

Modeling the Black Hole Spin

Eugenio Bottacini

University of Padua (Italy)

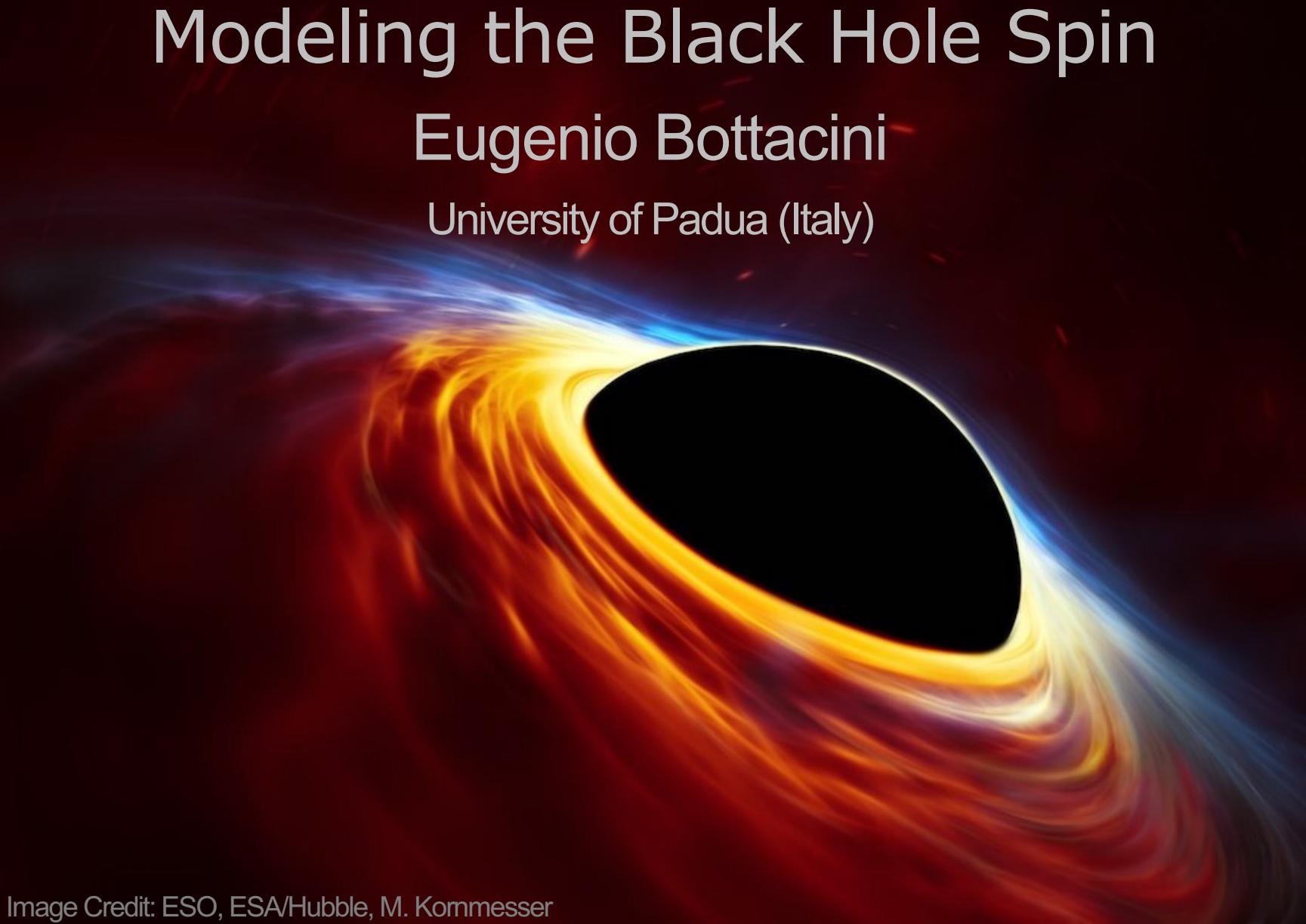
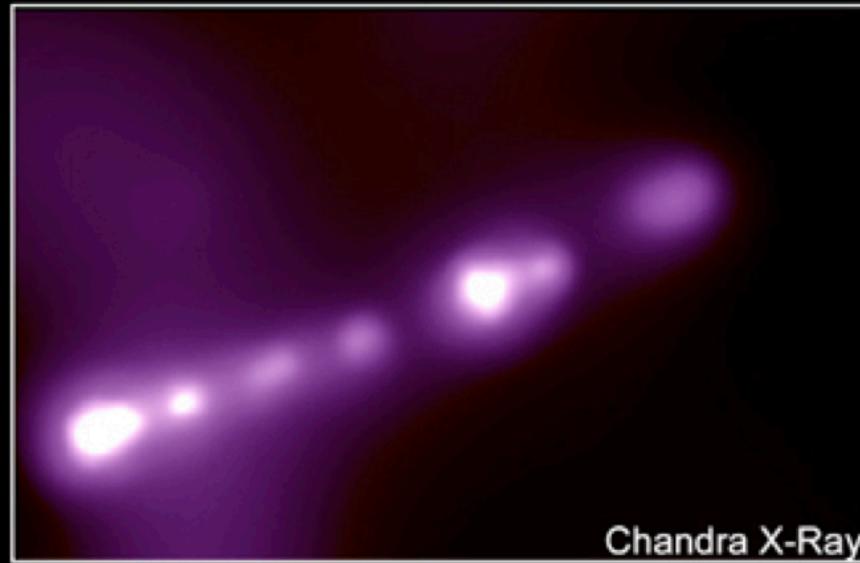
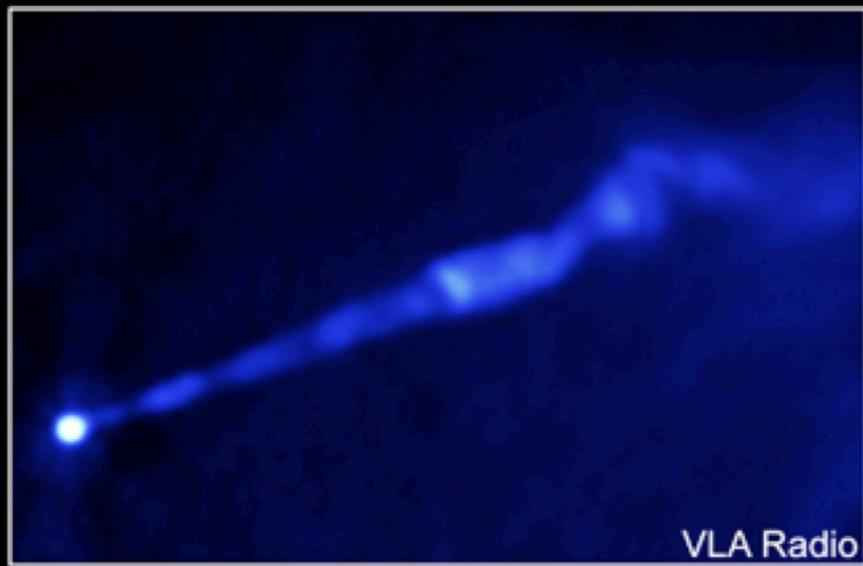


