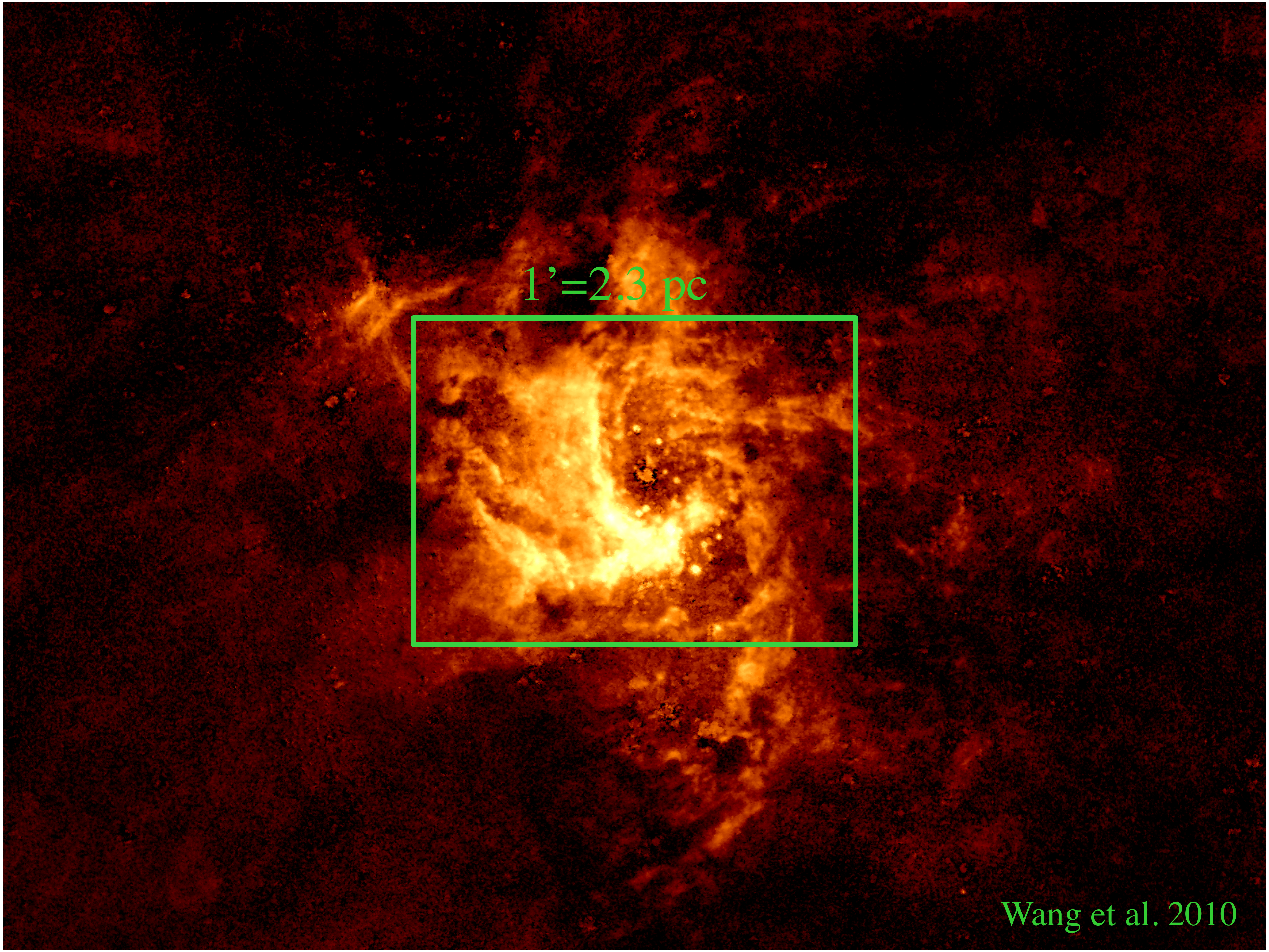
