

STINGRAY

TIME SERIES METHODS FOR
ASTRONOMICAL X-RAY DATA
THAT AREN'T FISHY AT ALL!

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@ABIGAILSTEV

X-RAY VARIABILITY

- X-ray binaries: can't spatially resolve them
- Vary on timescales from tens of microseconds to months/years
- X-ray pulsations, zoology of quasi-periodic oscillations, broadband “peaked” noise
- Similar variability phenomena in gamma, optical, IR

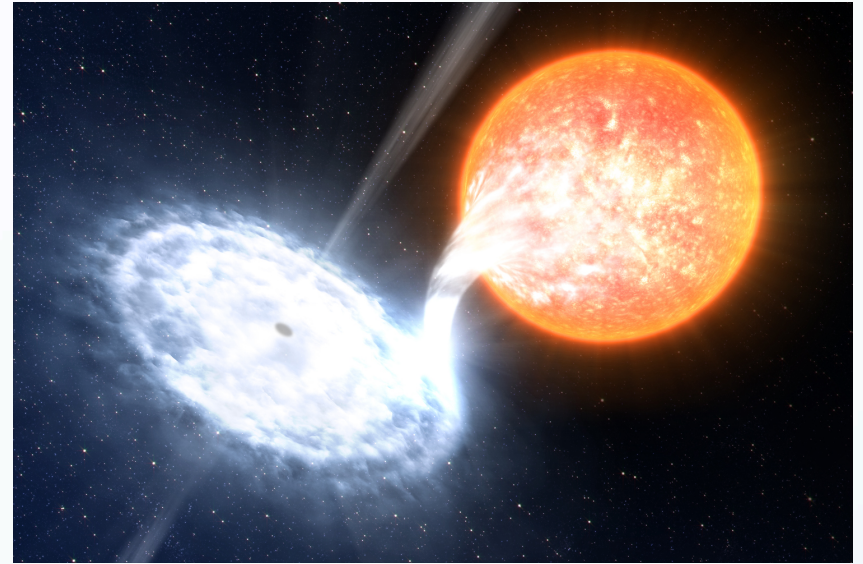
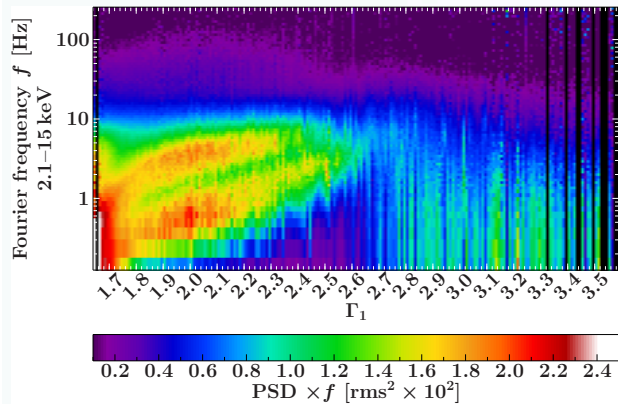
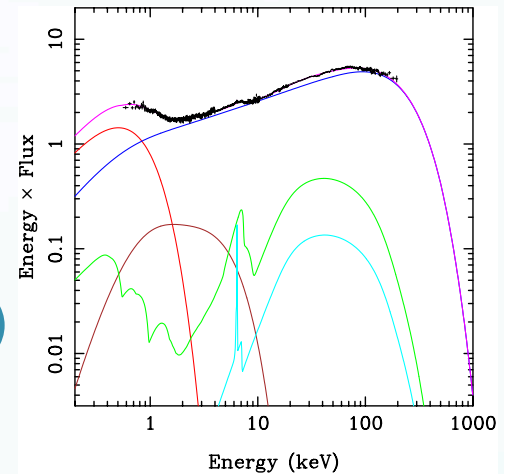