Image Credit: ESO, ESA/Hubble, M. Kornmesser

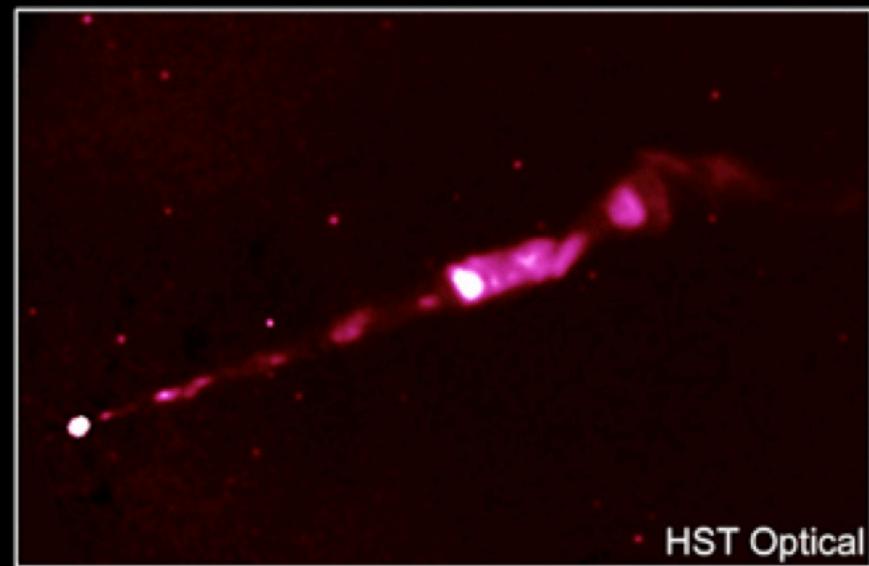
<https://doi.org/10.1093/mnras/stac1890>