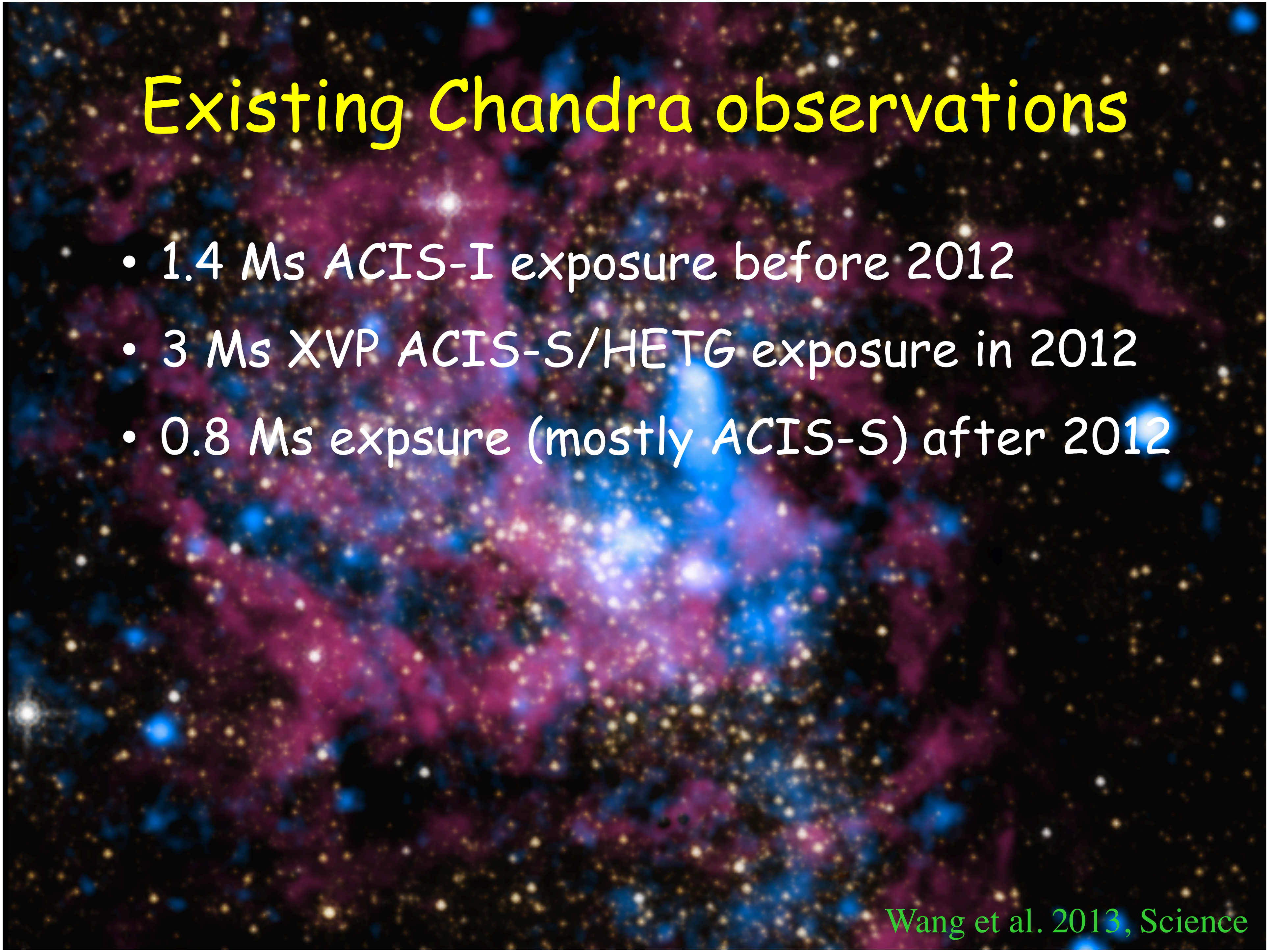
