New frontiers in optical fast-transient discovery

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The Deeper Wider Faster program

Chasing the fastest bursts in the sky with deep, wide-field, fast-cadence SIMULTANEOUS multi-messenger observations

Cooke et al., in prep
Andreoni et al., in prep
Andreoni & Cooke (2018)
Andreoni et al. (2017a,b)
Vohl et al. (2017)
Meade et al. (2017)
Howell et al. (2015)

Sarah Hegarty’s talk @ASA2018
The transient sky: a matter of definitions?
Fast optical transients: from weeks to hours

Luminous fast transients and kilonovae are fast (hours/days) but we like to go much faster...

for Australian-led observations

see Andréoni, Ackley, Cooke, et al. (2017)

and also Hallinan+2017; Kasliwal+2017; Dobie+2018
Deep, fast-cadence observations using DECam

3 deg²
Deep: mag_g ~ 23.8 in 20s
62 CCDs (59 well functioning)
1.2 GB

NGC 6744
The importance of deep, fast observations

Andreoni et al., in preparation
Past and current surveys probe the \(~30\) minutes time domain in the optical

Berger et al. (2013)

"What if we systematically explore the Deeper Wider Faster dataset?"*

*question that inspired this work
Data analysis 1/2 – has any source become brighter?

“Mary Shelley” pipeline, coded for the DWF program

Pipeline described in
Andreoni et al. (2017b), PASA, 34, id.e037
Data analysis 1/2 – has any source become brighter?

5 target fields
Total of 25.76 hours of DECam g-band images with 20s exposure and ~20s readout time
1870 images (59 CCDs, 1.2GB each)
2744 x 59 runs of the Mary pipeline (~4TB of data)

detection efficiency 97.8% and missed fraction 3.4% for S/N>10

654,503 candidates: a lot of interesting sources and a lot of bogus detections mixed together

Andreoni et al., in preparation
Data analysis 2/2: searching for minute-timescale transients

Sequence of images acquired on 1 night, 1 target field (~100 images, 20s exposure time)
Data analysis 2/2: searching for minute-timescale transients

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Non-detection

Detection!

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template image  science image  subtraction

DWF17ax
Data analysis 2/2: searching for minute-timescale transients

Sequence of images acquired on 1 night, 1 target field (~100 images, 20s exposure time)

Candidates must be well constrained in time (given the limiting magnitude of the images)
Data analysis 3/2: stack to go deeper - and search again!

Sequence of images acquired on 1 night, 1 target field (~100 images, 20s exposure time)

- Search in individual, 20s exposure images
- Stacking groups of 5 images and search
- Stacking groups of 9 images and search
- Stacking groups of 13 images and search
- Stacking groups of 17 images and search

Limiting magnitude (g band) preliminary estimates:
- 23.0
- 24.3
- 24.9
- 25.2
- 25.4

Deeper searches for faint fast transients

Andreoni et al., in preparation
Any extragalactic minute-timescale fast transient?

654,503 initial candidates

28 candidates pass the time constraint criteria AND pass other sanity checks AND are not classified as stellar.

18 candidates are stellar flares (see Seo-Won Chang’s talk @ASA2018)

6 candidates are likely stellar flares, but non-detected in deep stacks
  → 1 from L-Type star?!

3 candidates have no detectable counterpart in any filter – are they real astrophysical sources?!?

1 candidate is located at the centre of a galaxy – short-timescale precursor of a nuclear transient?

Yes, we do have hundreds of flare stars in our database

Preliminary results

Andreoni et al., in preparation
DWF breaks new ground with deep observations that can probe timescales down to 1.17 minutes

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“Fast images” acquired during DWF
Limiting magnitude \(\sim 23\)
timescale = 1.17 minutes

Rate < 1.6 day\(^{-1}\) deg\(^{-2}\)

Andreoni et al., in preparation
Art meets Astronomy
Hawthorn Town Hall - just across the street!

Inspired by our Deeper Wider Faster astronomy program

Artists: Pam Bain and Carolyn Lewens
also featuring Swinburne astronomers’ artworks!