Chandra X-Ray



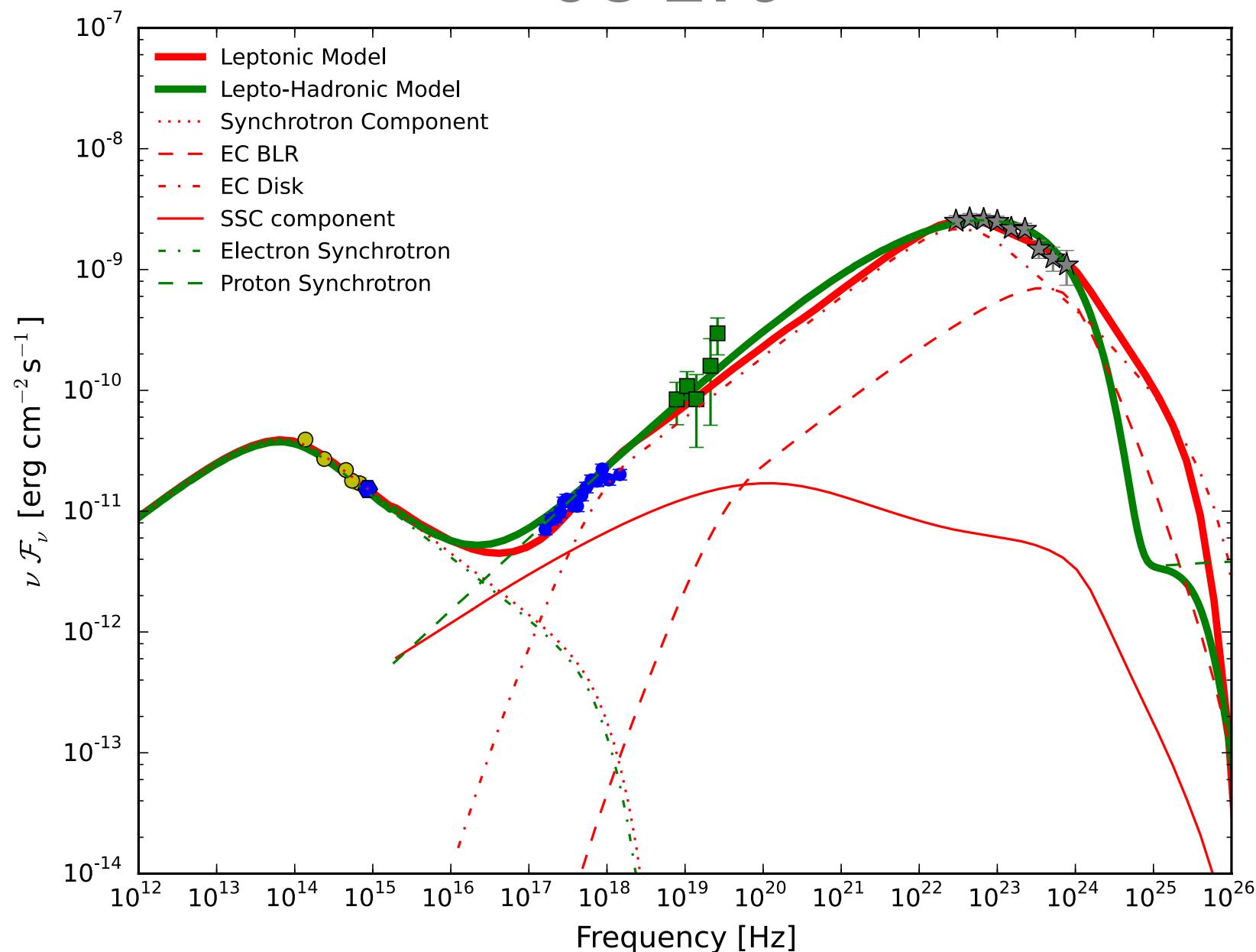
VLA Radio



HST Optical

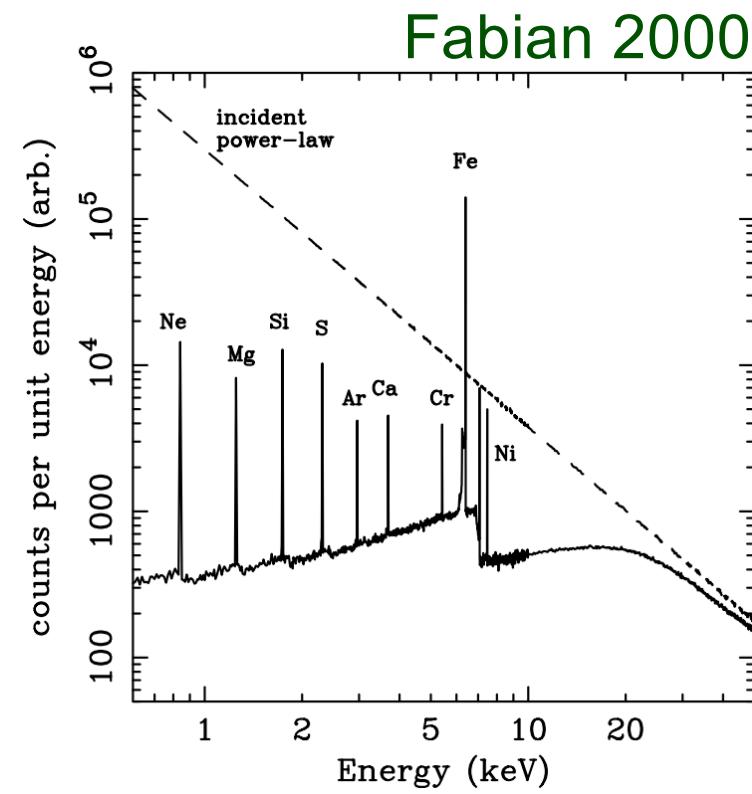
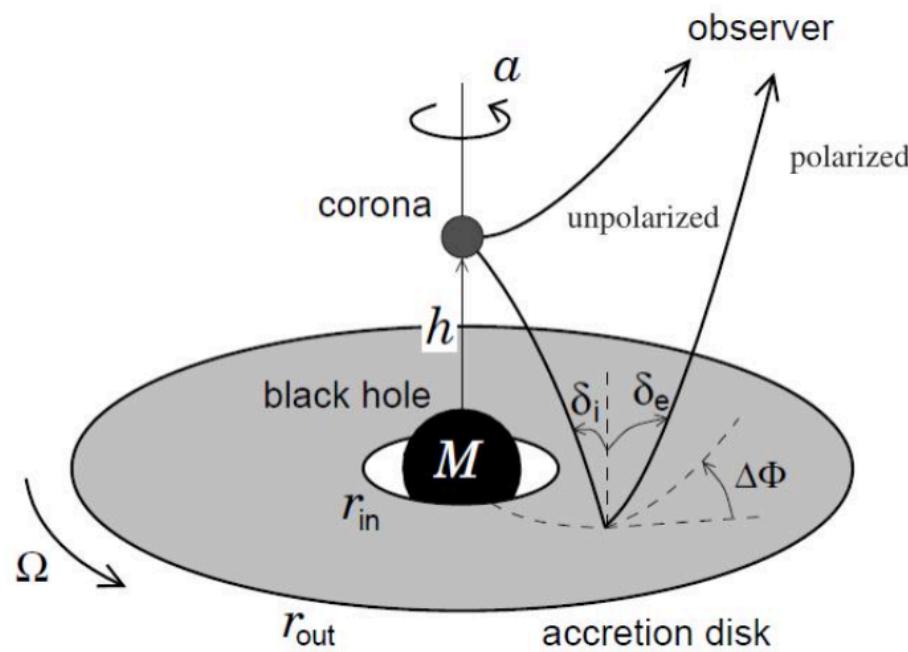
3C 279

Bottacini et al. 2016



Formation of Jets

From General Relativistic Magneto-Hydrodynamic simulations (e.g. De Villiers & Hawley 2003; McKinnery 2006) accreting and rotating black holes form jets: the higher the spin, the higher the jet power.