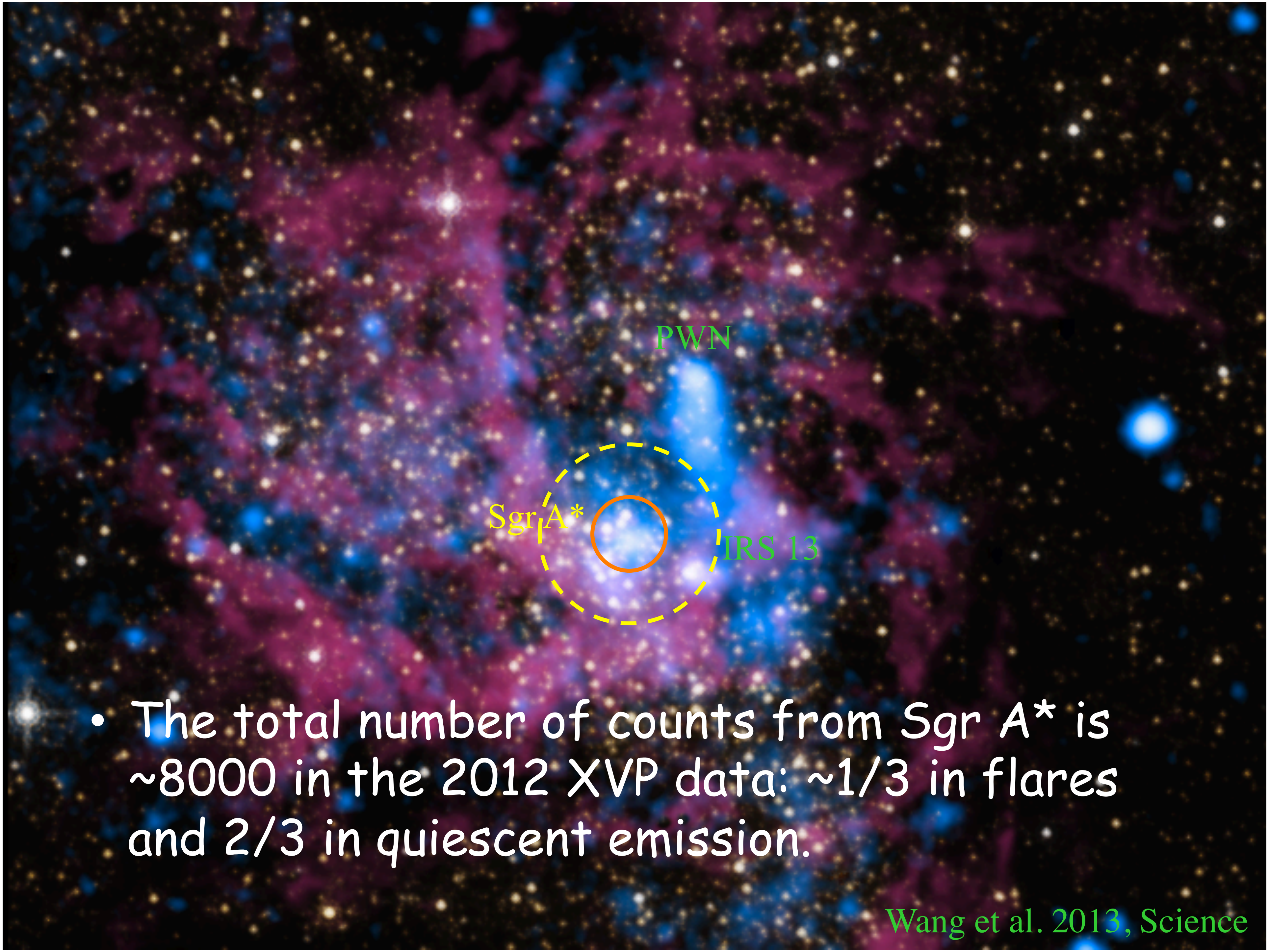

