

# Peering through the veil: using hard X-ray spectroscopy to probe the circum-nuclear environment in NGC 3982

Cologne-Prague-Brno meeting 2022

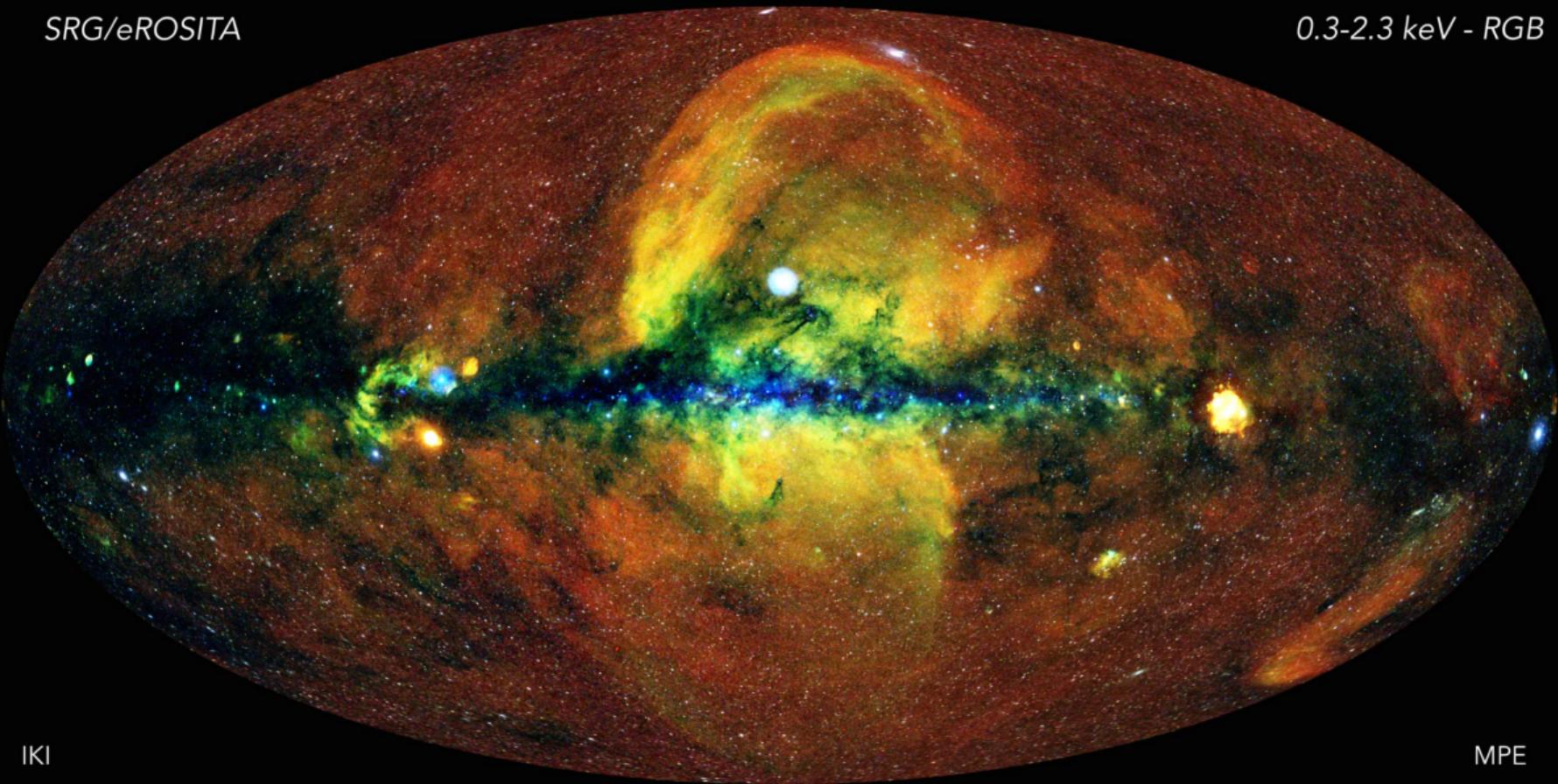
Kristína Kallová

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June 3, 2022

SRG/eROSITA

0.3-2.3 keV - RGB



IKI

MPE

# Motivation - CXB

- the first cosmic background discovered (Giacconi+ 1962)
- residual diffuse emission
- largely isotropic emission
- extragalactic origin
- very wide range of wavelengths
- broad bump with peak at ~ 30 keV

