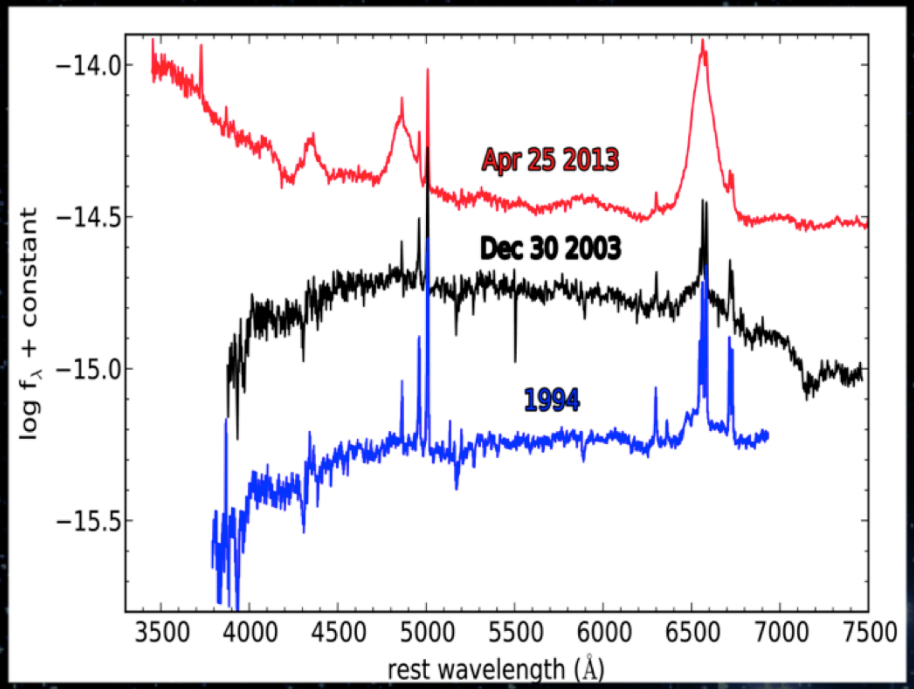
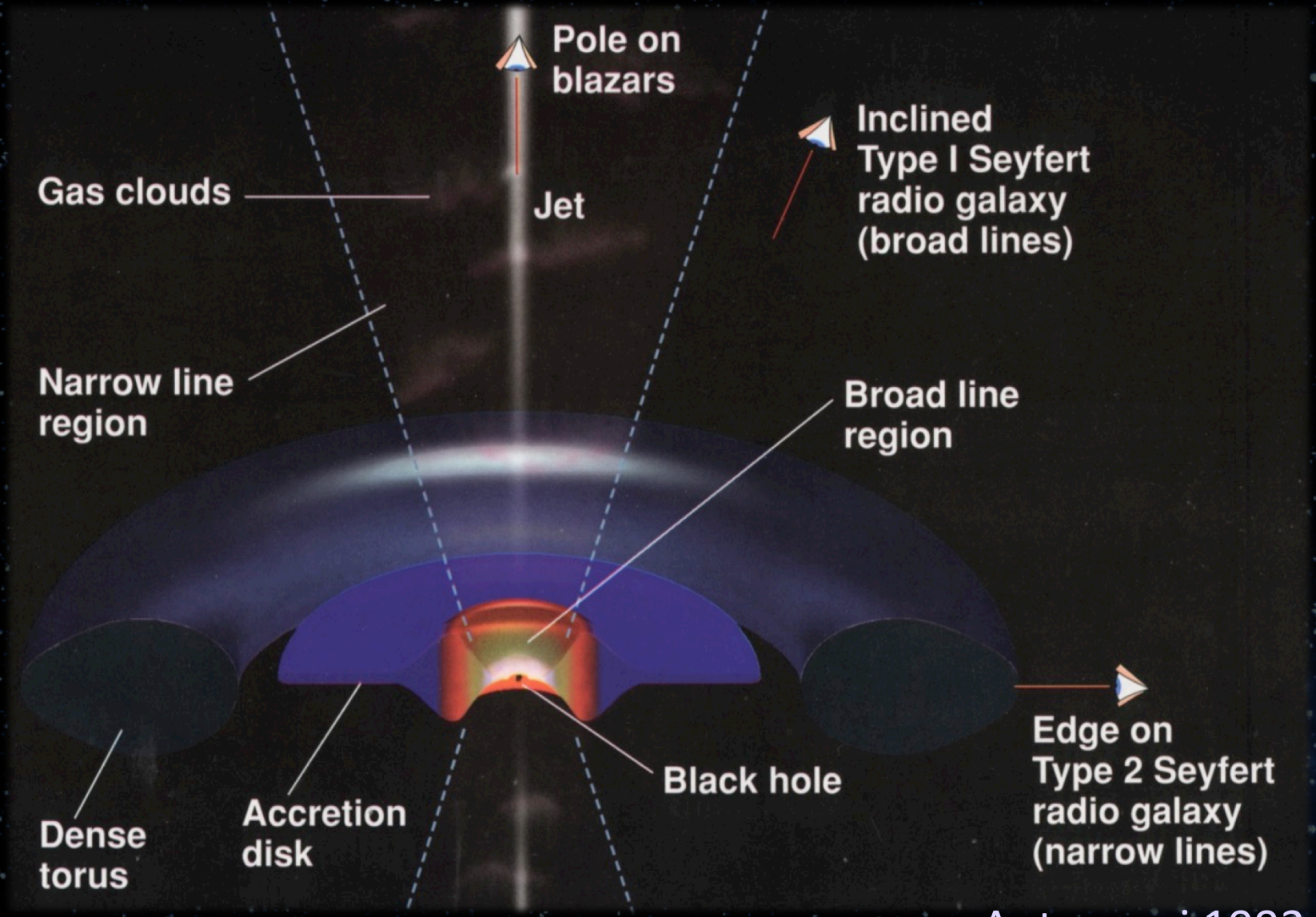
“Changing look” AGN: NGC 2617

- ASAS-SN triggered on a 10% increase in flux from AGN + host
- Follow-up imaging showed AGN continued to brighten by 1.3 mag
- Follow-up spectroscopy showed that the AGN changed from a Seyfert type 1.8 to 1.0



