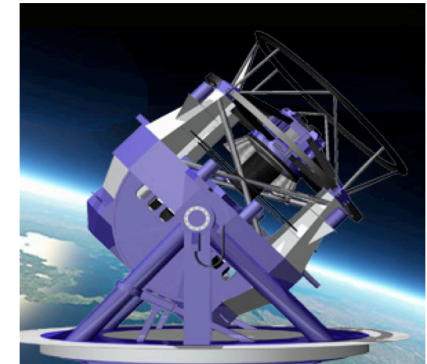
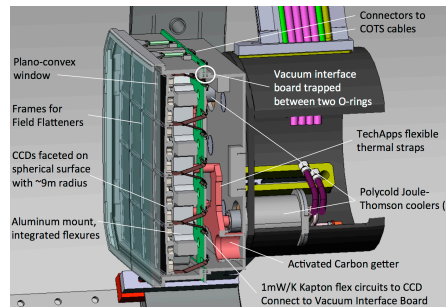
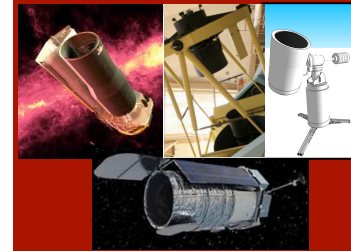




# Time Domain Science with WFIRST-AFTA

Mansi M. Kasliwal  
Carnegie Institution for Science  
(& soon, California Institute of Technology)

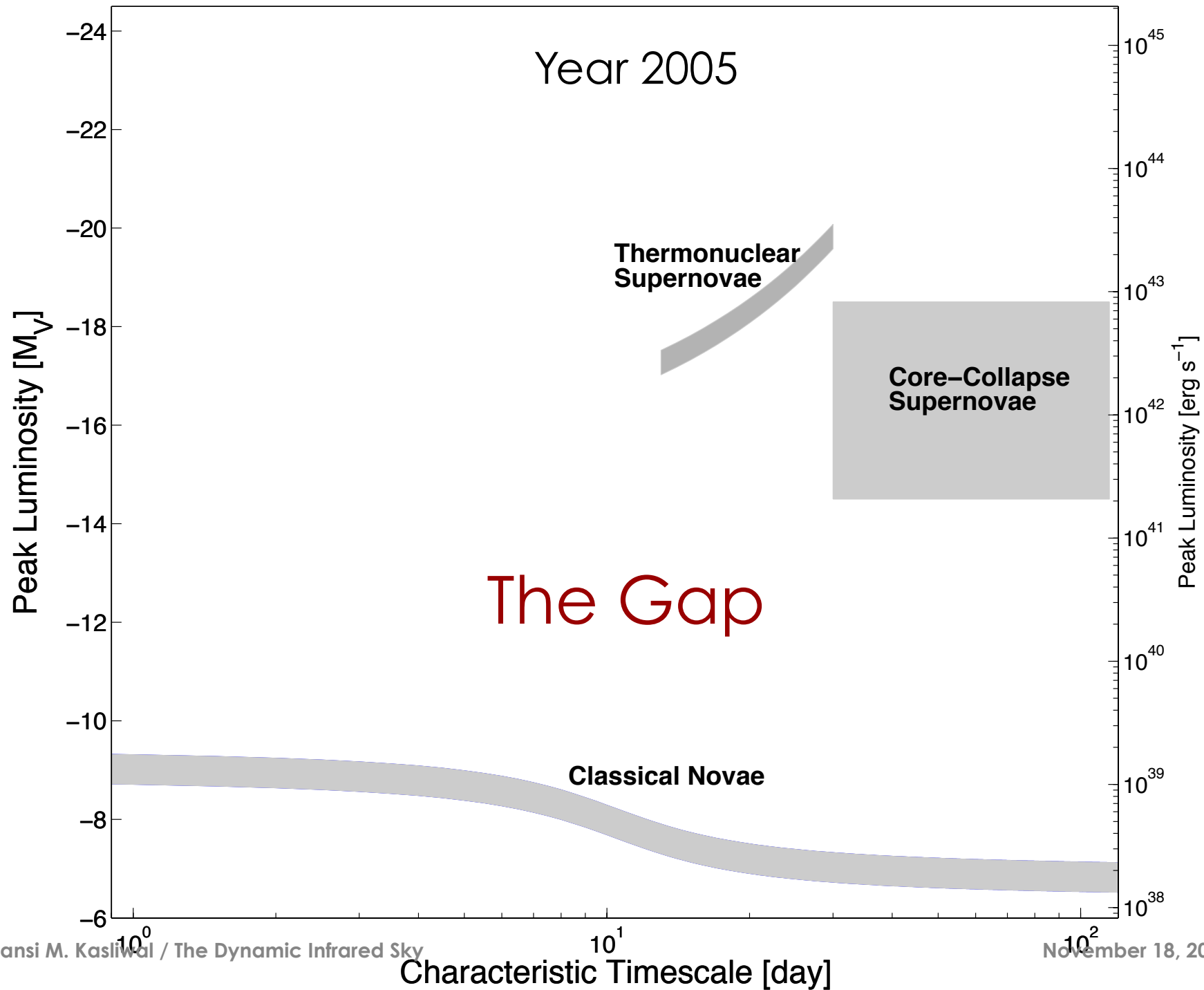
# A Renaissance in Time-Domain Astronomy

