Stellar/AGN photometric astronomy in the era of SDSS Phase V
Carnegie, May 3rd 2019

ZTF as a public survey

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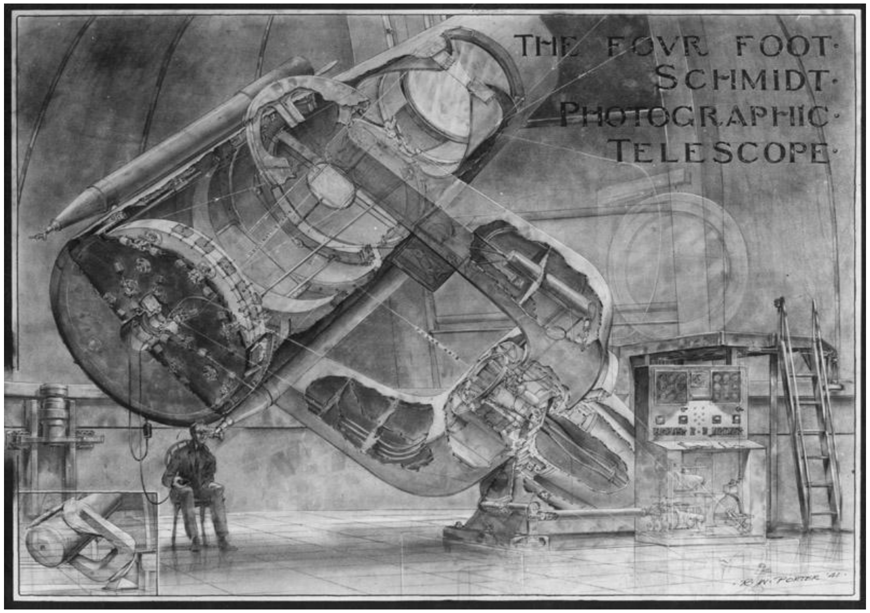
The Palomar legacy