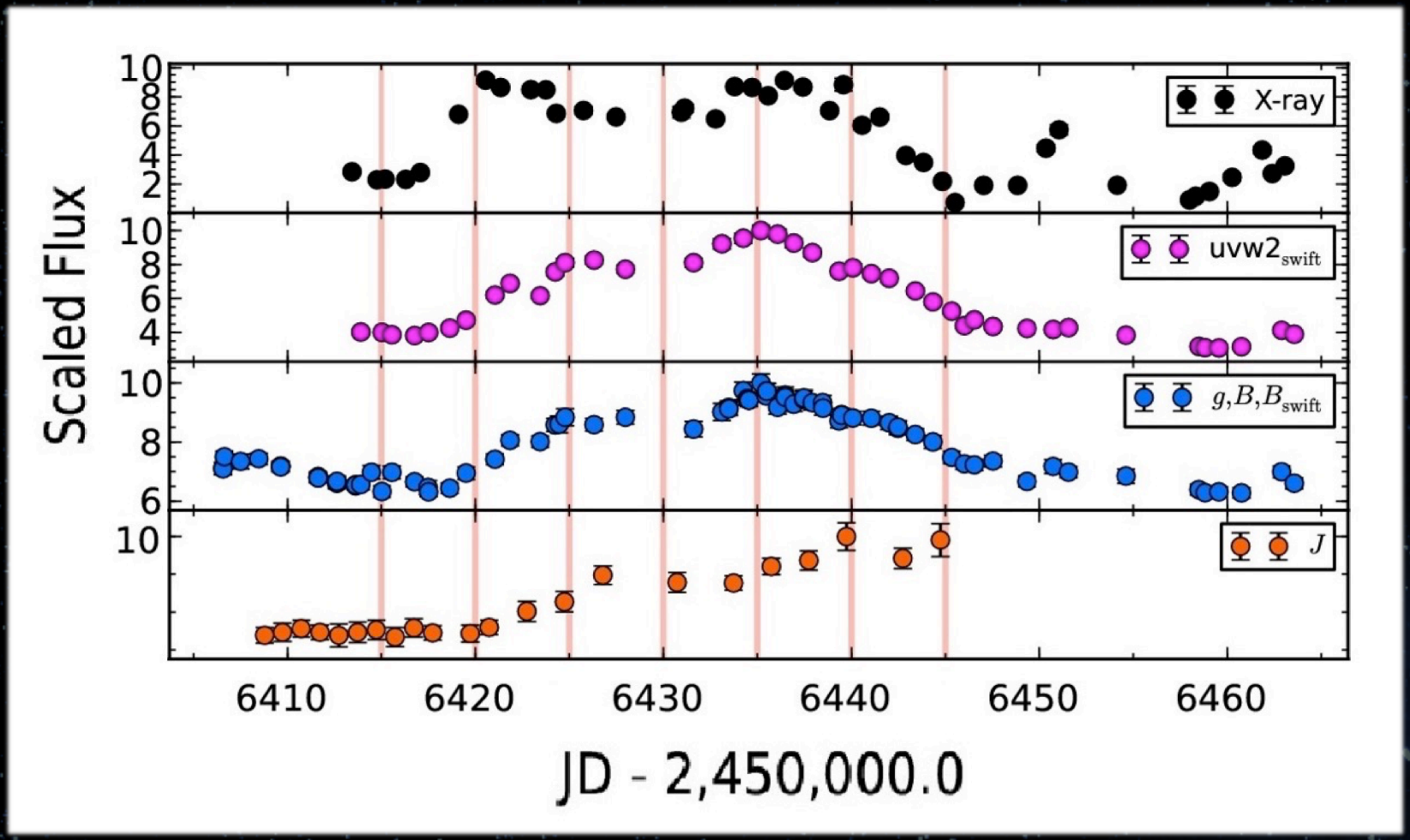
Shappee et al. 2014

Unified Model of AGN



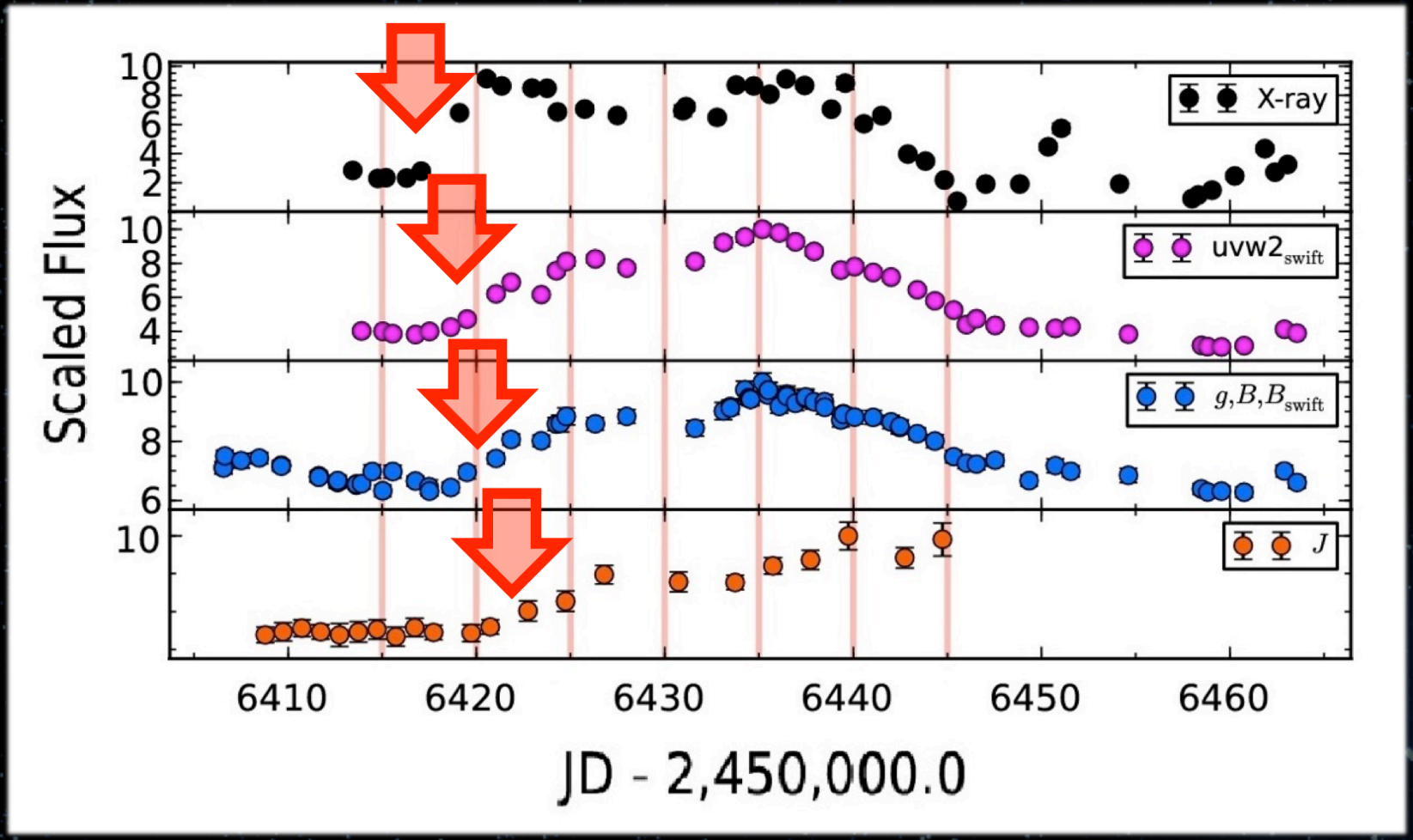
Antonucci 1993

NGC 2617 X-ray–NIR light curves



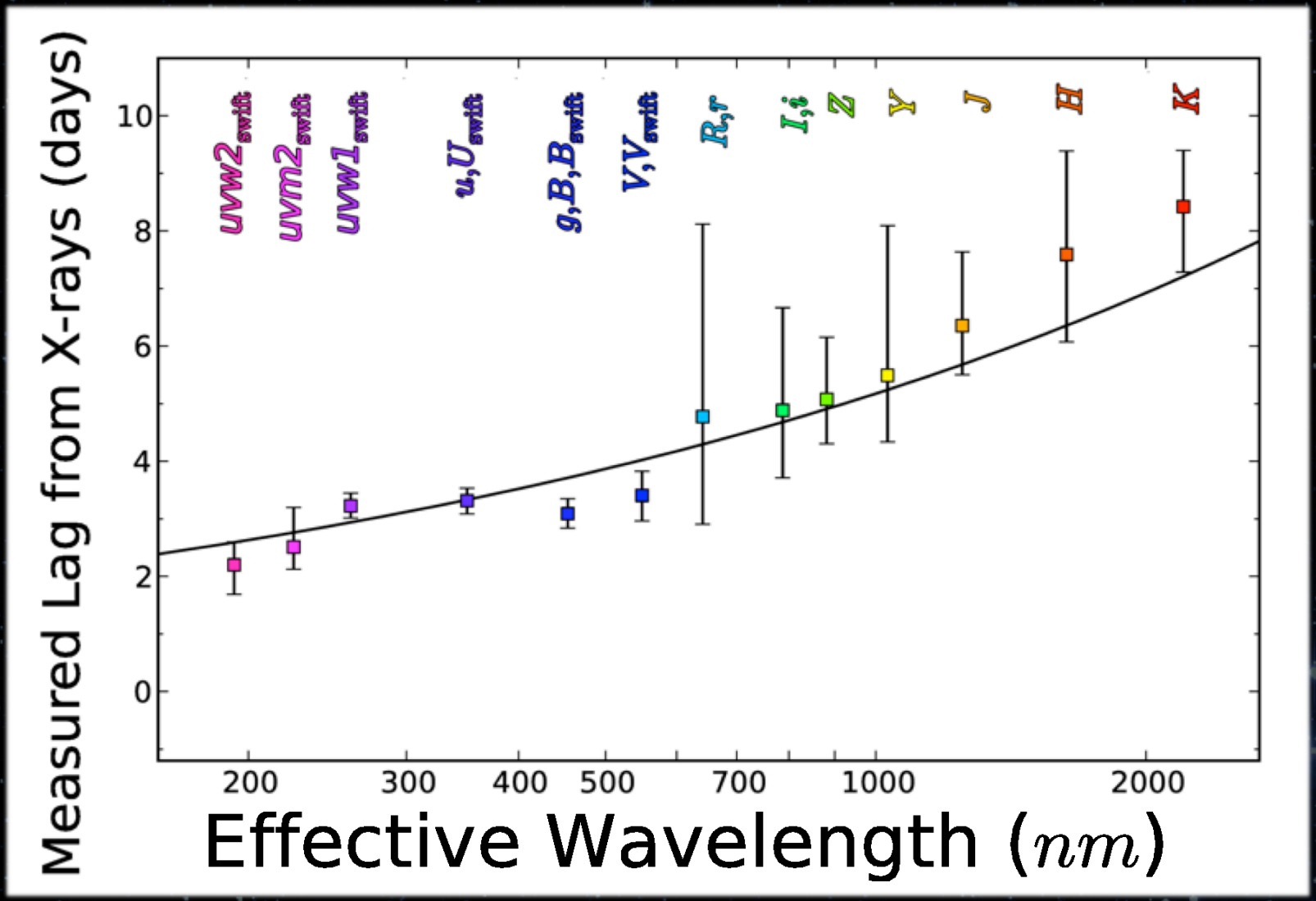
Shappee et al. 2014

NGC 2617 X-ray–NIR light curves

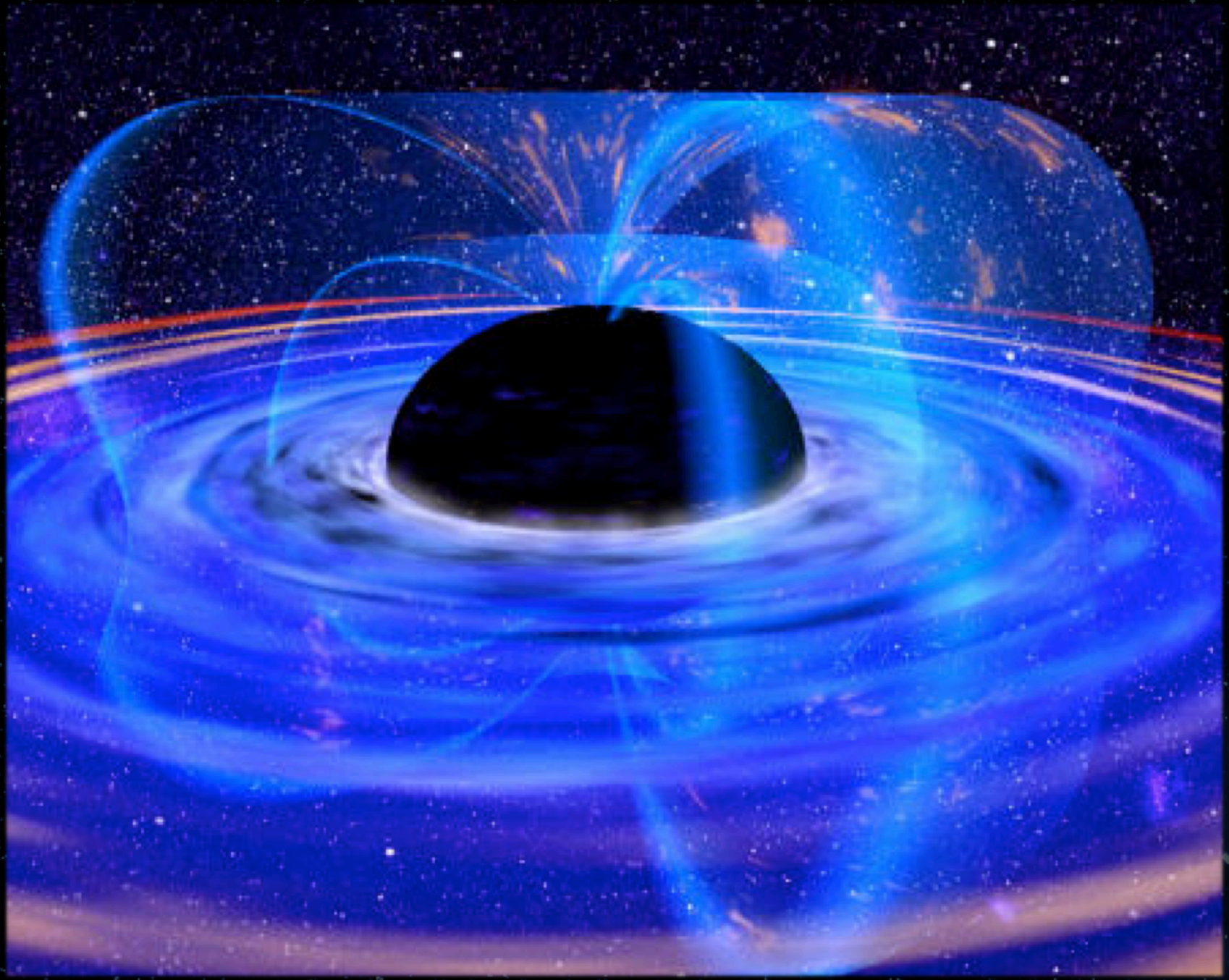


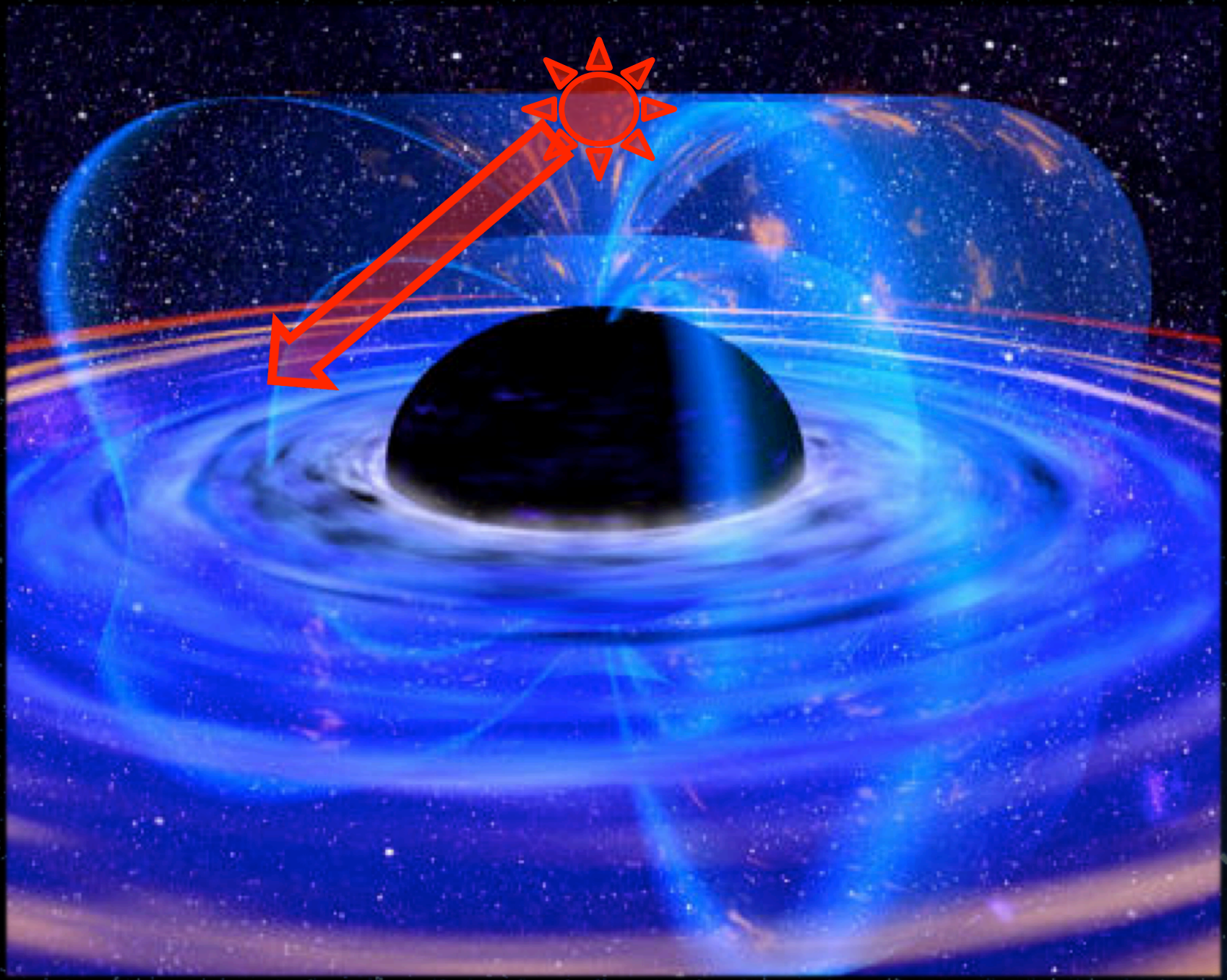
Shappee et al. 2014

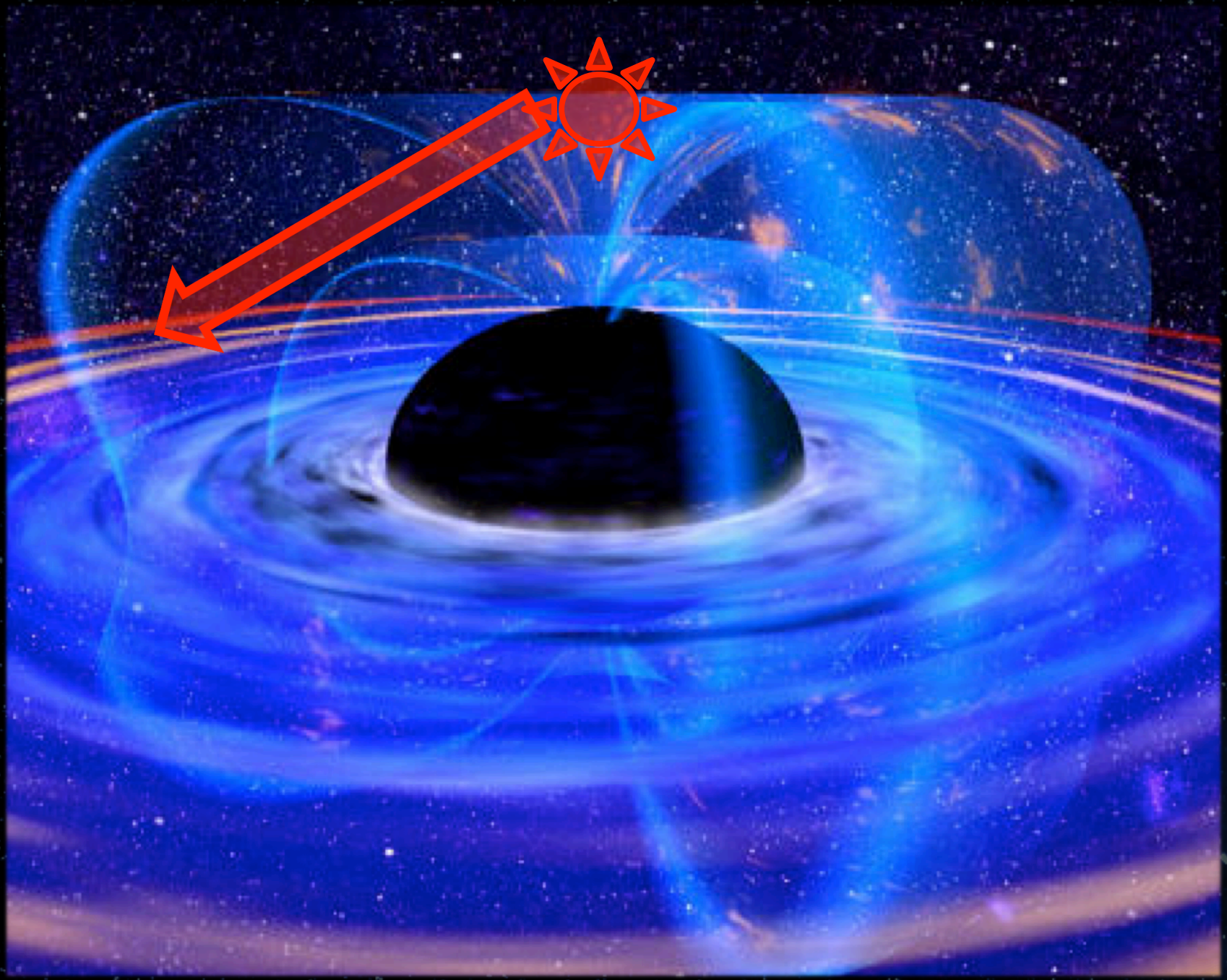
NGC 2617 Photometric Lags



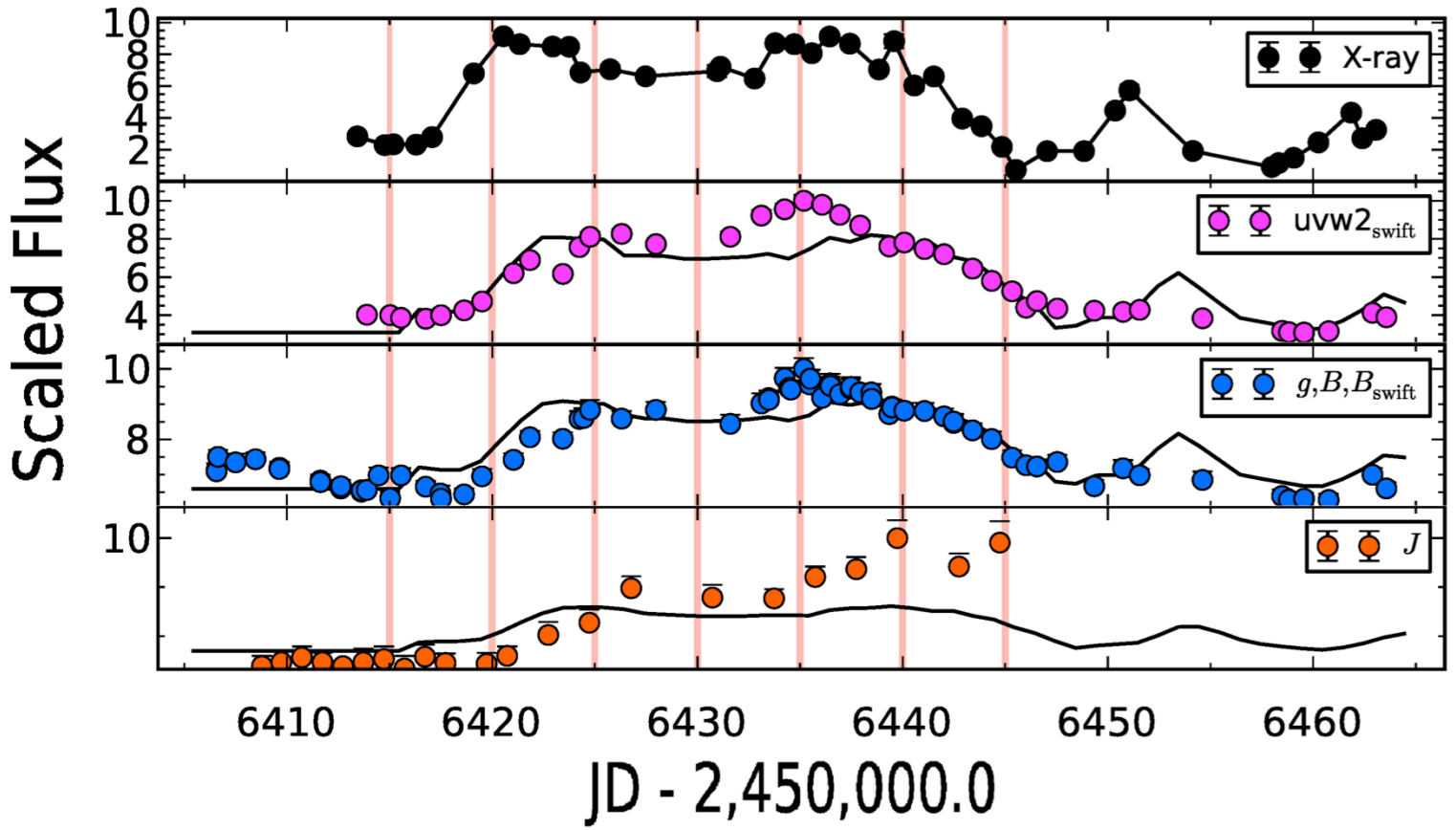
Shappee et al. 2014







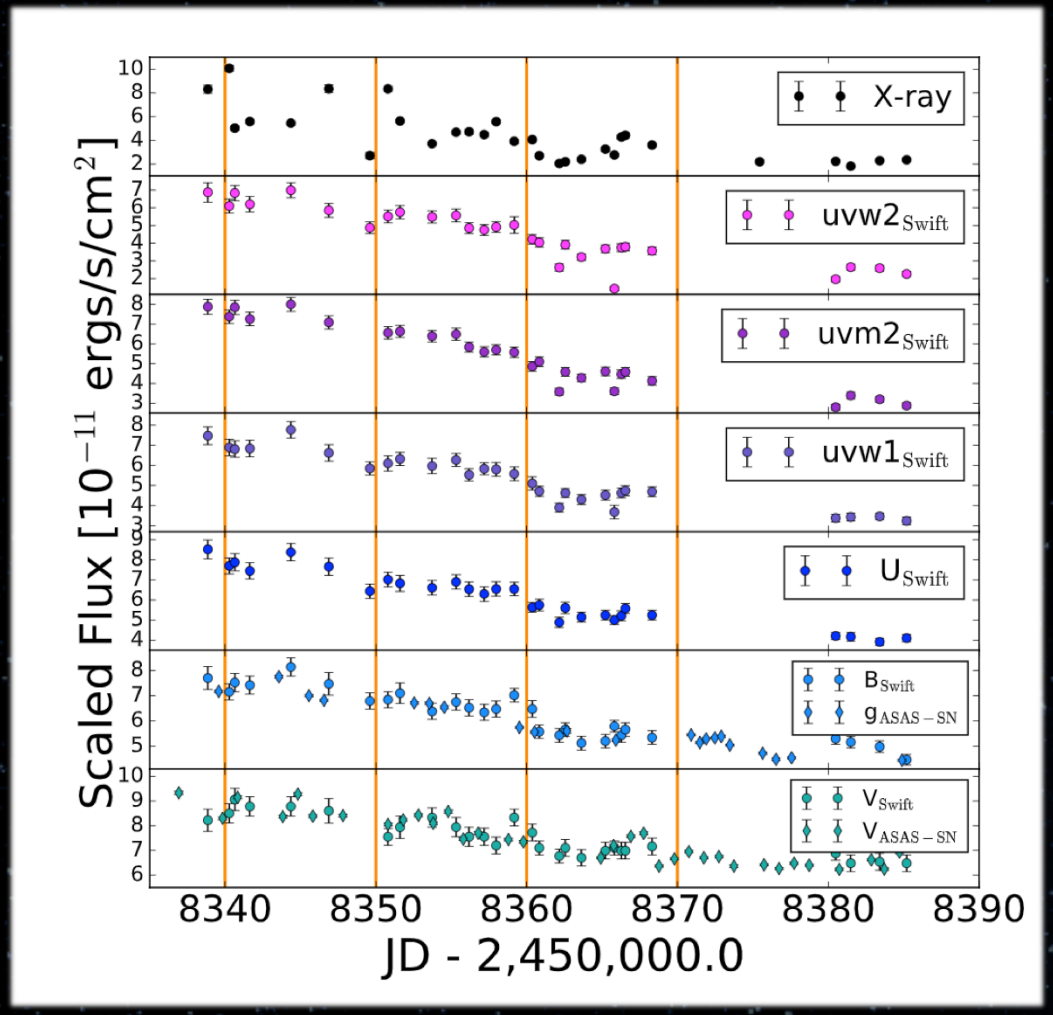
NGC 2617 X-ray–NIR light curves



Shappee et al. 2014

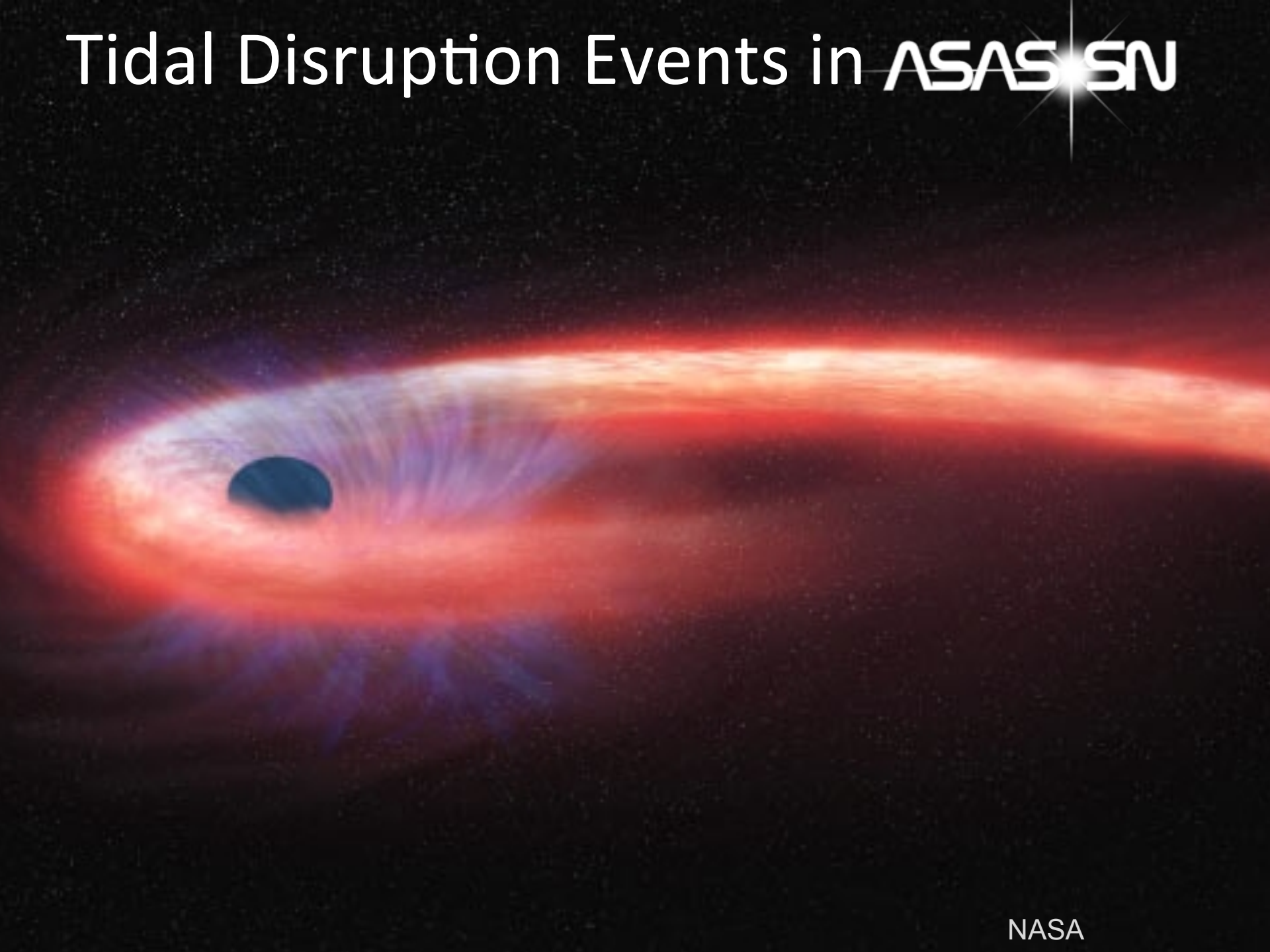
NGC 1566 X-ray and UV/optical

Anna Payne



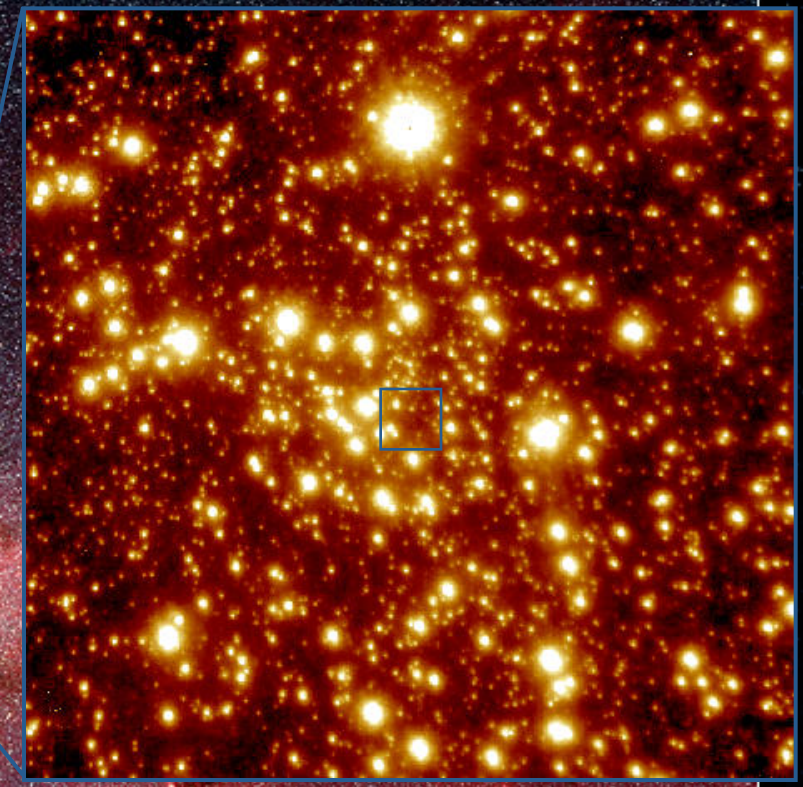