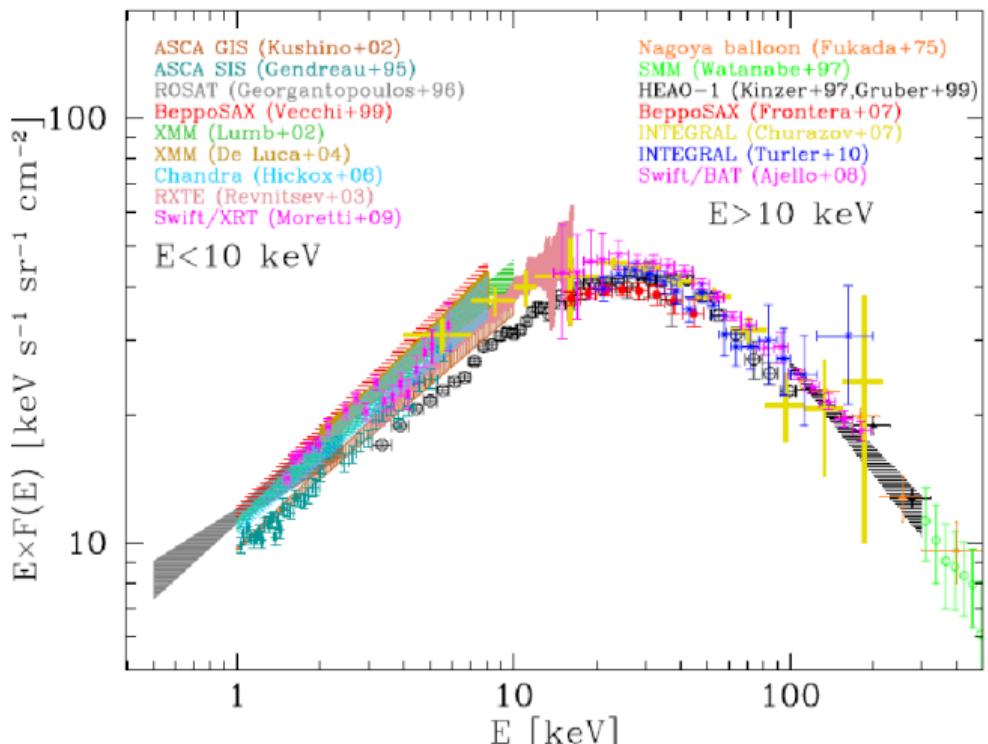
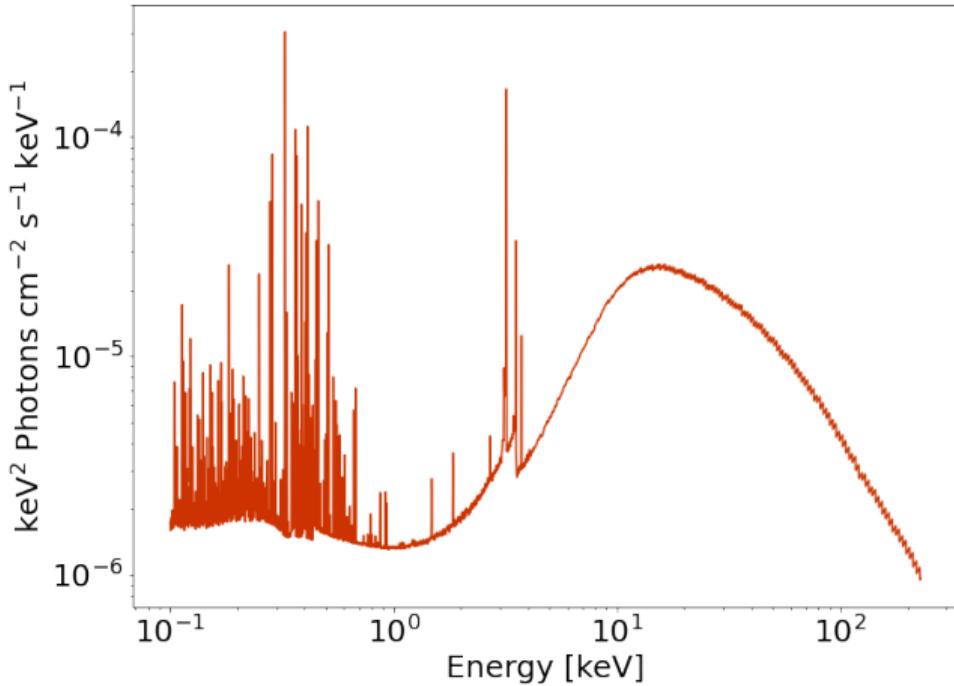


Figure: Gilli, 2012

## Motivation - CXB

- many individual unresolved point sources
- discrete AGNs with significant contribution from obscured AGN
- CXB predicts large fraction of heavily obscured AGN



**Figure:** Broadband X-ray spectrum of heavily obscured AGN

# Obscured AGN

- unified model in optical classification  
see Antonucci 1993,  
Urry & Padovani 1995
- in X-rays obscured and unobscured AGN depending on the  $N_{\text{H}}$  of the obscuring circum-nuclear material

