

S. Bradley Cenko - NASA GSFC and Univ. Maryland

Swift and the Discovery Channel Telescope (DCT)



What is GROWTH?



GROWTH = People + Facilities + Science + Education

GROWTH = People



Tiara Hung (UMd)



Suvi Gezari (UMd)



Stuart Vogel (UMd)



Leo Singer (GSFC)



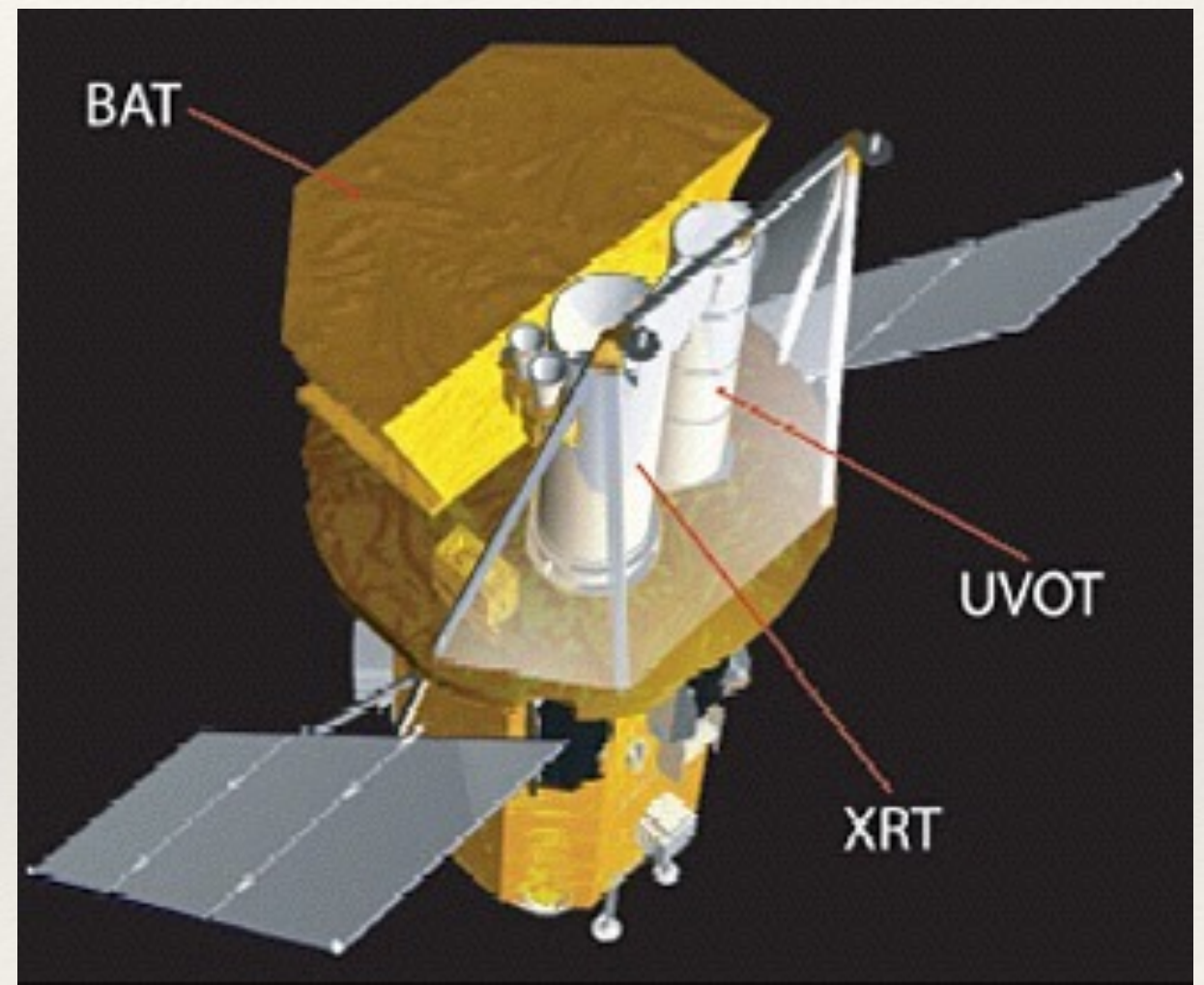
Melissa Hayes-Gehrke (UMd)



Neil Gehrels (GSFC)