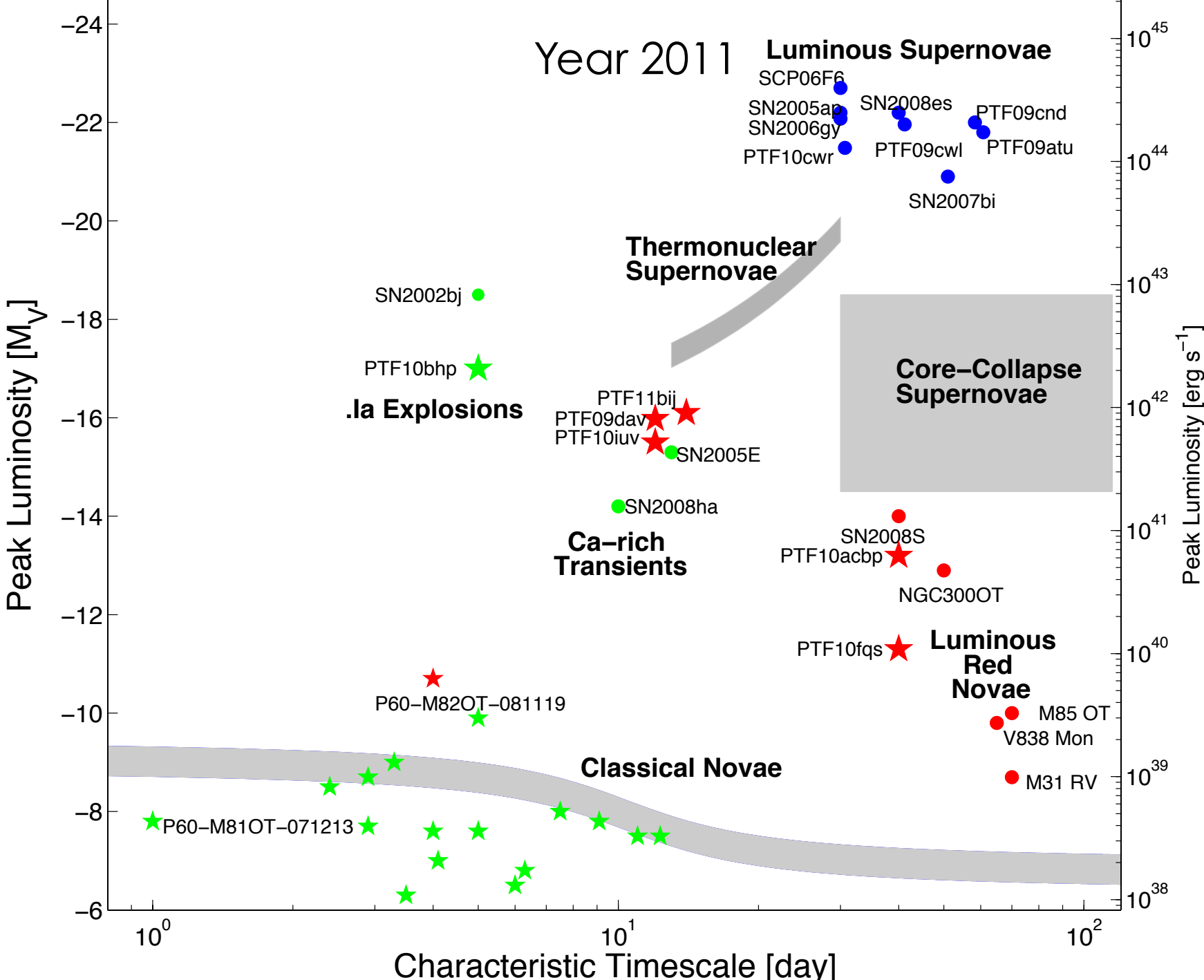


Evryscope, ASASSN, HATPI ZTF, CSS-II, PS, BG

