

Tenth International Fermi Symposium

9th-15th October 2022

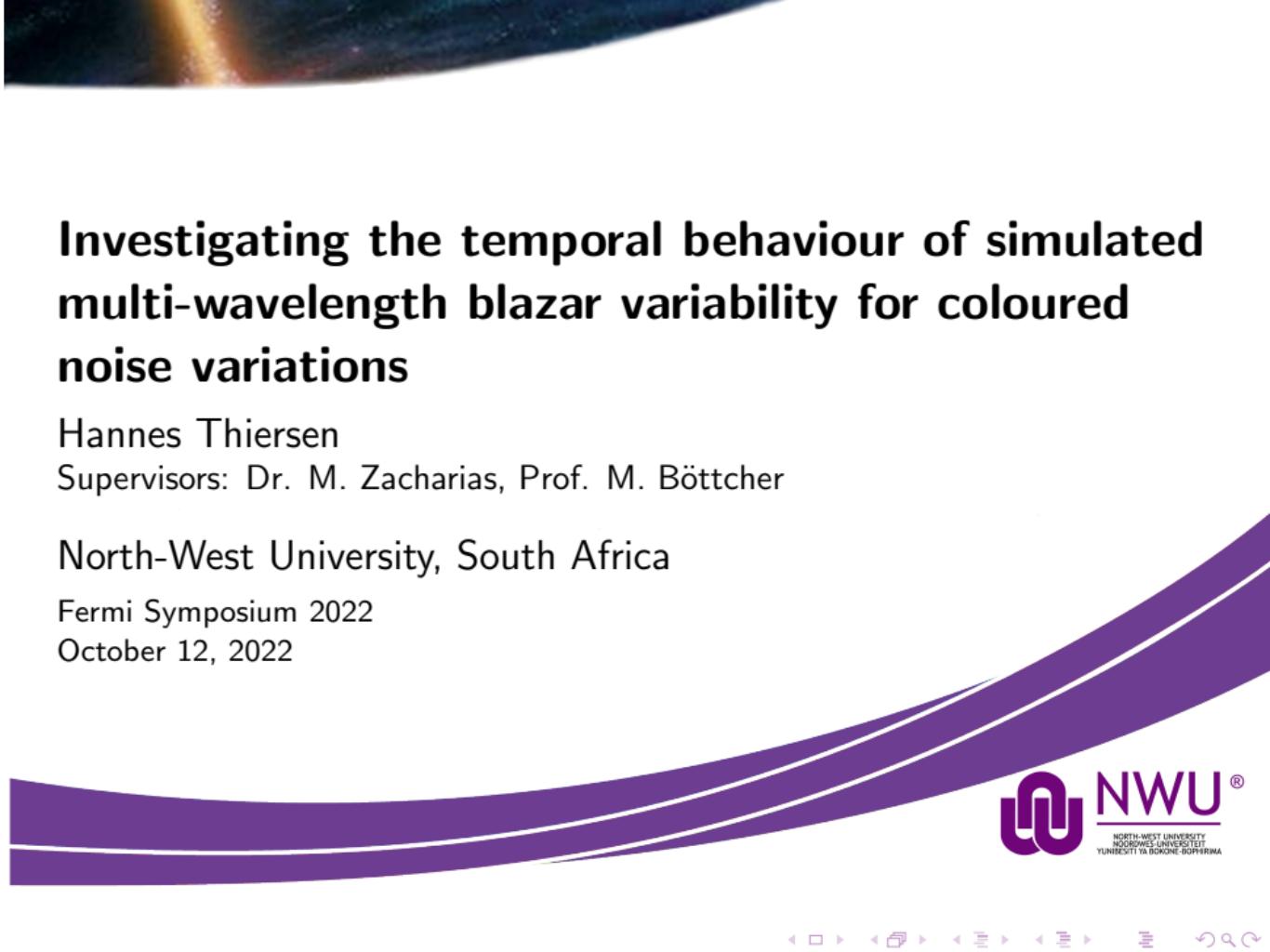


Investigating the temporal behaviour of simulated multi-wavelength blazar variability for coloured noise variations.

