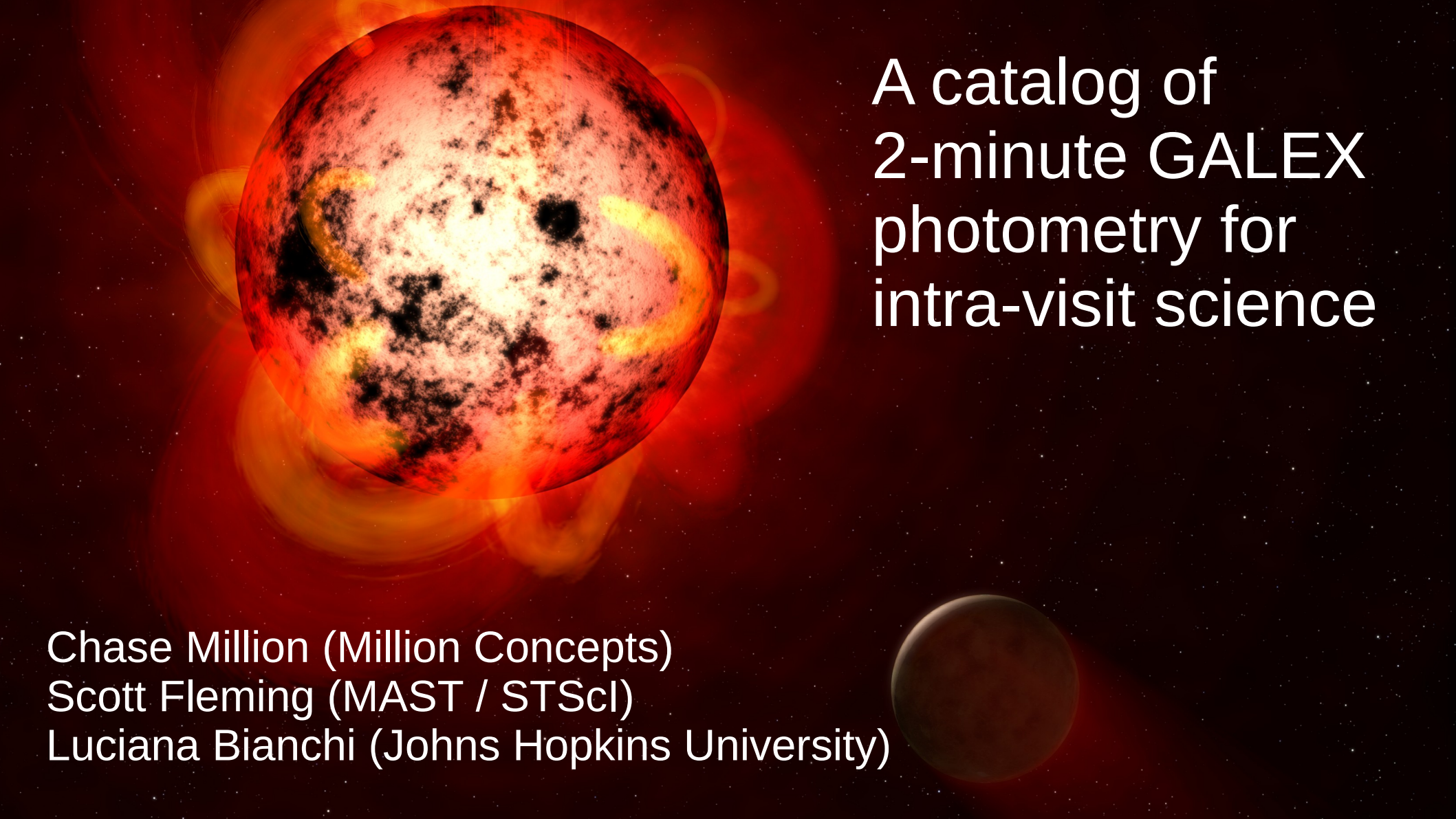
ULTRAVIOLET ASTRONOMY IN THE XXI CENTURY