Payne et al. In prep.

Tidal Disruption Events in ASAS-SN



NASA

Black holes eat whole stars.



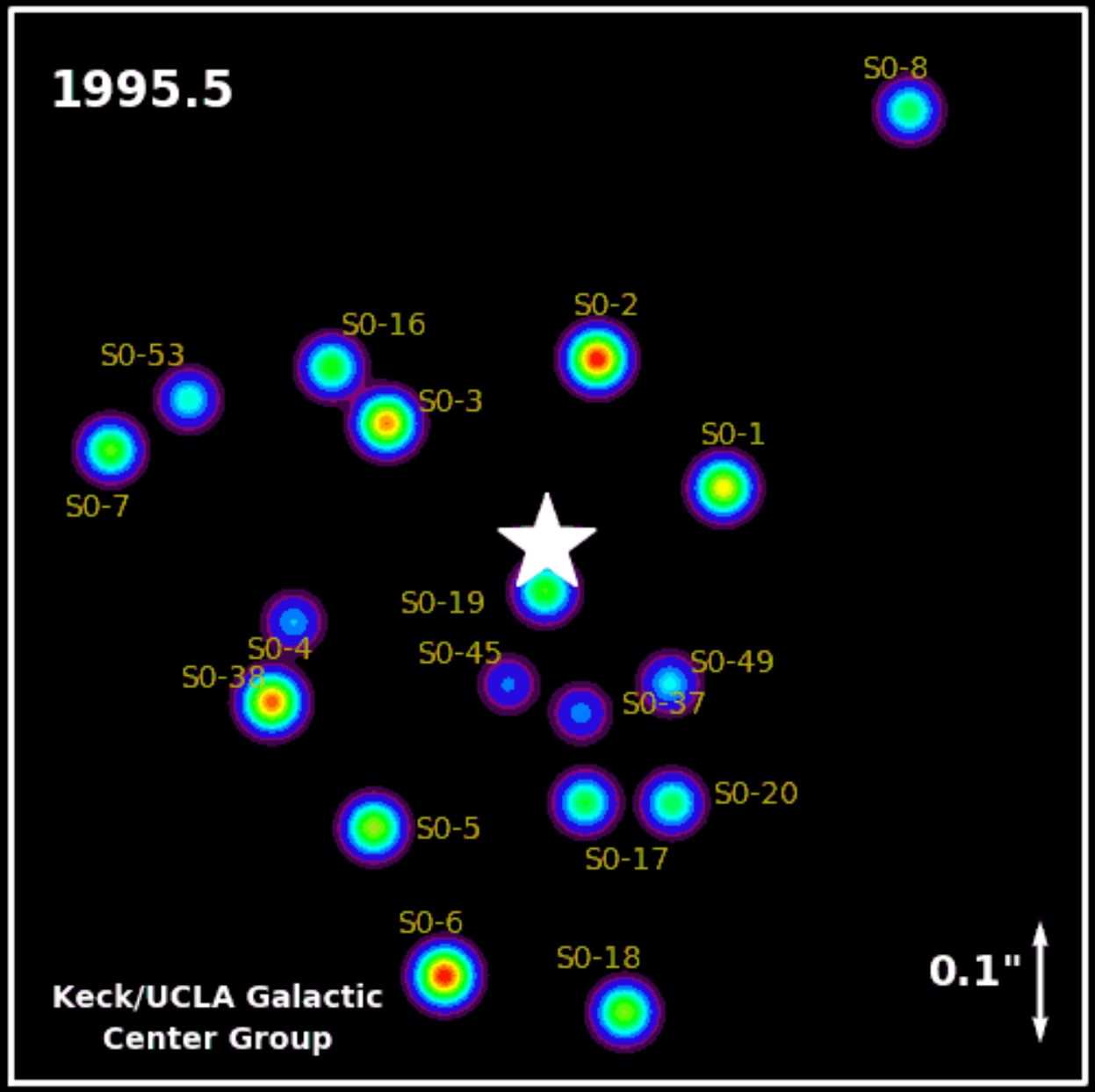
The Center of the Milky Way Galaxy

NASA / JPL-Caltech / S. Stolovy (Spitzer Science Center/Caltech)

Spitzer Space Telescope • IRAC

ssc2006-02a

Our own Galaxy



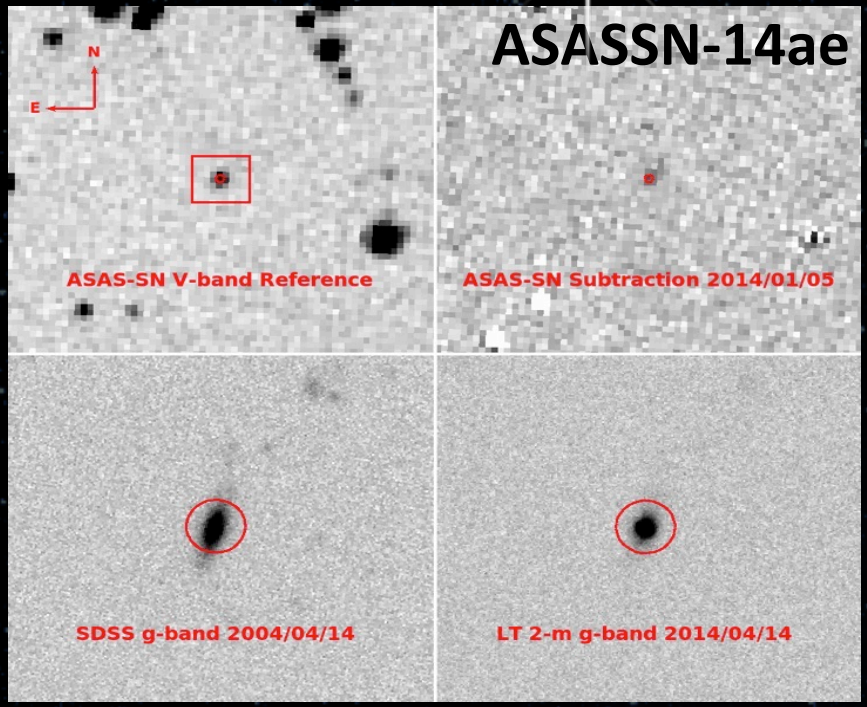
CXO

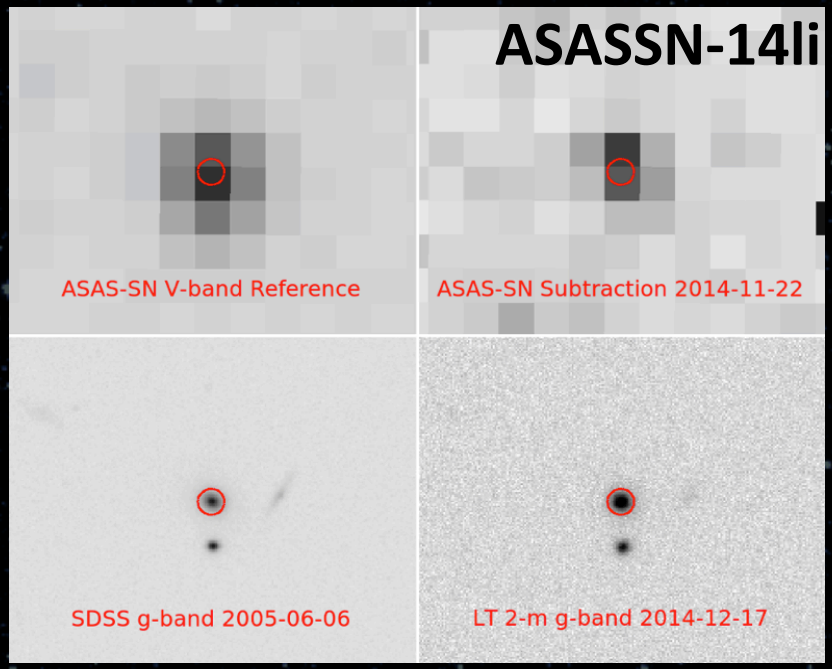
Tidal Disruption Events in ASAS-SN

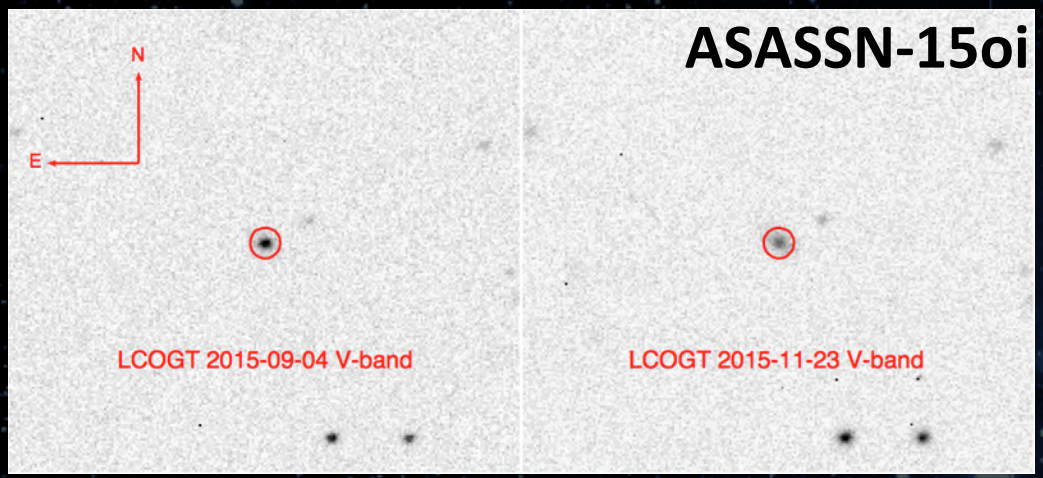
UNIVERSITY OF CALIFORNIA
SANTA CRUZ

Tidal Disruption Events in ASAS-SN

- 3 of the b*rightest* and *(arguably) best-studied*
  - 20 total in the optical
- ASAS-SN is more complete than previous surveys
- Rates closer to theoretical rates