Compton-thin:  $N_{\text{H}} = 10^{22} - 10^{24} \text{ cm}^{-2}$

Compton-thick:  $N_{\text{H}} \geq 10^{24} \text{ cm}^{-2}$

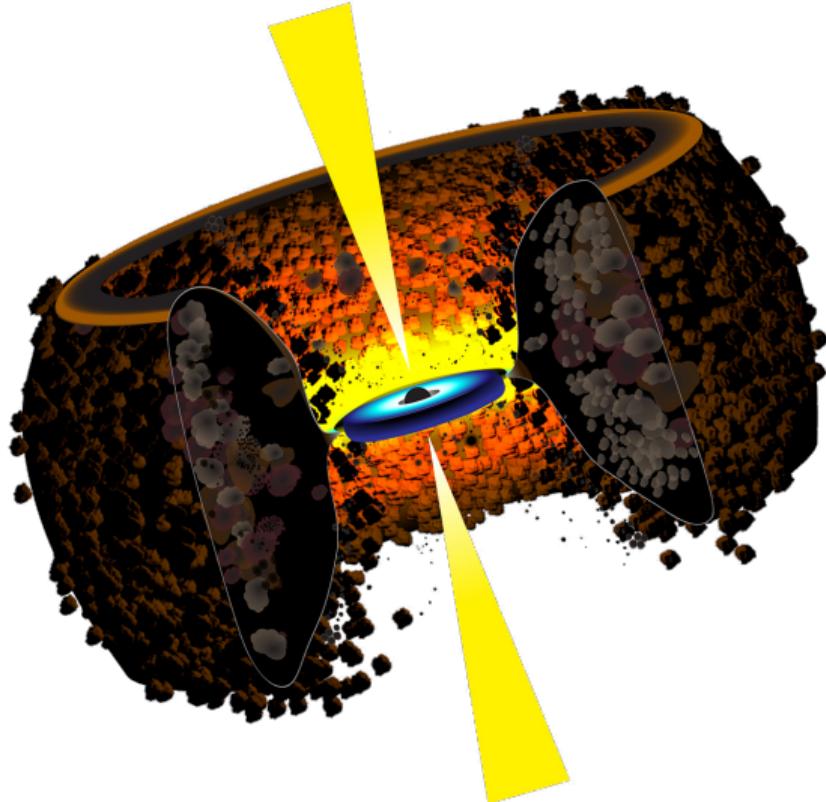


Figure: Bill Saxton, NRAO/AUI/NSF

# NGC 3982

- Seyfert 2 galaxy
- $z = 0.00371$ ,  $D \sim 19$  Mpc
- $\log M_{\text{BH}} \sim 6 - 7 M_{\odot}$
- EW Fe K $\alpha \gtrsim 1$  keV
- $\log L_{2-10\text{keV,obs}} / \text{erg s}^{-1} = 39.8$
- Compton-thick candidate  
see Guainazzi+ 2005,  
Kammoun+ 2020, Saade+ 2022

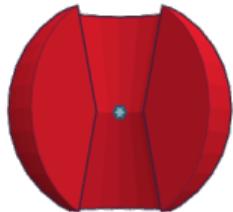


Figure: HST image of NGC 3982

# Models

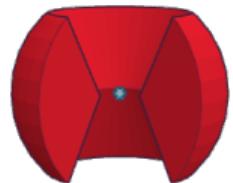
*semi-infinite slab geometry:* pextrav

Magdziarz & Zdziarski 1995



*spherical geometry:* borus02

Baloković+ 2018



*toroidal geometry:* mytorus, rxtorus

Yaqoob & Murphy 2010,  
Paltani & Ricci 2017

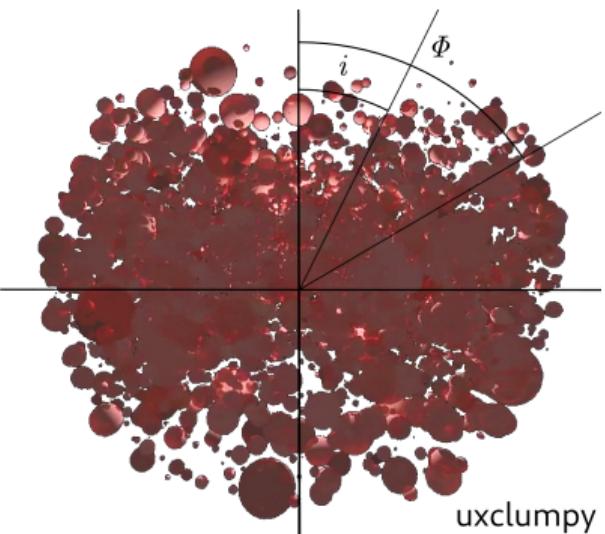
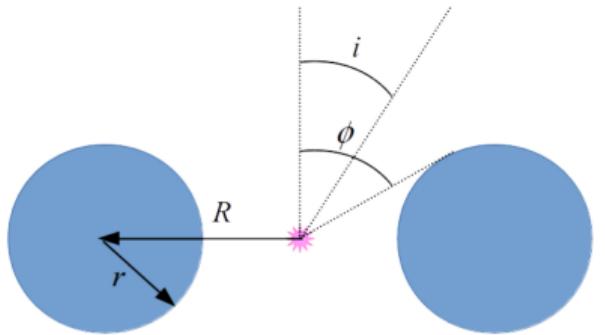
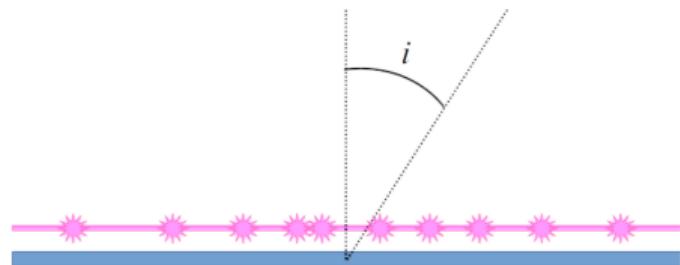