GROWTH = Facilities: *Swift*

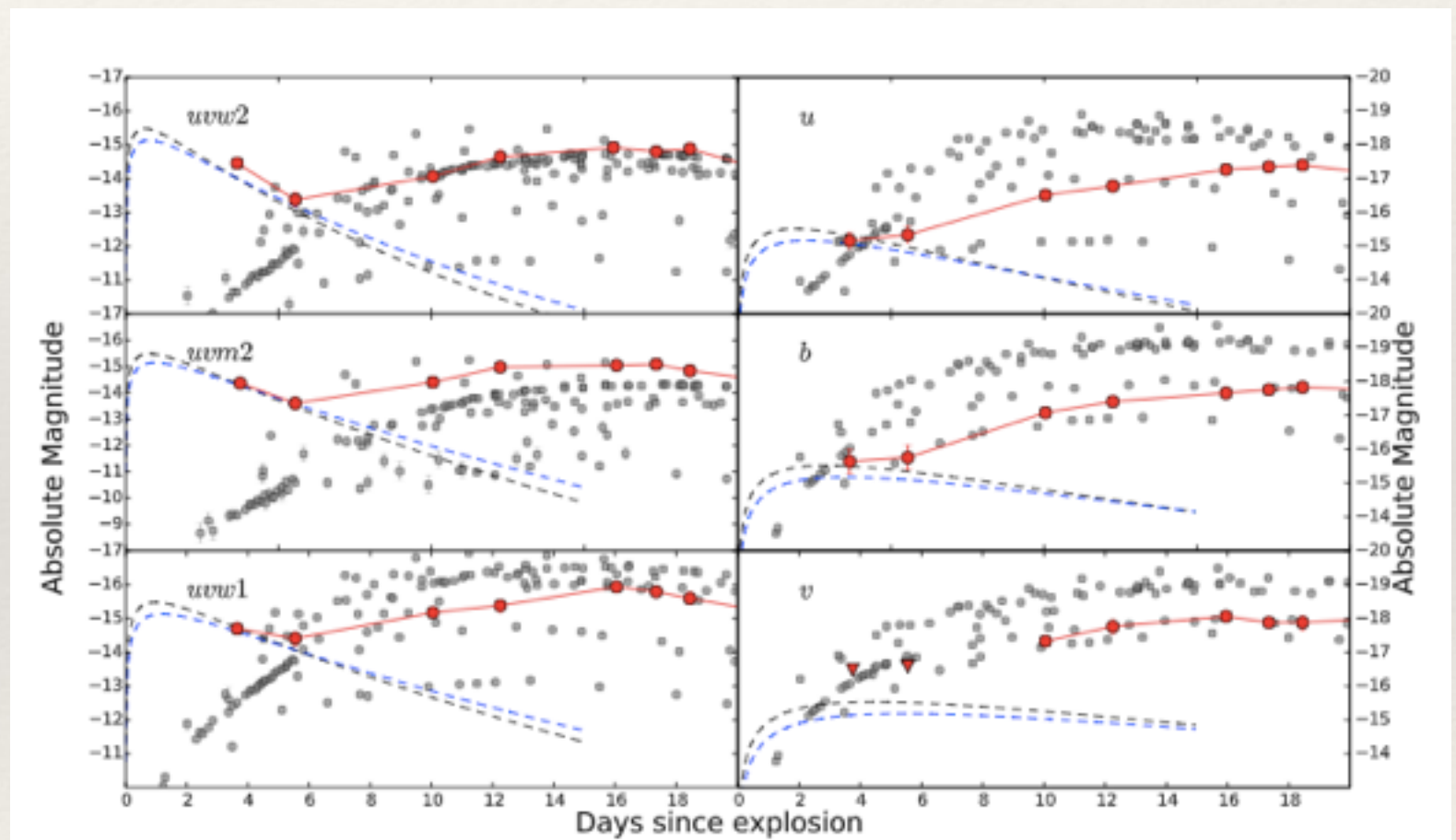
- ❖ Burst Alert Telescope (BAT):
15-350 keV, 1.4 sr field-of-view,
~ 3' resolution
- ❖ X-ray Telescope (XRT): 0.2-10
keV, 24' x 24' field-of-view, ~ 3''
resolution
- ❖ UV-Optical Telescope (UVOT):
170-650 nm, 17' x 17' field-of-
view, ~ 0.5'' resolution



GROWTH = Facilities: *Swift*

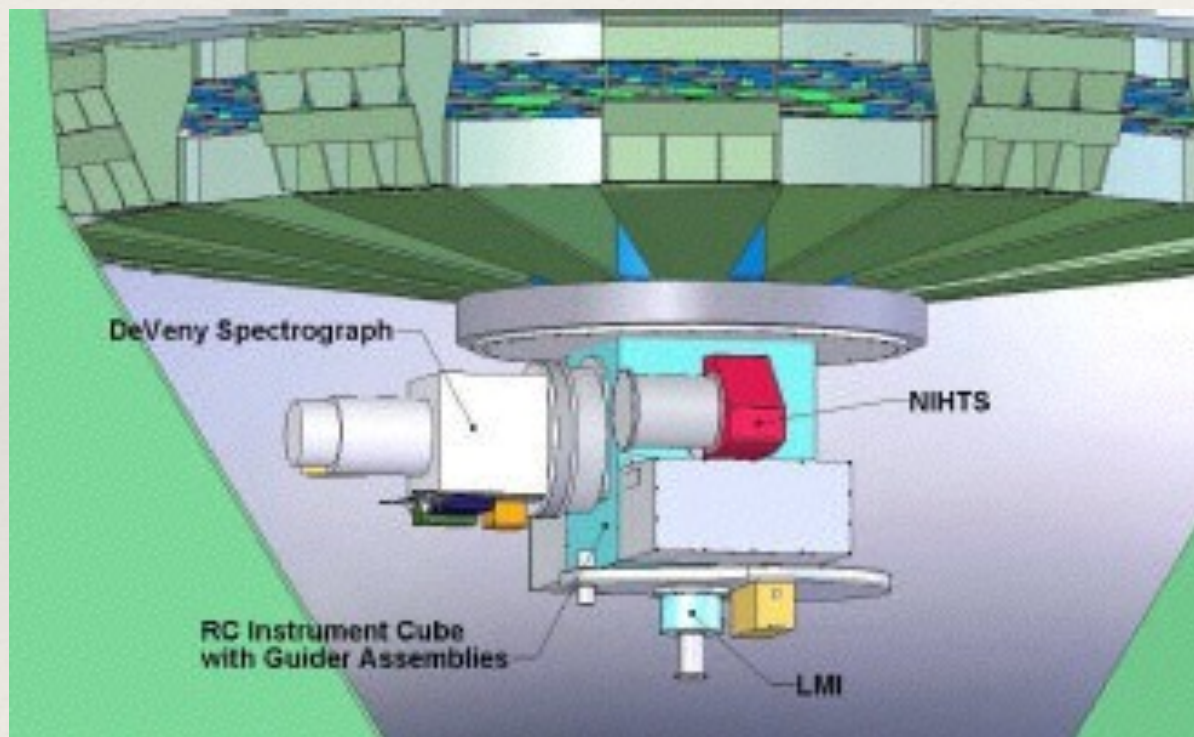
- ❖ Fast slewing, dynamically scheduled spacecraft makes *Swift* the go-to facility for time-domain science in the X-ray and UV
- ❖ GROWTH partner facilities follow-up *Swift* high-energy discoveries (e.g., gamma-ray bursts)
- ❖ *Swift* XRT and UV can rapidly (hours) follow-up GROWTH discoveries

