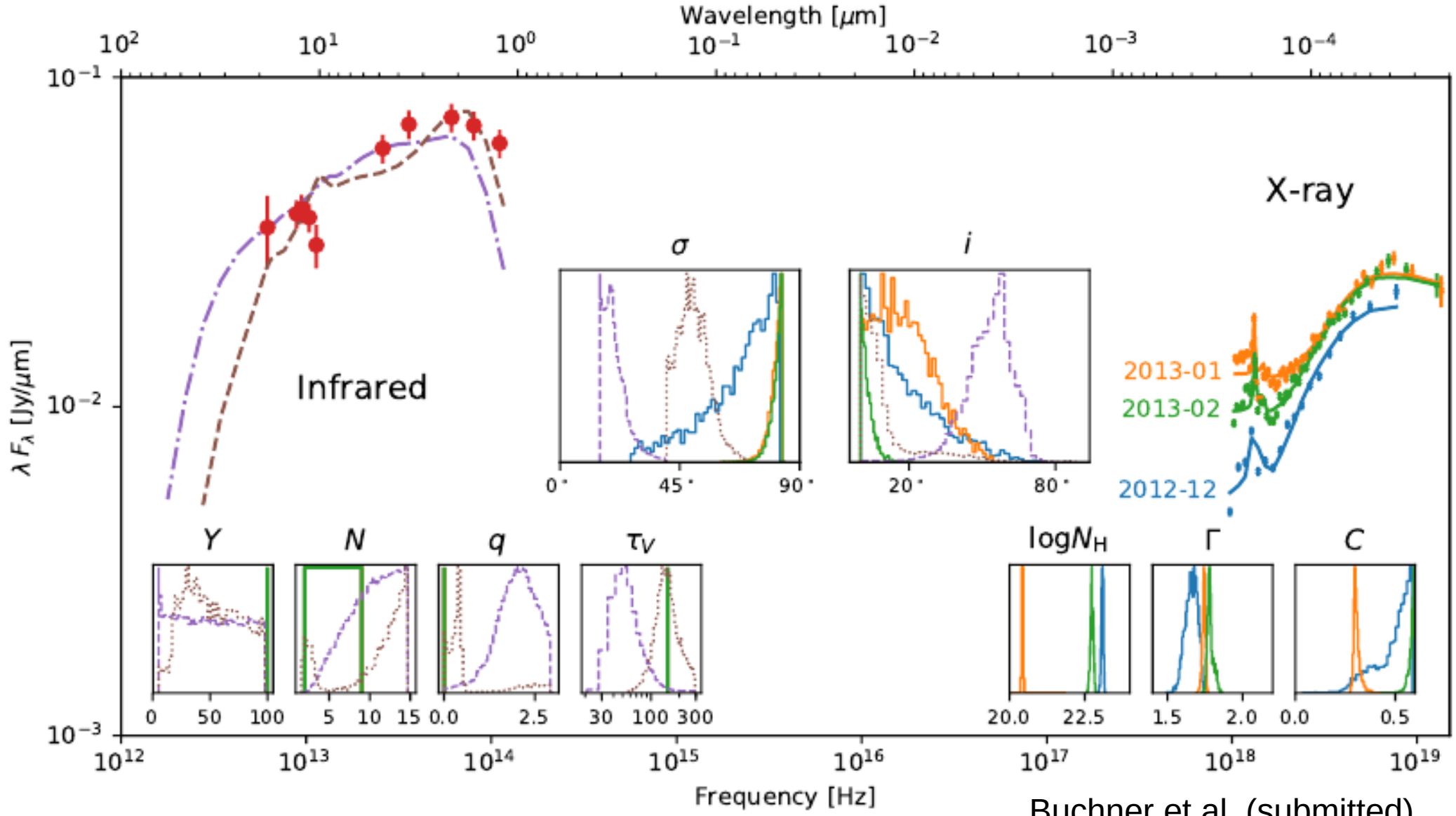


Models, Code & Movies at:

github.com/JohannesBuchner/xars/

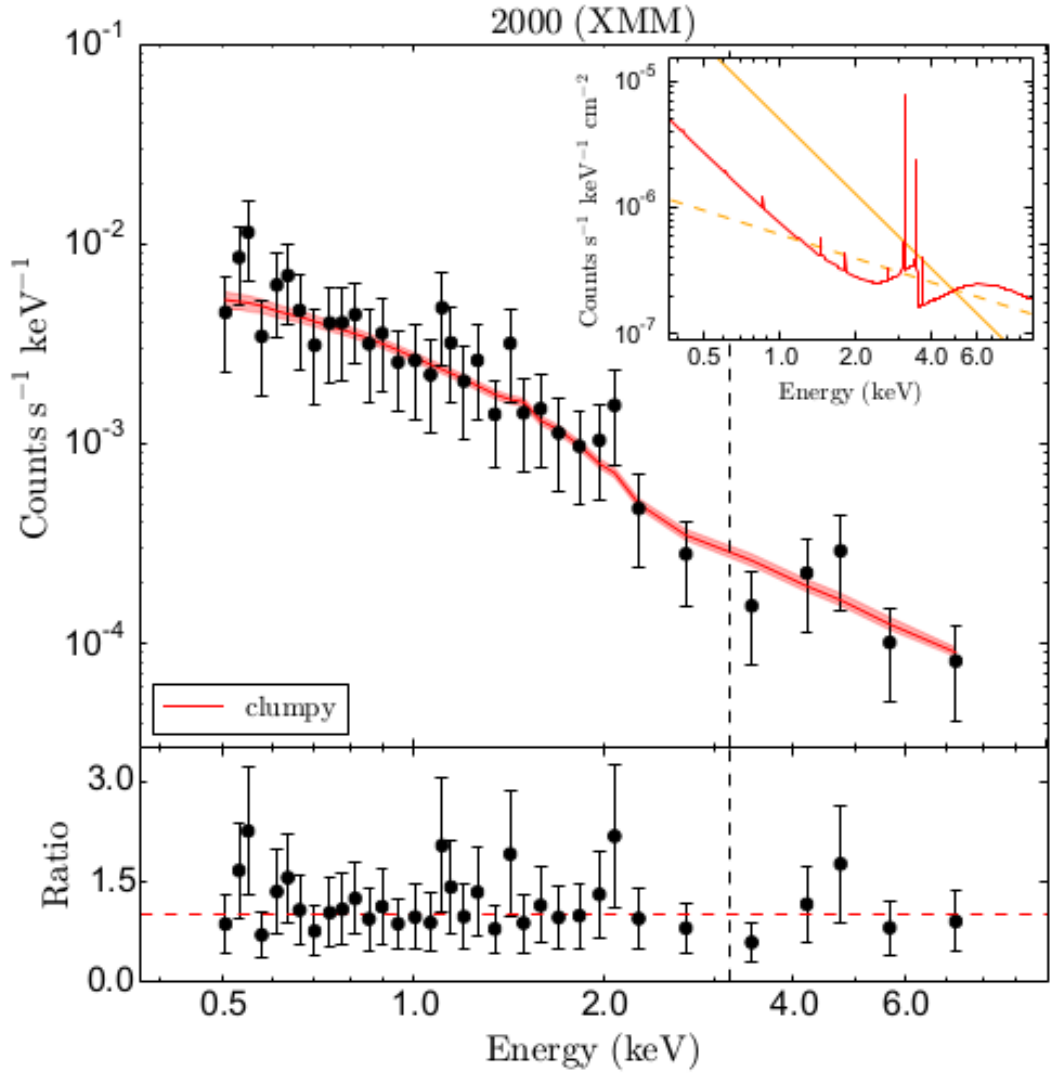
Buchner et al. (submitted)