*clumpy geometry:* uxclumpy

Buchner+ 2019

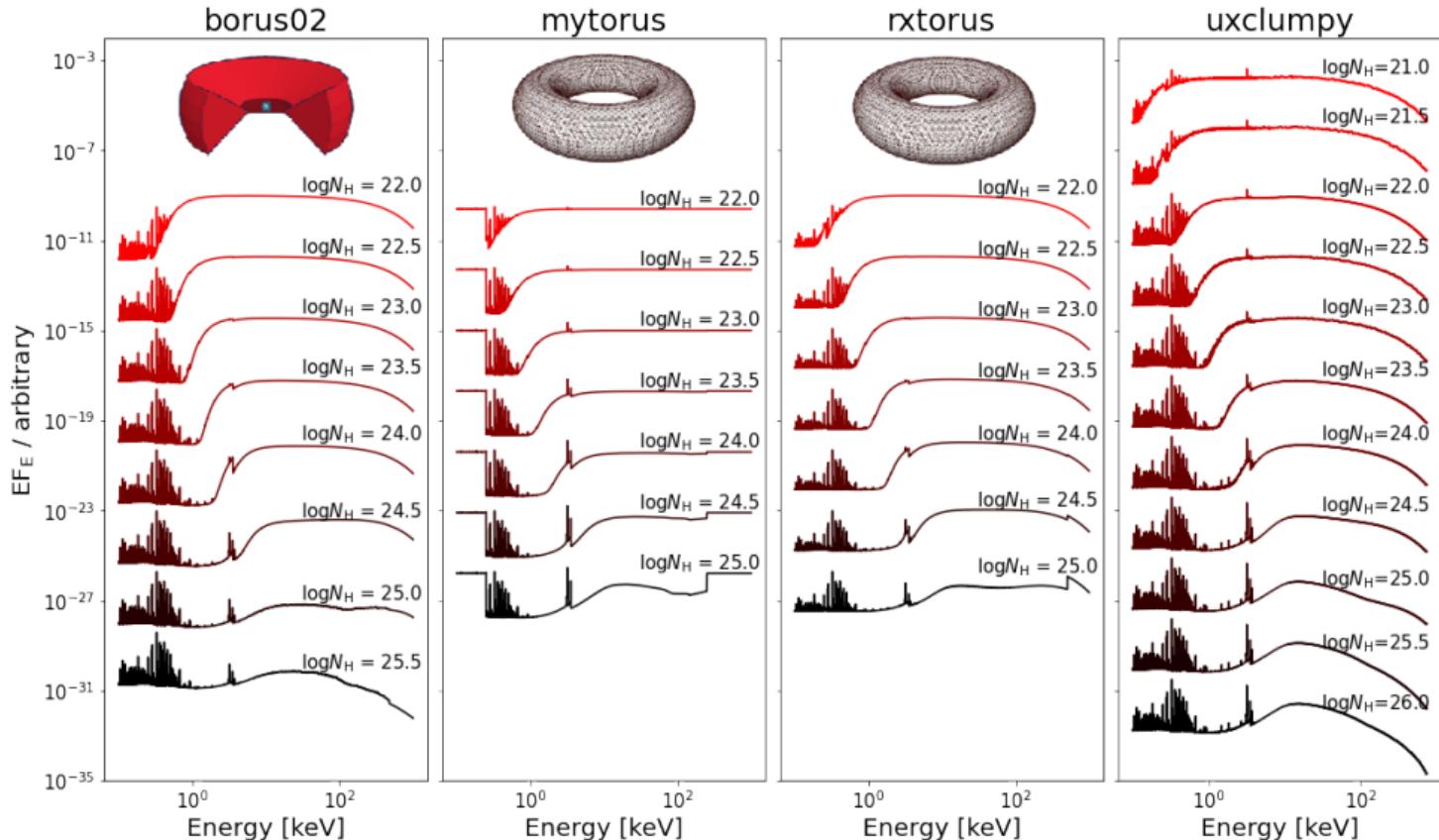


mytorus  
rxtorus

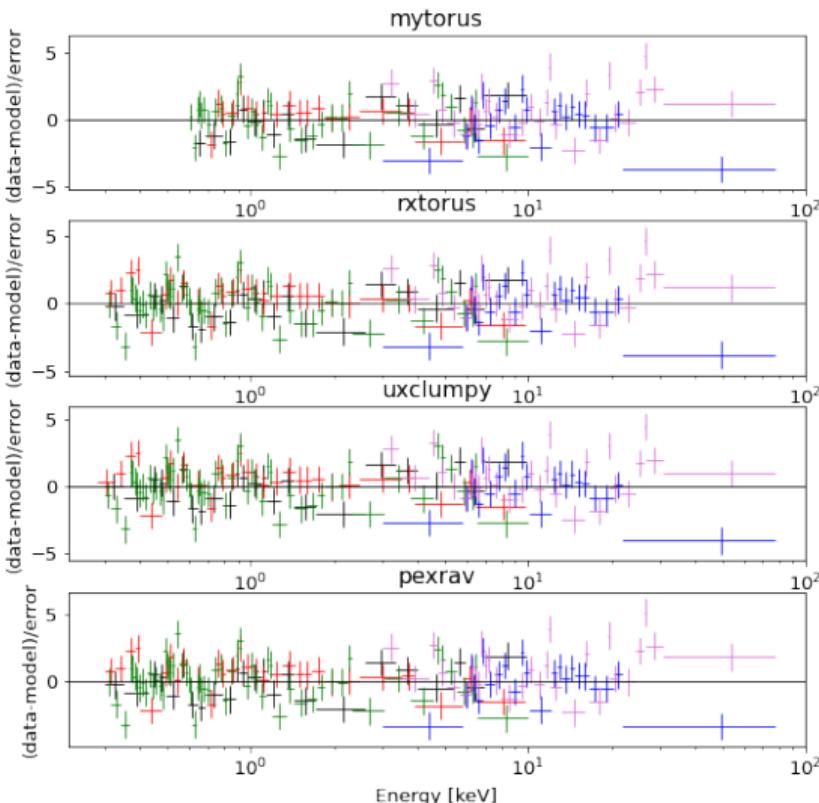
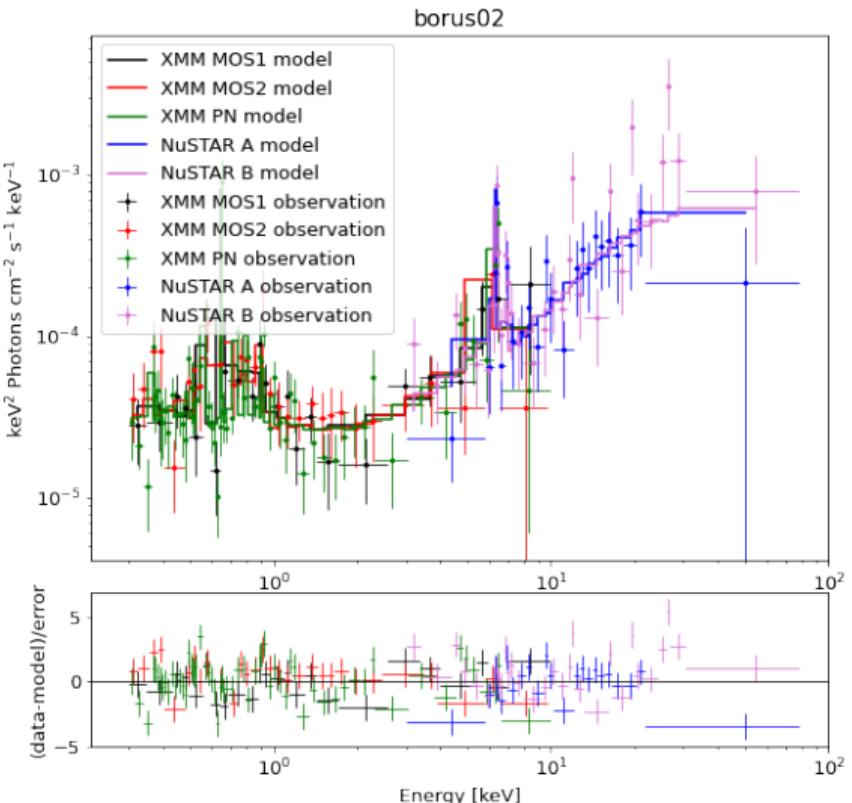