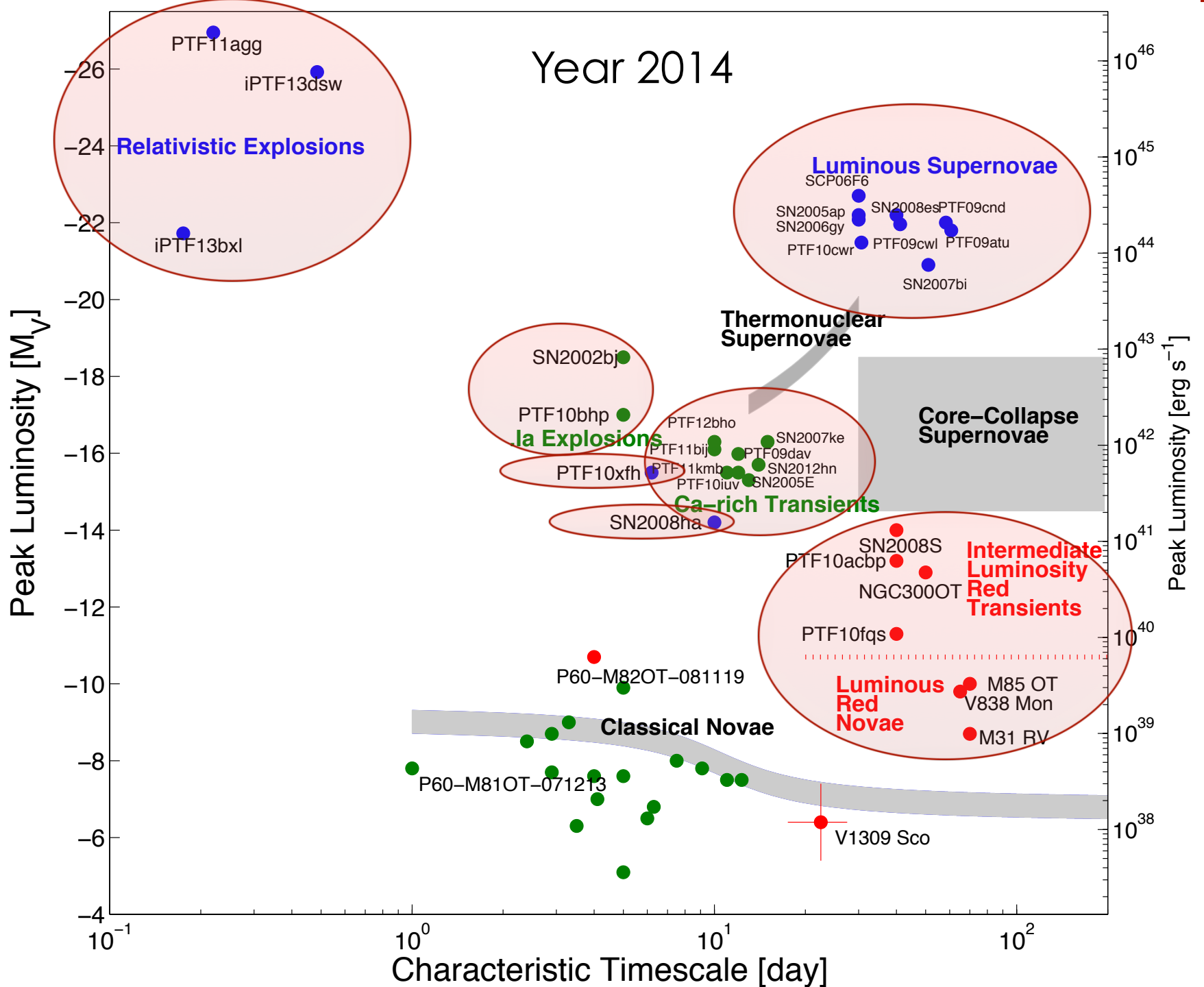
DECAM, HSC, LSST

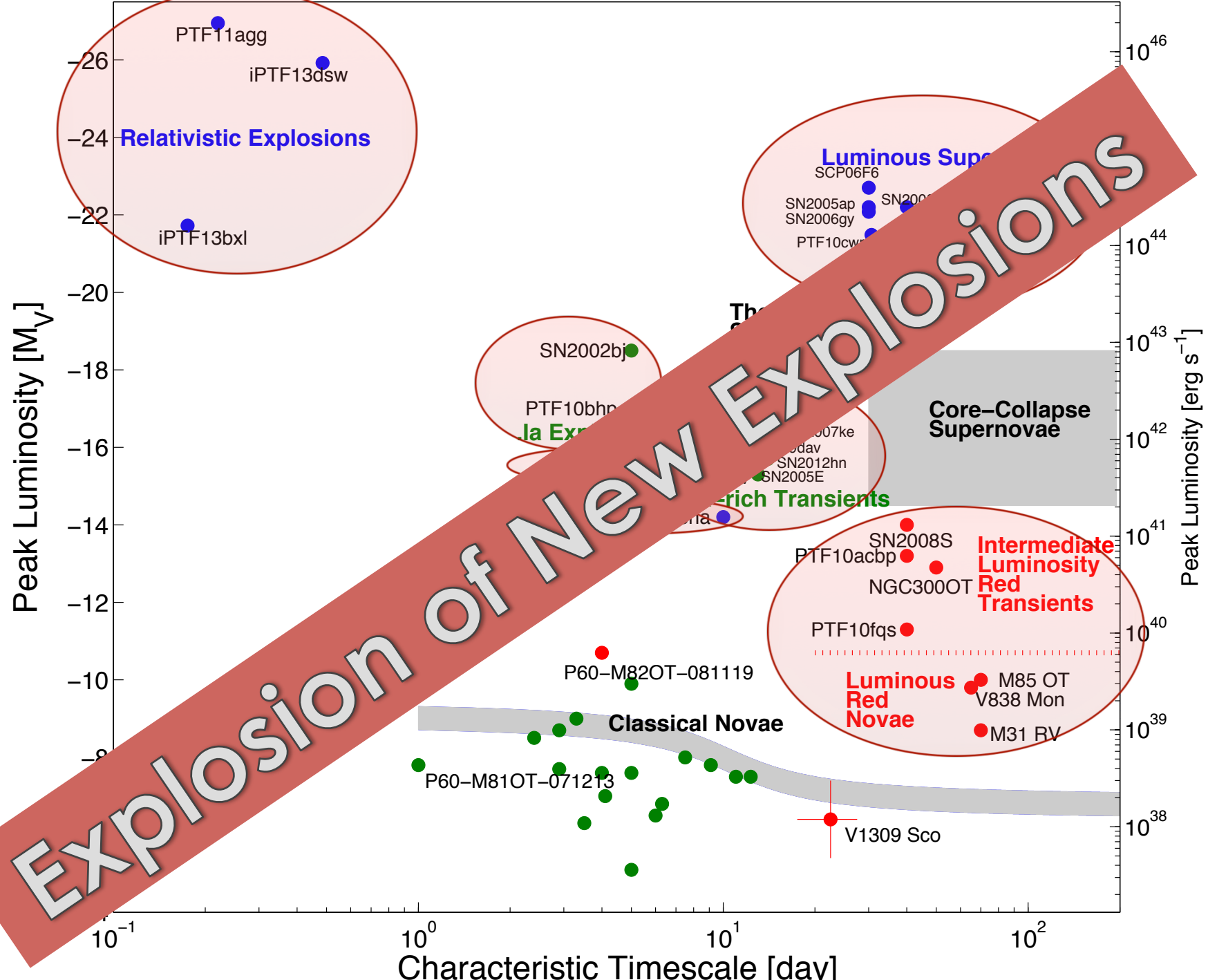
LOFAR, MWA and LWA: meter and decameter-mapping  
 Apertif, Meerkat and Askap: decimetric mapping