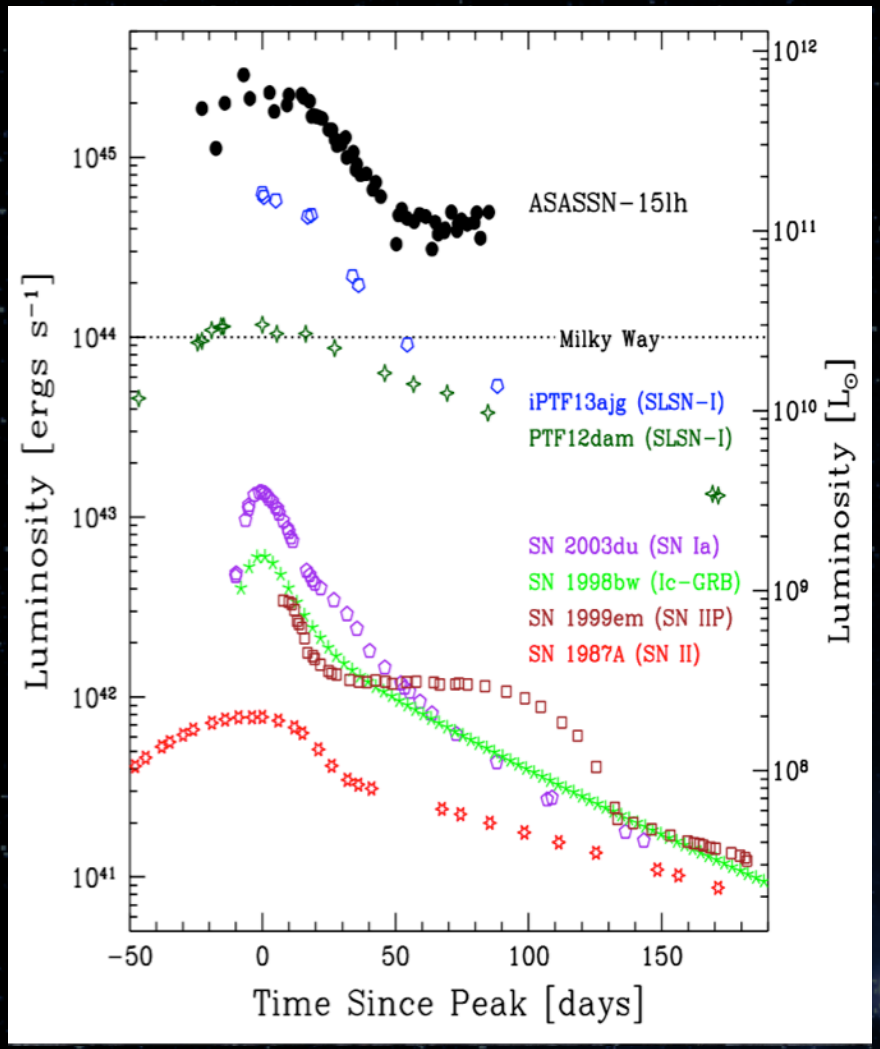




Holoien et al. 2014a,b, 2016

The most luminous supernova(?)

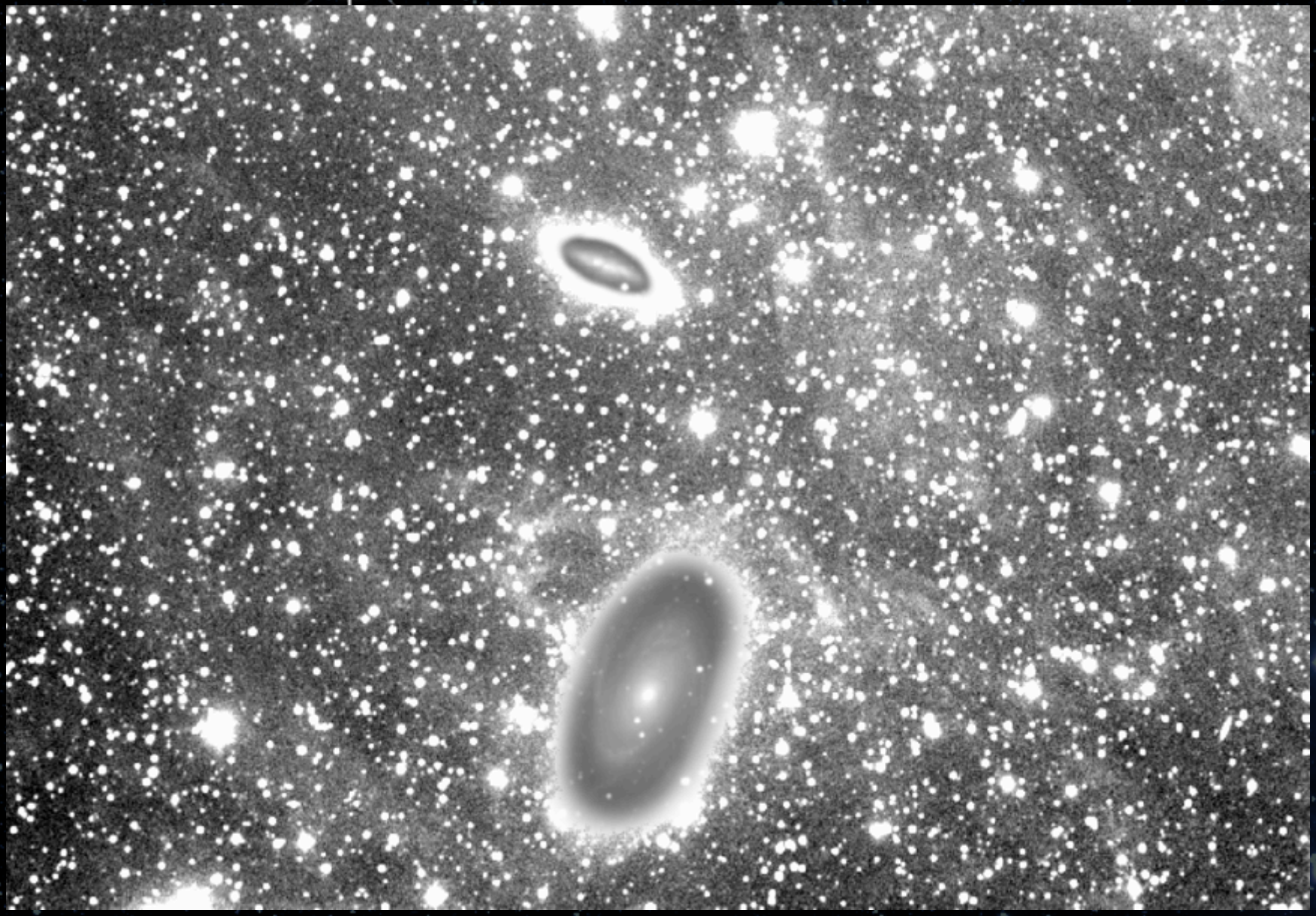
- Nuclear transient, massive host
- The most luminous SN ever discovered?
  Dong, Shappee, Prieto et al. 2016
- Magnetar powered supernova? (most energy possible?)
  Metzger et al. 2015
- TDE like no other?
  Leloudas et al. 2016
- Extreme events challenge all models, unbiased survey



Dong, Shappee et al. 2016

New science with ASAS-SN !