1’=2.3 pc
Wang et al. 2010

Existing Chandra observations

- 1.4 Ms ACIS-I exposure before 2012
- 3 Ms XVP ACIS-S/HETG exposure in 2012
- 0.8 Ms expsure (mostly ACIS-S) after 2012



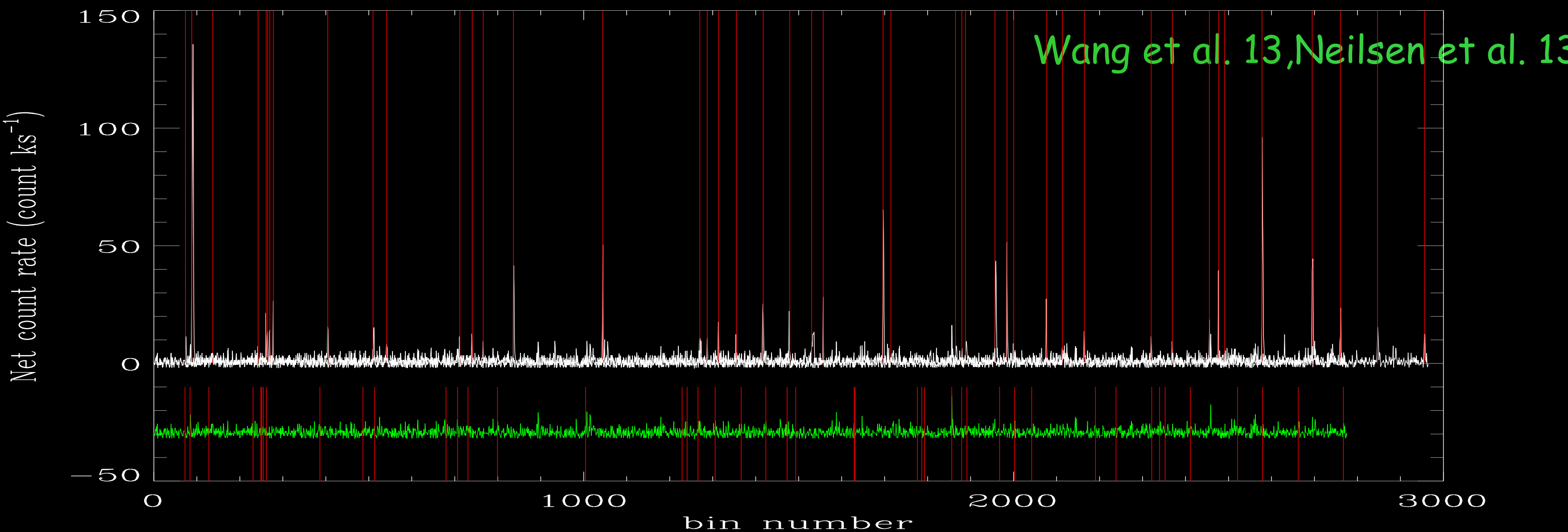
Wang et al. 2013, Science

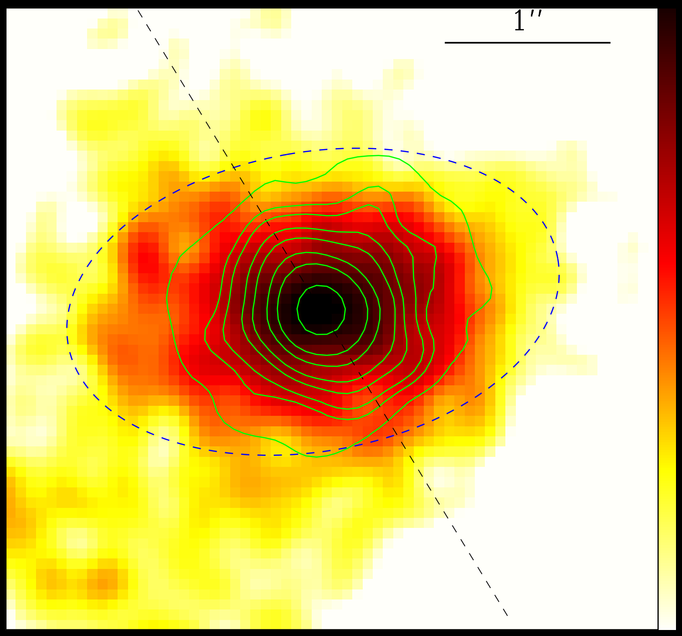


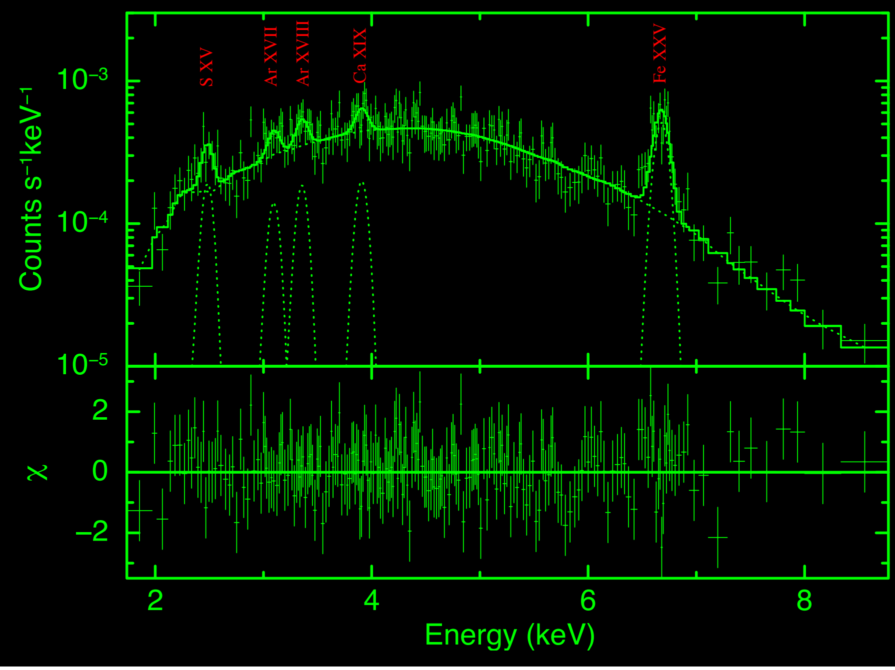
- The total number of counts from Sgr A* is ~8000 in the 2012 XVP data: ~1/3 in flares and 2/3 in quiescent emission.