A UV Pulse from a Young Type Ia Supernova



Cao et al. 2015

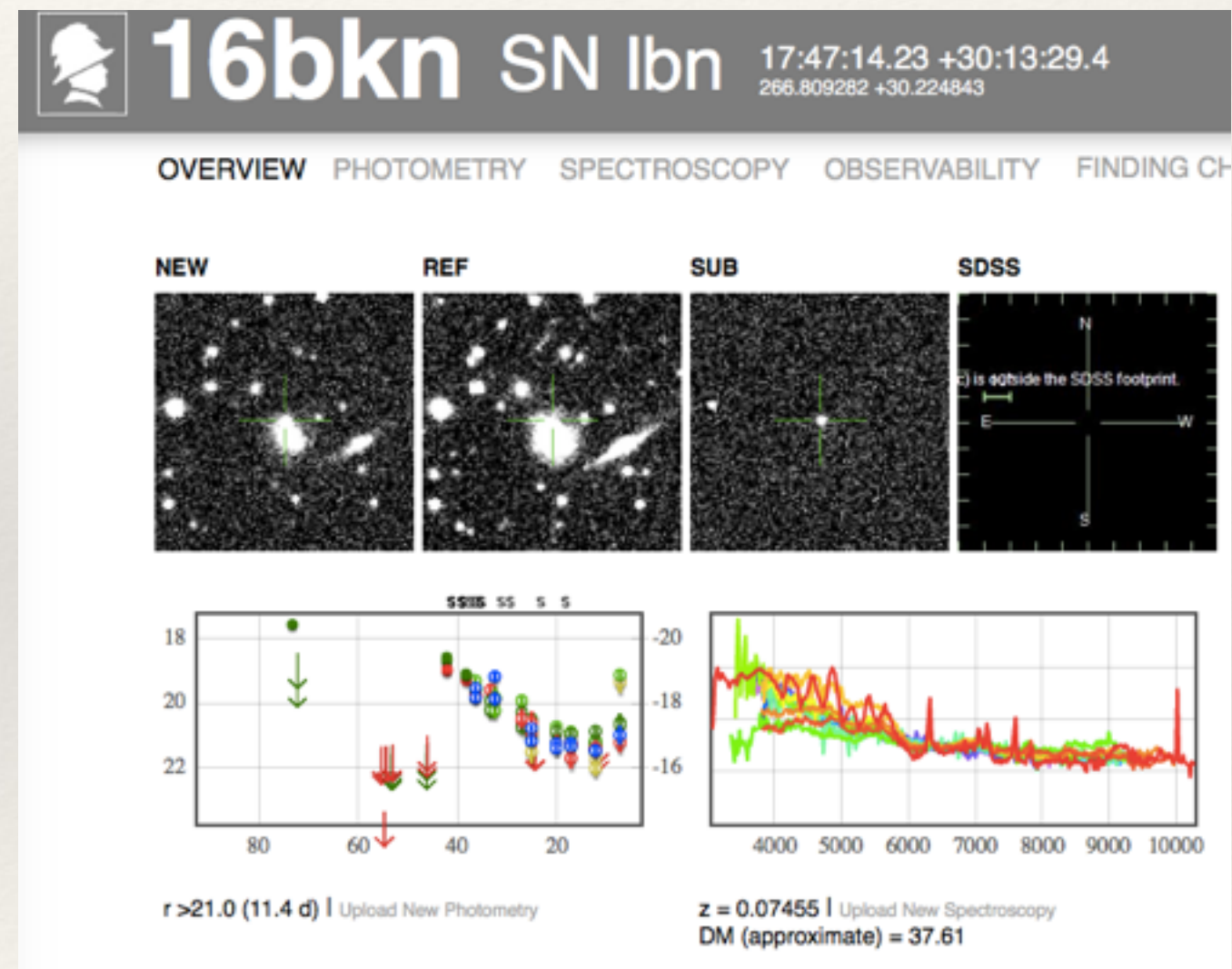
GROWTH = Facilities: DCT



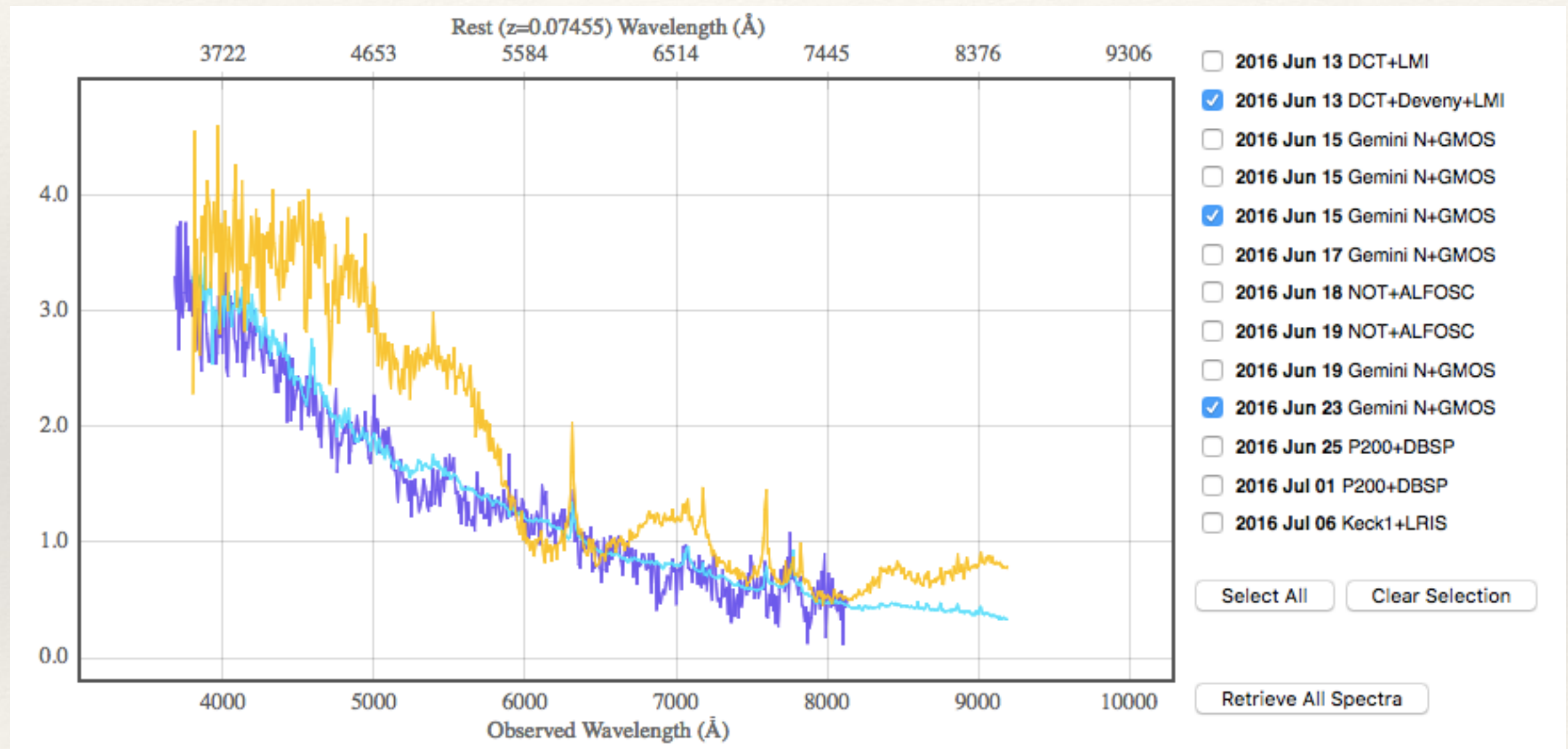
- ❖ 4.3m primary located in Happy Jack, AZ (248.5778, 34.7444, 2360)
- ❖ “Instrument cube” allows rapid switching between instruments
- ❖ Optical imager, low-resolution optical spectrograph, moderate resolution NIR spectrograph (end of year)