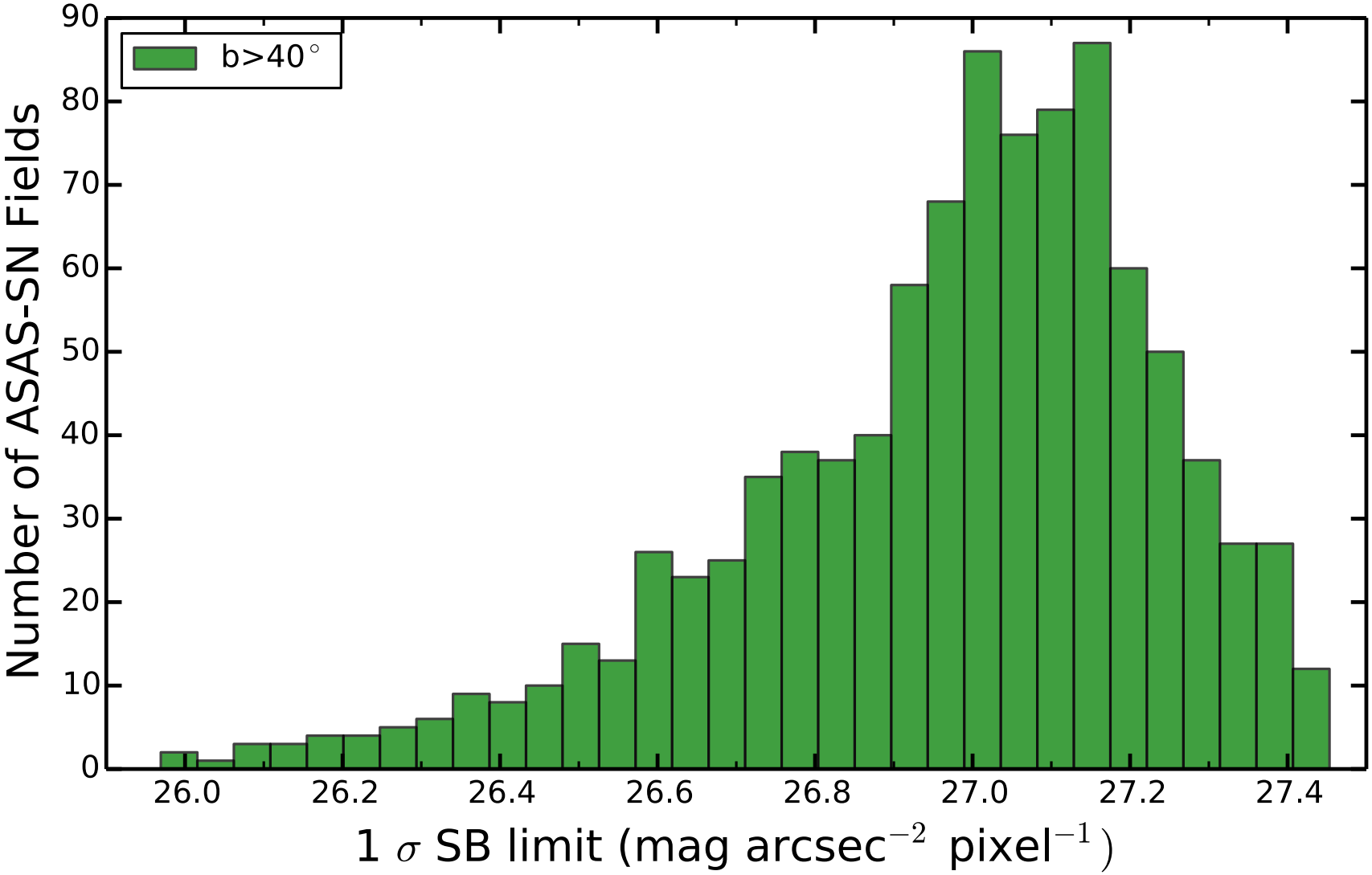
ASAS-SN: Low Surface Brightness



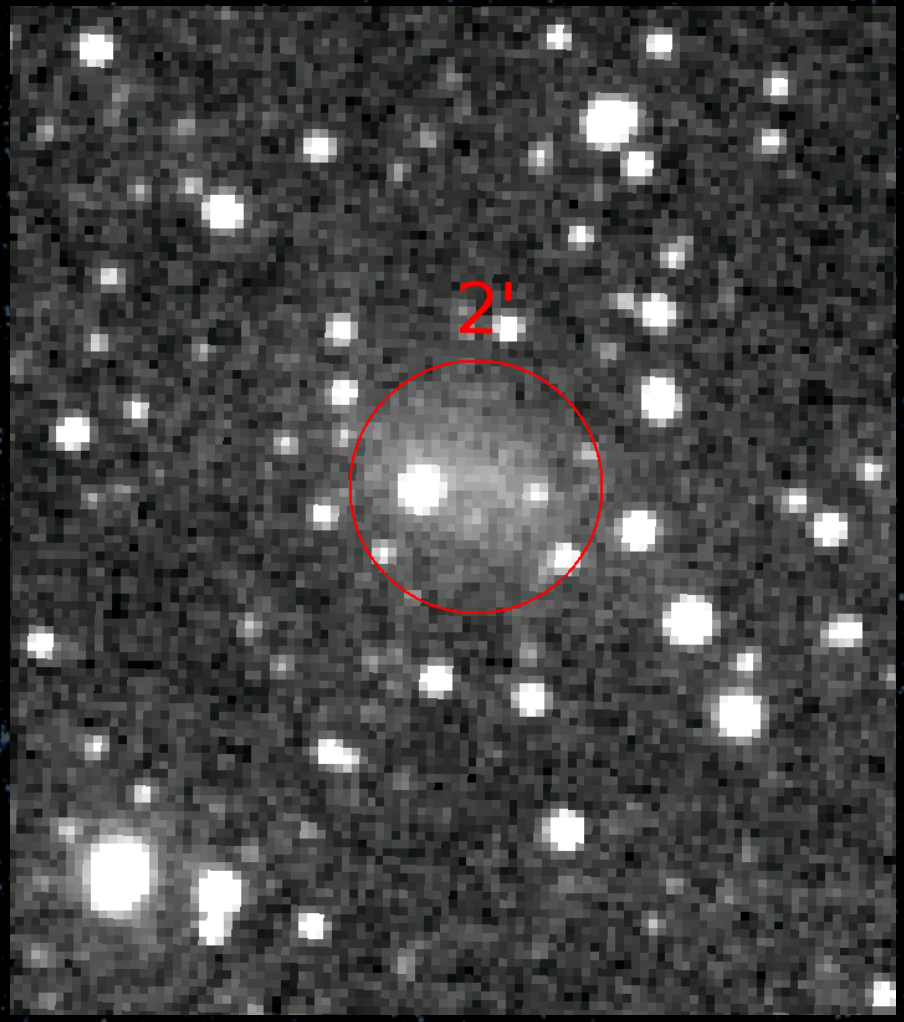
ASAS-SN: Low Surface Brightness

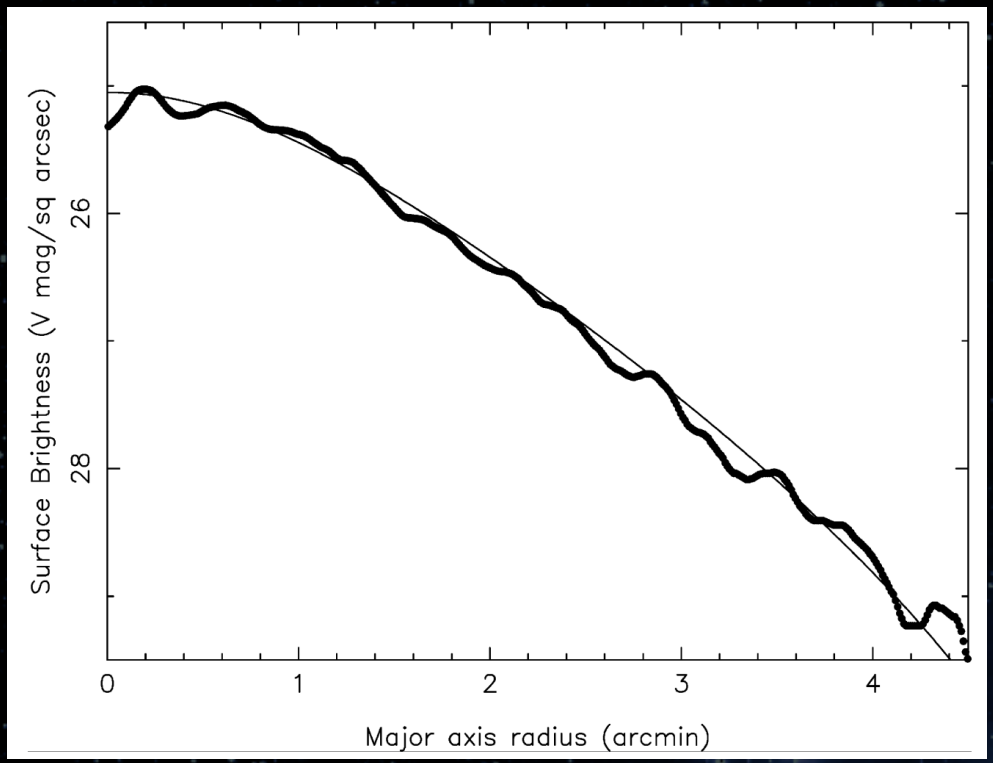
Image credit: Mark Seibert

ASAS-SN: Low Surface Brightness



ASAS-SN: Cetus Dwarf Galaxy

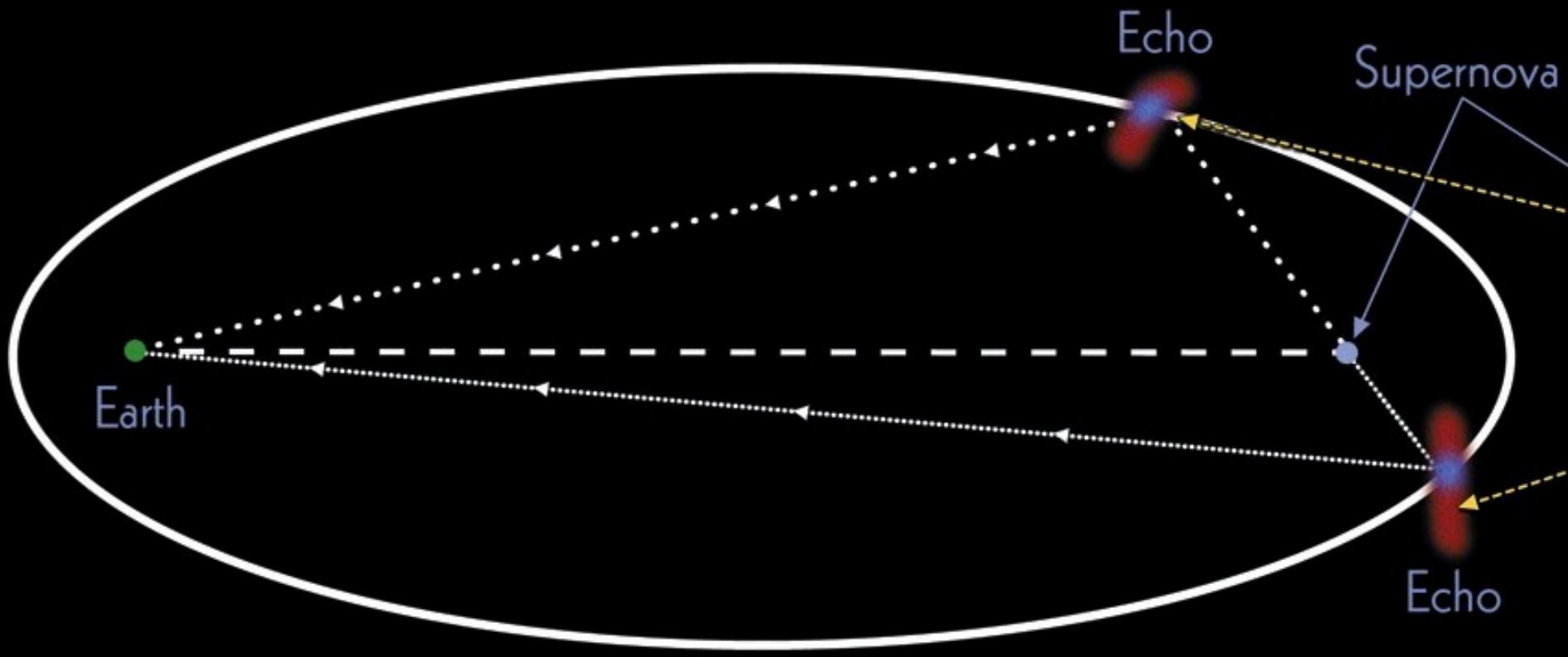




Benjamin Shappee and Johnny Greco

Whiting, Hau, and Irwin 1999

Light echoes, Time machines.

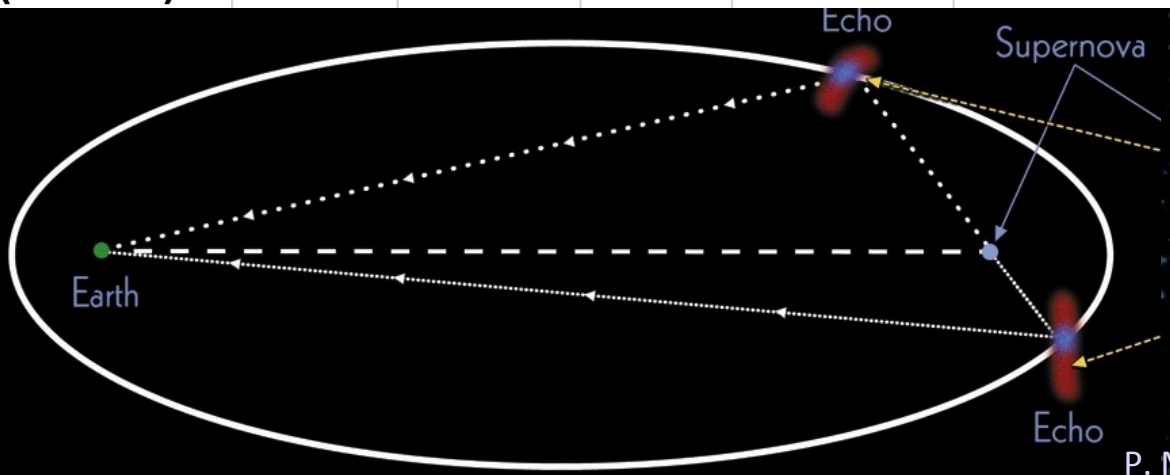


P. Marenfeld and NOAO/AURA/NSF

Light echoes, Time machines.

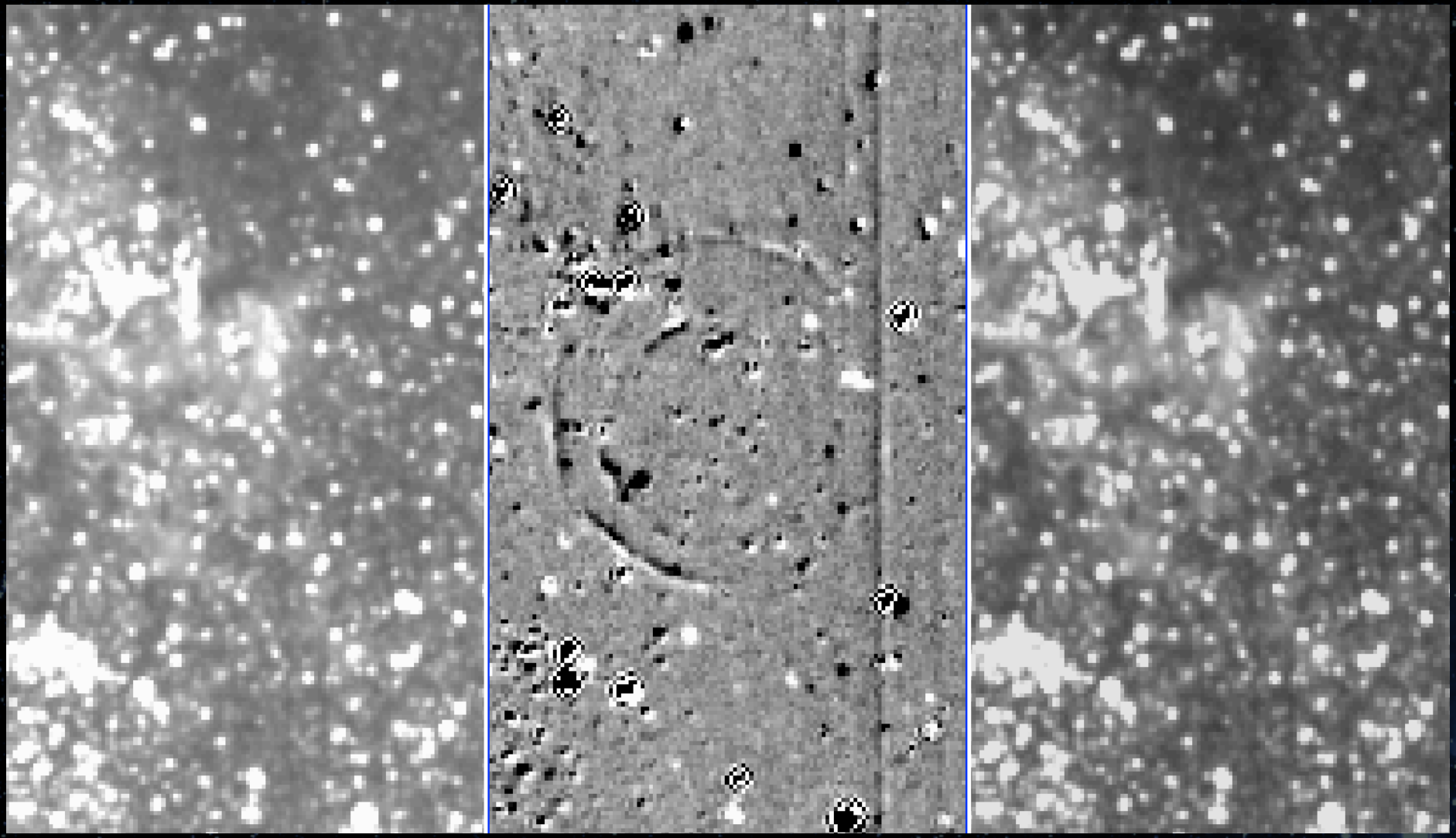
SN Name	RA	Dec	Date	Distance (kpc)	Type	Search Area (square deg)
Cas A	23:23	+48:58	1680	3.2	SN IIb	66
Tycho	00:25	+64:09	1572	2.3	Norm. SN Ia	287
Eta Car	10:45	-59:41	~1840	2.4	Great Eruption	36
SN 1181	02:05	+64:49	1181	2.6	?	2400
P Cygni	20:17	+38:02	1600	1.6	Great Eruption	3000
Crab Nebula	05:34	+22:01	1054	1.9	SN II?	3000
W49B	19:11	+09:06	1000	8	Core-Collapse?	113
Kepler	17:30	-21:29	1604	2.9	Pec. SN Ia?	140
SN 1006	15:02	-42:06	1006	2.2	Norm. SN Ia?	2300
RCW 86 (SN 185)	14:43	-62:28	0185	2.8	SN Ia/II ?	6000