Signatures of Spinning Black Holes

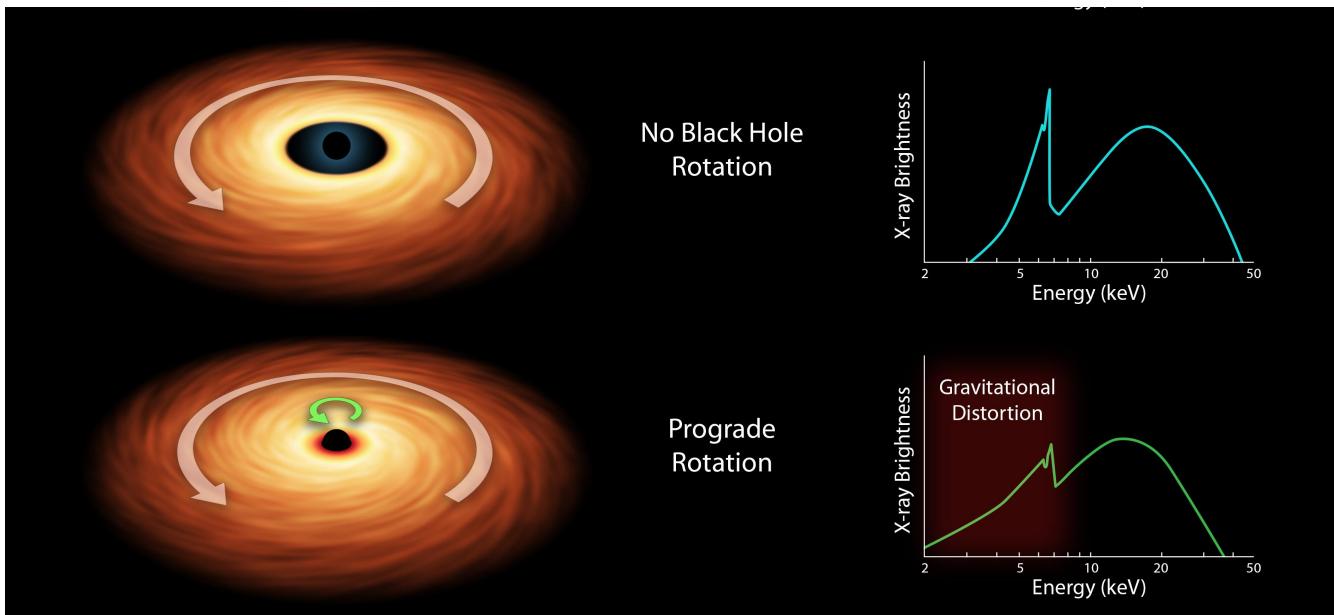


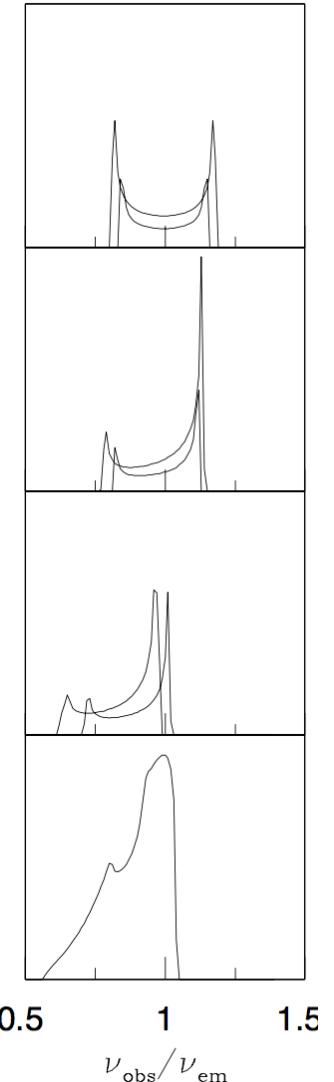
Image Credit: NASA/JPL Caltech

Newtonian
Doppler

Special relativity
Beaming +
transverse
Doppler

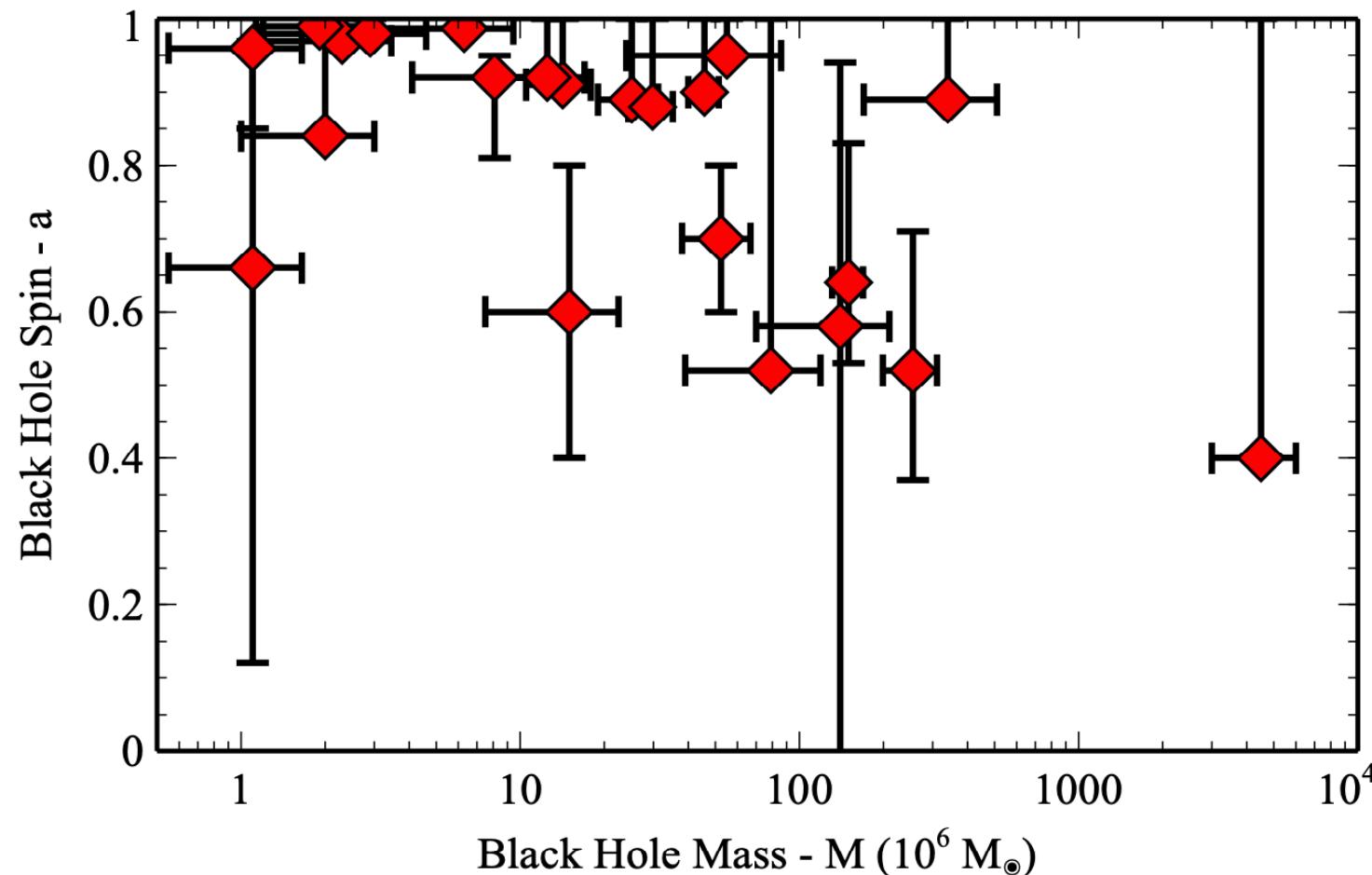
General relativity
Grav. Redshift

Line profile
Resulting line

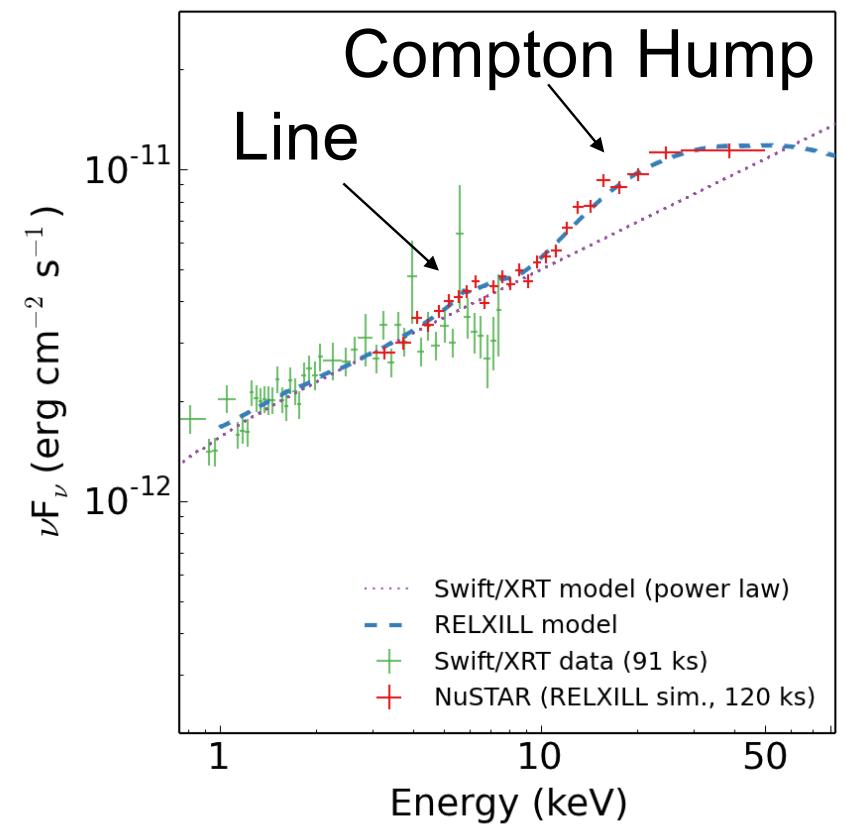
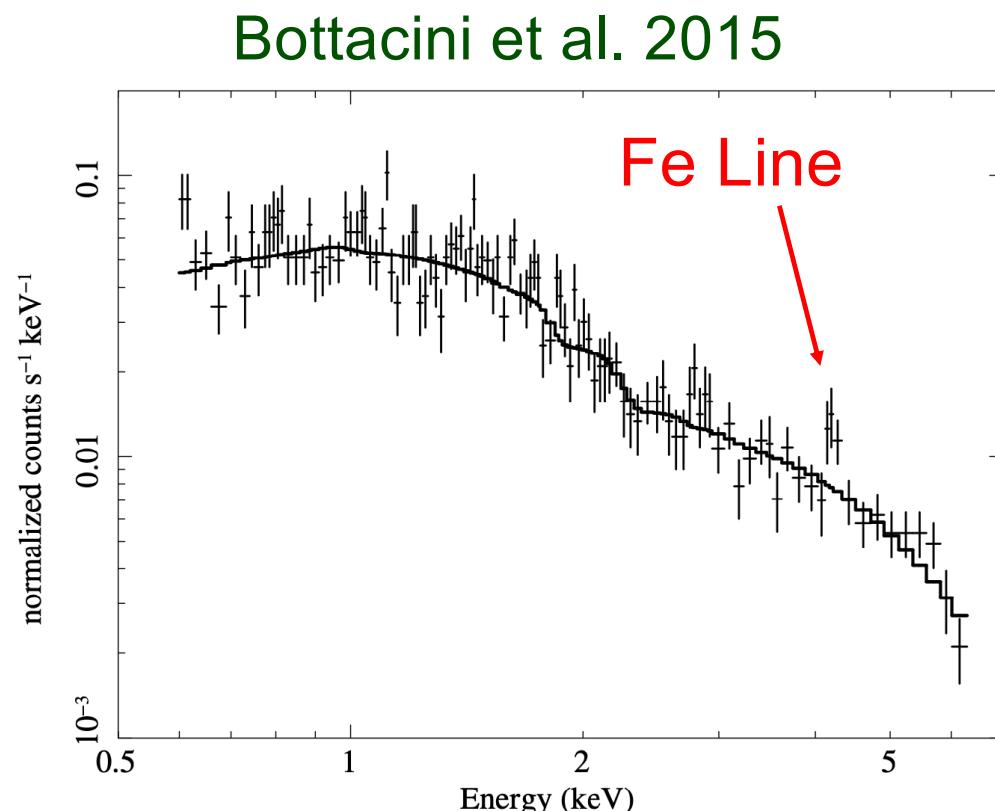