Year 2014







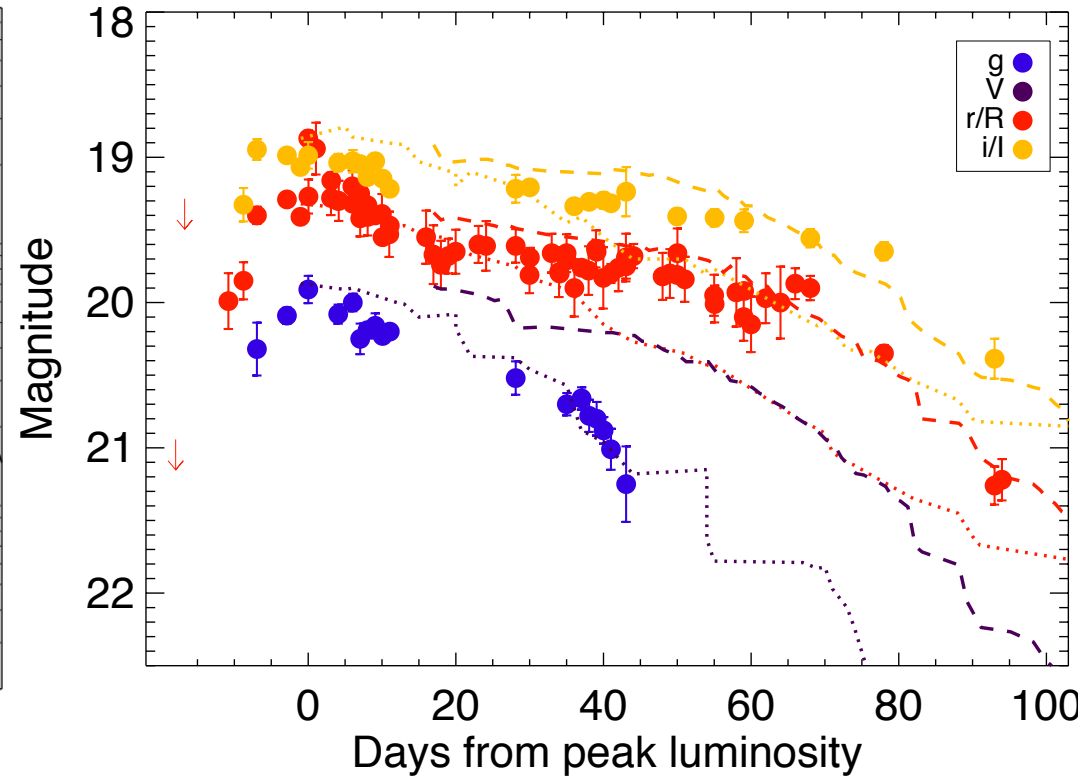
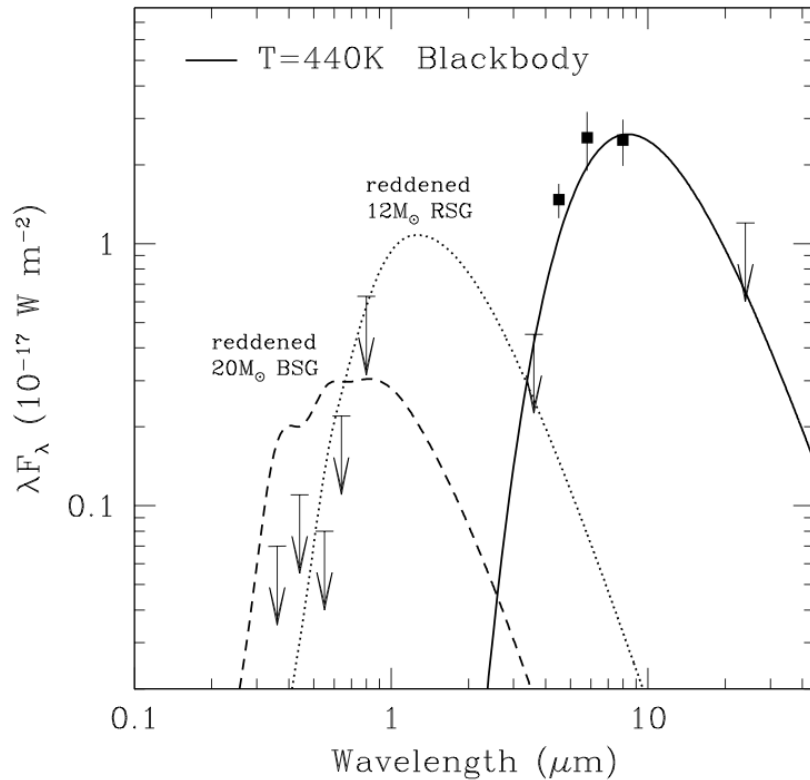
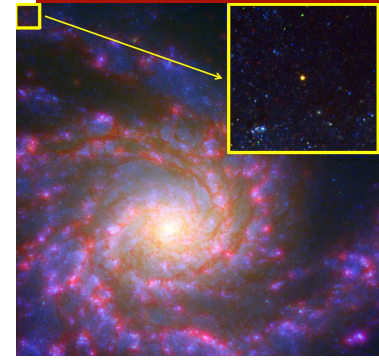
# The Dynamic Infrared Sky is Pristine