e-Workshop 2020 – October 27-29

JcUVa



A catalog of 2-minute GALEX photometry for intra-visit science

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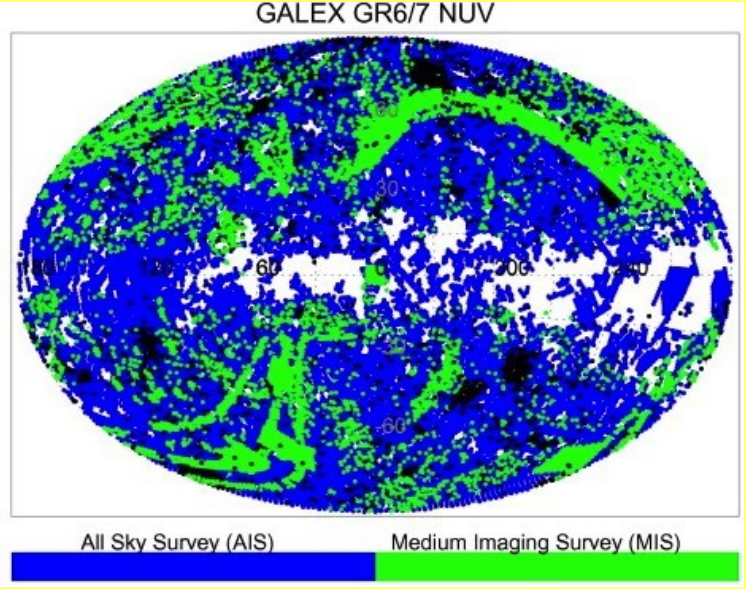
Scott Fleming (MAST / STScI)
Luciana Bianchi (Johns Hopkins University)

Quick summary of GALEX:

- Ultraviolet all-sky survey mission. Operated April ‘03 to June ‘13.
- 1.2 deg. diameter FOV. ~6” resolution.
- Direct imaging and spectral (grism) modes.