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Investigating the temporal behaviour of simulated multi-wavelength blazar variability for coloured noise variations

Hannes Thiersen

Supervisors: Dr. M. Zacharias, Prof. M. Böttcher

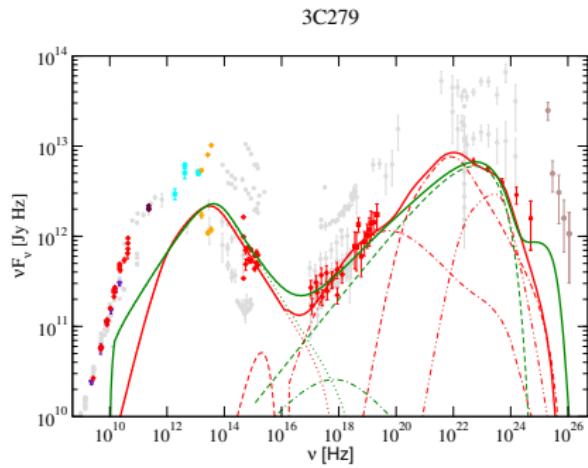
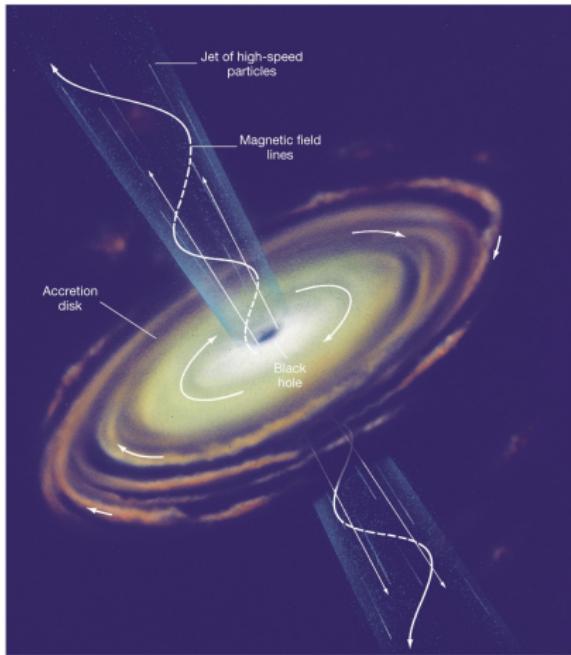
North-West University, South Africa

Fermi Symposium 2022

October 12, 2022

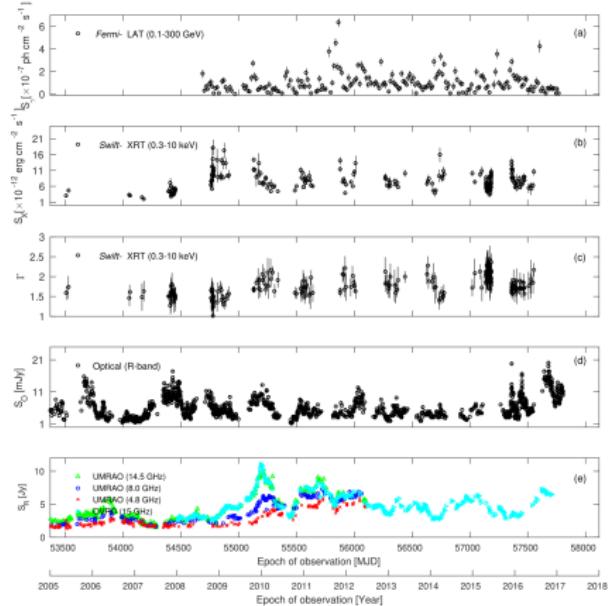


Blazars



Böttcher et al., 2013.