Wang et al. 2013, Science

Projections of Sgr A* XVP data







Sgr A*: new insights from X-ray observations

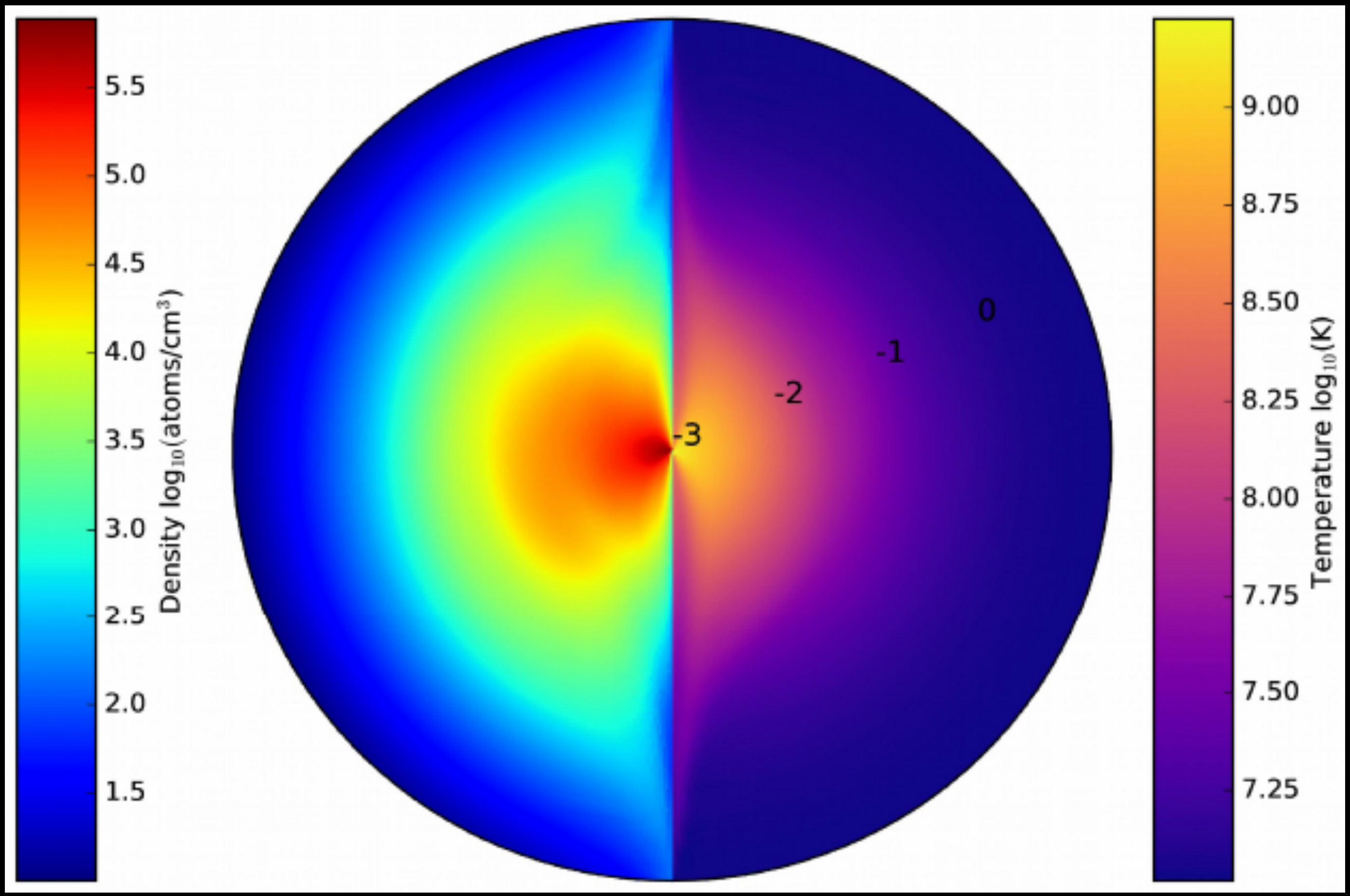
Q. Daniel Wang

(University of Massachusetts)

- A systematic Chandra study of Sgr A⋆ flares (Qiang Yuan & QDW 16)
- Self-Consistent Modeling of the Sgr A* Accretion Flow: Linking Theory and Observation (Shawn Roberts, Yan-Fei Jiang, QDW, & Jerry Ostriker 16, submitted)
- 3-D hydro simulations of colliding Wolf-Rayet winds and comparison with the Chandra observation near the Bondi radius (Christopher Russell, QDW, & Jorge Cuadra, 16)

