The High Energy X-Ray Probe (HEX-P)

Probing accretion onto stellar mass black holes

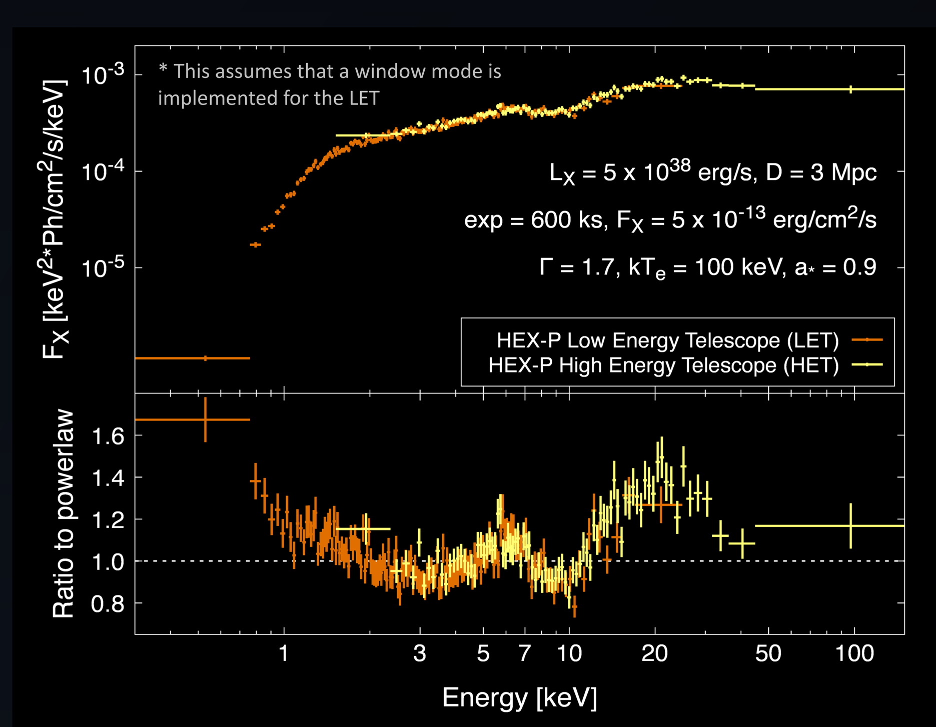
Riley Connors[1], **Javier Garcia**[2], John Tomsick[3], Paul Draghis[4], Benjamin Coughenour[3], Nicole Rodriguez[5], Andrew West[5], Navin Sridhar[6], Kristin Madsen[7], Daniel Stern[8,1], & the HEX-P Team

Overview:

HEX-P is a probe-class mission concept that will combine high spatial resolution X-ray imaging (<10 arcsec FWHM) and broad spectral coverage (0.1-150 keV) with an effective area far superior to current facilities (including XMM-Newton and NuSTAR) to enable revolutionary new insights into a variety of important astrophysical problems. We present a summary of simulations of HEX-P observations of accreting black holes in binary systems to demonstrate the power of this observatory to conduct binaries science. We show that HEX-P will allow us to: 1) probe the physics and energetics of accretion flows in the vicinity of black holes; **2)** break the model degeneracies that hinder accurate and precise measurements of black hole spin; **3)** revolutionize the study of black hole binaries in nearby galaxies, allowing us to broaden the population of black hole spins; **4)** determine the physical and geometrical nature of the X-ray corona; and much more. More information on HEX-P, including the full team list, is available at https://hexp.org.