GROWTH = Facilities: DCT

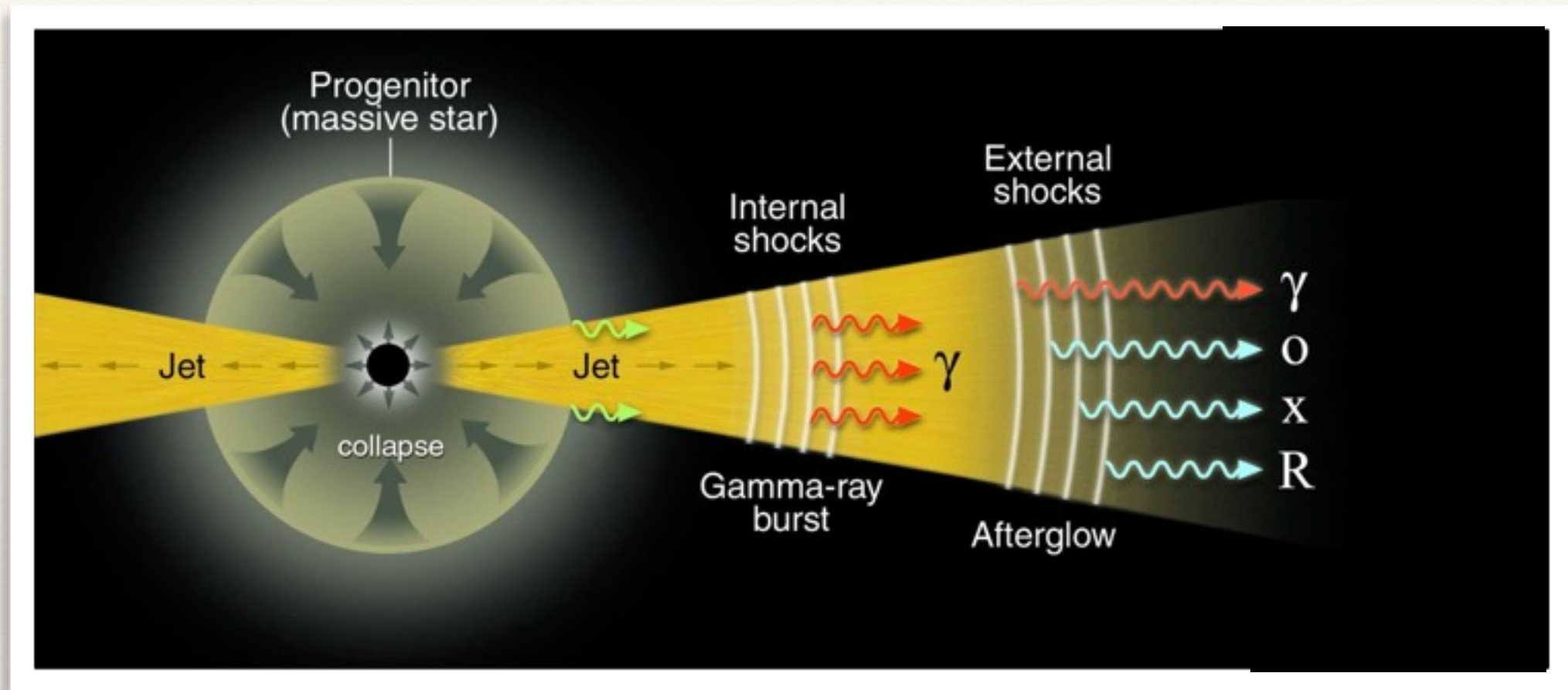
- ❖ Target-of-Opportunity program enables (manual) interrupts on ~ 10 minute time scale
- ❖ Same-night spectroscopy of young supernovae, EM/GW counterparts, ...
- ❖ Semi-automated pipelines for optical photometry and spectroscopy