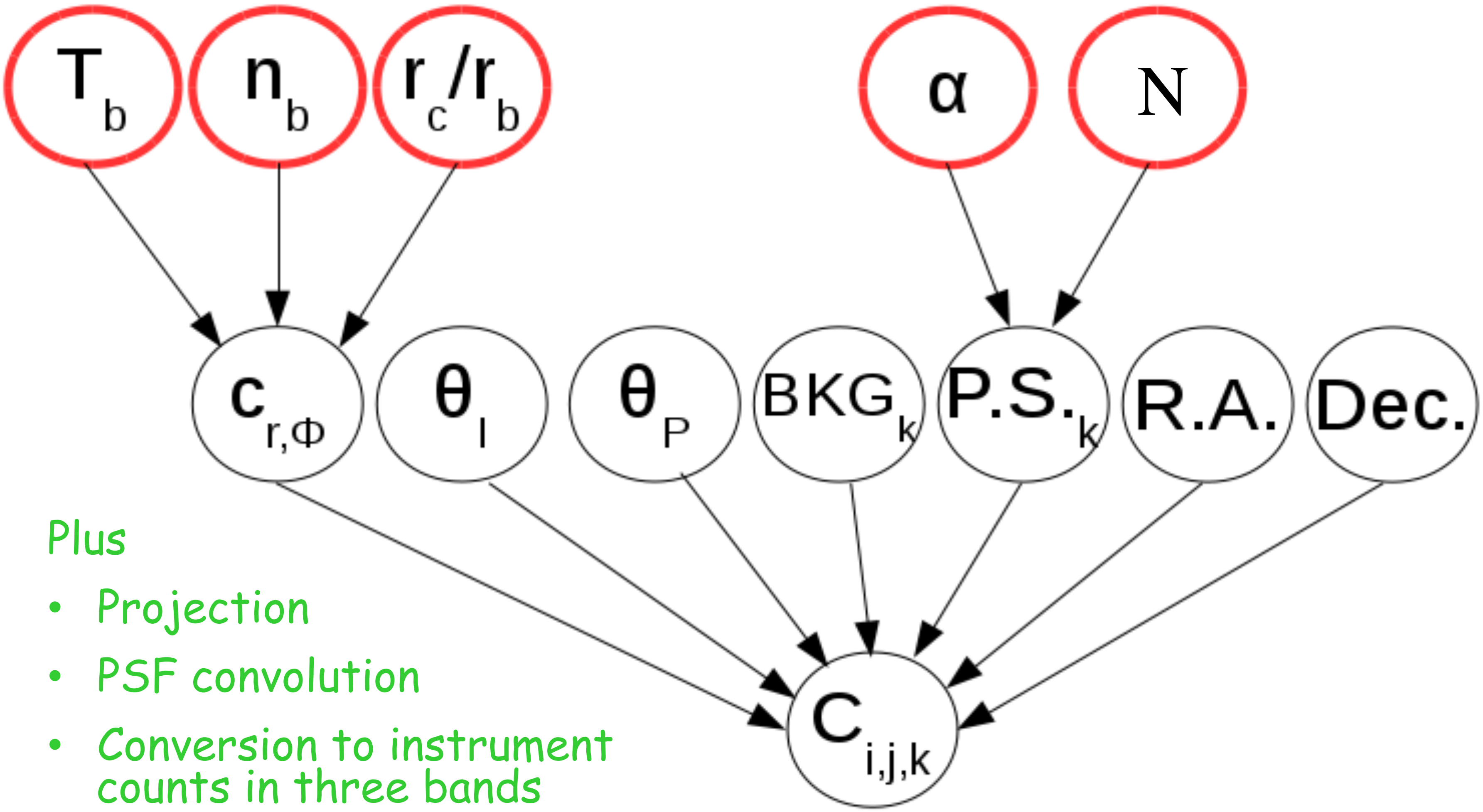
Time Averaged 2-D Athena Simulations

We performed a set of simulations with different angular momenta (or centrifugal radii r_c), which are scalable to cover all the parameter space of the accretion flow down to 10^3 r_s.



Roberts, Jiang, Wang, & Ostriker (2016)