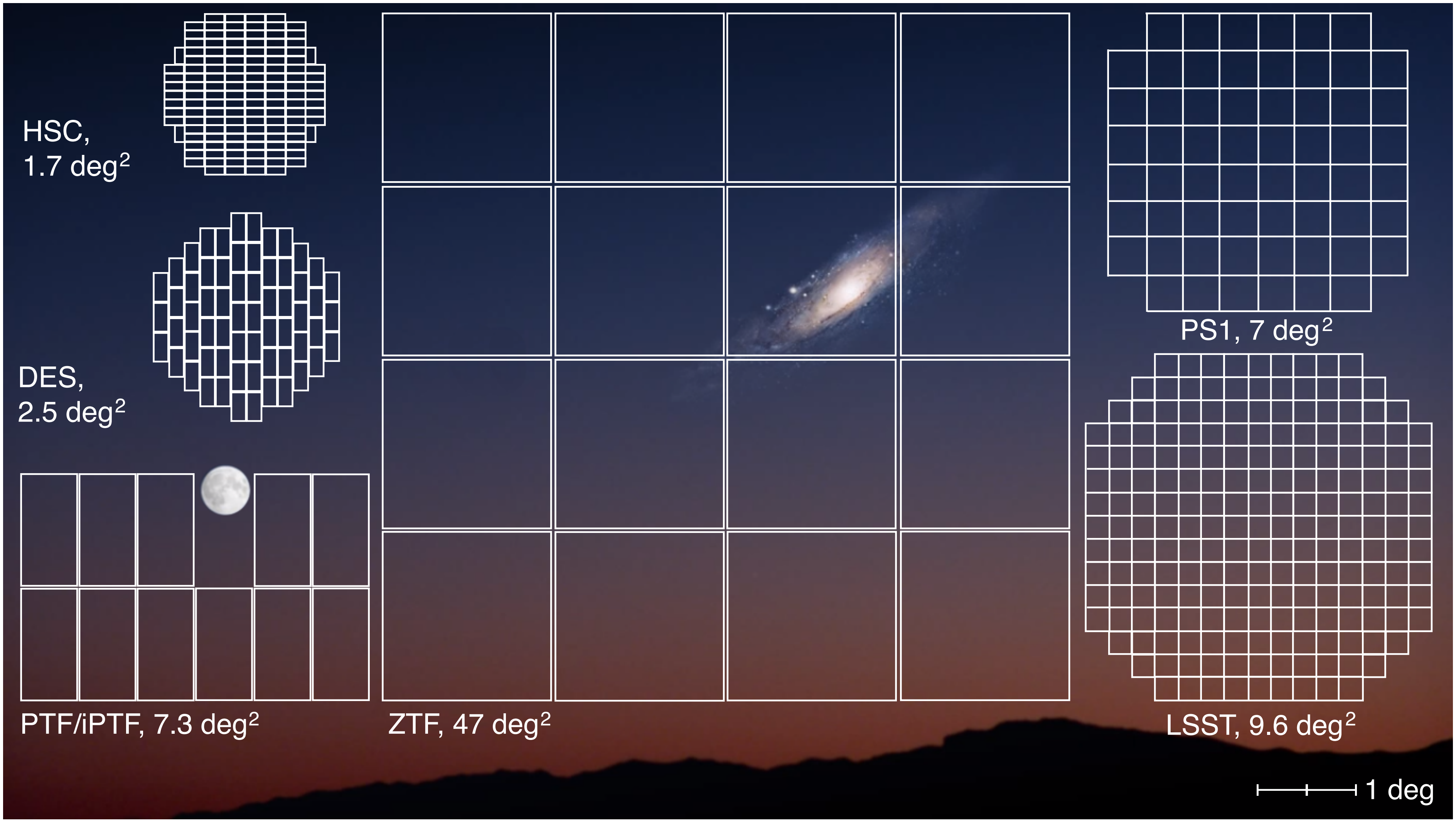


	Dates	Sky	Bands	Depth
POSS-I	1949-1956	Dec > -33	103a-O, 103a-E	22.0 (B)
POSS-II (DPOSS)	1985-1995	Dec > -22	IIIaJ, IIIaF, IVN	22.5-19.5
Palomar-Quest	2002-2009	Dec > -25	BVRI, griz	21 (V)
PTF	2009-2012		gr	20.5
iPTF	2013-2015	Dec > -30	gr	20.5
ZTF-I	2018-2020	Dec > -30	gri	20.5 (r)

The current landscape of sky surveys

	ATLAS	ASAS-SN	Pan-STARRS	ZTF	LSST
Total sources	-	10^8	10^{10}	10^9	37×10^9
Total detections	10^{12}	10^{11}	10^{11}	10^{12}	37×10^{12}
Annual visits/source	1000	180	60	3000	100
No. of filters	2	2	5	3	5
No. of pixels	10^8	4×10^6 (x 4)	10^9	6×10^8	3.2×10^9
CCD surface area (cm^2)	90	9	1415	1320	3200
Field of view (deg^2)	30	4.5	7	47	9
Hourly survey rate (deg^2)	3000	960	-	3760	1000
5σ detection limit in r	19.3	17.3	21.5	20.5	24.7
Nightly alert rate	-	-	-	10^6	10^7
Nightly data rate (TB)	0.15	-	-	1.4	15
Telescope (m)	0.5	4 x 0.14	1.8	1.2	6.5
No. of telescopes	2 (6)	5	2	1	1