GROWTH = Facilities: DCT

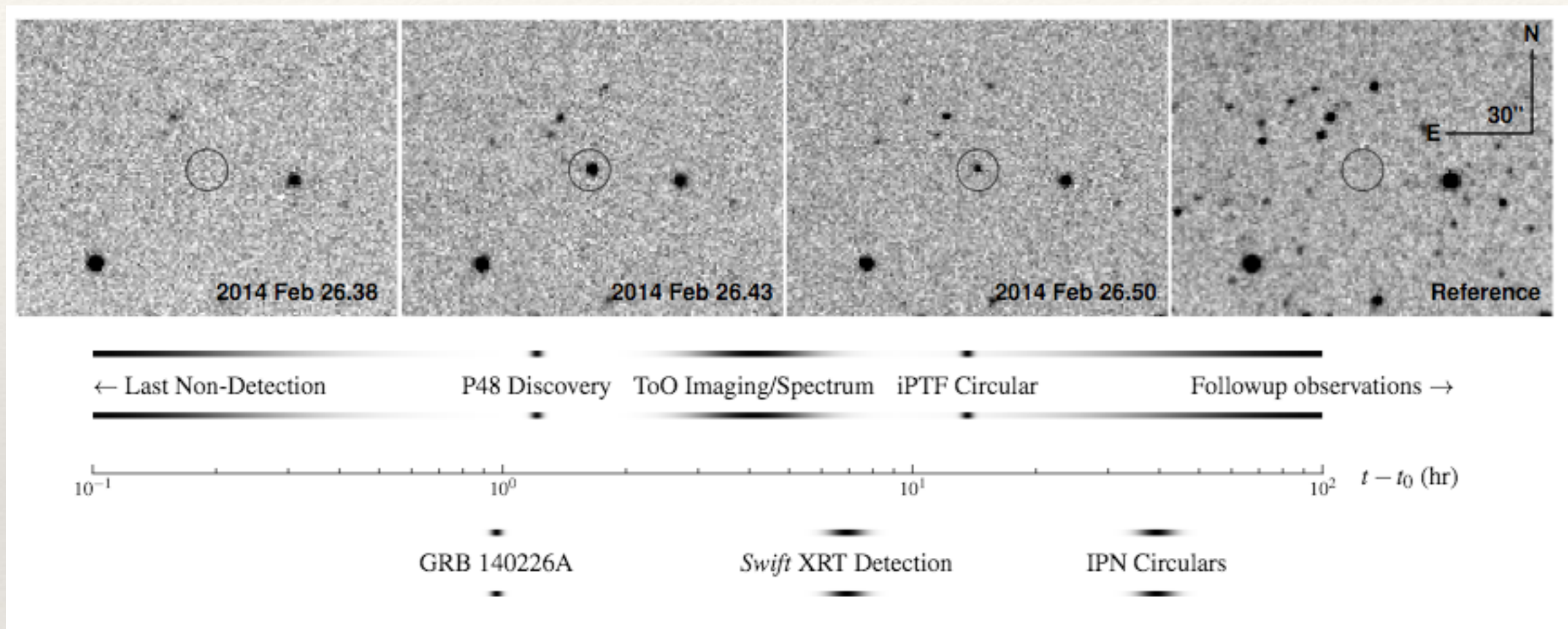


GROWTH = Science: Relativistic Explosions



Gamma-ray bursts: ultra-relativistic, highly collimated explosions. But what happens if viewed off-axis (“orphan” afterglow), or if outbursts lack high-energy emission altogether (“dirty fireballs”)?

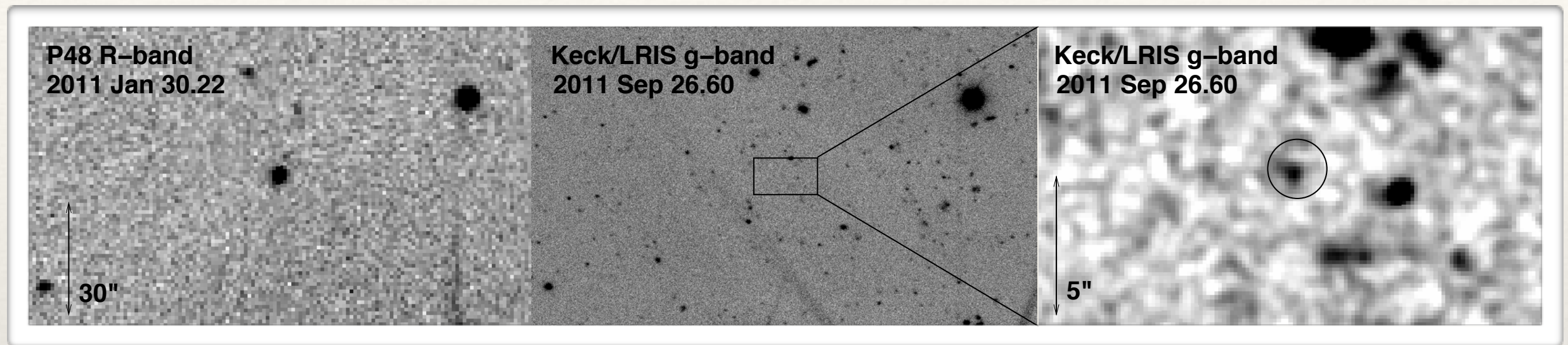
GROWTH = Science: Relativistic Explosions



