Simulated Observations of High-Frequency Variability in X-ray Binaries

- We develop an end-to-end simulation pipeline to evaluate the detectability of high-frequency quasi-periodic oscillations (HFQPOs) in signals from black hole X-ray binaries with various space observatories.
- Detectors used are WFI onboard newATHENA and Resolve onboard XRISM
- Light curves (LC) from analytic and ray-traced hotspot models are combined with the global flux of microquasar GRS~1915+105; and photon events with SIXTE, using SIMPUT
- We analyze power density spectra (PDS) of observed LC to recover the fundamental and harmonic frequency peaks across models and signal-to-background ratios, where:
  F_final = n · F_signal + (1−n) · F_background, where **n** is a mixing percentage
- We found that WFI detector onboard newATHENA robustly recovers the HFQPO fundamental and harmonics for the tested setups
- XRISM/Resolve (GV closed) recovers only strong fundamentals in short exposures, with harmonics generally below detectability.

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Results

- Top: PDS of the combined signal before using SIXTE for n=25%.
- Middle: PDS for the simulation output with newATHENA.
- Bottom: PDS for the simulation output with XRISM.
- Marked frequencies are ν_r=55.83 Hz, ν_K=167.5 Hz and ν_P=111.67 Hz with the harmonic at 223.34 Hz, corresponding to the total mass of object of 11 Solar masses, radius of the hot spot of 6.75 M and spin a=0 for the simulated hot spot with LSD code data.

Thank you for your attention.