Table adapted from Armin Rest

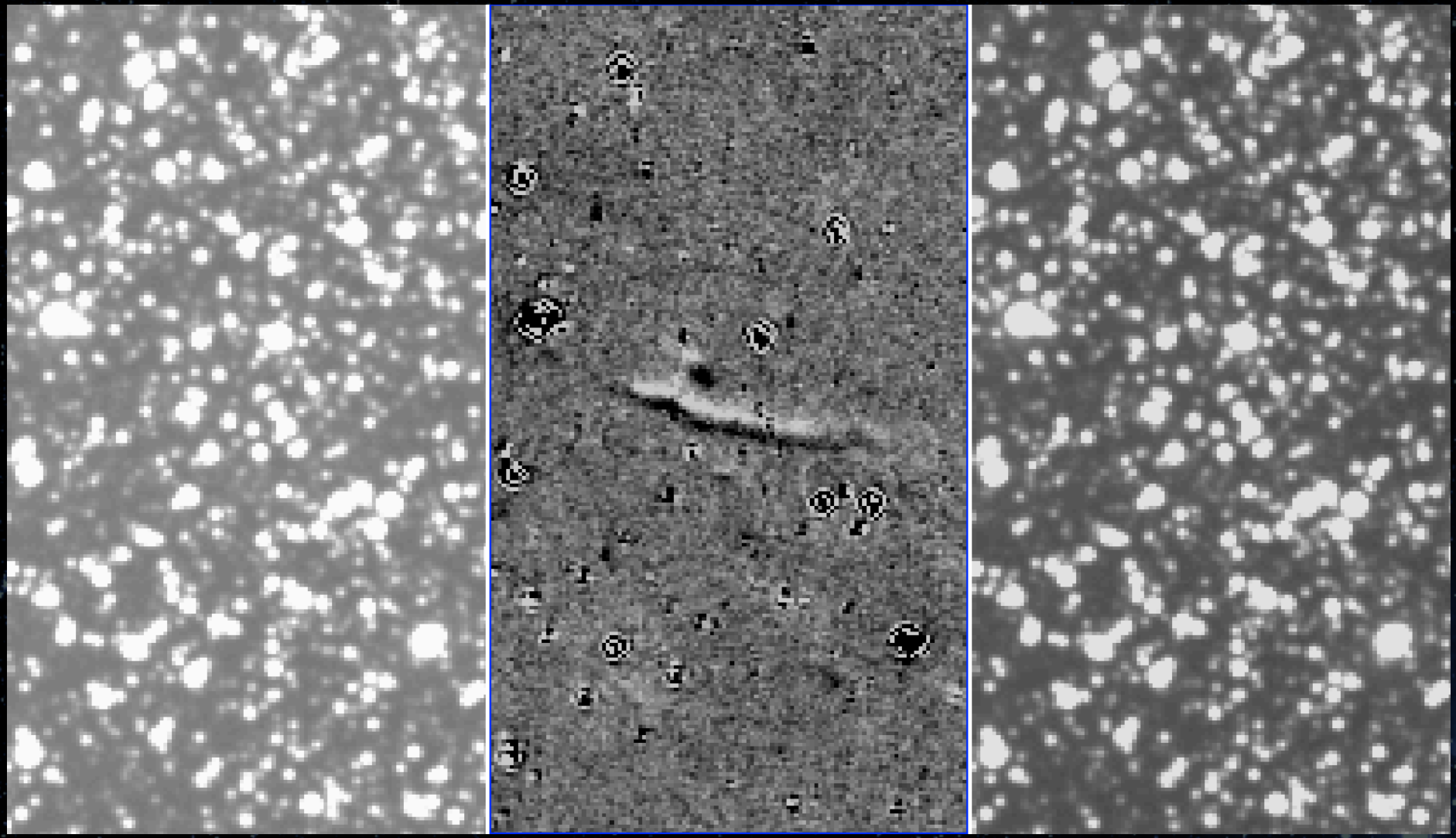


P. Marenfeld and NOAO/AURA/NSF

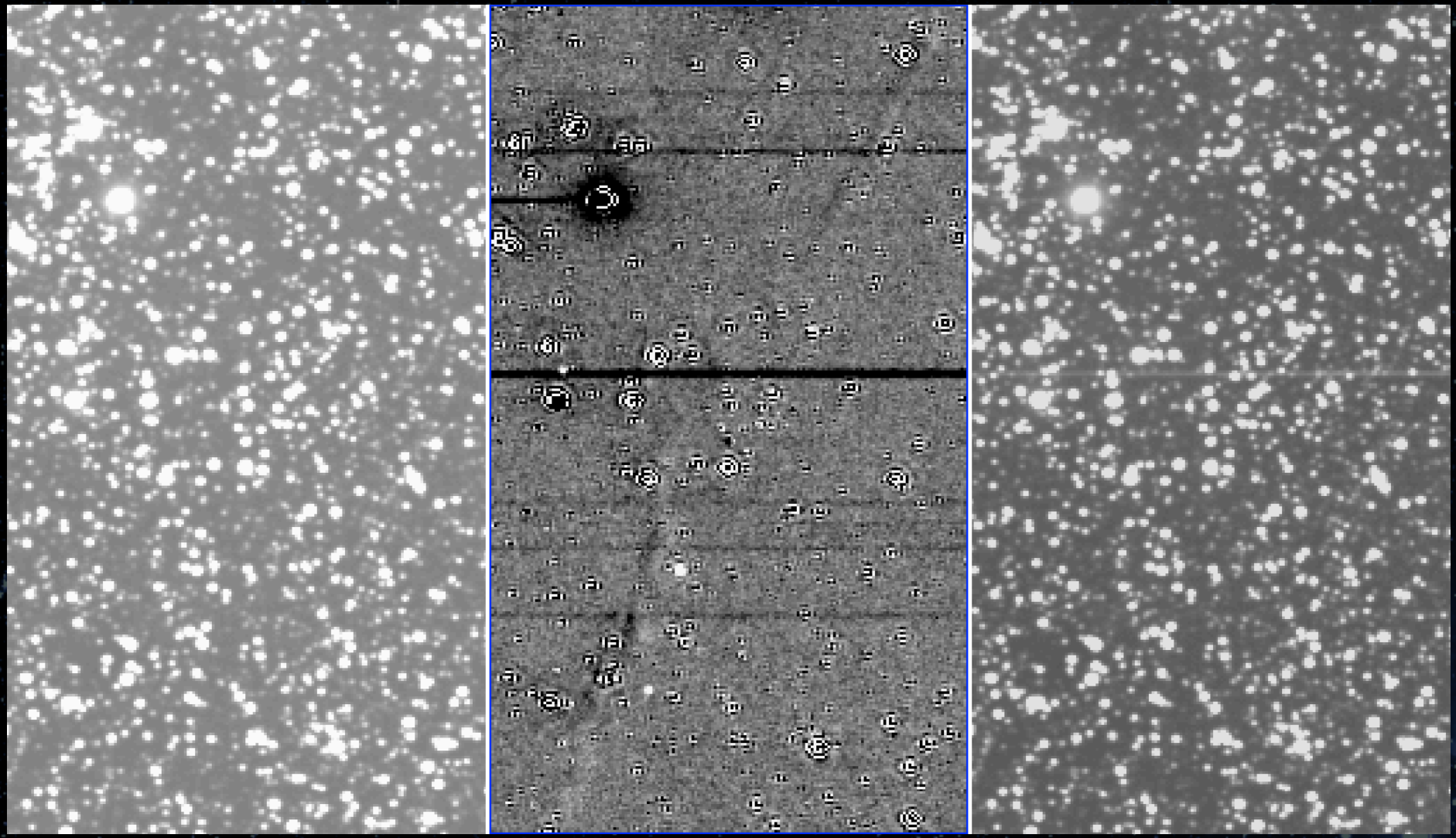
ASAS-SN: SN 1987A light echoes



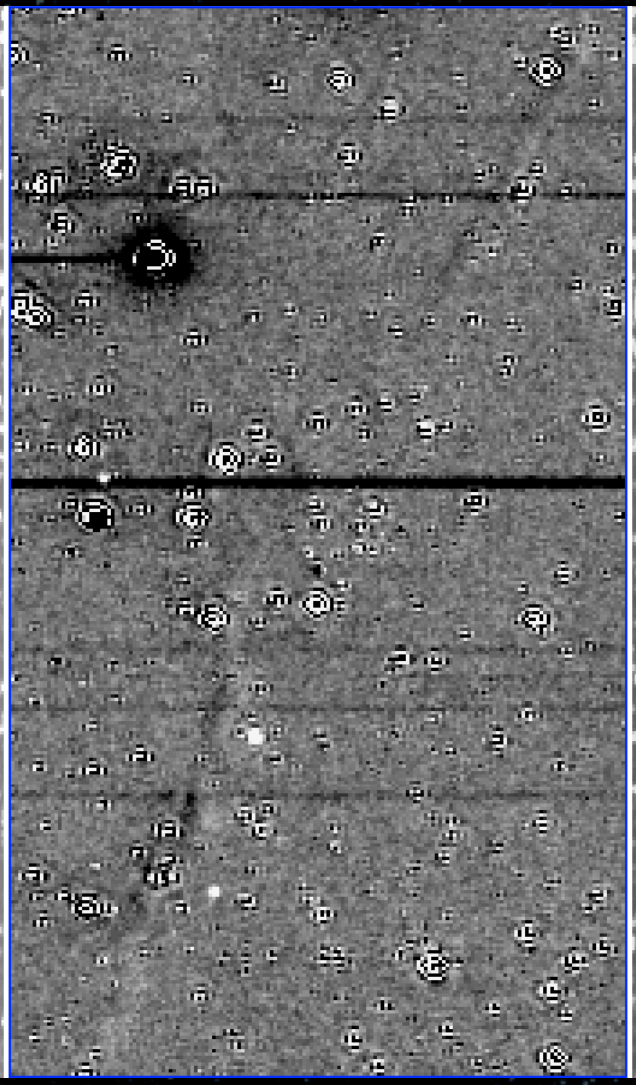
ASAS-SN: Tycho light echoes



ASAS-SN: Cas A light echoes



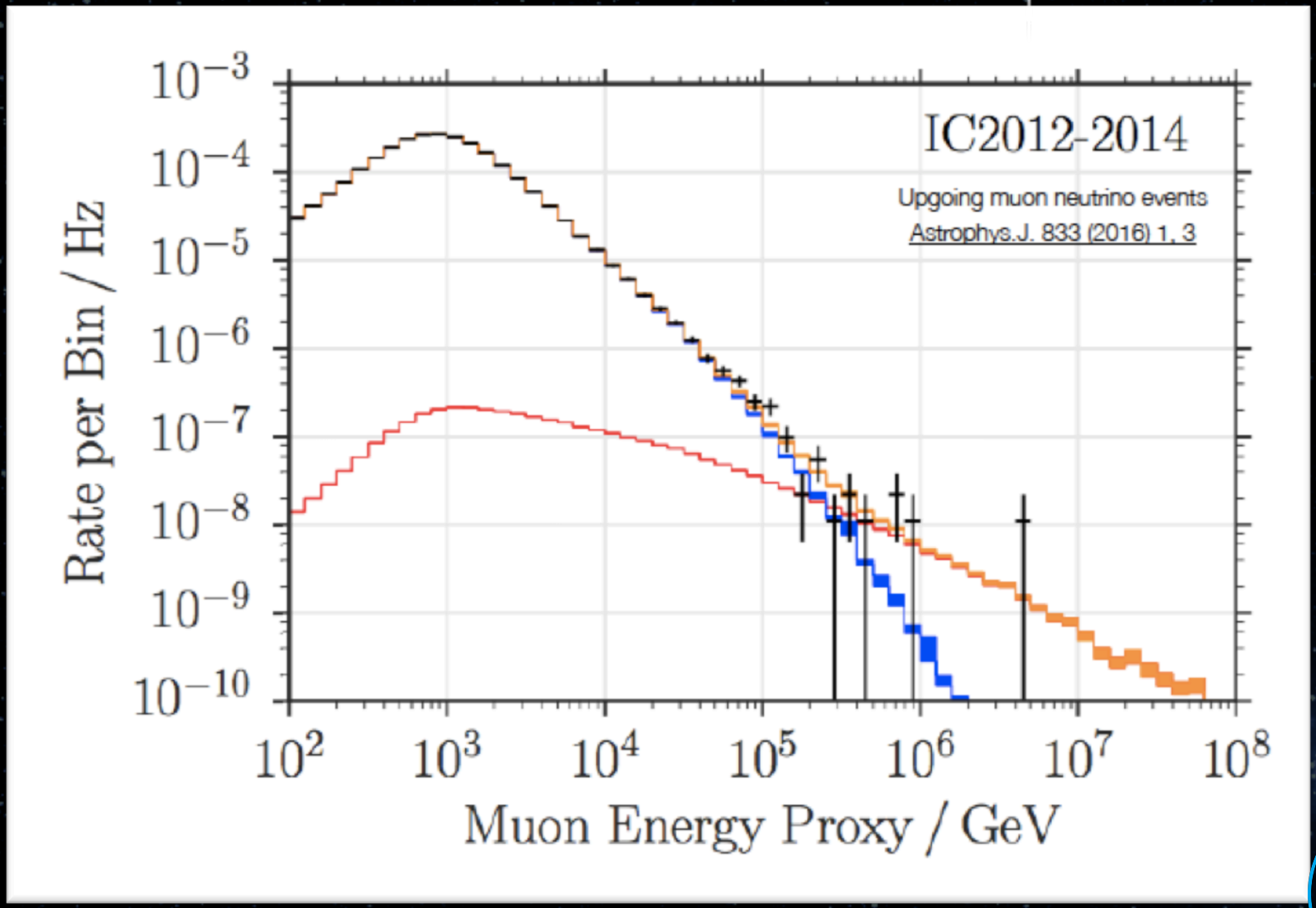
ASAS-SN: Cas A light echoes



Michael Tucker


IceCube
SOUTH POLE NEUTRINO OBSERVATORY
+
ASAS SN
DESY

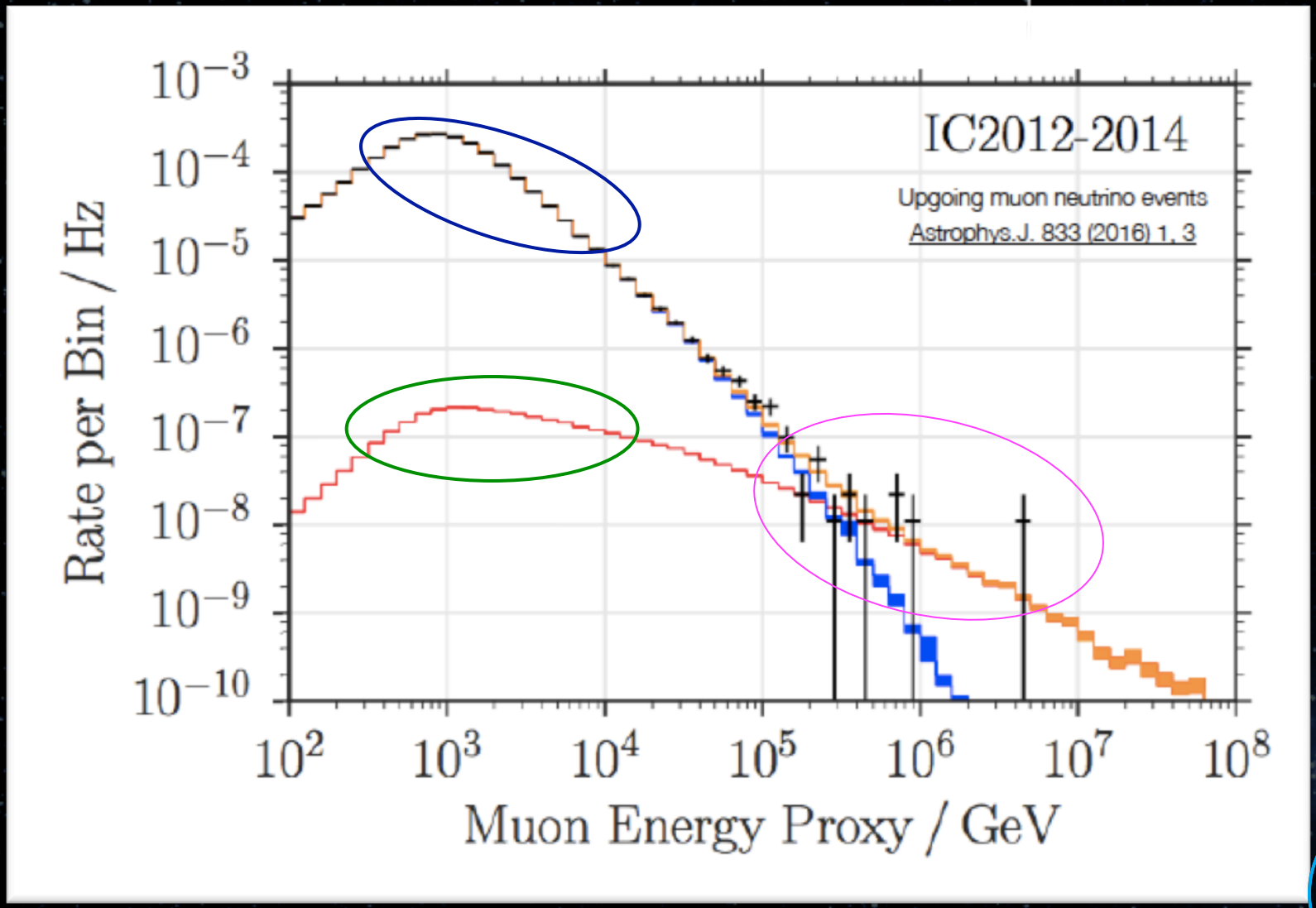
IceCube + ASAS-SN



Slides courtesy of Anna Franckowiak and Robert Stein

DESY

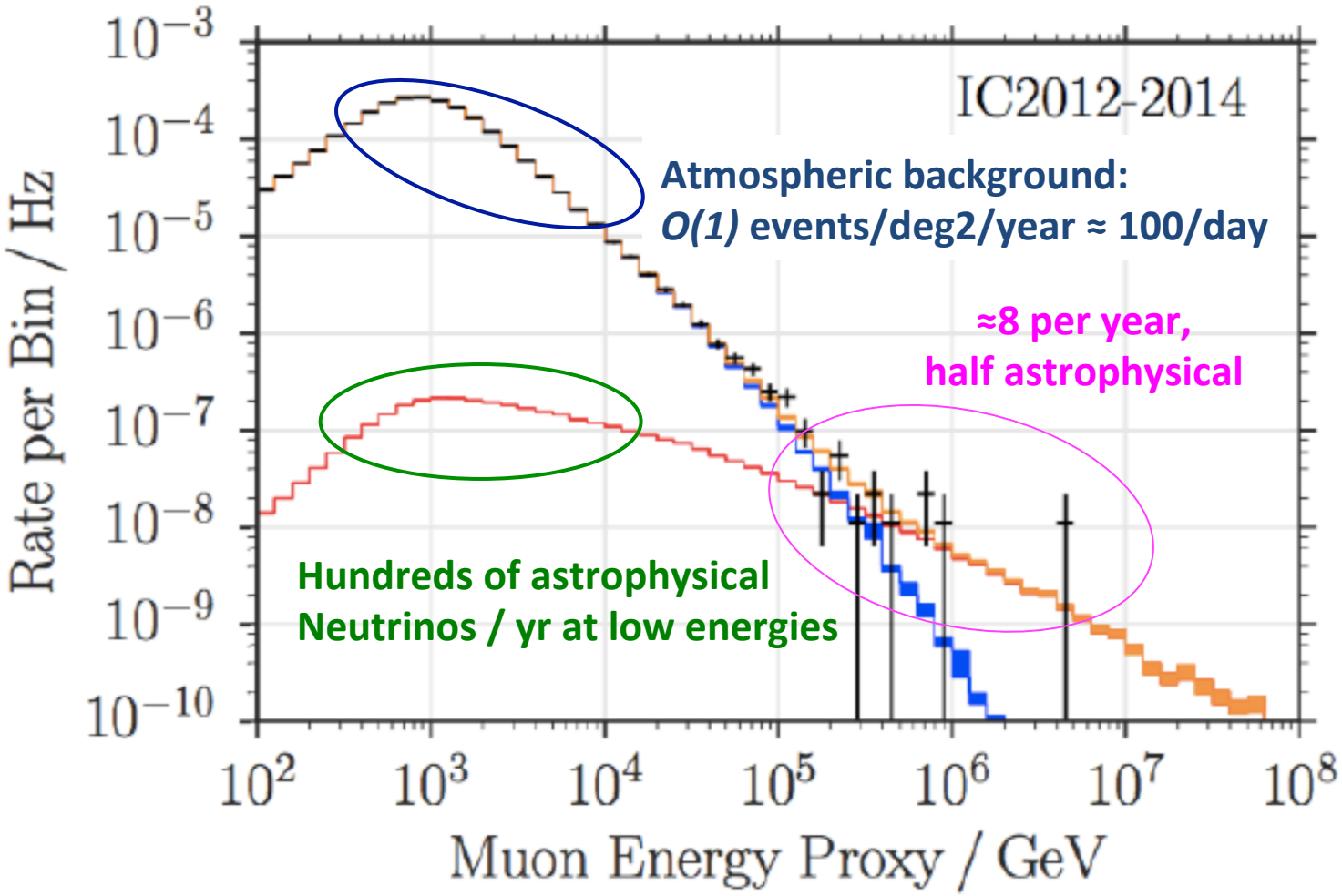
IceCube + ASAS-SN



Slides courtesy of Anna Franckowiak and Robert Stein

DESY

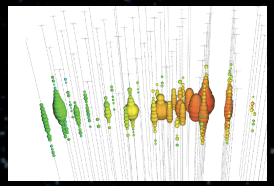
IceCube + ASAS-SN



Slides courtesy of Anna Franckowiak and Robert Stein

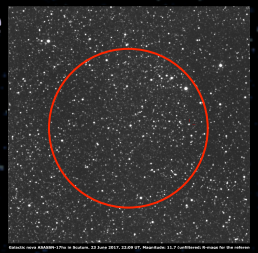
DESY

Two Approaches To Correlate Neutrinos

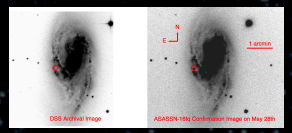


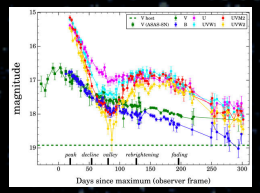
neutrino arrives