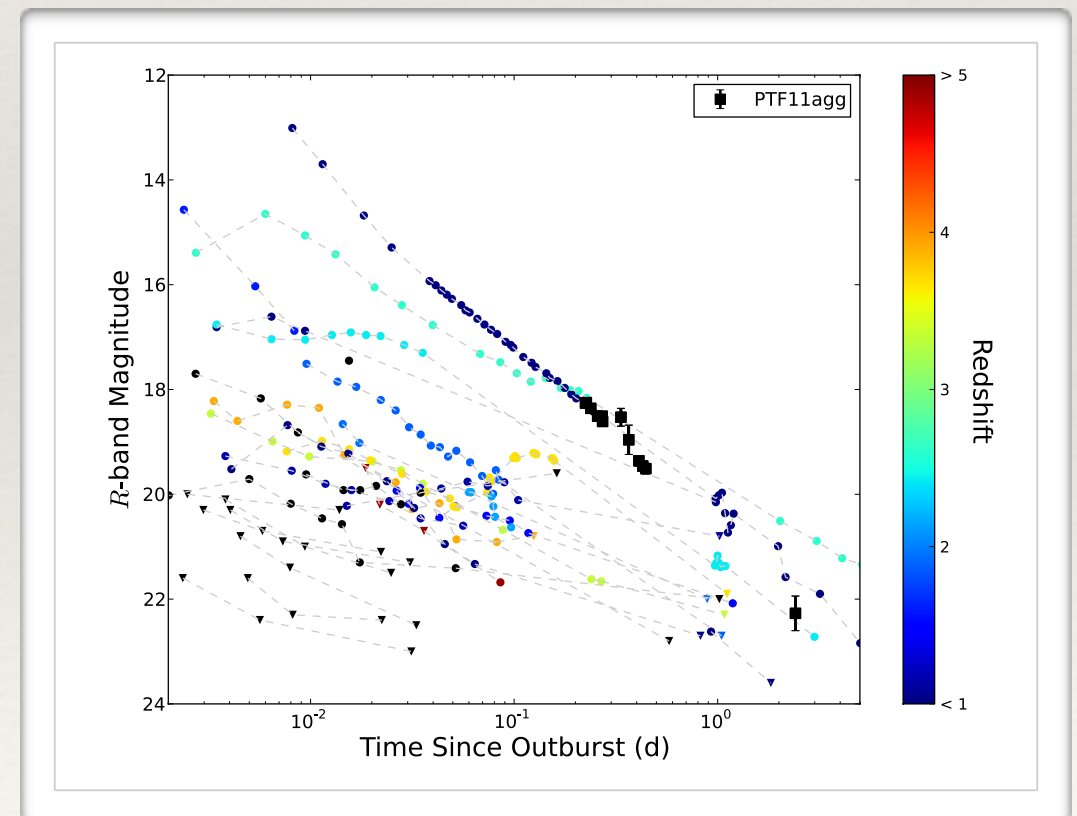
Cenko *et al.* 2015

iPTF14yb: “Untriggered” GRB — First gamma-ray burst detected by
afterglow emission (and not prompt gamma-rays)

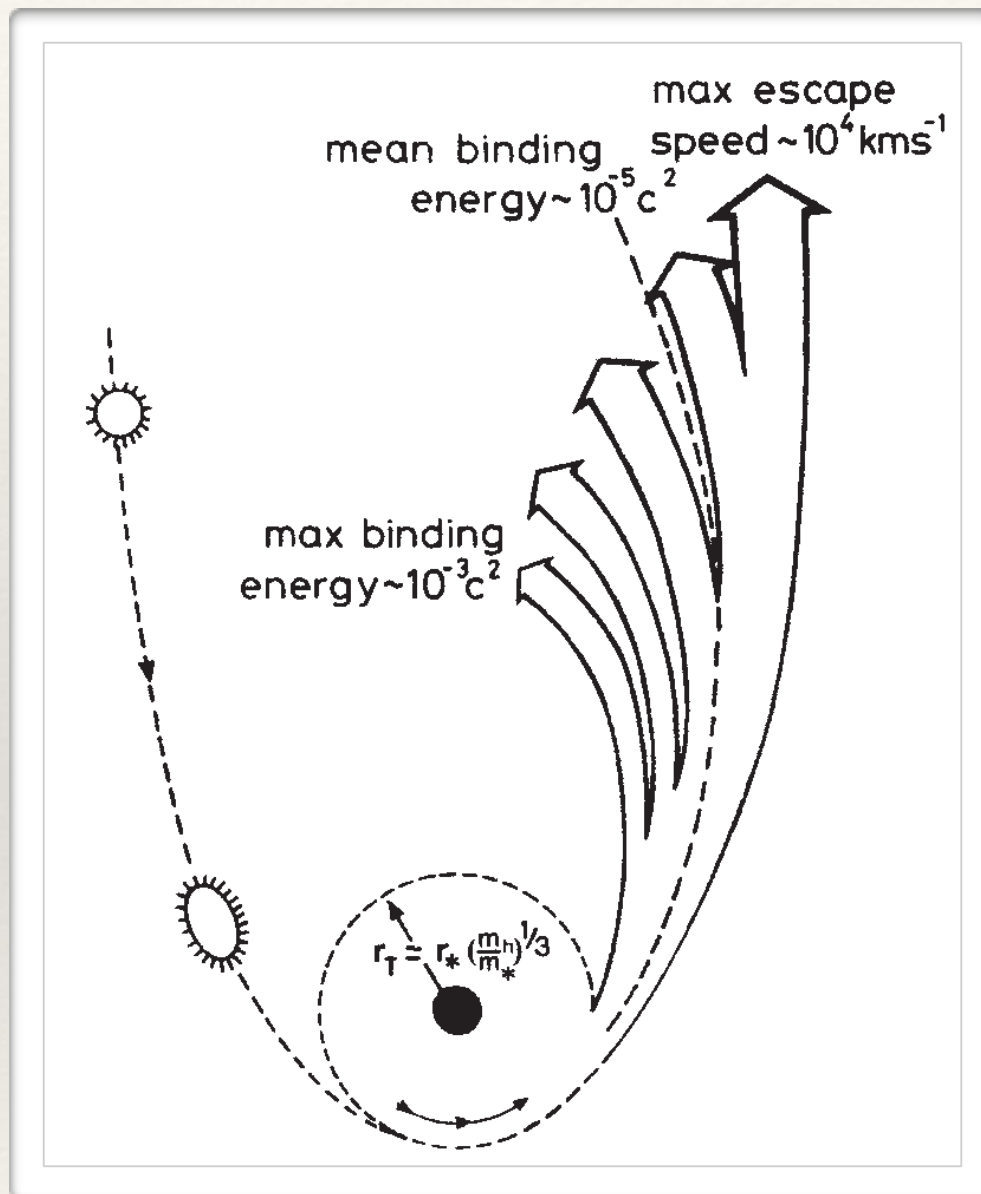
GROWTH = Science: Relativistic Explosions