Spin Measurements through X-Ray Spectra

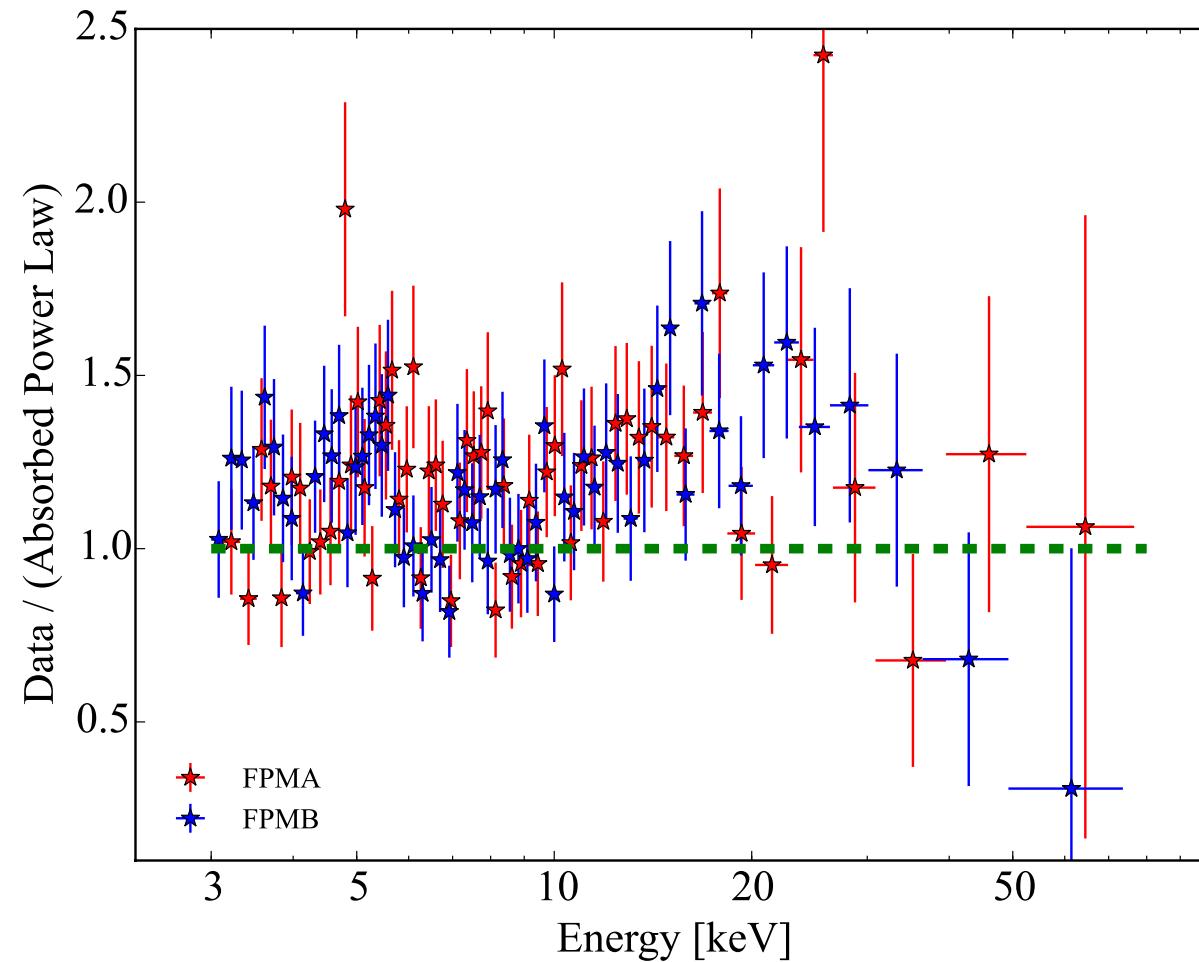
Vasudevan et al. 2016



Mrk 876: A Gravitationally Redshifted Fe Line

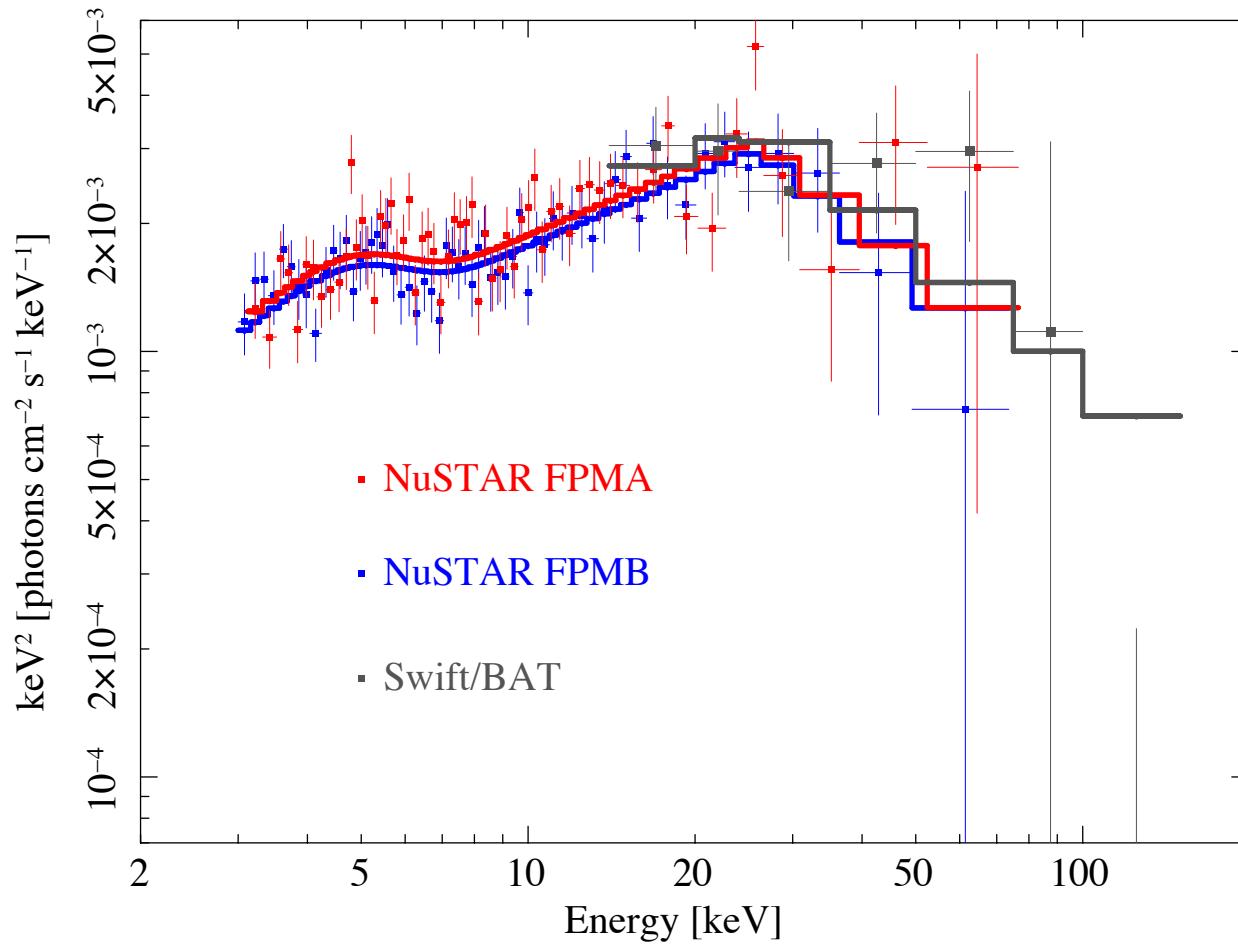


NuSTAR Broadband Spectrum (30 ksec)