# Step 1: Infrared Follow-up of Optical Discoveries

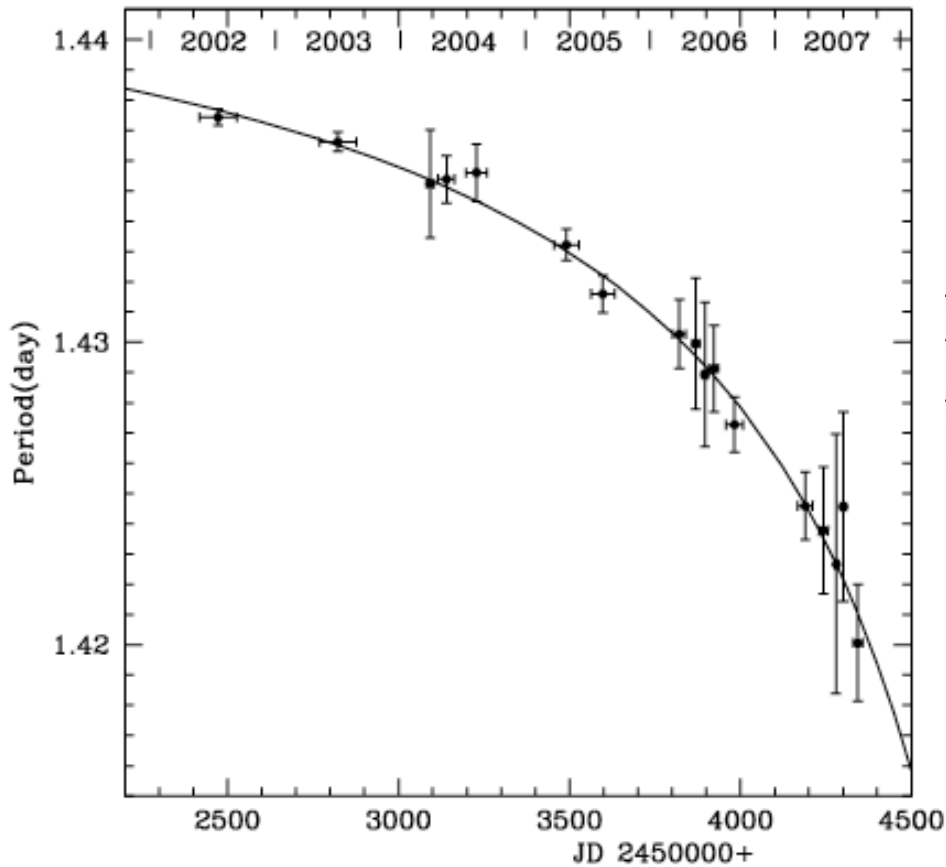
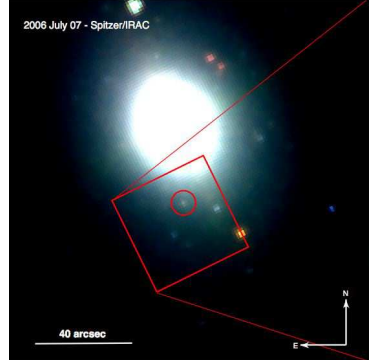