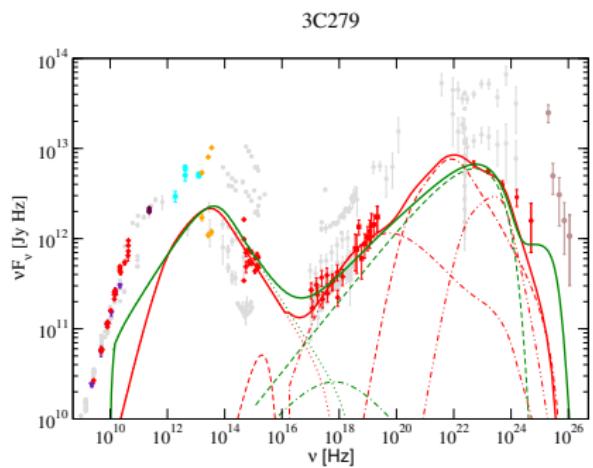
Blazar Variability



- Variability is present in all wavelengths.
- Exact cause is still unknown.
- Coloured noise temporal frequency spectra.

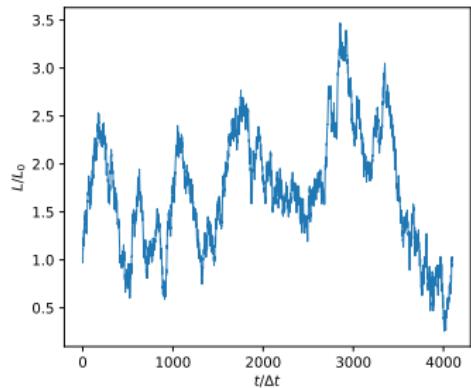
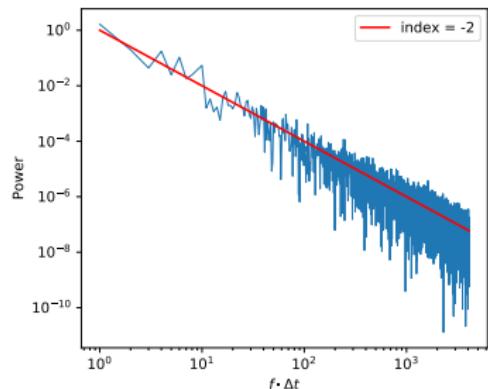
Goyal et al., 2018.