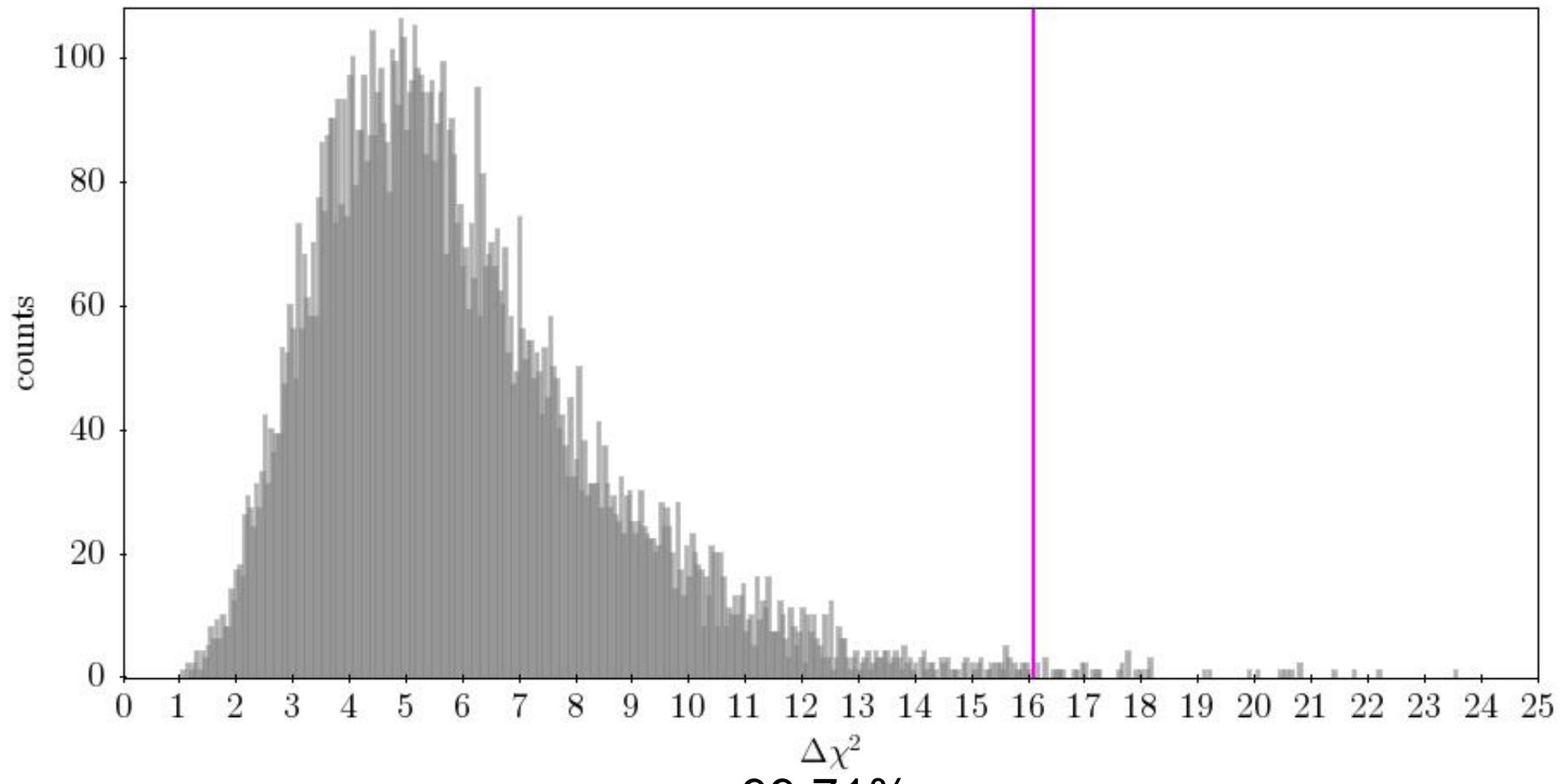


$$\chi^2_{red} = 1.15$$

NuSTAR + Swift/BAT Broadband Spectrum

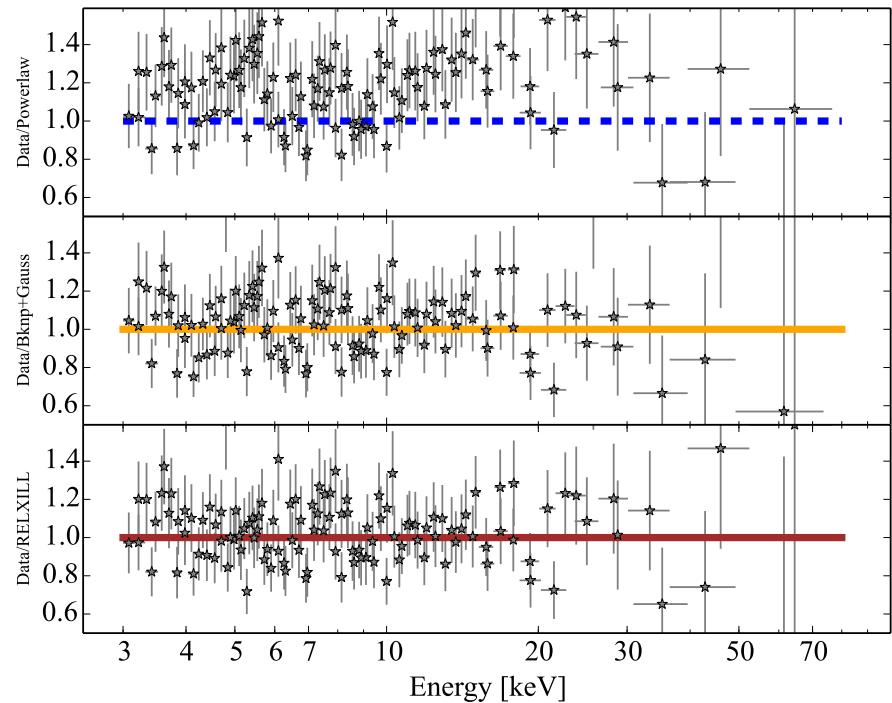
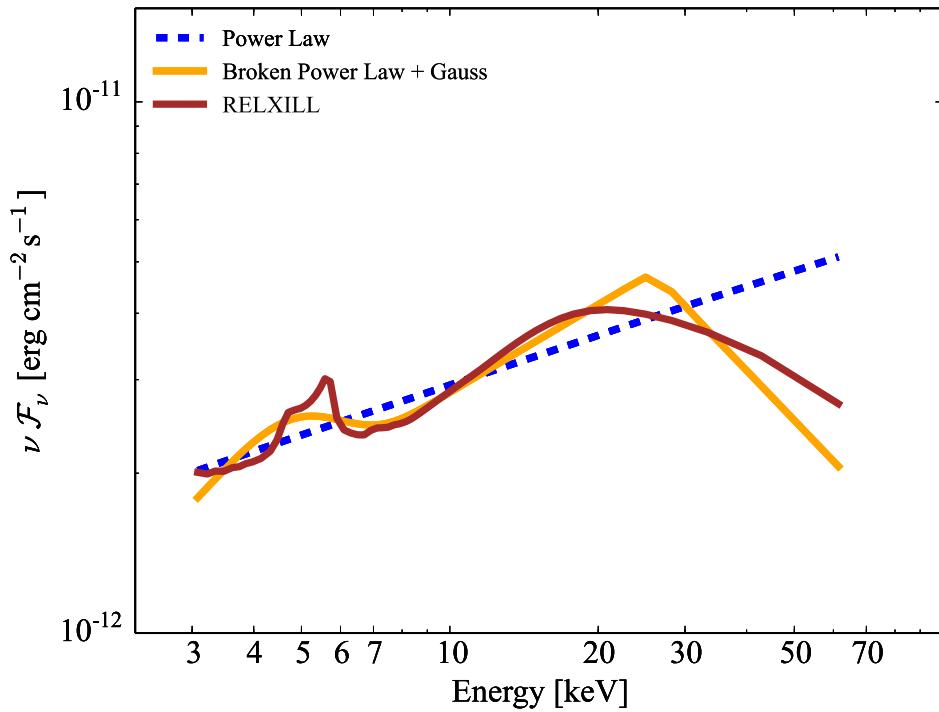