# New Class: e-capture supernovae

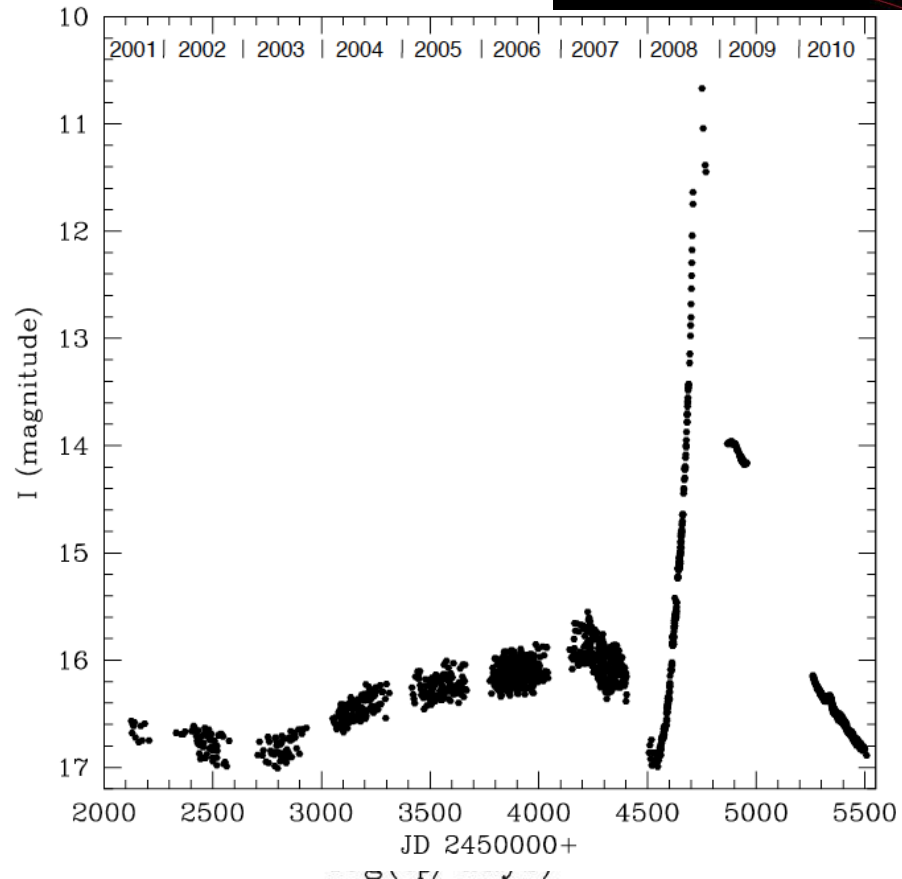


e.g. Prieto et al. 2008, Thompson et al. 2008, Kochanek 2011,  
Kasliwal et al. 2011b, Bond et al. 2009, Botticella et al. 2009