Simulating Variability



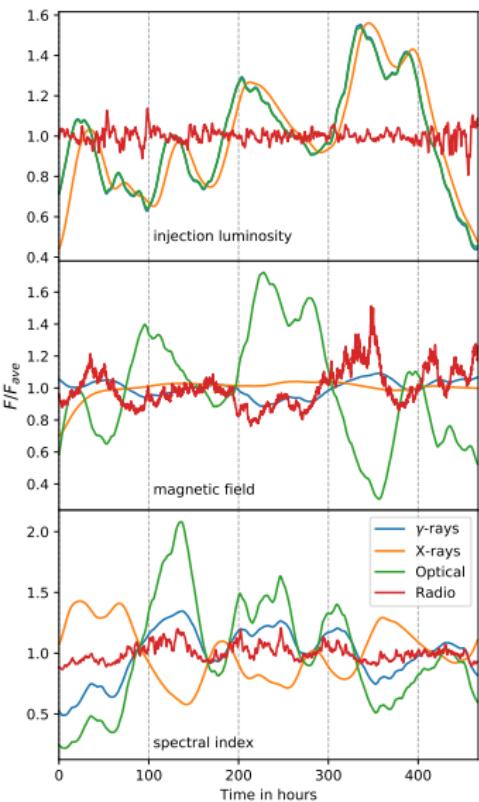
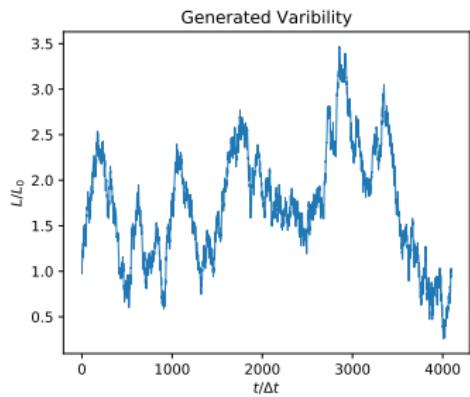
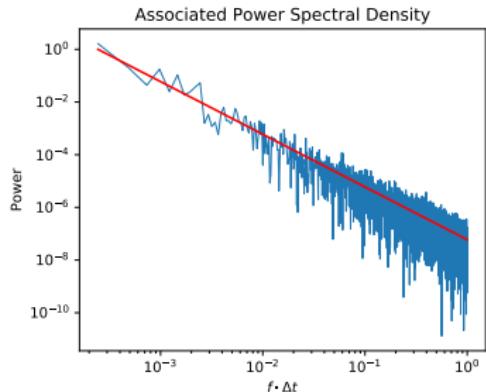
- Time-dependent one-zone leptonic model produce blazar emissions.
- Equilibrium phase: model relax to equilibrium state.
- Variability phase: variations are introduced into the model at each time step causing variable emissions.
- Variations are only applied to a single model parameter in independent simulations.

Generating Stochastic Variations

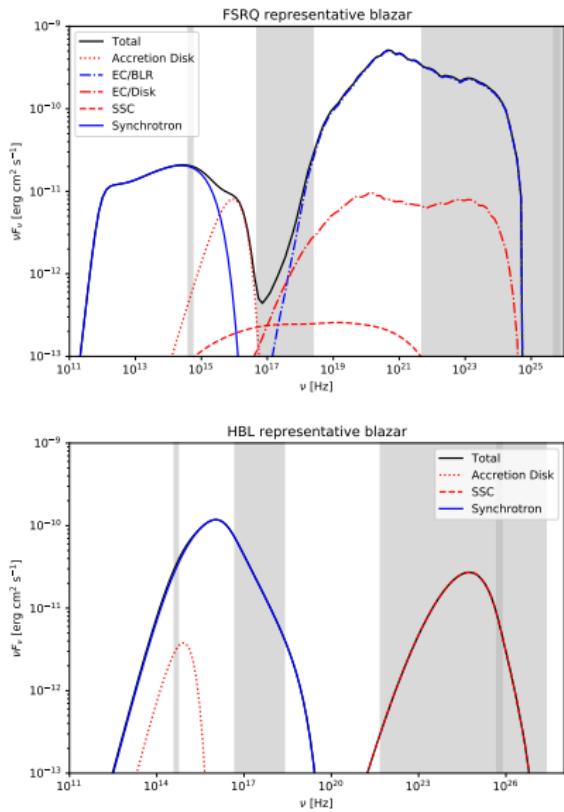


- Stochastic variations generated with algorithm of Timmer and König (1995).
- Pure power law power spectrum is used throughout this work.