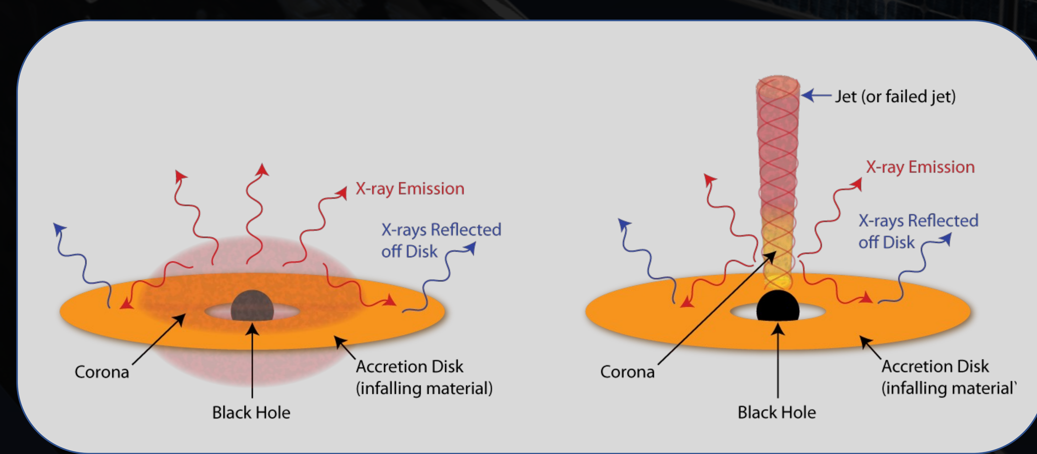
Black holes in nearby galaxies

- Several known BH XRBs in nearby galaxies, BUT most too faint to perform detailed spectral analyses or detect spectral features with current instruments
- HEX-P will : (i) expand population of BH XRBs in nearby galaxies (see poster by K. Garofali, 103.24); (ii) allow deeper spectral studies of these sources
- Bright hard state BH XRB (Lx ~ 5 x 10^{38} erg/s) at distance = 3 Mpc with 600 ks HEX-P exposure exhibits strong reflection features in broadband X-ray spectrum - **HEX-P will measure line profiles of new population of BHs**



For more information on the capabilities of HEX-P to resolve X-ray populations in nearby galaxies see poster by K. Garofali (103.24) or visit hexp.org/pillar-3-science/

Constraining the geometry of the corona



Credit: D. Wilkins

- Distinguishing geometry of corona essential to understanding physics of inner accretion flow, key to breaking degeneracies between accretion physics and BH spin
- Broad energy coverage of HEX-P, combined with high sensitivity, allows us to detect spectral differences at E > 100 keV
- GR ray tracing code kerrC predicts polarization and energy spectra for different coronal geometries

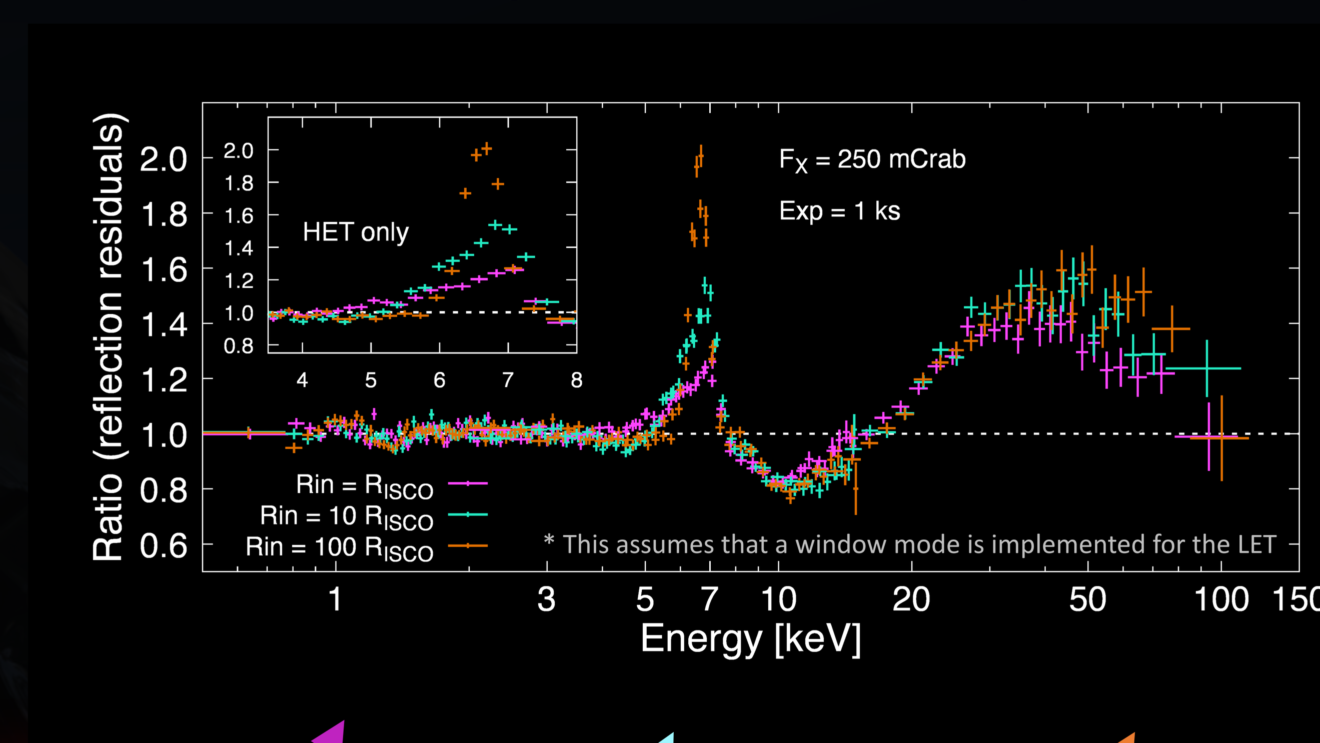
- **Combination of X-ray polarization (e.g., IXPE) and broadband HEX-P spectra key to constraining coronal orientation/geometry**