uxclumpy

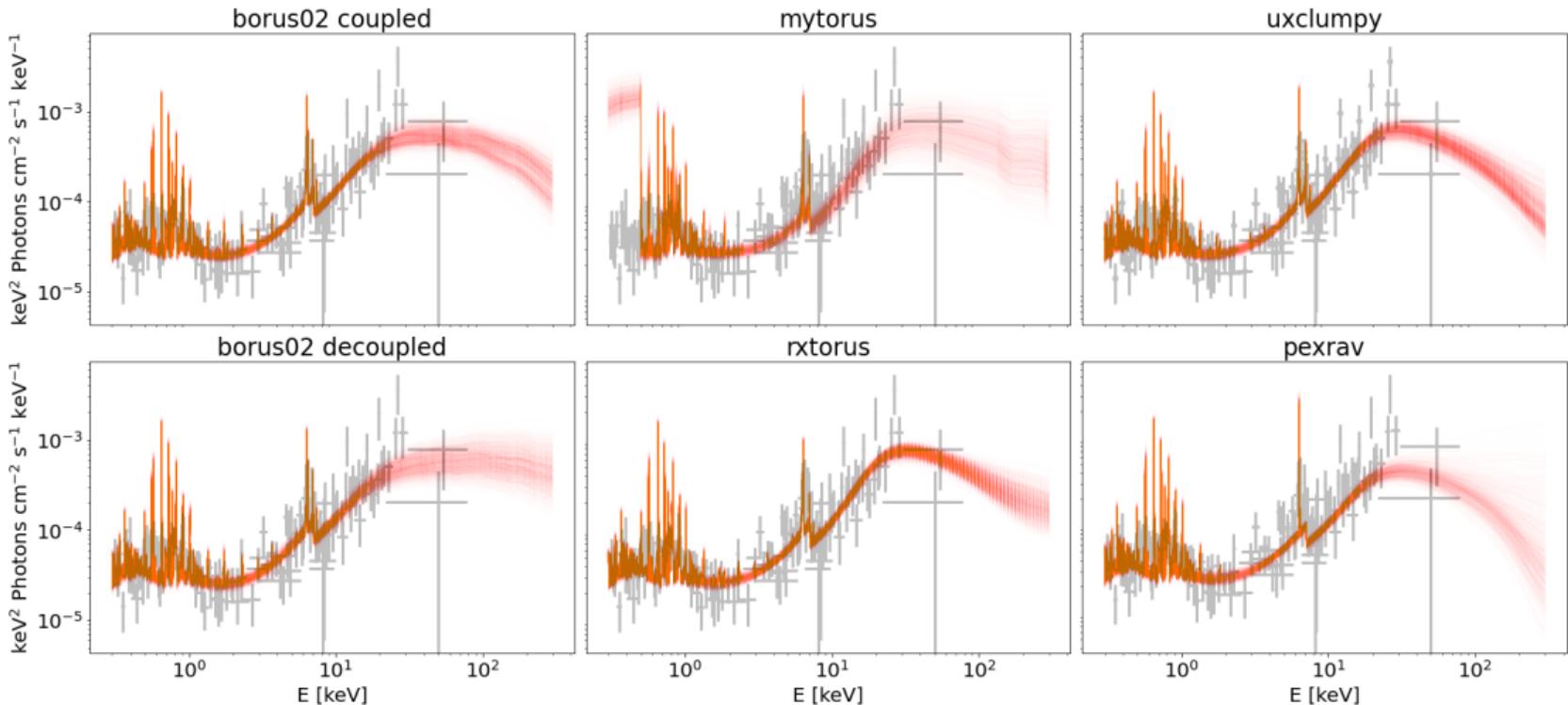
## Models: physically-motivated table models