Variable Light curves

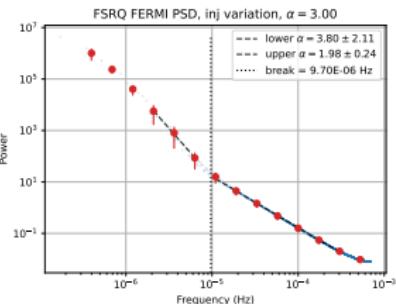
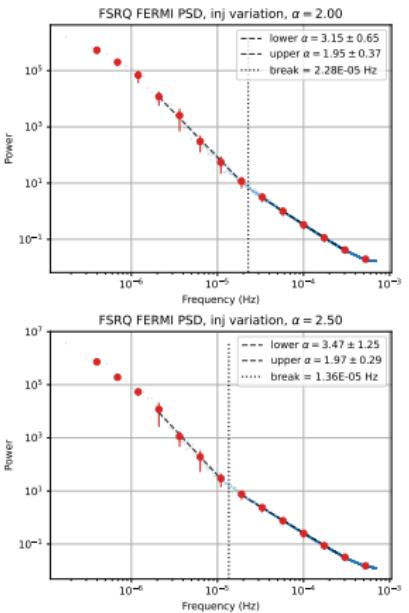
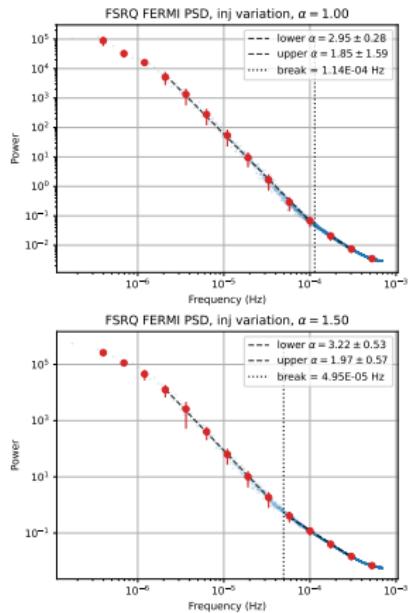


Scenario of this Work



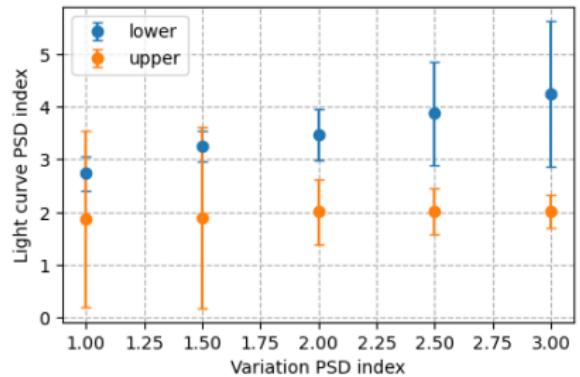
- Two types of blazars: FSRQ and HBL
- Two model parameters: γ_{max} and injection luminosity
- Pure power law variations with $\alpha = \{1.0, 1.5, 2.0, 2.5, 3.0\}$.
- 10 or 20 simulations for each permutation of parameters.