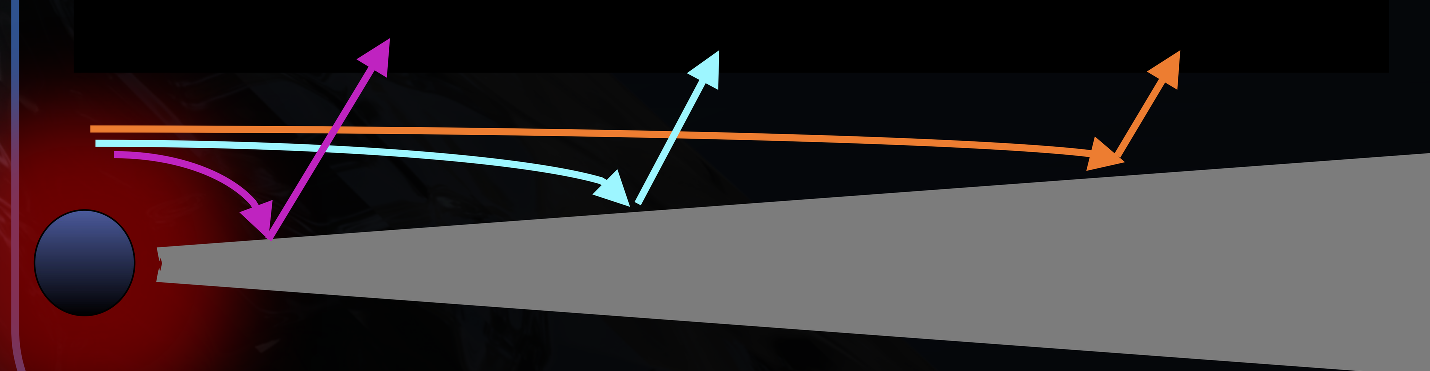
- **See poster by N. Rodriguez (116.93)**

Accretion physics and disk truncation

- Degree to which accretion disk is truncated during hard states of BH XRBs still an open question, as well as coevolution of disk and corona – **both key to spin measurements!**

- Improved sensitivity and broad spectral coverage of HEX-P allow us to probe both the disk truncation radius, via reflection, and coronal temp, at low Lx and with short exposures
- **See poster by P. Draghis (108.02) and B. Coughenour (116.65)**





Do you have ideas for how HEX-P would revolutionize your science? Get in touch!