Monte Carlo Simulation of Broad Low-Energy Excess



compared to 50% for a narrow line

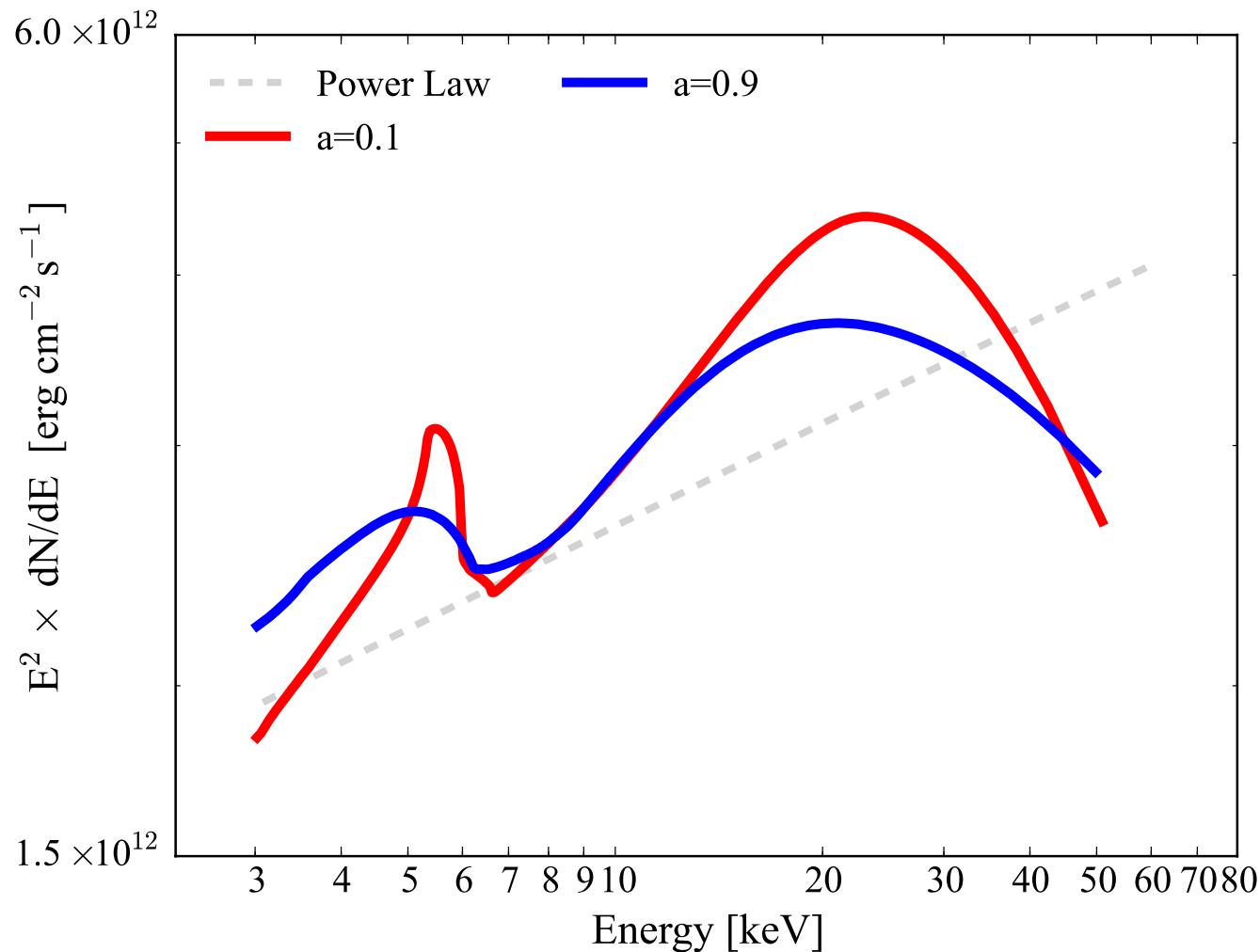
Relativistic Reflection off the Accretion Disk



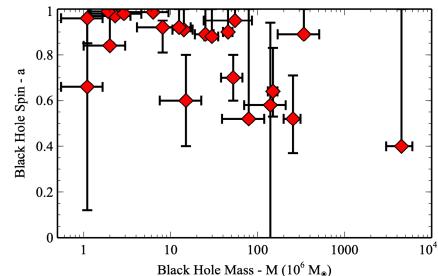
$$\begin{aligned}a &< 0.85 \\i &= 32.84 \\q &= 4.56\end{aligned}$$