Results(preliminary): Broken power laws

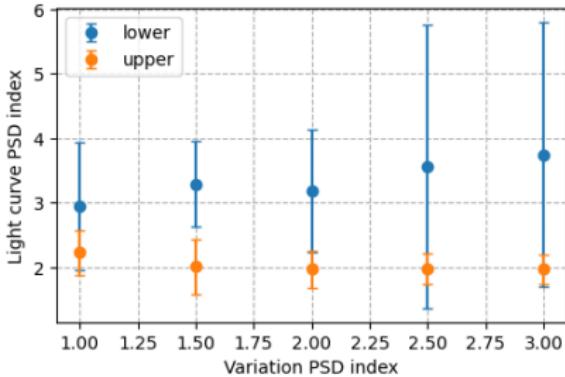


Results(preliminary): Index relations

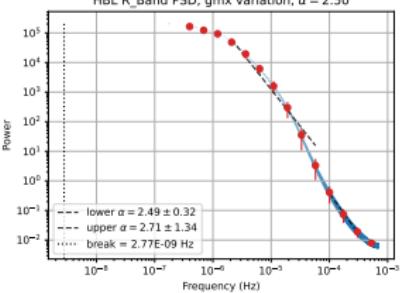
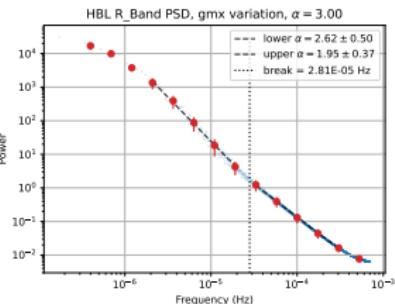
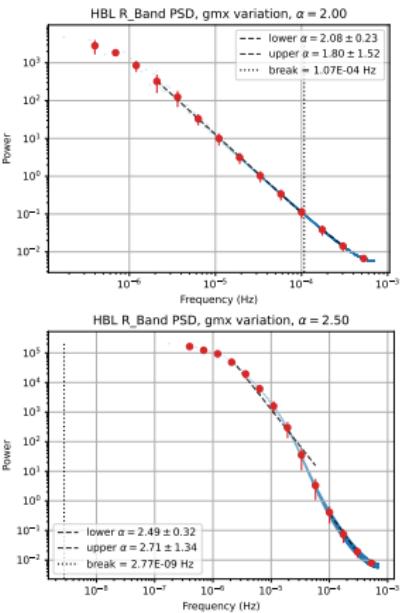
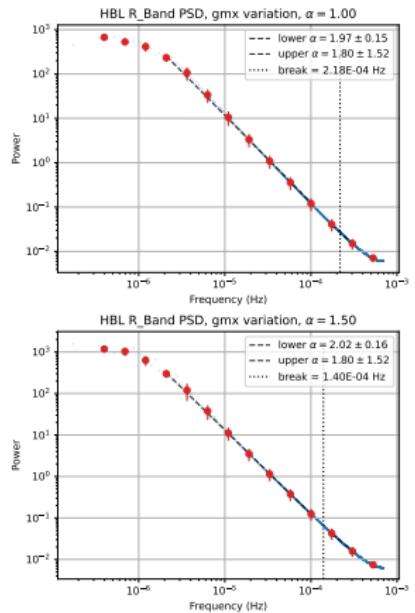
FSRQ optical PSD index relation for
 γ_{max} variations



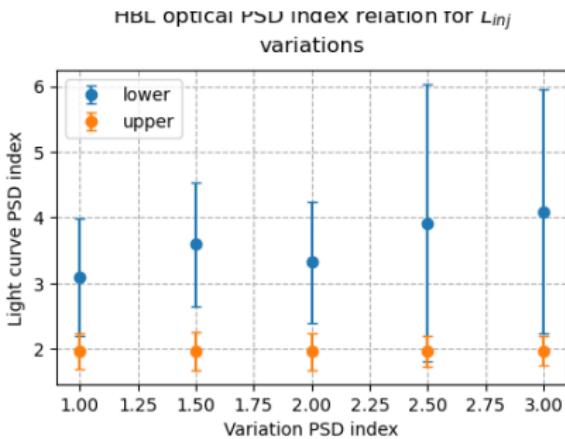
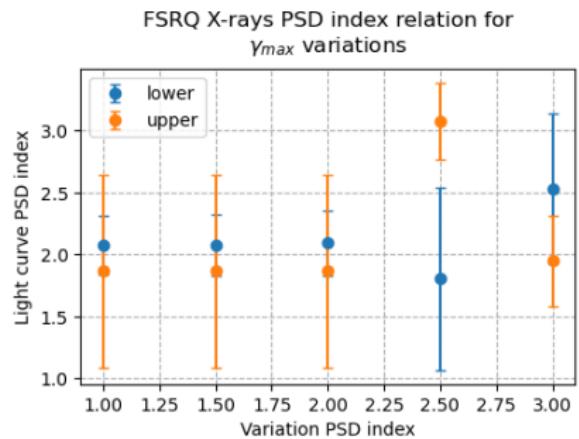
HBL VHE γ -rays PSD index relation for
 L_{inj} variations