- 2 UV bands. FUV: 1350-1750 Å. NUV: 1750-2750 Å.
- Microchannel plates record (x,y,t) at 5ms resolution.
- Drift / scan style observations with reconstruction in ground processing.
- ~30 minute maximum integration depth (while in Earth’s shadow).
- Morrissey, et al. "The calibration and data products of GALEX." ApJ Supl. 173.2 (2007): 682.



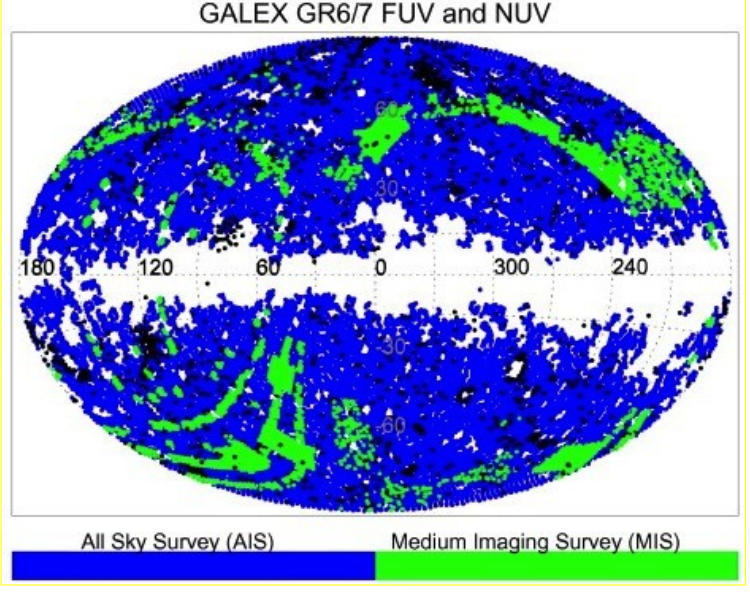
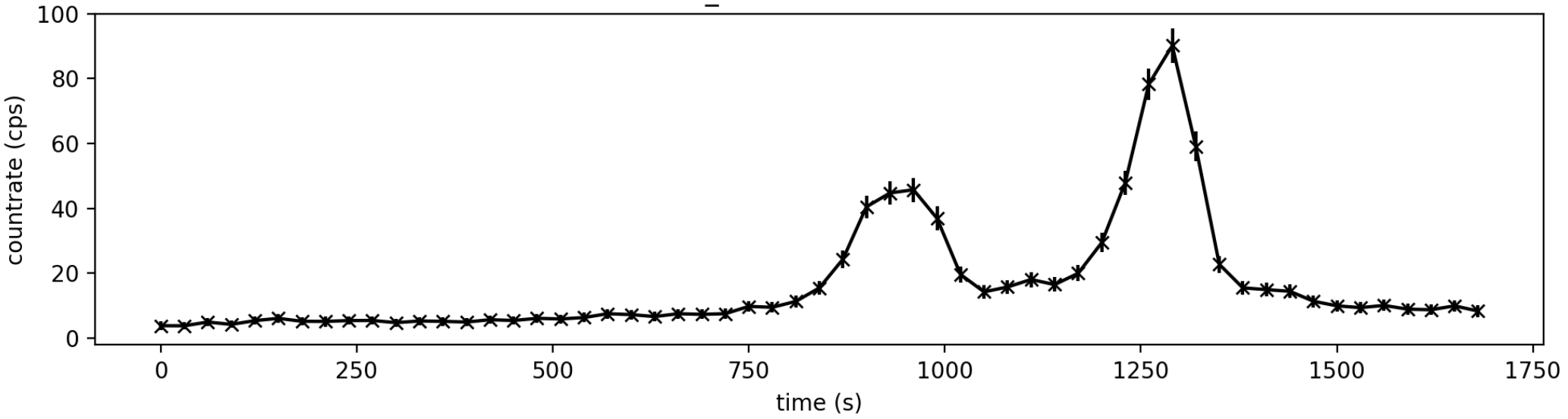