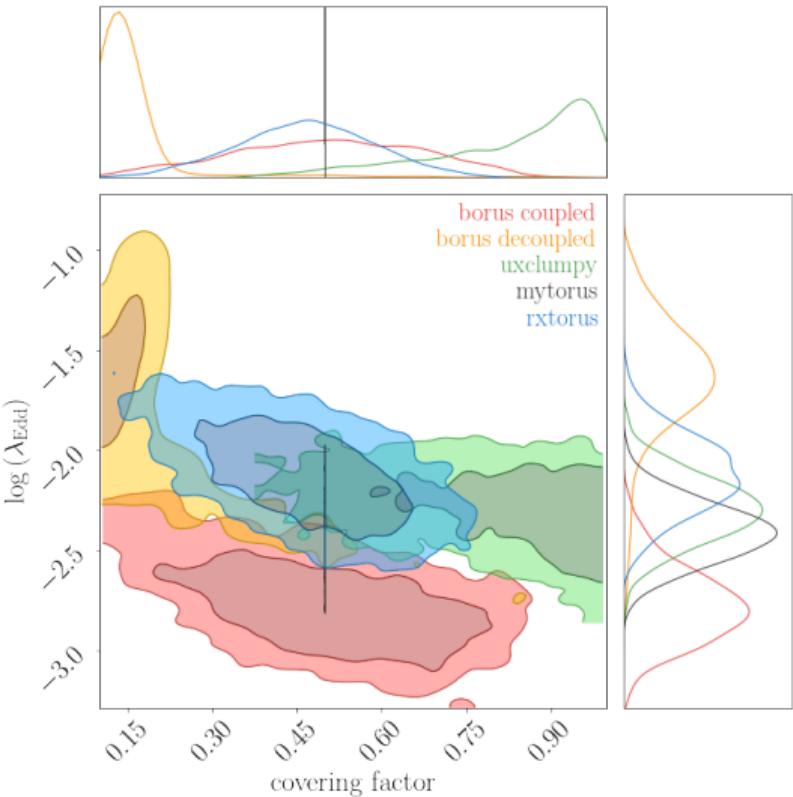
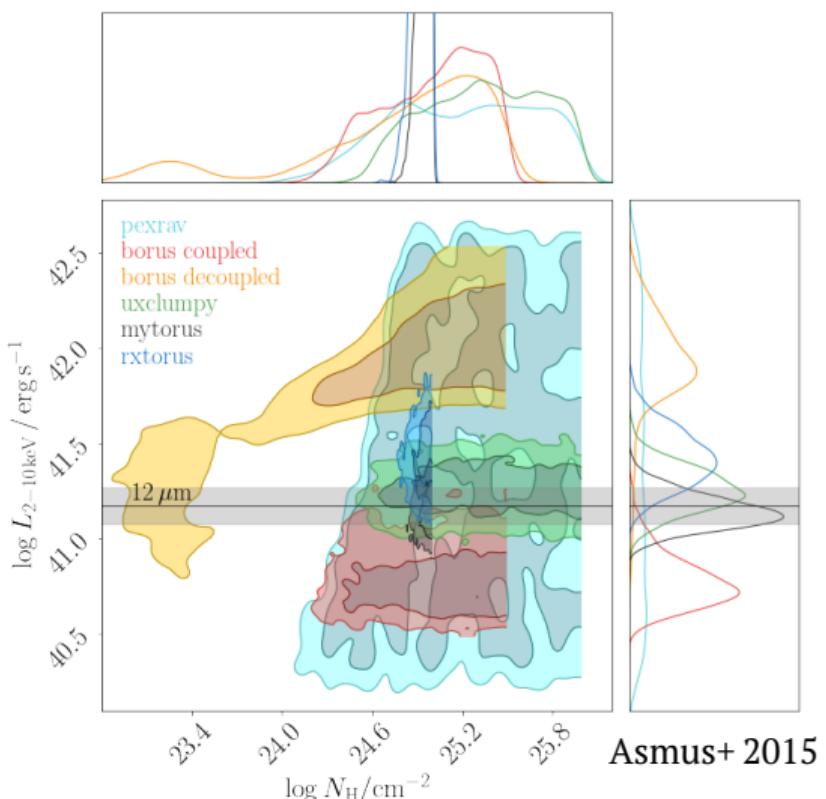
# Xspec modelling