ASAS-SN observes neutrino error circle

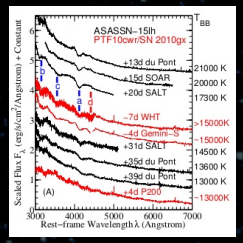


discovery of transient



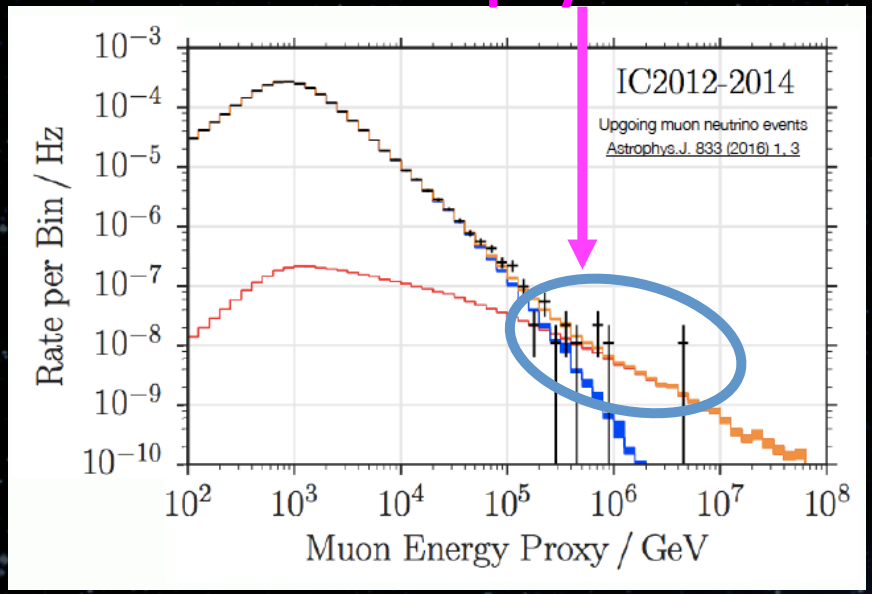


identification of transient



calculate p-value (how significant is detection?)

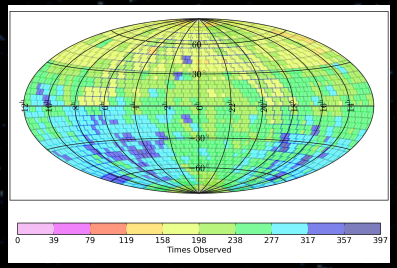
Roughly 8 per year, half astrophysical



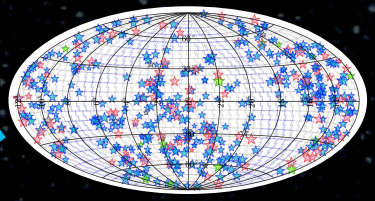
Slide courtesy of Anna Franckowiak and Robert Stein

Two Approaches To Correlate Neutrinos

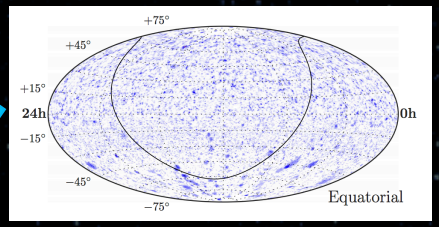
ASAS-SN scans entire sky



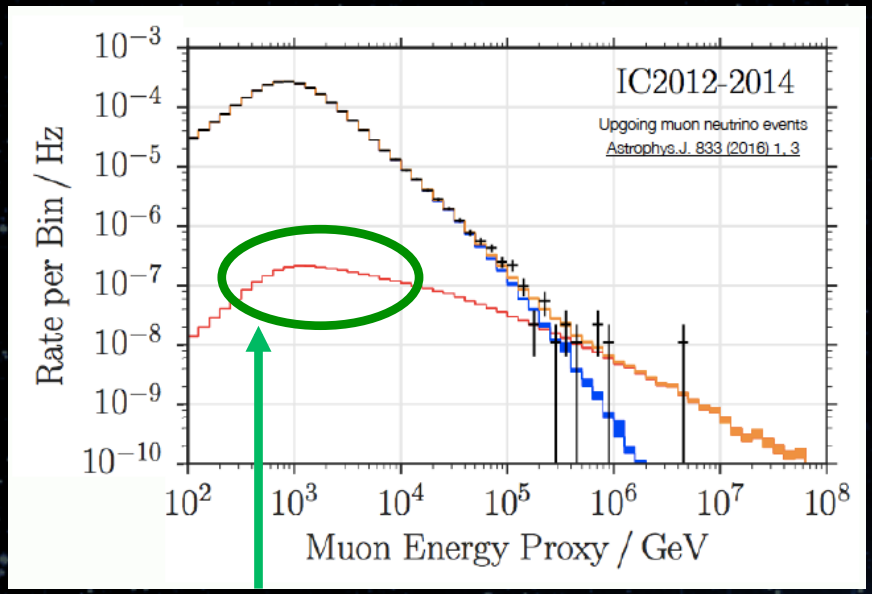
ASAS-SN finds many transients



After ≈1year: Cross-correlate with neutrinos search for statistically significant excess



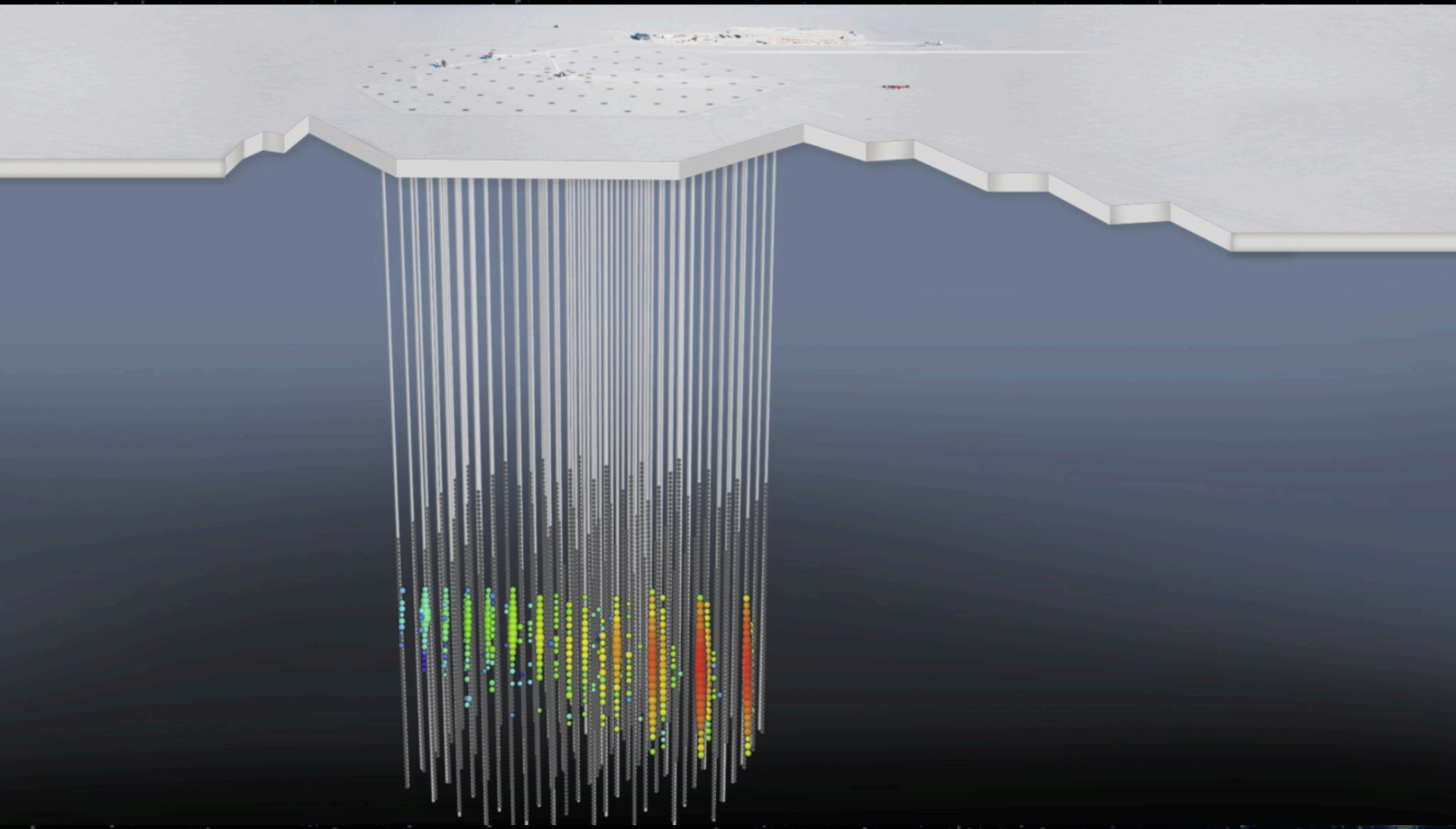
IceCube detects ≈100 neutrinos per day



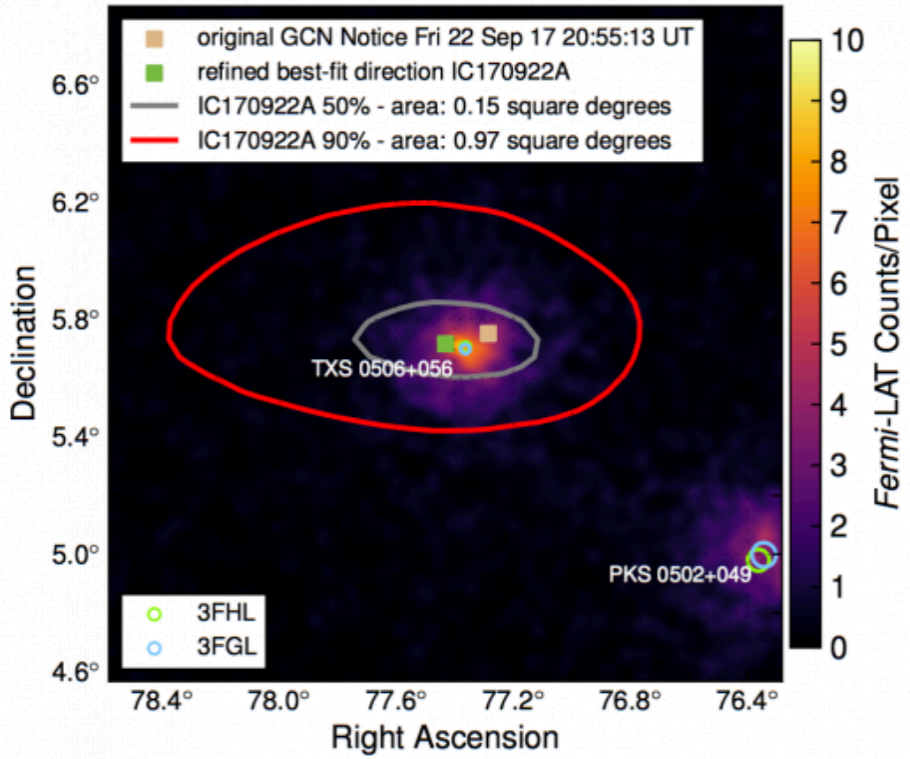
Hundreds of astrophysical Neutrinos per year at low energies

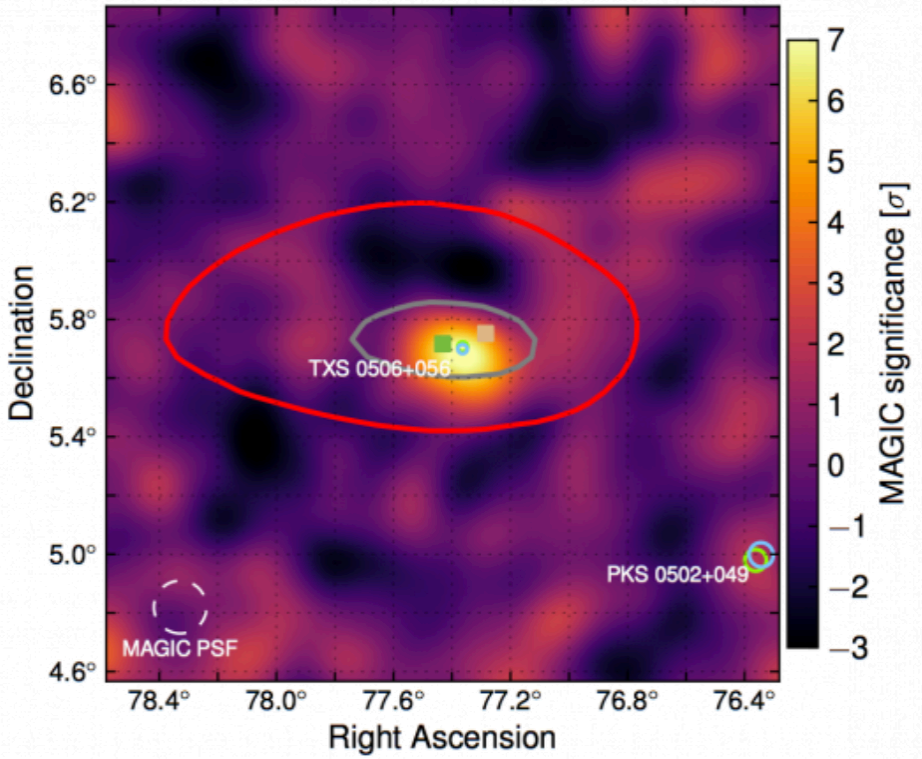
Slide courtesy of Anna Franckowiak and Robert Stein