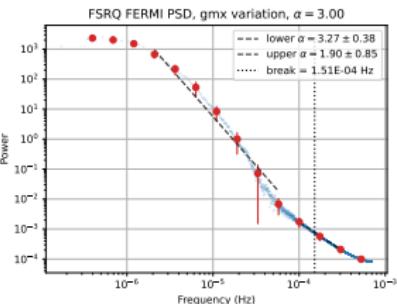
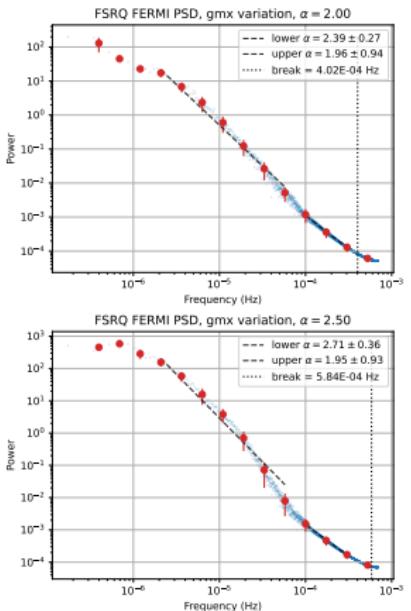
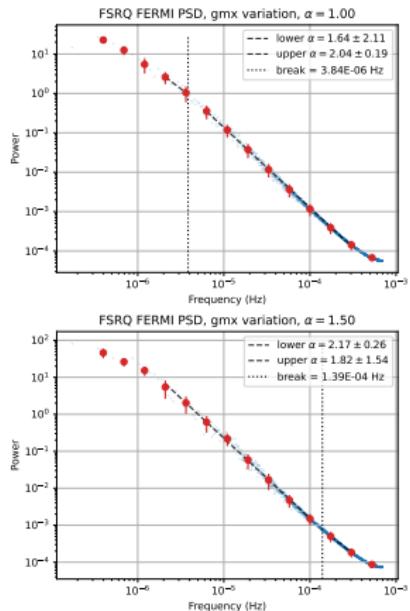
Results(preliminary): Pure power laws