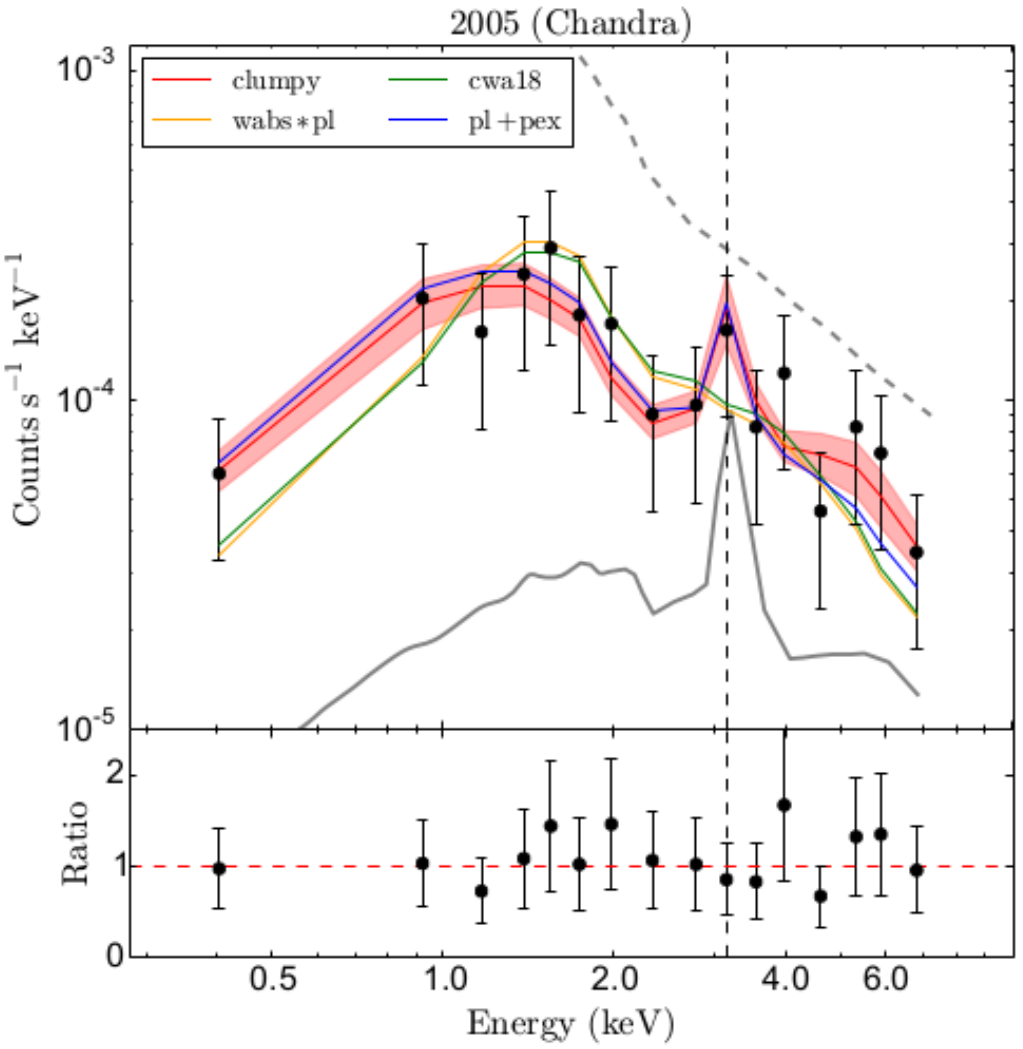
Multi-wavelength NGC 1365



Buchner et al. (submitted)