IceCube-170922A



IceCube-170922A





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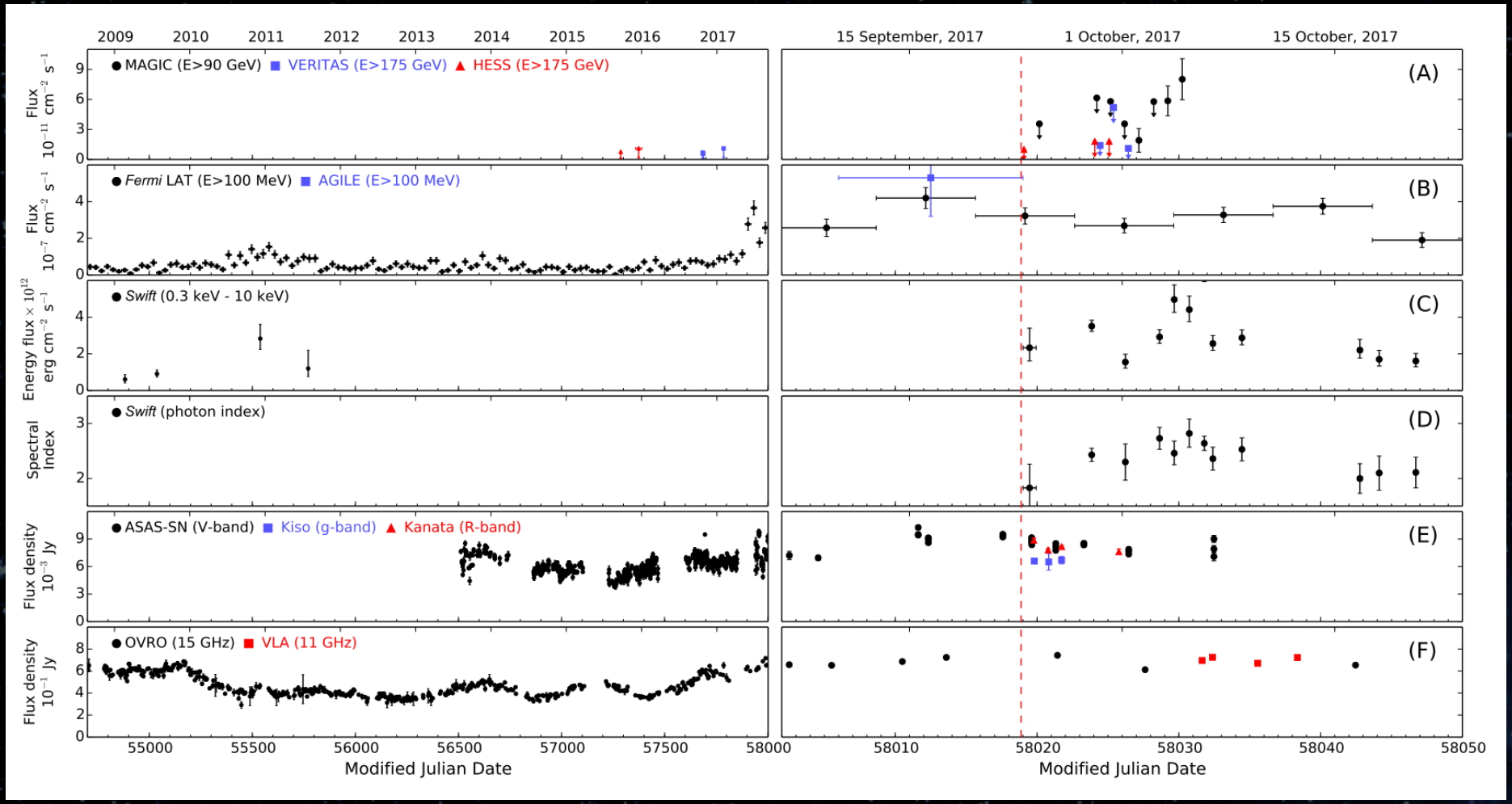
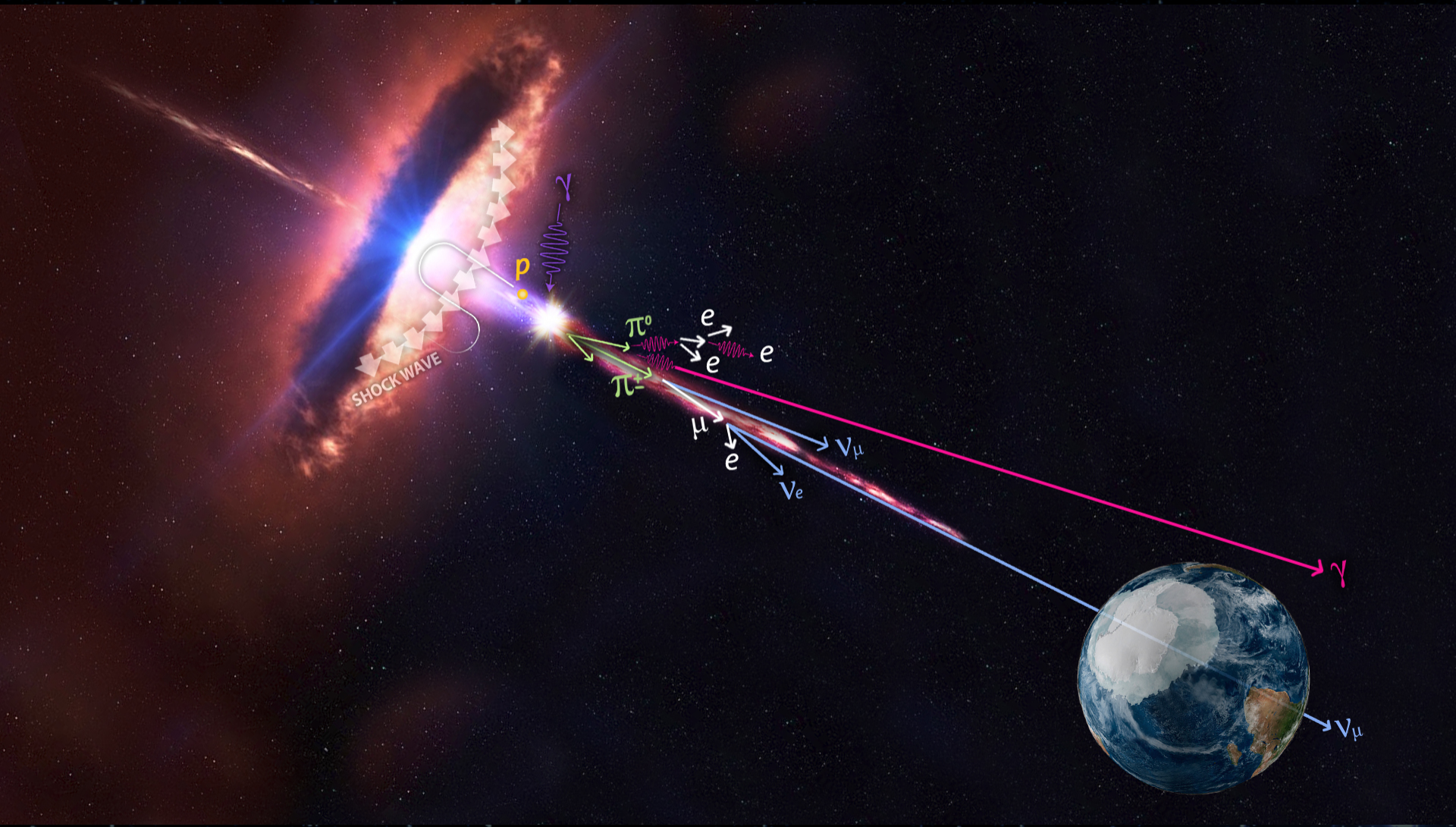
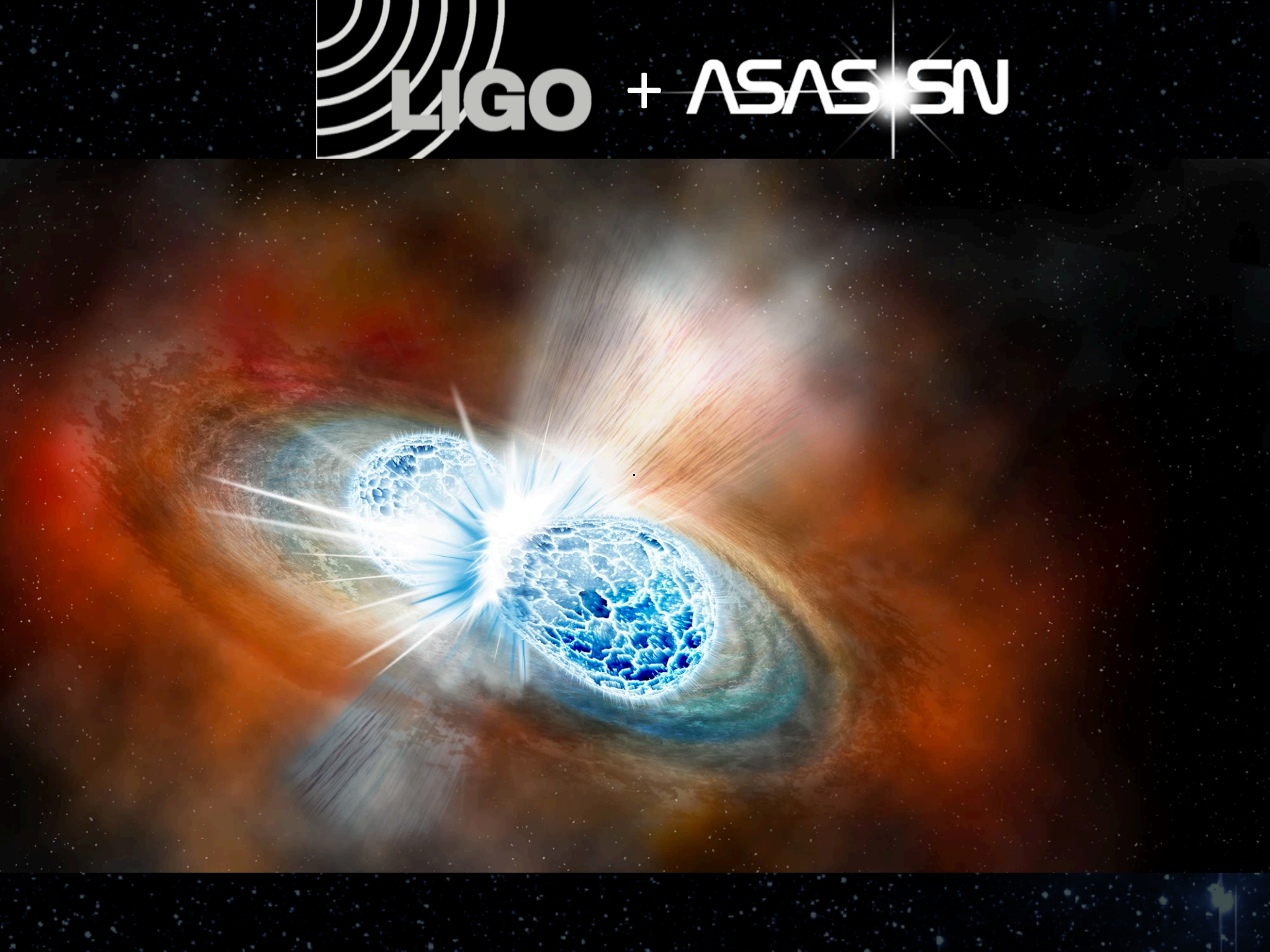
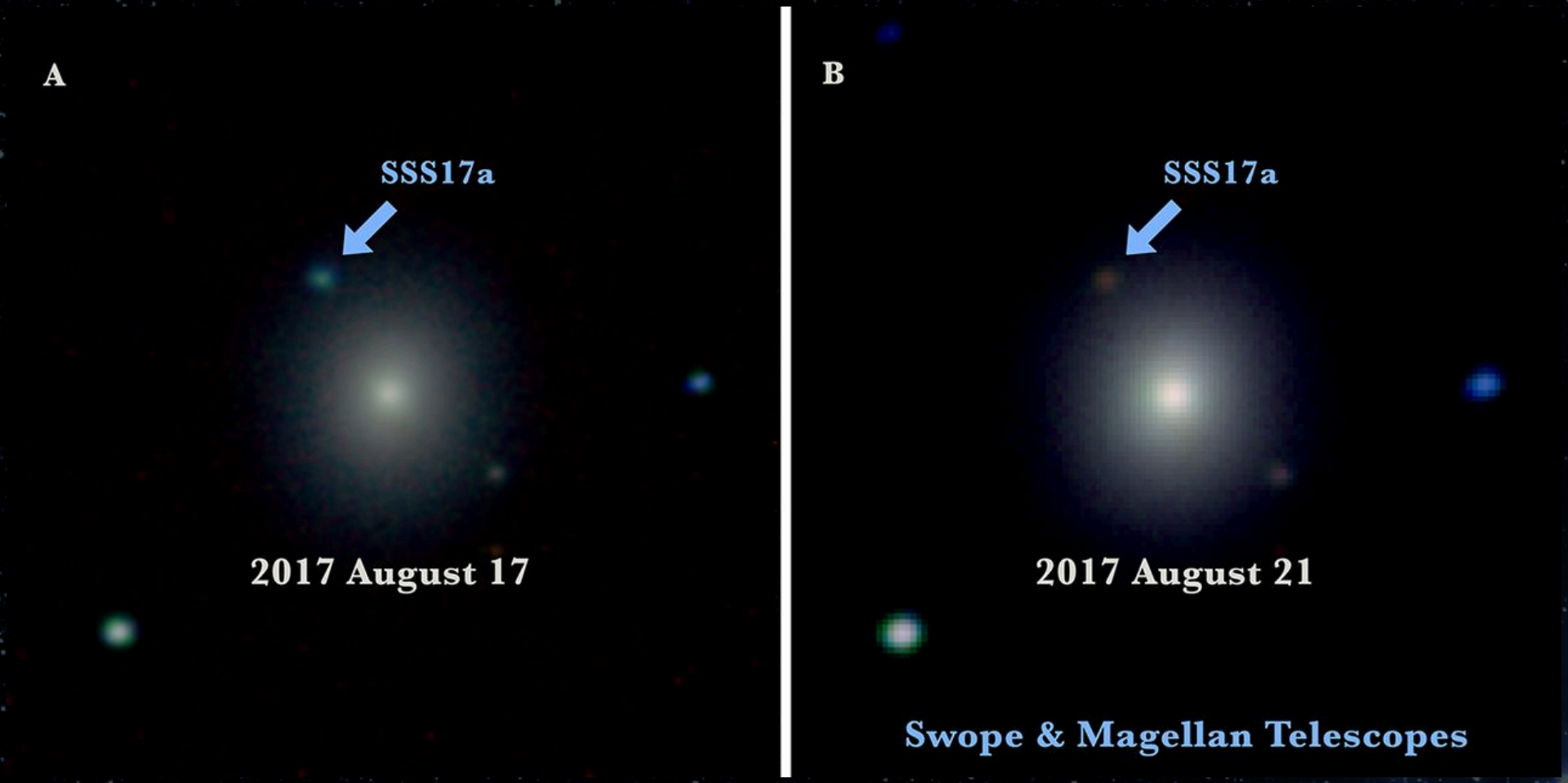


IceCube-170922A




LIGO
+ ASAS SN

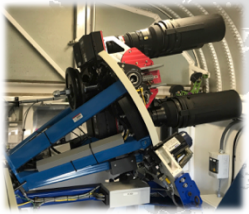
Evolution of SSS17a

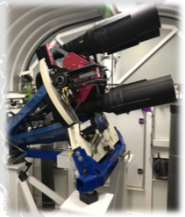


Drout, Piro, Shappee, et al. 2017

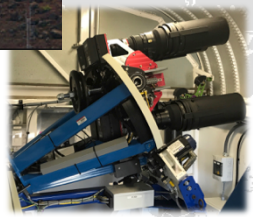
LIGO + ASAS SN

Late-2018

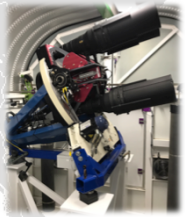




LIGO + ASAS SN



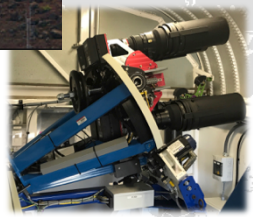
Late-2018

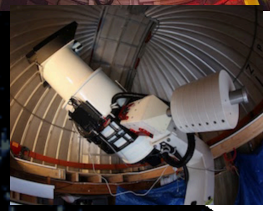


+ PanSTARRS

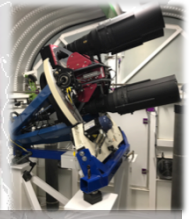
INSTITUTE FOR ASTRONOMY
UNIVERSITY OF HAWAI'I

LIGO + ASAS SN



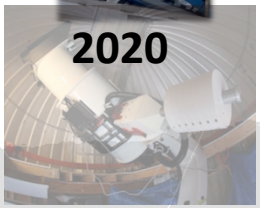


Late-2018



Late-2019

2020



+ ATLAS + PanSTARRS

INSTITUTE FOR ASTRONOMY
UNIVERSITY OF HAWAI'I

ASAS-SN

- ASAS-SN currently dominates bright transient discovery.
- First unbiased SN sample, rates, and census.
- Many recent science highlights: early-time LCs for SNe Ia, stellar flares, brightest TDEs, singular events like ASASSN-15lh, many more
- New science directions enabled by current system + upcoming massive expansion: LSB, echoes, **IceCube**!
- Challenges and opportunities for the future: public database, new individual objects, follow up…
- Discovery space is open, large, and promising!