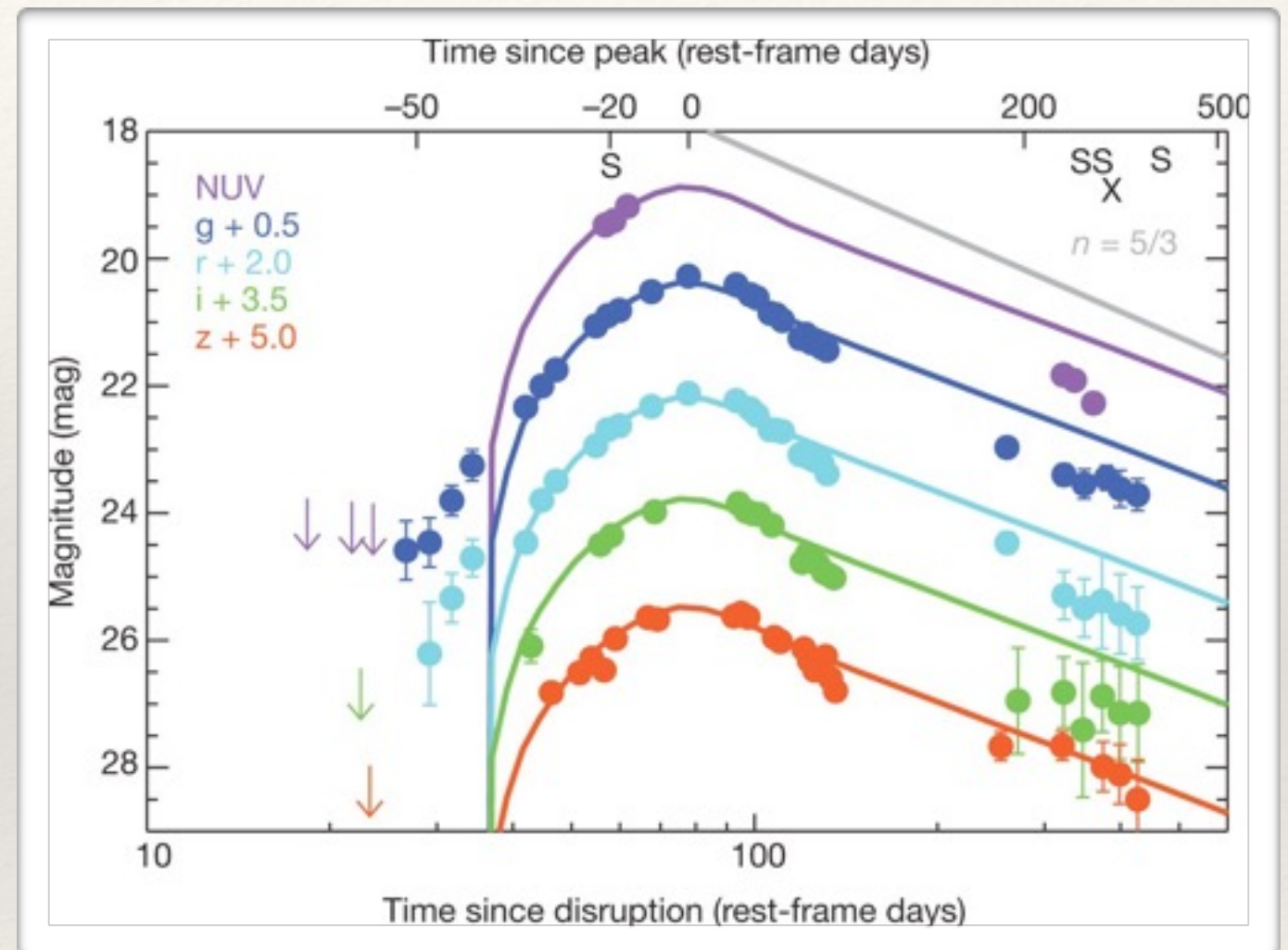
PTF11agg: Relativistic outburst lacking any detected high-energy counterpart. Could be first “dirty” fireball, or could have just been missed by high-energy monitors. ZTF will detect many more of these outburst (> 5 per year!)