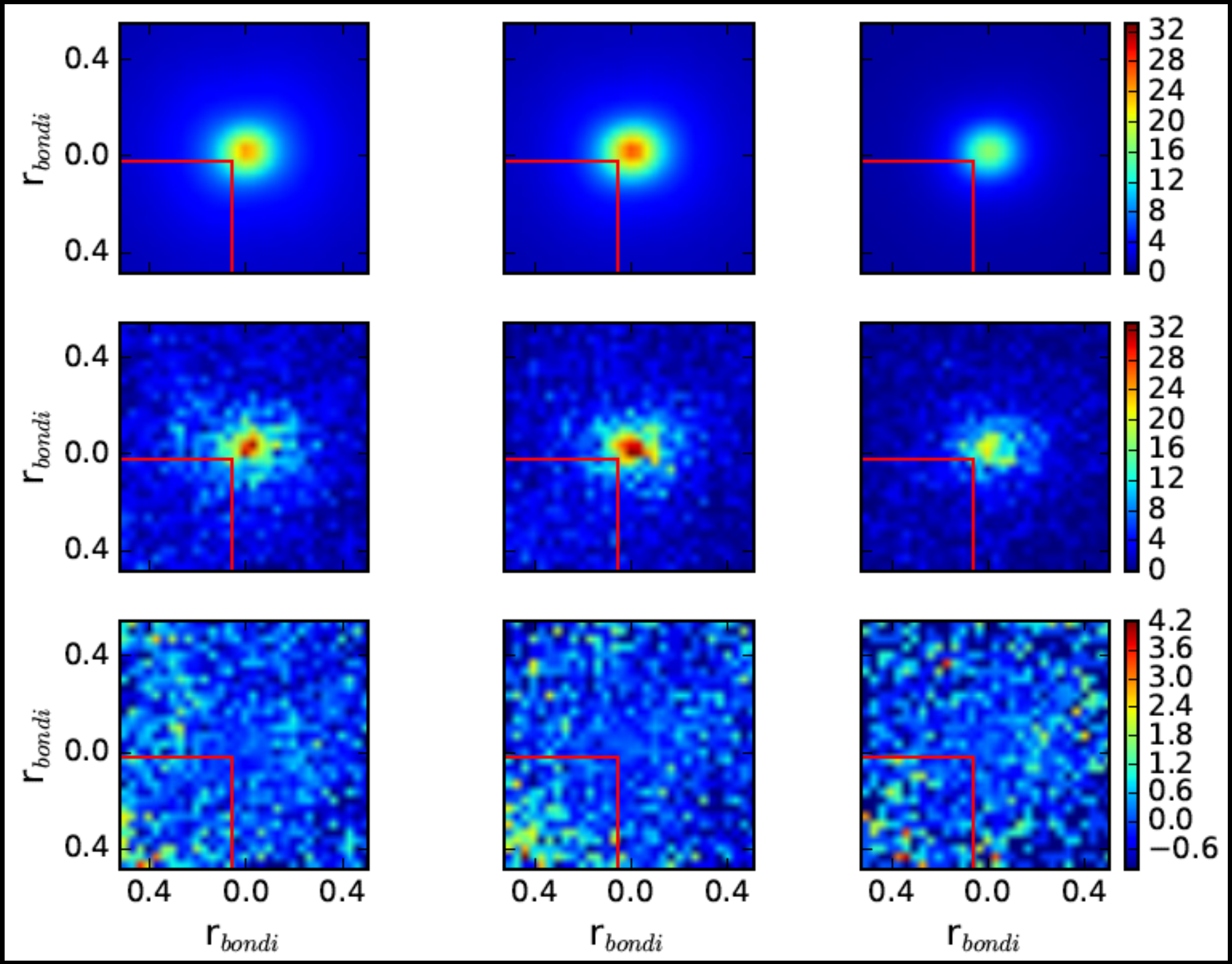
MCMC hierarchical Bayesian analysis to estimate the top level parameters



Plus

- Projection
- PSF convolution
- Conversion to instrument counts in three bands

Best-fit model, data, and residual images



1-4 keV

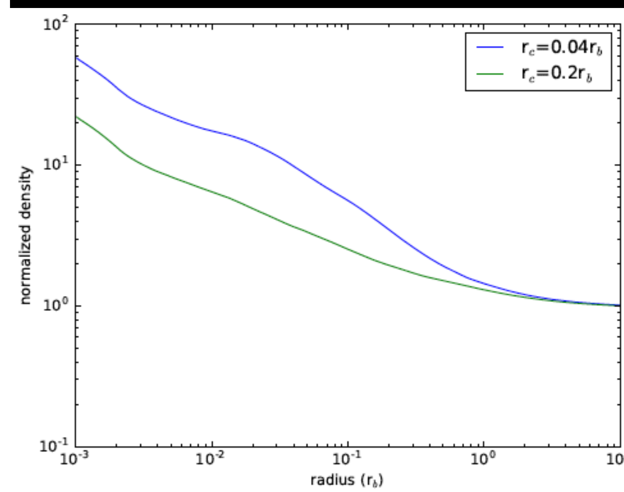
4-5.5 keV

5.5-9 keV

Best fit and 1σ confidence intervals of free parameters

θ_I (deg.)	126.4 (122.6,130.4)
θ_P (deg.)	99.1 (96.3,101.8)
r_c/r_b	0.056 (0.048,0.066)
T_b (K)	1.28e7 (1.19e7,1.42e7)
n_b (cm^{-3})	101.6 (91.4,111.1)
BKG1 (counts/pix)	0.21 (0.01,0.45)
BKG2 (counts/pix)	0.41 (0.17,0.65)
BKG3 (counts/pix)	0.48 (0.30,0.69)
α	4.8 (3.5,7.5)
$\log_{10}$(K) (ergs/s at 5 keV)	31.96 (31.32,32.18)