Figure: NASA

HOW TO STUDY X-RAY BINARIES

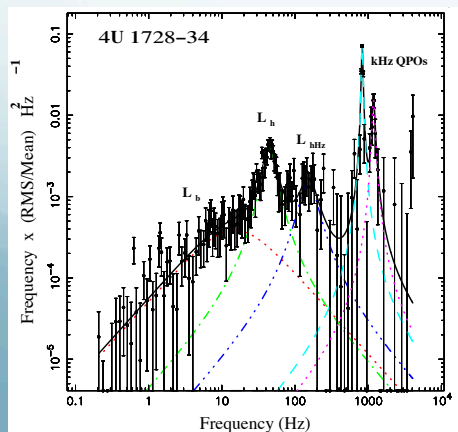


Spectroscopy



Timing

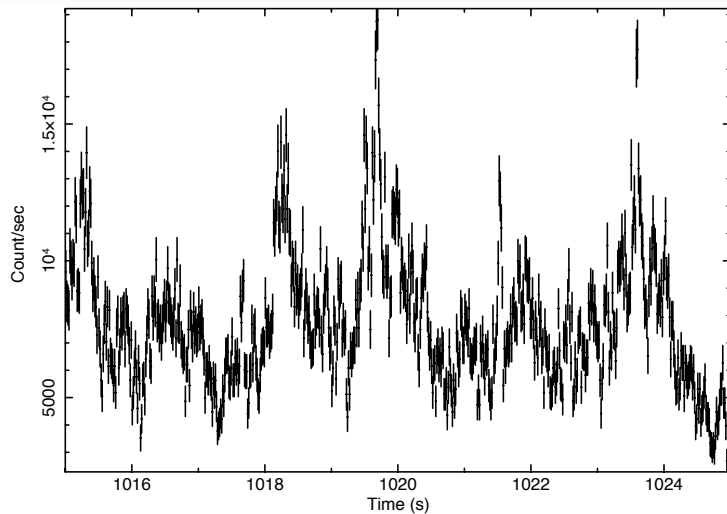
Polarimetry??



Figures: Grinberg et al '14, Done et al '07,
Altamirano et al '12

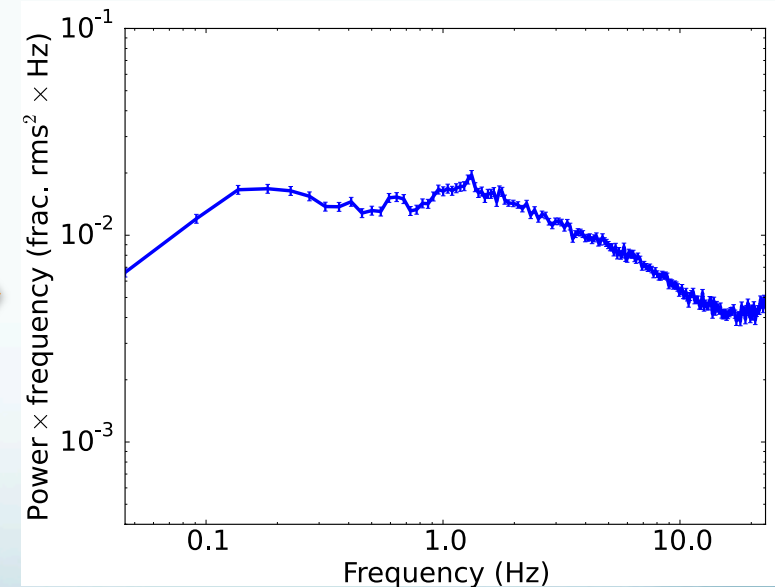
VARIABILITY ANALYSIS

Time domain
Light curve



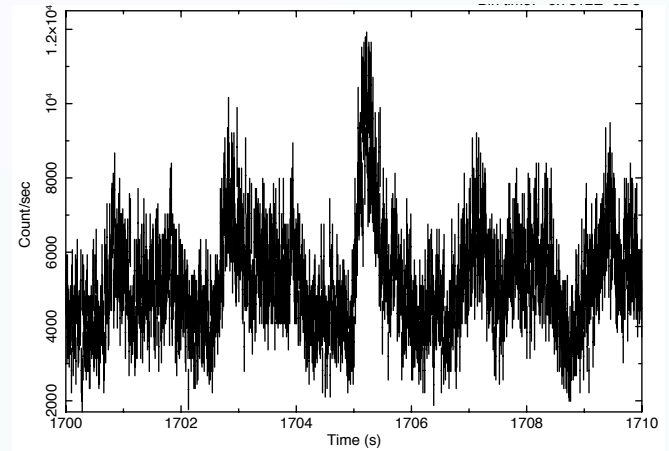
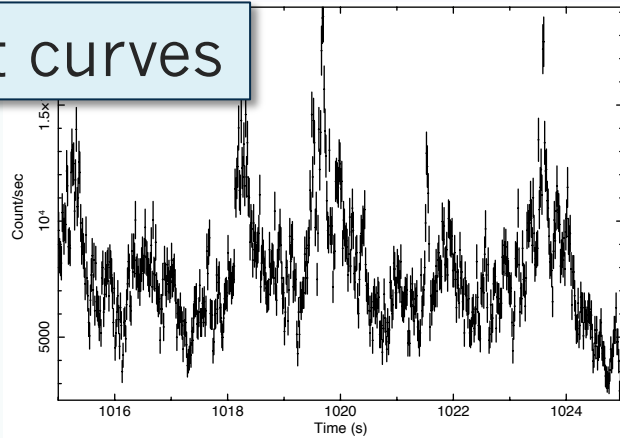
FOURIER
TRANSFORM