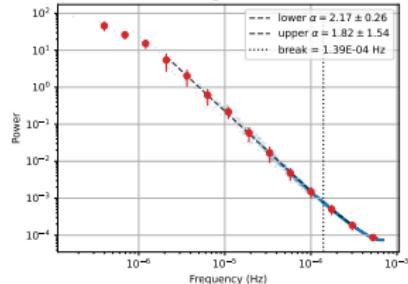
Results(preliminary): Index relations



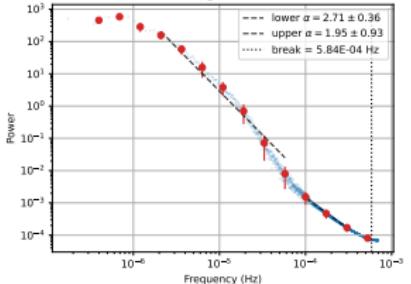
Results(preliminary): S-shaped spectra



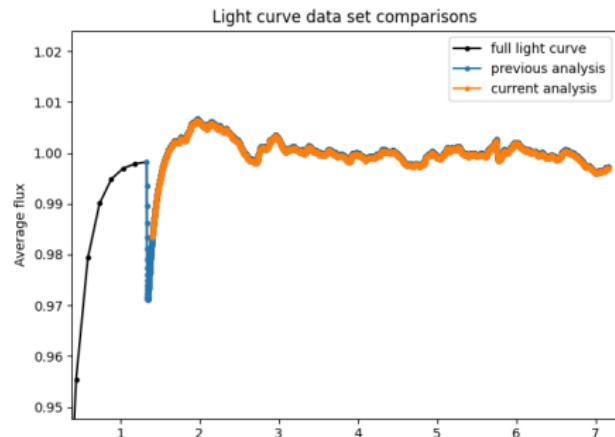
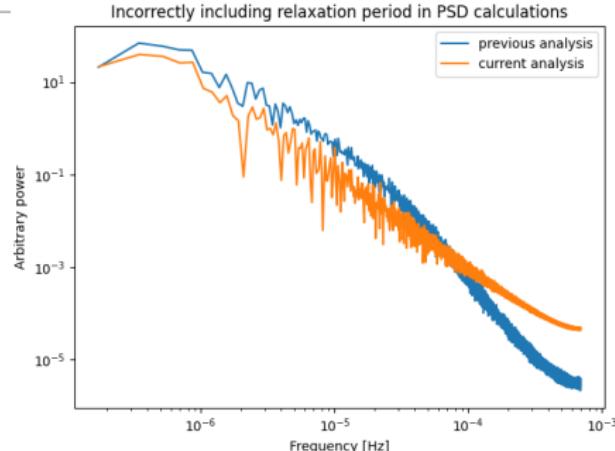
FSRQ FERMI PSD, gmx variation, $\alpha = 1.50$



FSRQ FERMI PSD, gmx variation, $\alpha = 2.50$

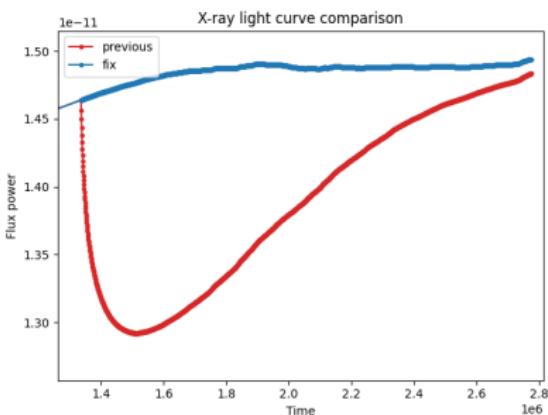
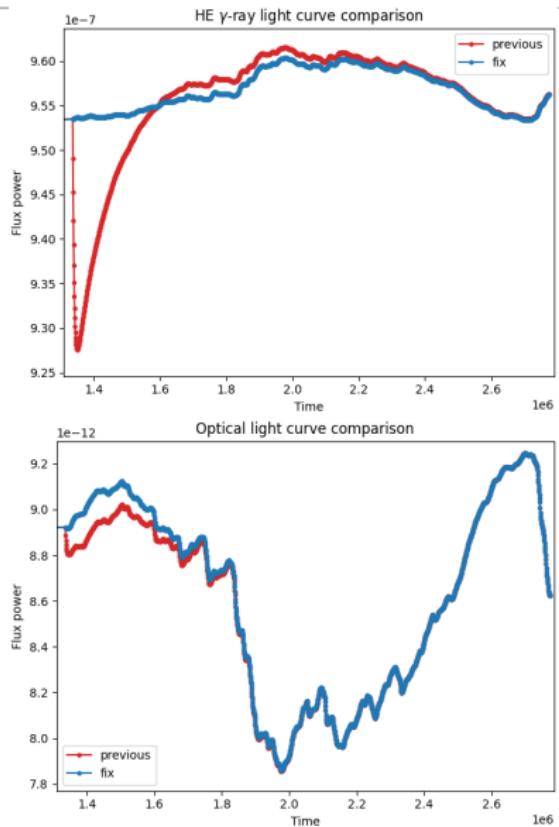


Careful considerations



- Anomalies much shorter in duration compared to the light curve can have a big impact on the PSD.

Recent fixes



- Pure power law variation do not necessarily produce pure power law variability.
- Power law index of variability show weak dependence on power law index of underlying variation.
- Short duration anomalies can produce breaks that is not representative of entire light curve.

Thank you

Questions are welcome and appreciated



This work is funded by the NRF. Any opinion, finding and conclusion or recommendation expressed in this material is that of the author, and the NRF does not accept any liability in this regard.



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Thank you for your attention!

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