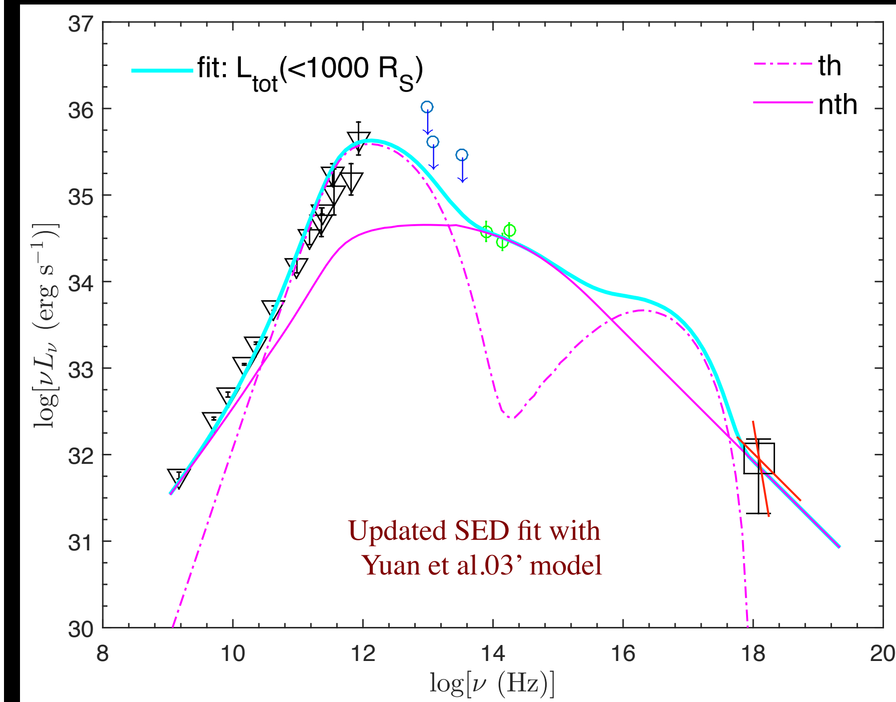
1st direct estimate of the centrifugal radius

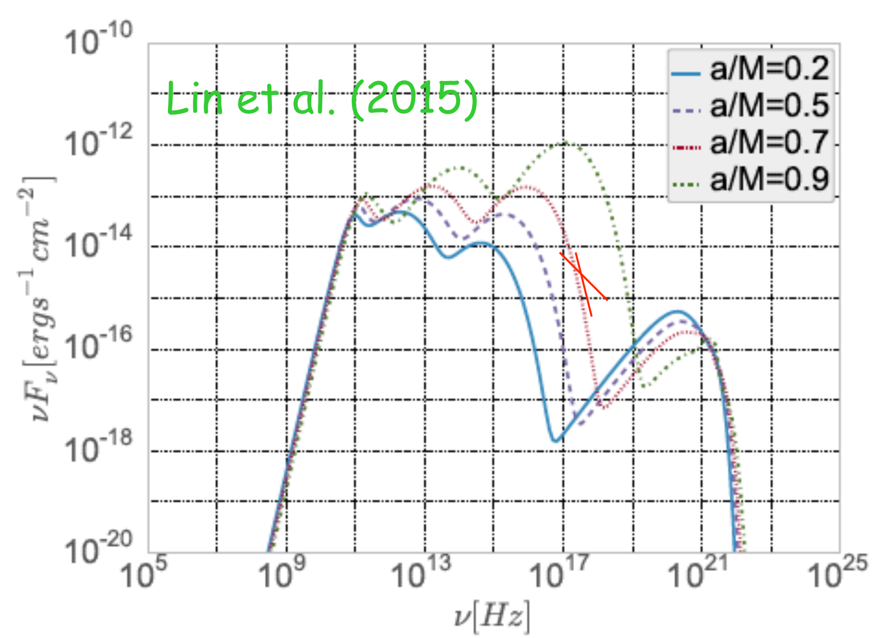


The orientation of the accretion flow is consistent with the so-called clockwise stellar disk.

Consistent with a shocked stellar wind origin.

Angular momentum flattens the average radial density profile of the flow





Point-like source

- ~4% of the quiescent emission arises from the point-like emission (within the inner boundary of the simulation r= 10^3 r_s).
- Emission Mechansim:
  - ~~Bremsstrahlung (accretion flow)~~
  - Synchrotron of nonthermal electrons, plus minor contribution from IC of synchrotron emission from thermal electrons.

Detailed SED analysis could place strong constraints on the electron energy spectrum and potentially the spin parameter.

Summary

- The shocked stellar wind scenario for the accretion is confirmed by the fitted model parameters.
- We have made the first direct estimates of the centrifugal radius (~0.06 r_b) of the accretion flow and showed its angular momentum plays a critical role in determining the accretion rate.
- The point-like emission contributes only about ~4% of the quiescent emission, most likely due to the synchrotron emission from electrons with a steep power law energy distribution very close to the SMBH.
- Detailed 3-D MHD simulations can now be carried out for further comparison with such observations as Faraday's rotation measurements.
- The combination of the Chandra and EHT observations can be very powerful in probing Sgr A* and its related physics.