Image credits (above): *Taken from Bianchi, Conti & Shiao 2014, J. Advances in Space Research, 53, 900*

Quick summary of gPhoton:

- Re-implements portions of GALEX mission pipeline as Python.
- Re-calibrated >1T individual photon events to enable short time-domain science.
- Good for examination of specific targets.
- Database at MAST: https://archive.stsci.edu/prepds/gphoton/
- Python software tools: https://github.com/cmillion/gPhoton
- Million, et al. "gPhoton: The GALEX Photon Data Archive." ApJ 833.2 (2016): 292.



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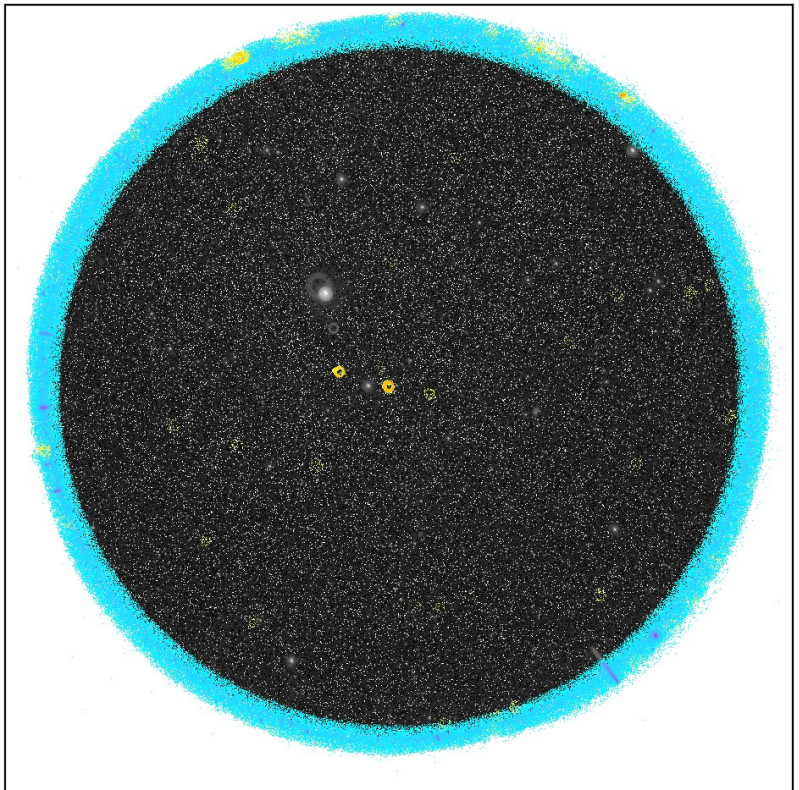
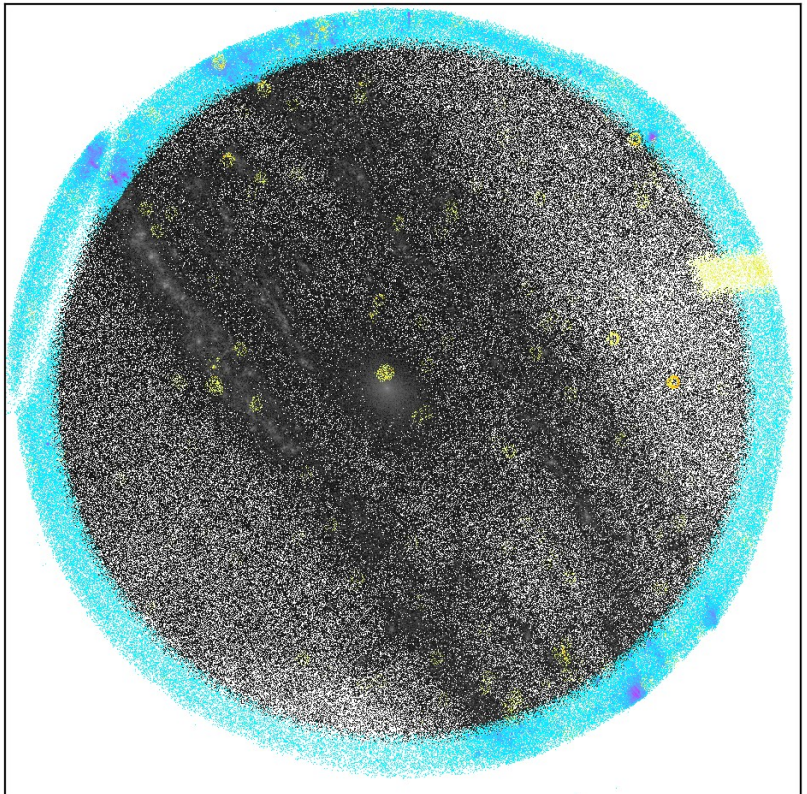
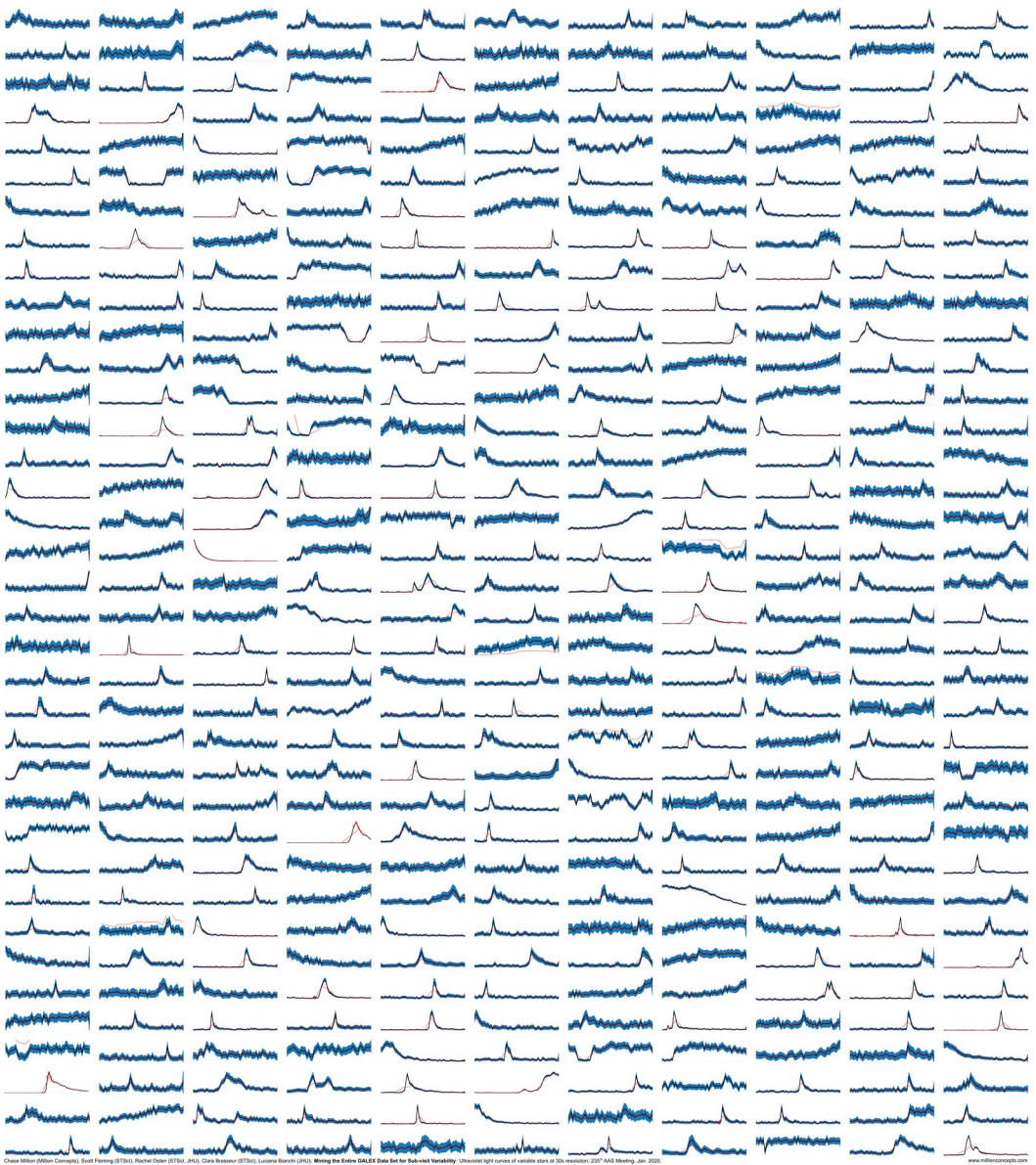
Quick summary of the GALEX Flare Catalog (GFcat):