Frequency domain
Power spectrum



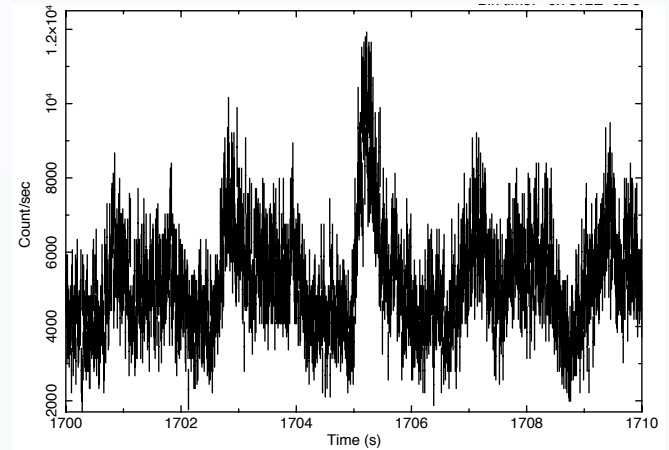
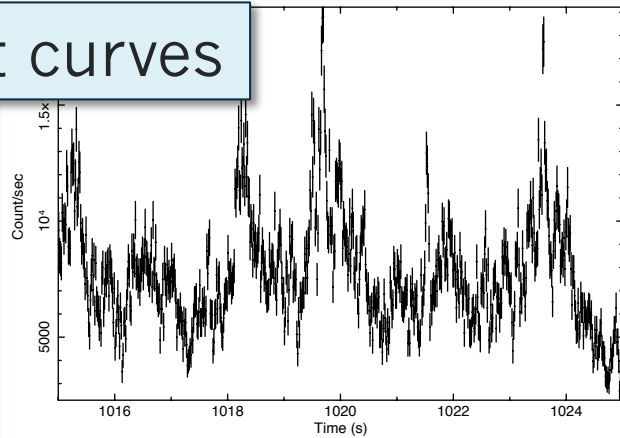
X-RAY VARIABILITY: HARD TO SEE BY EYE

Light curves

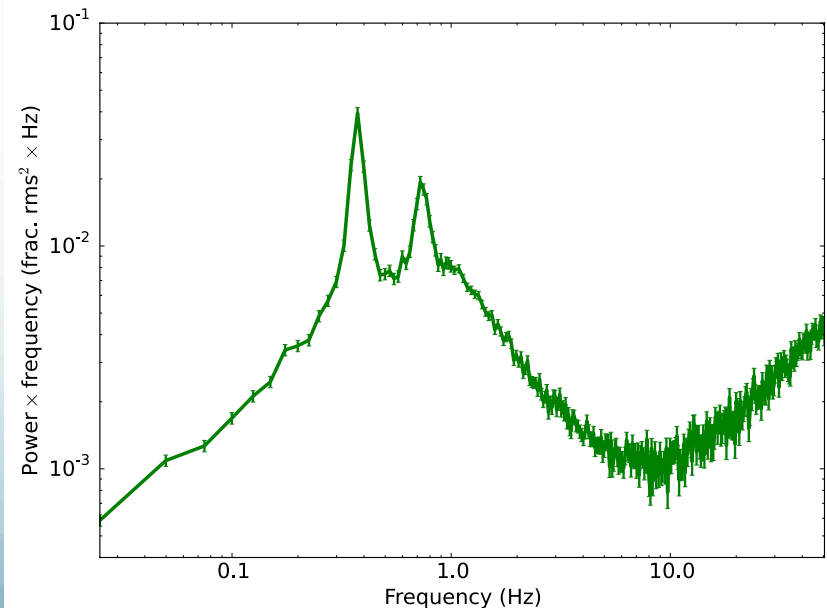
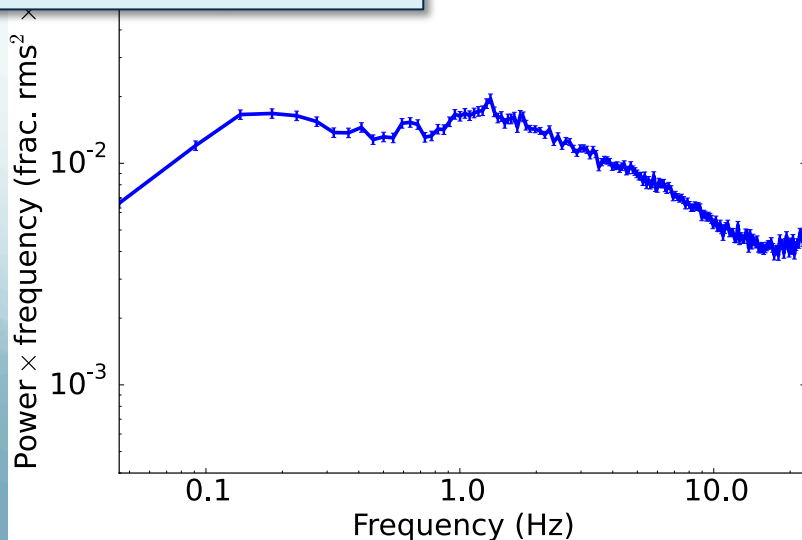