Relative coverages



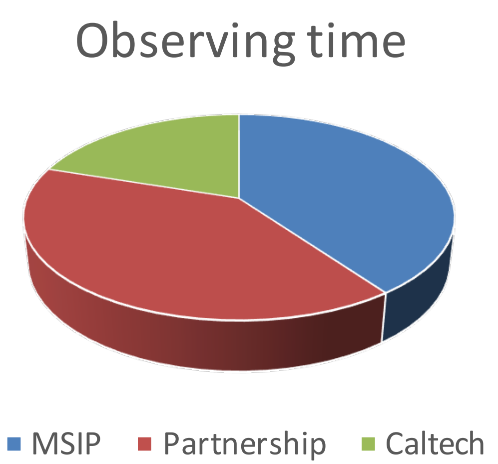
The public face of ZTF

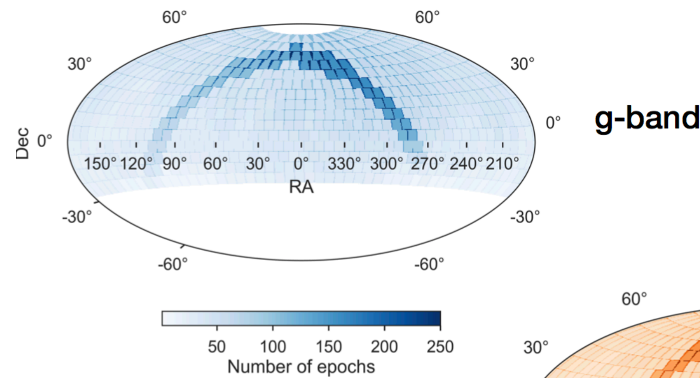
Northern Sky Survey

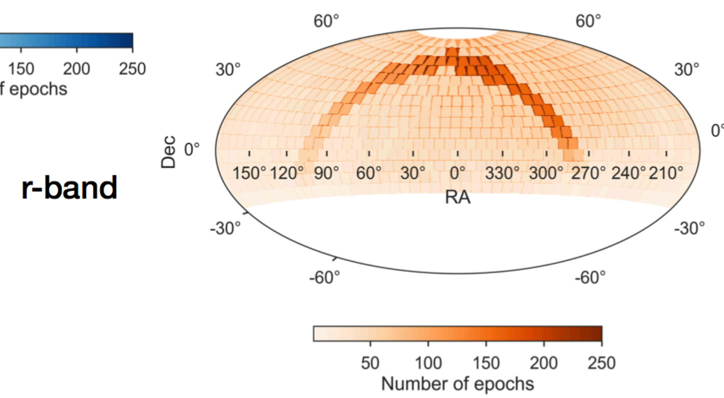
- Two visits/night (g+r) for asteroid rejection => 3-day average
- 23,675 deg^2 total footprint; 85% time; 4325 deg^2 average/night

Galactic Plane Survey

- Nightly sweep of the Galactic Plane (|b|<7; nightly g+r)
- ~2,800 deg^2 total footprint; 15% time; 1475 deg^2 average/night