- Added source detection / measurement functionalities to gPhoton.
- Re-process GALEX data to search for serendipitous variability on *all* sources.
- Strategy: Screen photometry in 2-minute NUV “movies” and then drill down with gPhoton.
- The 2-minute NUV photometry catalog as ~18M sources, w/ edge and hotspot flags.
- The 2-minute NUV photometry and code are currently available on Github.
- Everything (images, movies, photometry, code, ...) will live in MAST in the future.







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Mining the Entire GALEX Data Set for Sub-visit Variability

235th AAS Meeting, Honolulu, Jan. 2020

Ultraviolet light curves of variable stars at 30s resolution

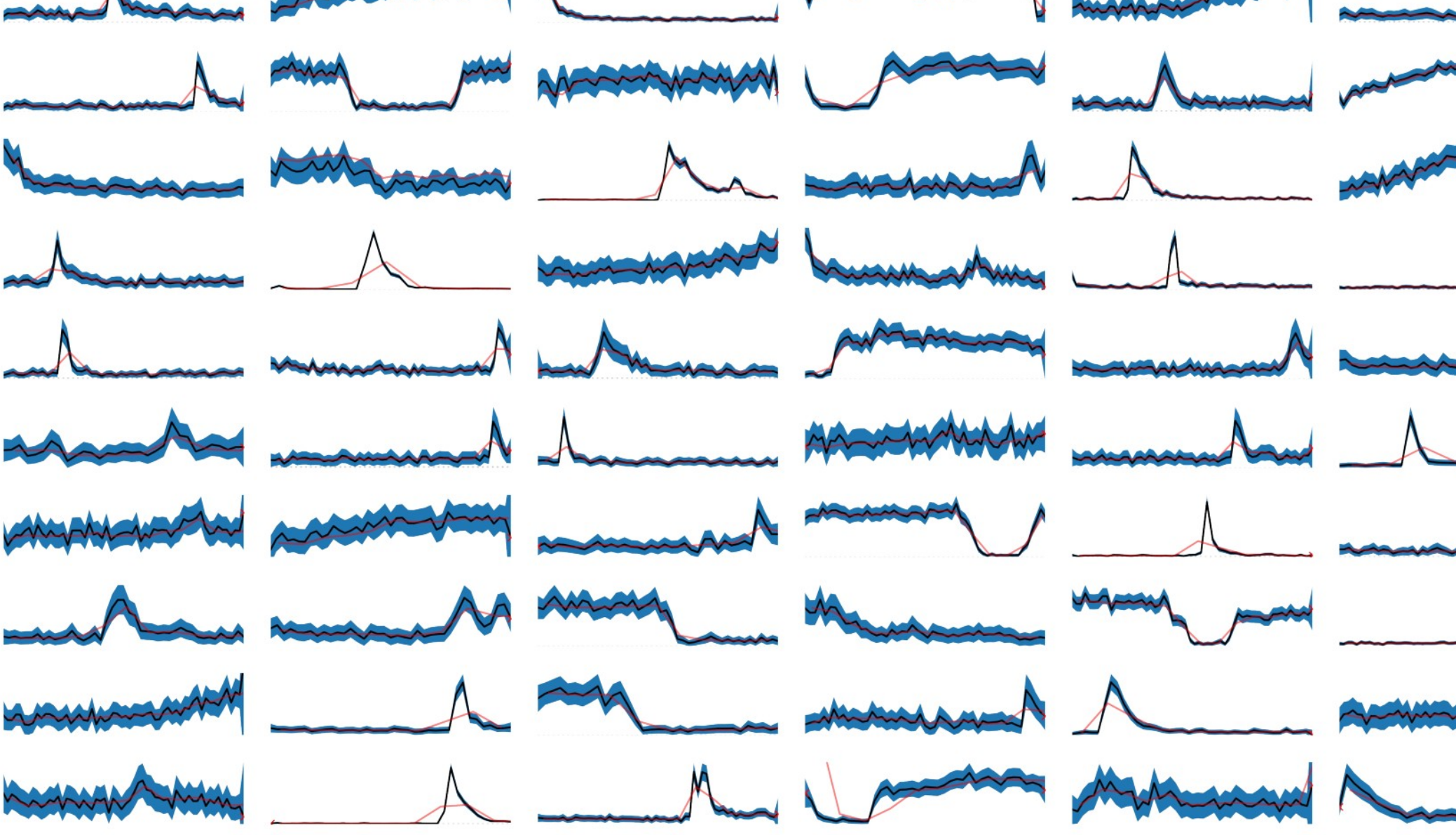
The image depicts the result of a search for variable sources in NUV GALEX (2003-2012) data. The red lines trace the 120-second resolution light curves produced by extracting photometry from calibrated image sequences, without error bars.The black lines trace 30-second light curves of variable sources, with the blue shaded regions delimiting the 3-sigma error bars from counting statistics.

Types of variables include flares, eclipsing binaries, and two possible asteroid transits. What variables do you see?

To perform this search, NUV GALEX observations with durations ~10-25 minutes were reprocessed into 120-second calibrated image sequences, from which light curves were extracted and algorithmically screened for variable behavior using the Anderson-Darling test. Light curves of candidate variables were then created by the gPhoton toolkit at 30-second resolution and screened again, both algorithmically and manually, for the presence of significant variability and the absence of markers of spurious variability. Such markers include strong correlations between photometry and detector position, hotspot or non-linearity conditions, and the presence of view-transiting artificial satellites.

Traditional scale bars have been omitted, inviting the viewer to meditate on both the variety and the similarity of signals produced by inherently chaotic processes.