hexp.future@gmail.com

hexp.org

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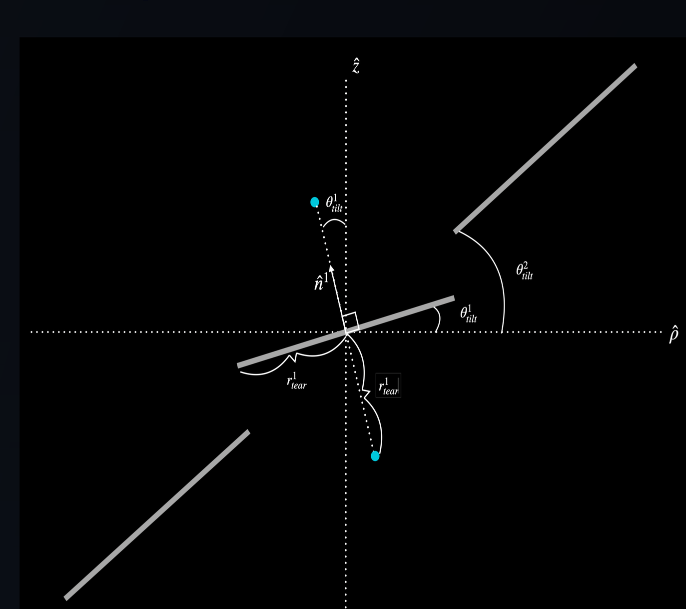
Disk tearing

- GRMHD simulations of misaligned disks predict tearing events in the inner accretion flow

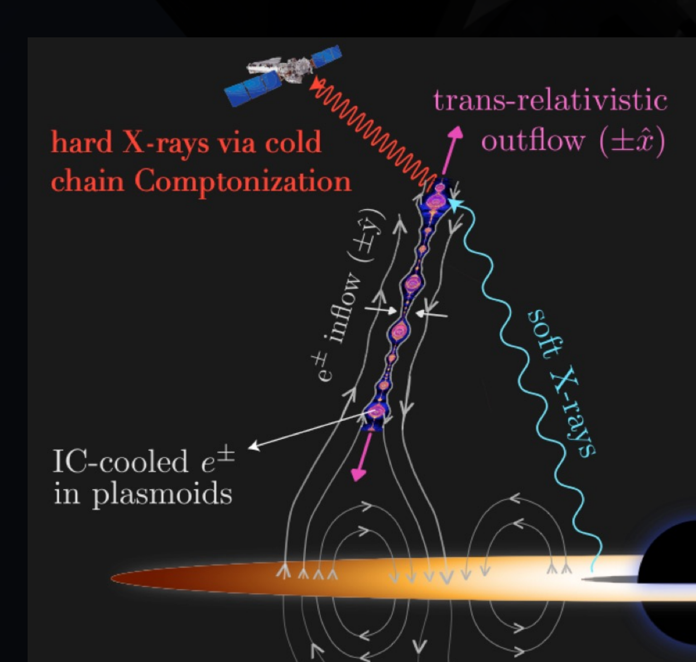
- Raytracing of the emission from such tearing events predicts complex iron line profile and timing features

- **HEX-P may allow detection of disk tearing! – see poster by Andrew West (116.92)**



Coronal energization

- State-of-the-art radiative kinetic plasma simulations revealed Comptonized emission might be powered by trans-relativistic bulk motions of magnetic reconnection plasmoids in BH coronae (Sridhar et al., 2021, 2023).



- Emission depends on magnetization parameter σ (also related to composition), mostly impacts high energies.

- **Broadband energy coverage and sensitivity out to E > 100 keV allows HEX-P to constrain σ and plasma composition where current instruments cannot (e.g., NuSTAR)**

HEX-P HIGH ENERGY X-RAY PROBE

[1]*Villanova University* [2]*California Institute of Technology,* [3]*SSL/University of California Berkeley,* [4]*University of Michigan,* [5]*Washington University ,* [6]*Columbia University,* [7]*NASA Goddard Space Flight Center,* [8]*Jet Propulsion Laboratory,*