# Posterior model realizations



# Key parameter distributions



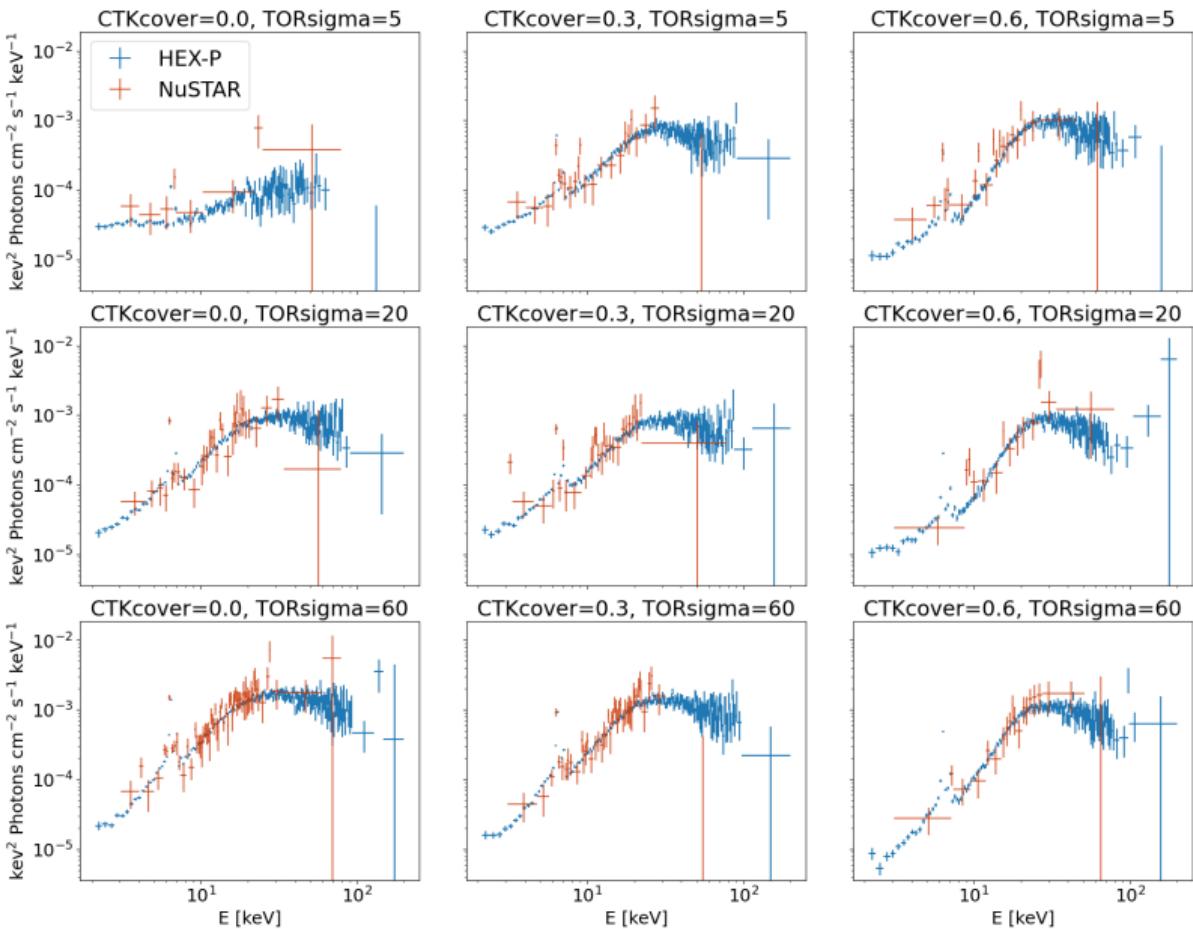
# Conclusions

- intrinsic luminosity of NGC 3982 is up to 2 orders higher than the observed luminosity
- all models assuming different unique geometries predict Compton-thickness, but geometry dependent degeneracies should be taken into account
- with available data quality we cannot distinguish between different unique geometries

# Future Work: HEX-P



Madsen+ 2020  
[www.hexp.org](http://www.hexp.org)





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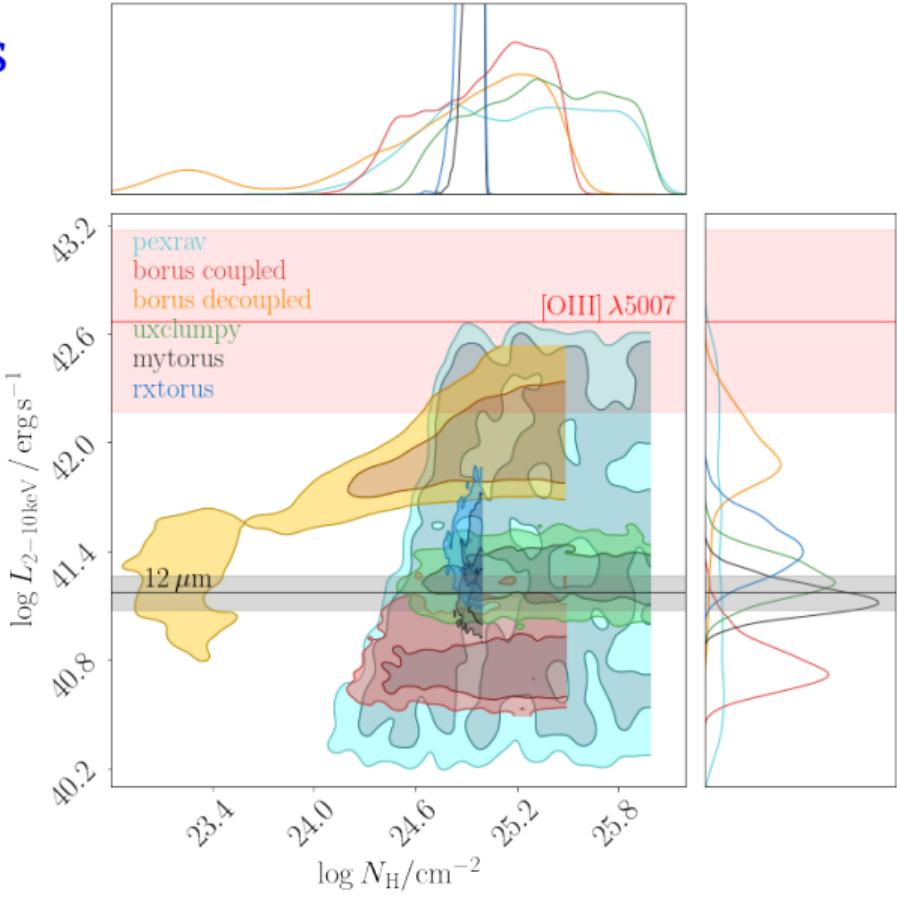
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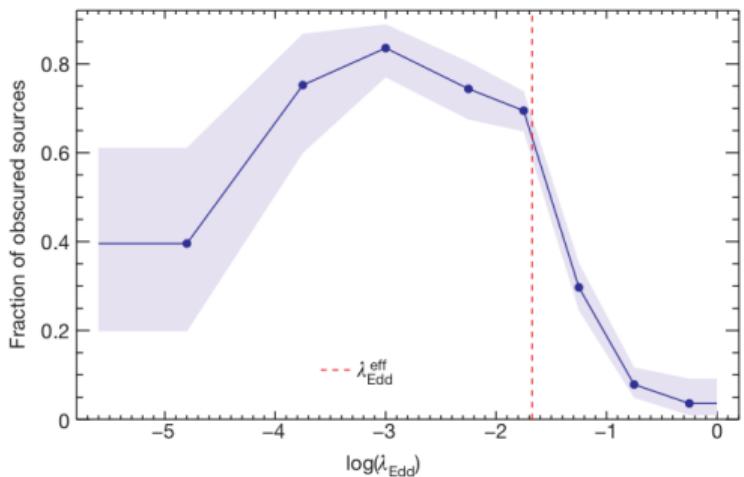
June 3, 2022