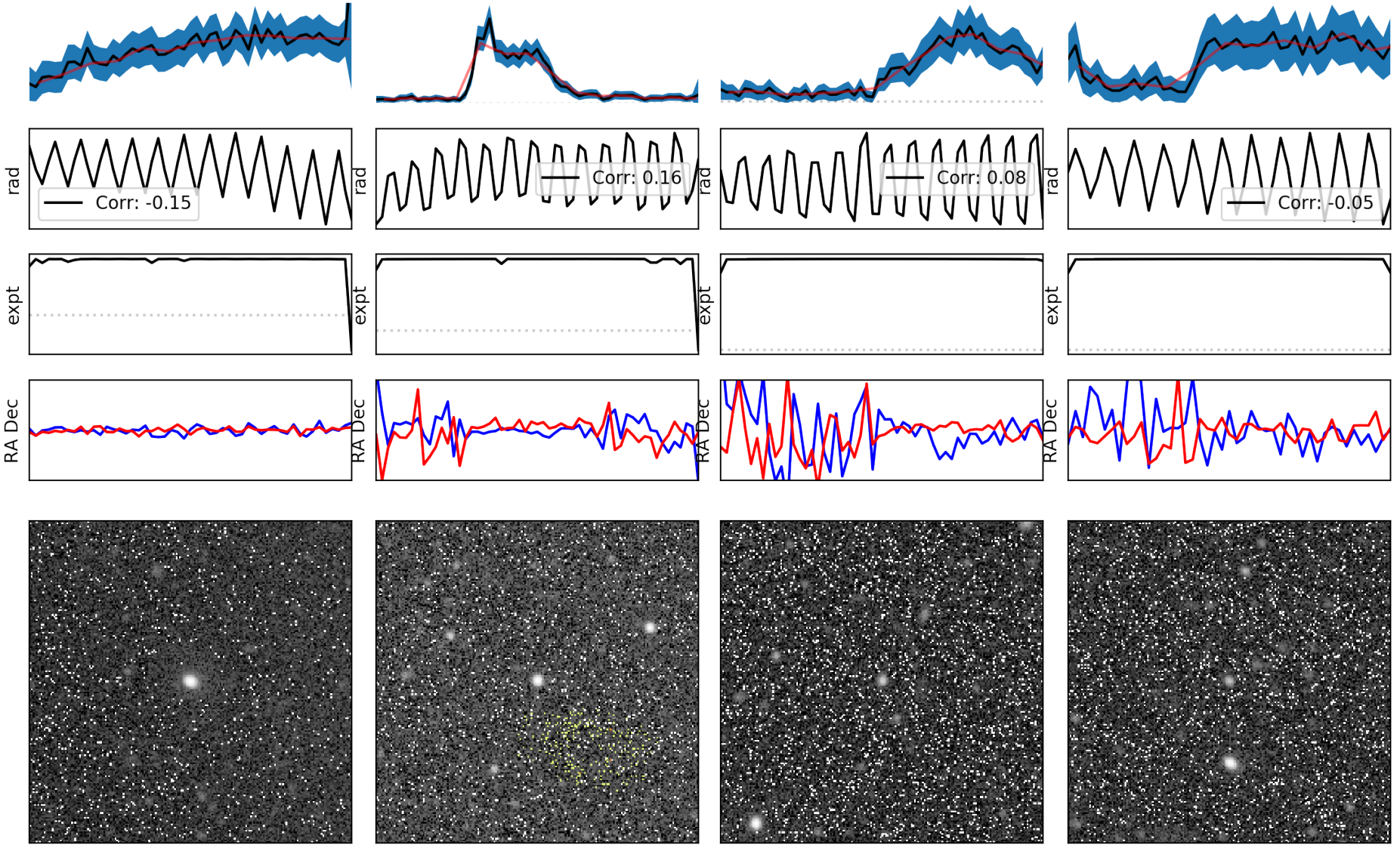
https://millionconcepts.com/aas235.html



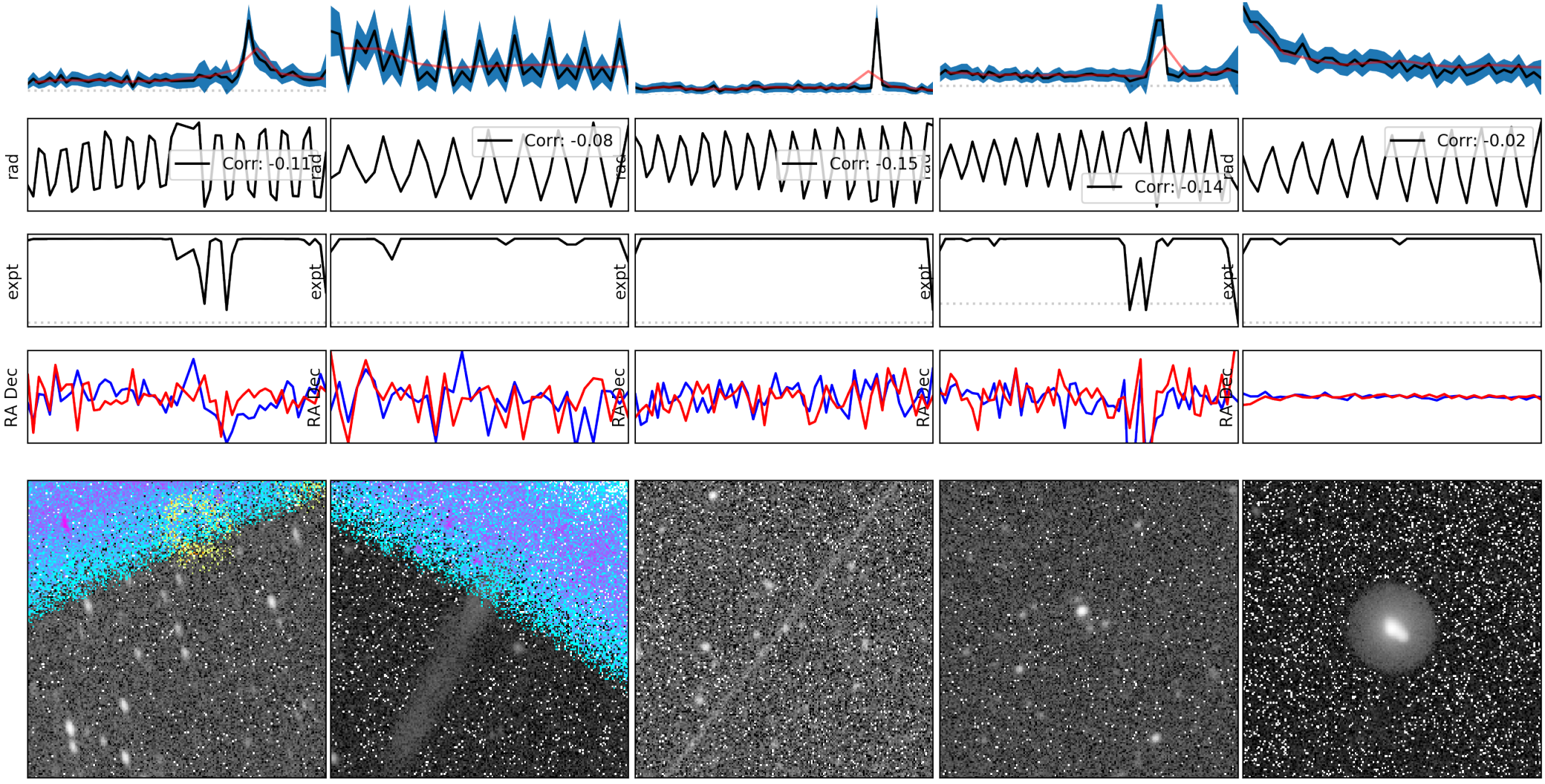
LIVE DEMO
AKA BASE JUMPING

https://github.com/MillionConcepts/gfcat

Real variables.



Common artifact types.



Edge effects. Internal reflection. Artificial satellite. Flaky exposure time. Gain sag?

The GALEX Flare Catalog (GFCat) 2-minute photometry data are now available at:

https://github.com/MillionConcepts/gfcat

- Re-calibrated >20-minute depth images to 2-minute movies.
- Re-extracted photometry on a per-visit level using DAOphot.
- Edge and hotspots flags / masks are now implemented as image backplanes.
- This is useful for first pass assessment of targets before running gPhoton.
- Other use cases are entirely at your own risk!
- There are also example workflows for querying and generating QA images.
- Check for strong correlations to detector position or exposure time.
- Always (always!) check the images for evidence of artifacts.
- Paper in prep, but please cite the repository for now.
- Feedback is welcomed. Make a Github issue or email (chase@millionconcepts.com).

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