X-RAY VARIABILITY: HARD TO SEE BY EYE

Light curves



Power spectra



WHICH ANALYSIS METHODS? ALL OF THEM!

- Power spectra (periodograms)
 - Fitting profiles to power spectra
 - Periodic and quasi-periodic signal detection
 - Dynamical power spectra
- Cross-/co-spectra, cross-correlation functions
- Averaged and frequency-resolved energy spectra
- Energy- or frequency-dependent time lags
- Rms and covariance spectra, coherence
- Bispectra, bicoherence, deadtime compensation, simulation support...

WHY MAKE STINGRAY?

- Relatively small sub-field of astronomy
- Almost everyone uses (variations on) the same analysis techniques
- Most code is private, not documented, not properly tested, not maintained --- “black box” codes
- Unnecessary duplication of efforts, high threshold for entering the sub-field, difficult to get new students started

WHY MAKE STINGRAY?

- Easier implementation of Bayesian methods & machine learning specific to X-ray (spectral-)timing
- Many analysis methods are already used in finance, music analysis, health care, neuroscience, and general signal processing
 - Make an interface for applying those techniques to X-ray timing data
- Goal: become an Astropy affiliate package!

CURRENT MODULES

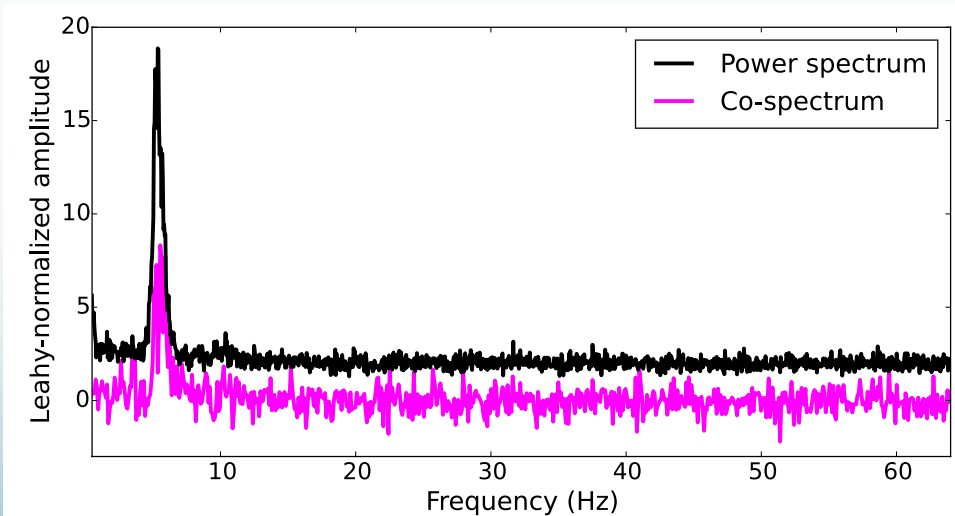
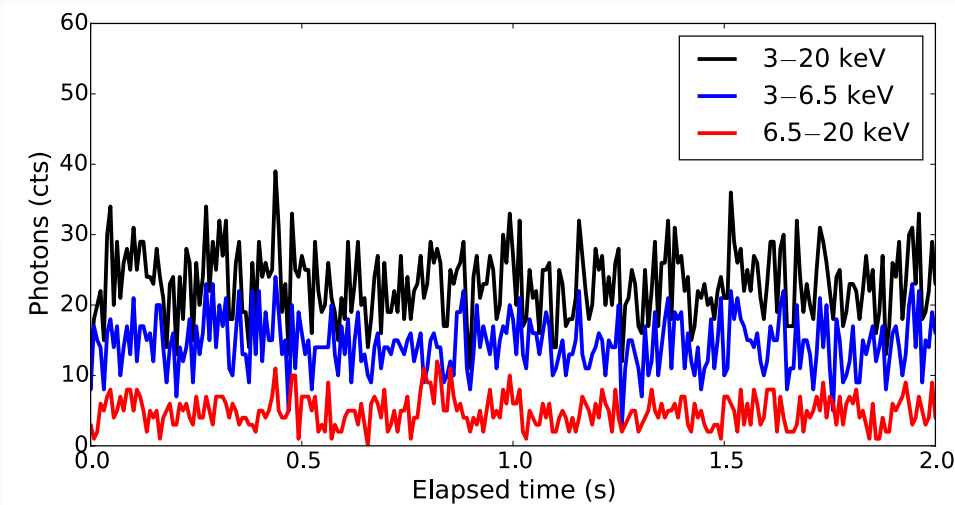
Light curve