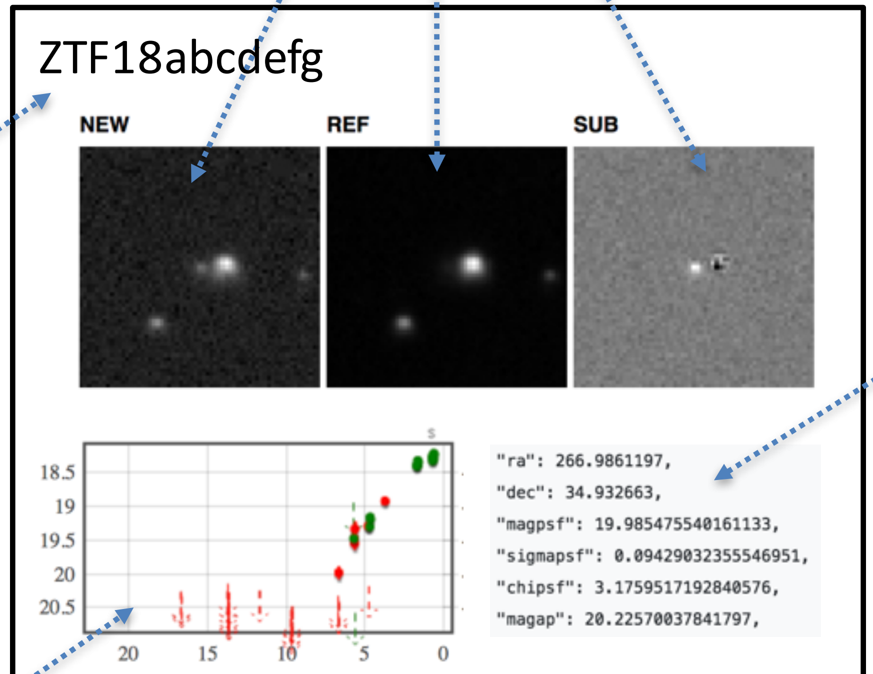




Alert structure: AVRO format

63 x 63 pixel 32-bit images

Unique spatially matched alert name (1.5” radius)



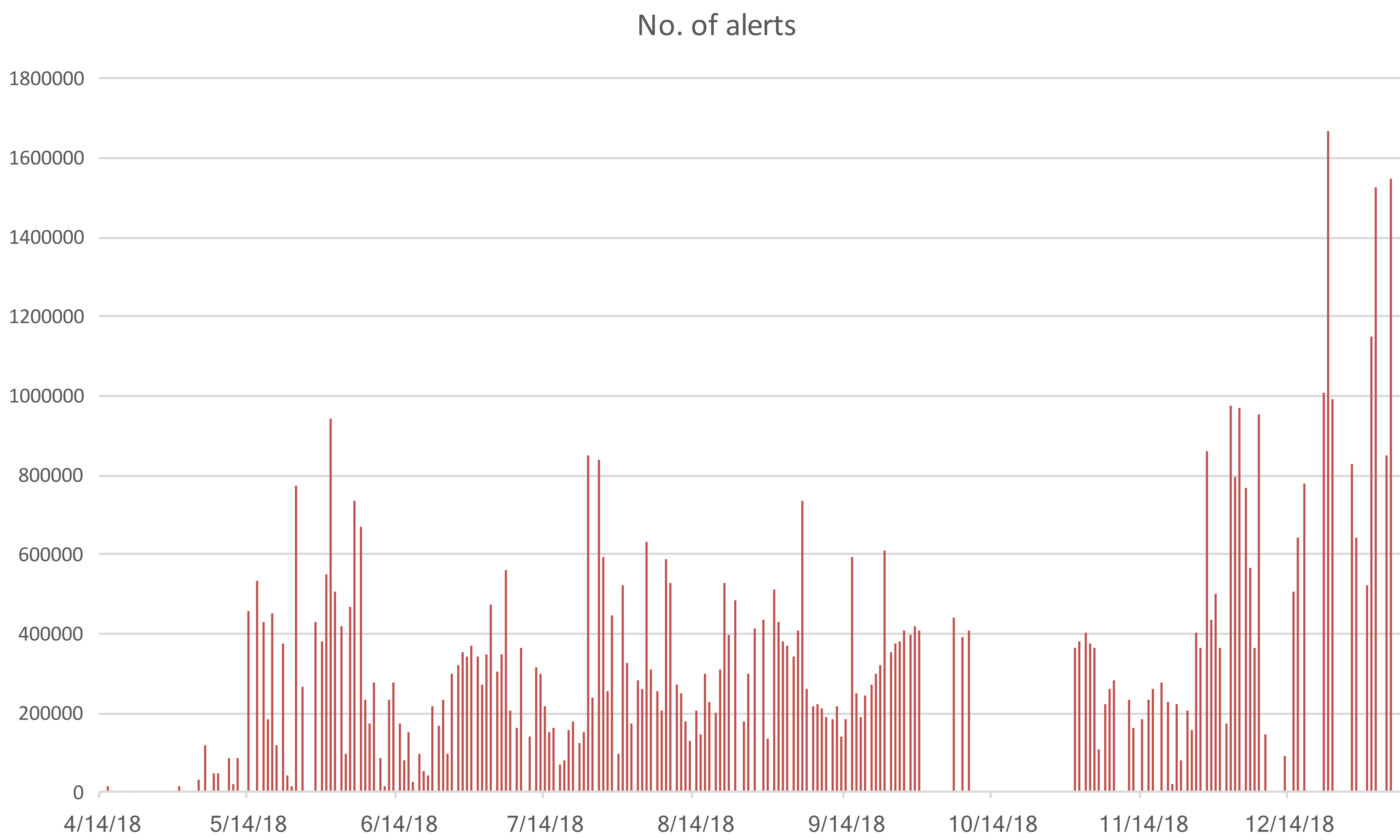
- ZOGY parameters
- Real-bogus score
- Star/galaxy score
- 3 nearest PS1 sources
- Nearest SS object
- Alert history