$$\begin{aligned}A_{Fe} &= 1.85 \\R &= 1.91 \\\log(\xi) &< 3.17\end{aligned}$$

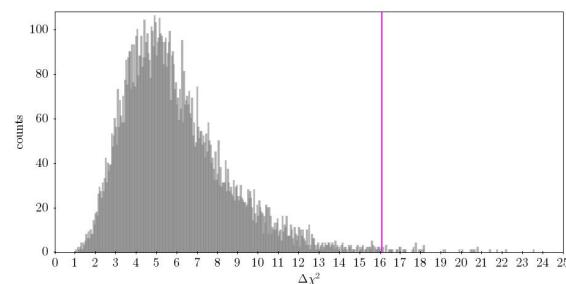
Simulating the BH Spin



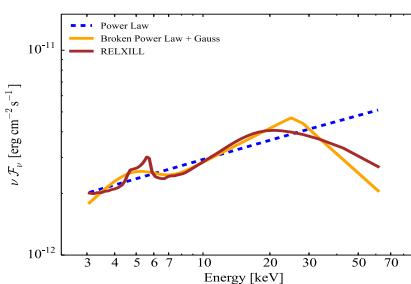
Take-Home Message



Spin measurements are important
as jets accelerate CRs



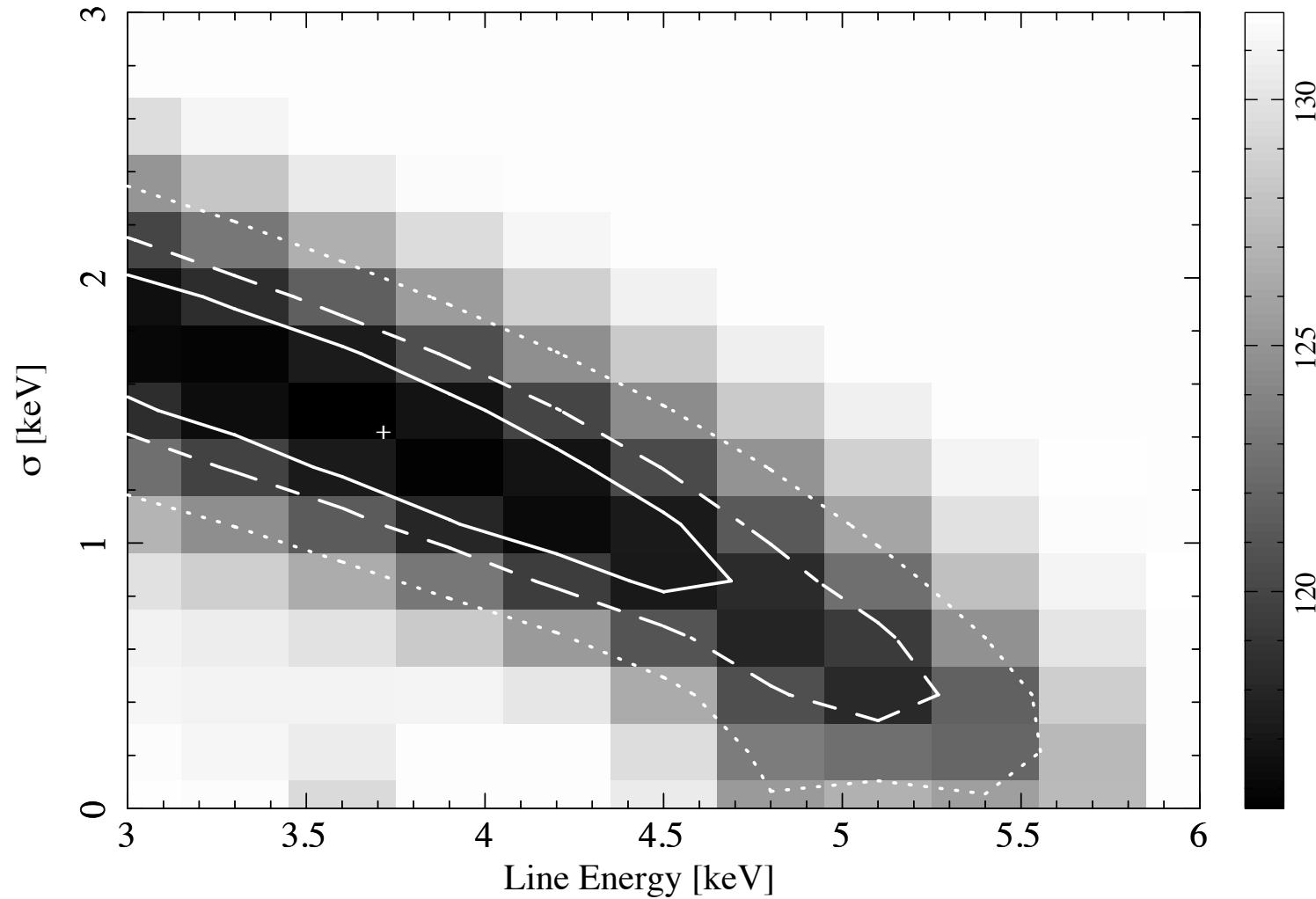
Statistics very limited



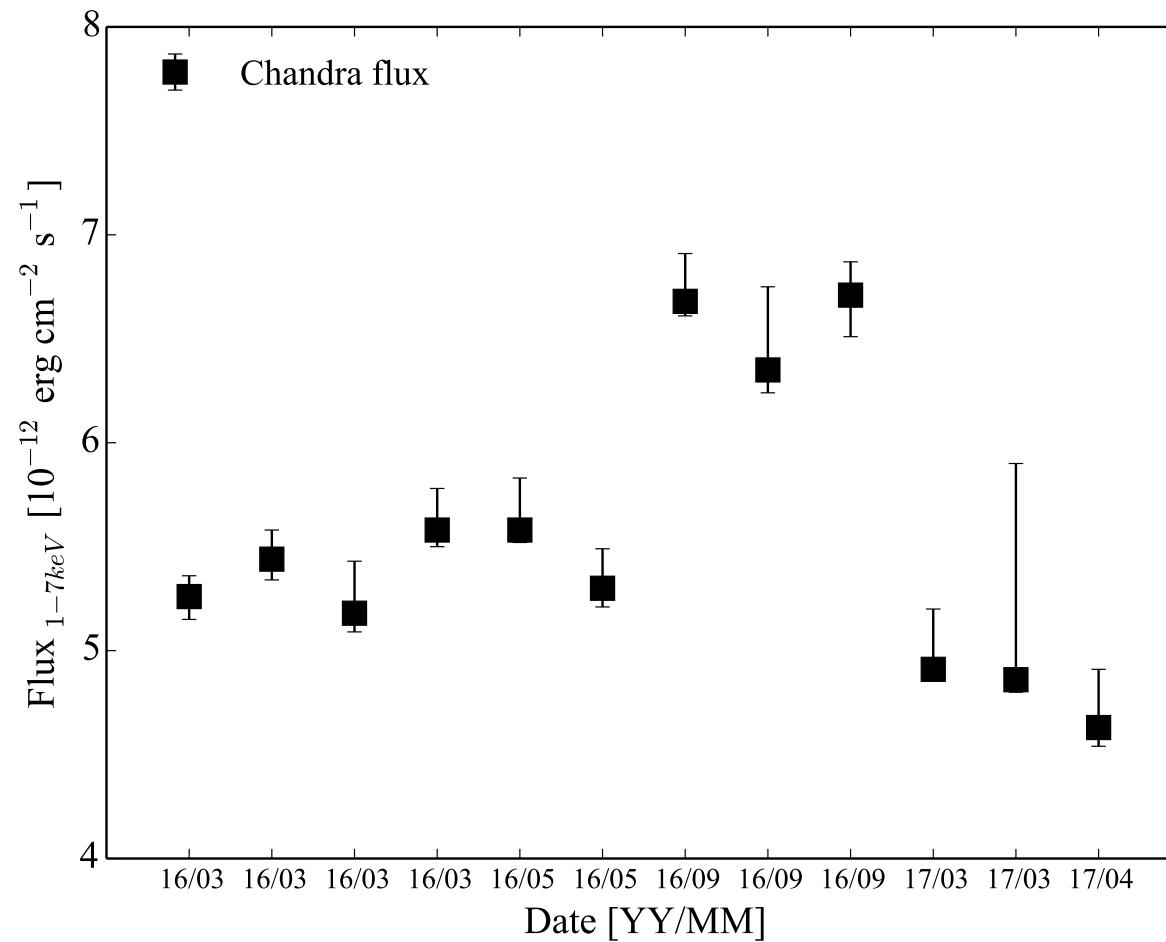
Mrk 876: an
explanatory example

<https://doi.org/10.1093/mnras/stac1890>

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