GROWTH = Science: Tidal Disruption Events

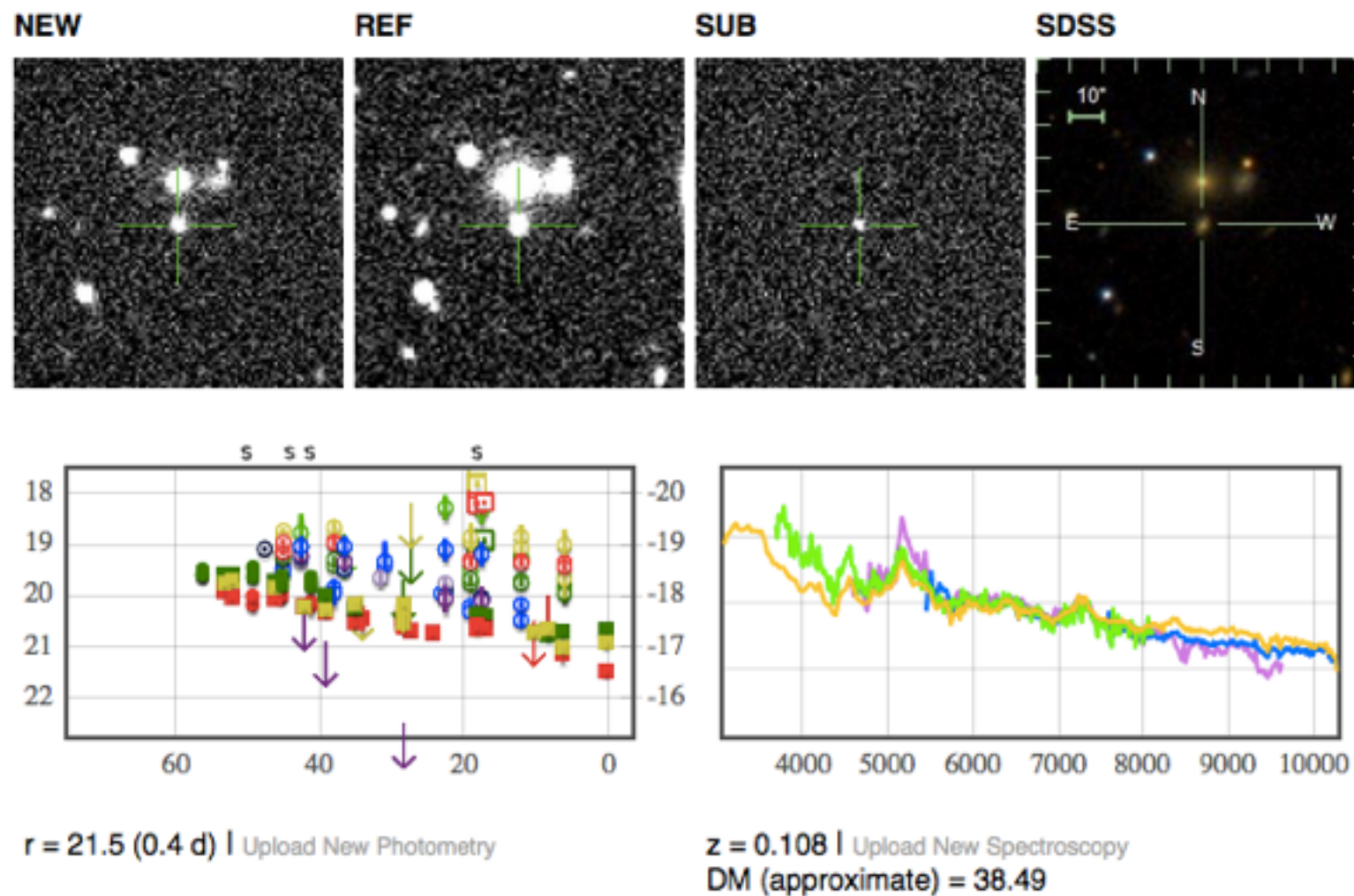


Rees *et al.* 2013



Gezari *et al.* 2012

GROWTH = Science: Tidal Disruption Events



COMMENTS

2016 Jun 14 assaf_h [info]: VLA observation on June 12 resulted in null detection. Limits are: 13 micro Jy rms at 6.1 GHz and 15 micro Jy rms at 22 GHz.

2016 Jun 08 suvi [info]: Brad noted in telecon that there is a bright galaxy 13.6 arcsec N of host galaxy at exact same redshift. Might be a member of a galaxy group.

2016 Jun 08 suvi [info]: Assuming the host galaxy is bulge dominated, M_R corresponds to $M_{BH} \sim 10^6 M_{\odot}$ (Tundo et al. 2007)

2016 Jun 08 tiara [info]: Month-long Swift follow up triggered in all 6 uvot bands.

2016 Jun 08 assaf_h [info]: VLA triggered

2016 Jun 07 tiara [info]: Swift detected UV emission!

2016 Jun 06 suvi [redshift]: 0.108

2016 Jun 06 suvi [classification]: TDE

2016 Jun 06 suvi [comment]: Redshift determined from absorption features in spectrum.

2016 Jun 05 iair [comment]: Possible broad He II and Halpha at $z \sim 0.1$, on top of a blue continuum and narrow host absorption lines. Good TDE candidate.

2016 Jun 01 tiara [info]: Swift triggered

2016 May 29 ilan [info]: Relatively bright. At the center of a galaxy. Probably nuclear. No prior limits.

2016 May 29 treasurer [nndist]: 0.25 arcsec. Nuclear event!

2016 May 29 ilan [type]: Transient

2016 May 29 joeljo [type]: Transient

Swift Key Project + DCT/Keck spectroscopy \Rightarrow First GROWTH TDE (iPTF16axa)

GROWTH = Education

- ❖ “Hands-On” undergraduate course with iPTF data (variable star light curves?) — Hayes-Gehrke
- ❖ GRAD-MAP: building ties between UMD and minority-serving institutions (MSIs) via summer internships, winter programs
- ❖ Undergraduates participate in GROWTH internships

Undergrads Discover Rare Eclipsing Double Asteroid

JANUARY 7, 2014 SHARE  EMAIL  PRINT  Recommend 1  Tweet

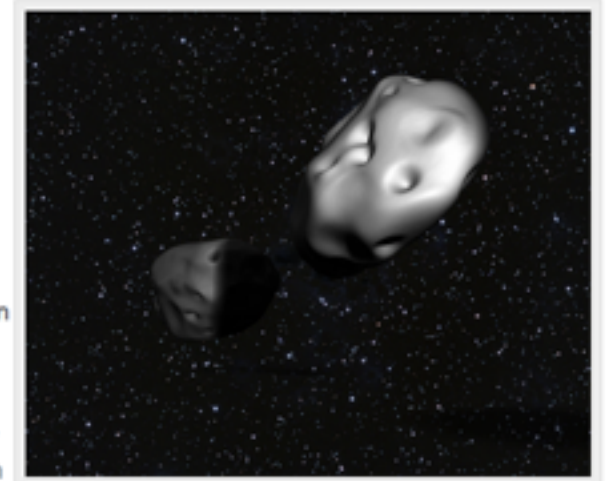
Contacts: **Heather Dewar** 301-405-9267
Lee Tune 301-405-4679

COLLEGE PARK, Md. — Students in a University of Maryland undergraduate **astronomy** class have made a rare discovery that wowed professional astronomers: a previously unstudied asteroid is actually a pair of asteroids that orbit and regularly eclipse one another.

Fewer than 100 asteroids of this type have been identified in the main asteroid belt between Mars and Jupiter, said **Melissa Hayes-Gehrke**, who teaches the hands-on class for non-astronomy majors in which eight students made the find in the fall semester 2013.

The students' discovery that 3905 Doppler is an eclipsing binary asteroid will be presented in a poster session Jan. 7 at the meeting of the American Astronomical Society in National Harbor, Md., and published in April in the Minor Planet Bulletin.

"This is a fantastic discovery," said UMD Astronomy Professor **Drake Deming**, who was not involved with the class. "A binary asteroid with such an unusual lightcurve is pretty rare. It provides an unprecedented opportunity to learn about the physical properties and



DCT + *Swift* Summary

- ❖ We are excited about the science and education/ outreach opportunities available as part of the GROWTH partnership (particularly the commissioning of ZTF!)
- ❖ If you have questions about *Swift* or the DCT, please don't hesitate to get in touch with me:
 - ❖ brad.cenko@nasa.gov