# Key parameters distributions

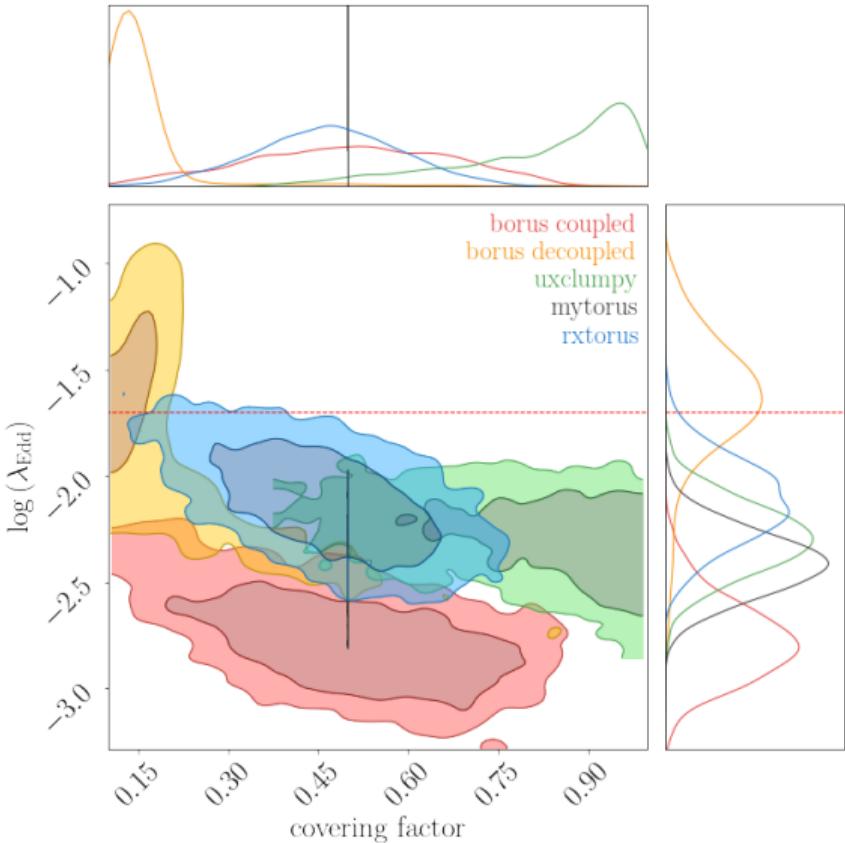
Prediction for  $L_{2-10\text{keV}}$  from  $L_{\text{OIII}}$   
Asmus+ 2015, Berney+ 2015, Woo  
& Urry 2002



# Key parameters distributions

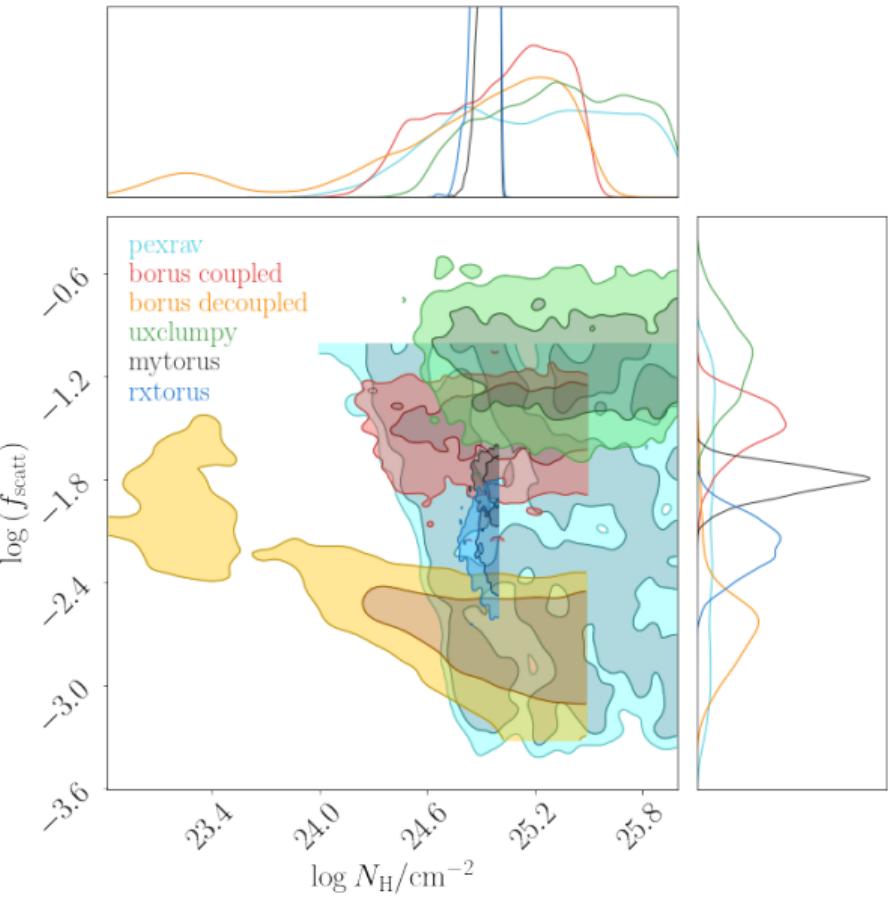


**Figure:** Distribution of  $\lambda_{\text{Edd}}$  for obscured AGN in local Universe from Ricci+ 2017



# Key parameters distributions

Thompson scattering fraction



MASARYK  
UNIVERSITY