Power spectrum

Cross spectrum

Pulsar tools

Using travis for
continuous
integration

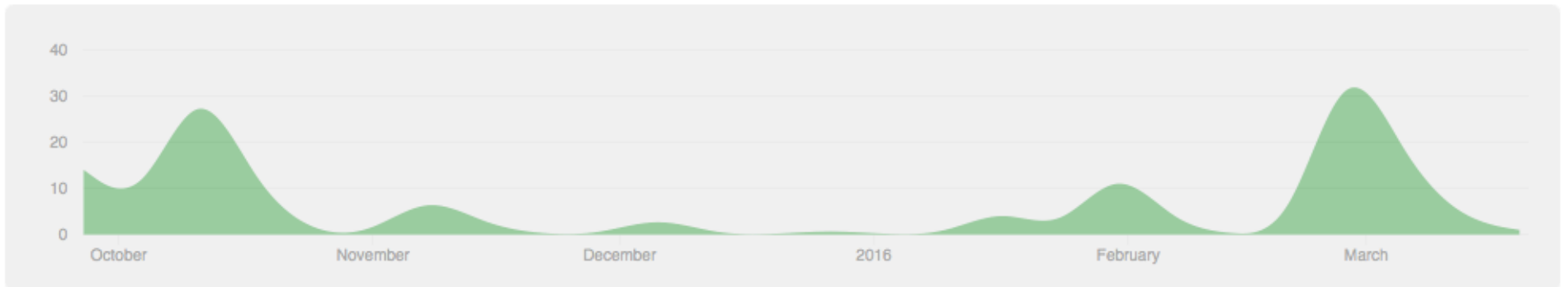


PROGRESS ON GIT

Sep 27, 2015 – Mar 21, 2016

Contributions: **Commits** ▾

Contributions to master, excluding merge commits



👁 Unwatch ▾

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★ Star

7

🍴 Fork

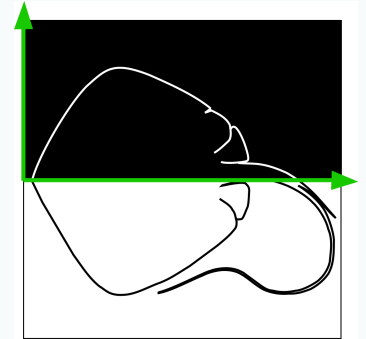
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SUPPORT FROM THE COMMUNITY

- ESA support for GUI for exploratory data analysis
- Part of the Google Summer of Code!
- Likely support from HEASARC for developing data structures and I/O interface with existing & future missions
- Potential for interfacing with astropy.modeling and/or Sherpa spectral fitting package, especially for cross-spectral models
- YOU CAN HELP! Extending to IR, optical fast variability (spectral-)timing?

STINGRAY DEVELOPMENT

<https://github.com/StingraySoftware/stingray>



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Mailing list:

<https://groups.google.com/forum/#!forum/spectraltiming-stingray>

WE HAVE A THEMESONG!

https://youtu.be/_w_Kx7EWNSA?t=6s