A type-1 with Compton-thick eclipse

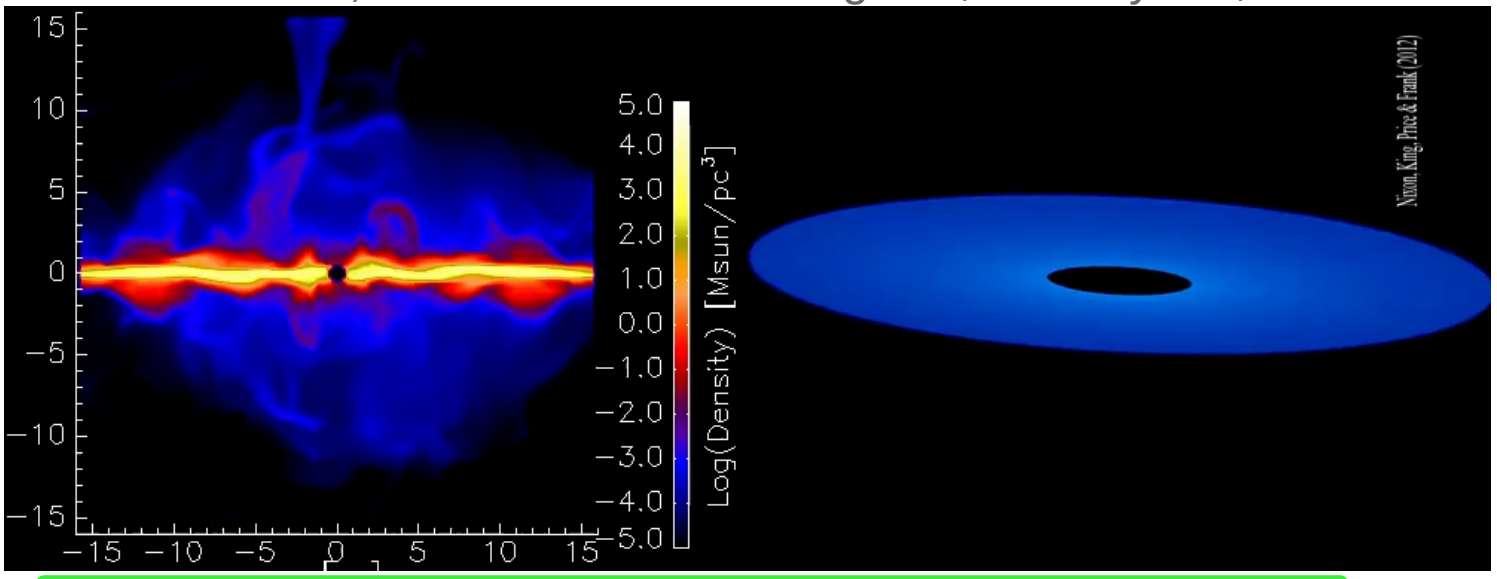




Simm, JB et al. 2018

Wada 2012, Wada+2016

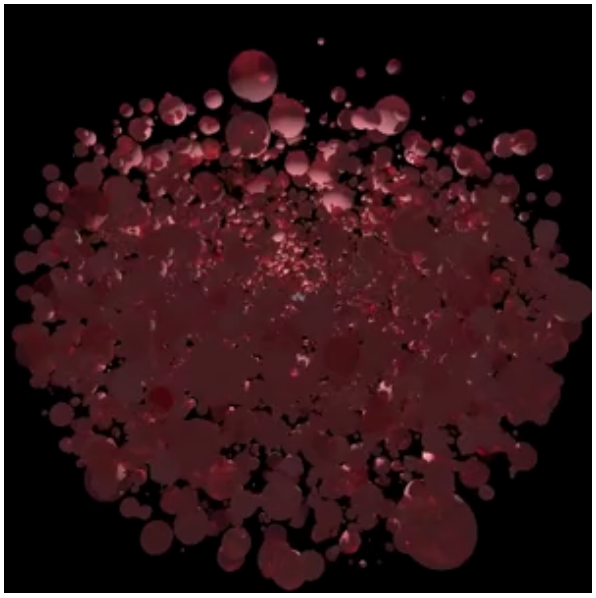
Pringle96,Maloney+96,Nixon+12



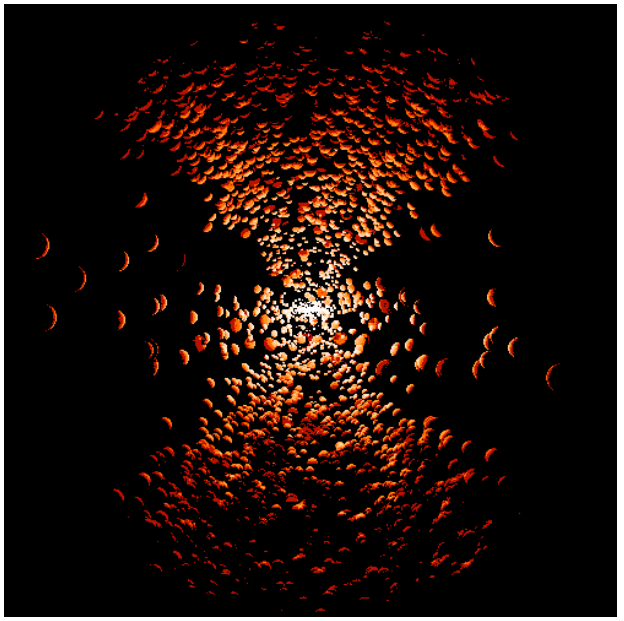
XARS
X-RAY PROPAGATOR

Outcomes

github.com/JohannesBuchner/xars



UXCLUMPY



CAT3D+WIND