Rolling 30-day window light curve

https://zwicky.tf/4t5

https://github.com/ZwickyTransientFacility/ztf-avro-alert

Alert statistics: 89,721,932 to 3/11/19

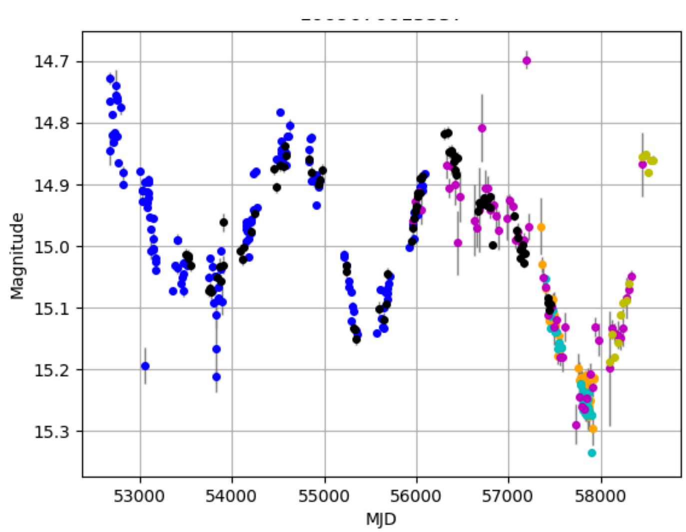


Where can I get alerts?

Service	Basic web search	User-defined filters	Notifications	Kafka streams	API	Bulk access
LCO MARS	Yes	No	-	No	JSON	No
ANTARES	No	Python	Slack	Yes	Python	(Yes)
LASAIR	Yes	SQL	-	No		No
UW	No	No	-	No	No	Yes
ALERCE	Coming soon					

The greater public legacy of ZTF

	Dates active	Magnitude limit	Mean Δt	Data available
LINEAR	1998-2007	18	22 d	Yes
CRTS	2003-2016	19.0-21.5	10 d	Yes
PTF/iPTF	2009-2015	20.5	77 d	Yes
ASAS-SN	2013-	18	1d	On demand
ATLAS	2016-	19	2d	No
ZTF	2018-	20.5	3 d	Yes



Why decadal baselines are important

- Quasars have a characteristic restframe variability timescale τ of 100s of days which scales with black hole mass
- Light curves need to cover at least 10τ for accurate estimates
- The bulk of the quasar population is $1 < z < 2$

=> observed frame data needs to cover at least 3000 days for just the least massive systems

Also for:

- Accurate periods for LPVs
- Period changes in close binary systems, Blazhko RR Lyrae, …

The predictable sky

- Generative models of variability can be produced for every variable source in the sky
- Deep learning models are appropriate for both periodic sources and aperiodic or stochastic sources
- The expected behavior of each source could then be compared with the observed by ZTF
- This allows for much earlier detection of slow events such as:
  - Changing-look quasars
  - Microlensing
  - Slow flares/long-lived TDEs