# New Class: Stellar merger

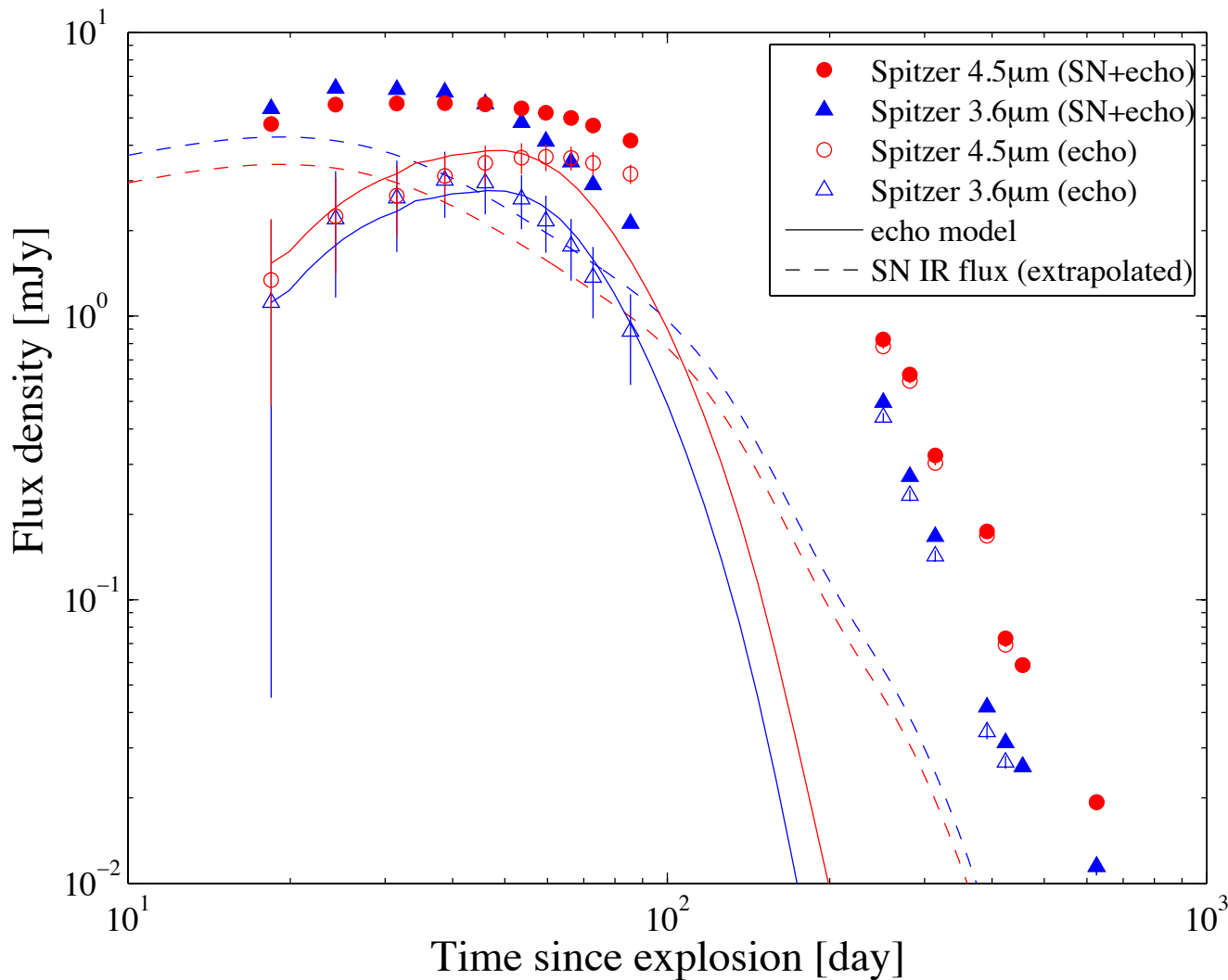


Tylenda et al. 2011



Ivanova et al. 2013

# Supernova Thermal Echoes



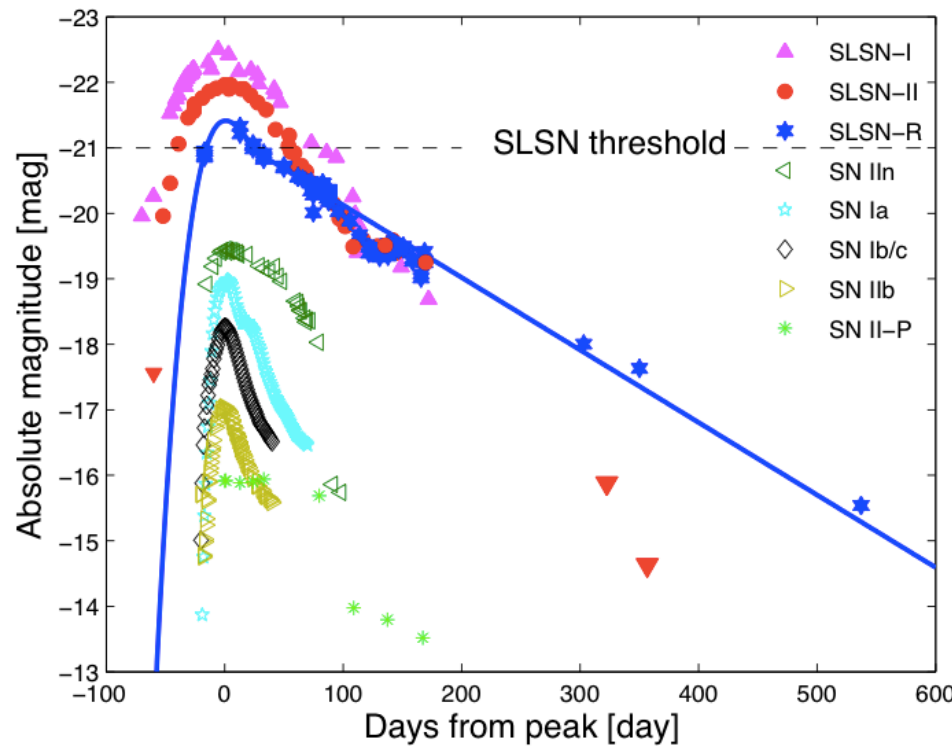
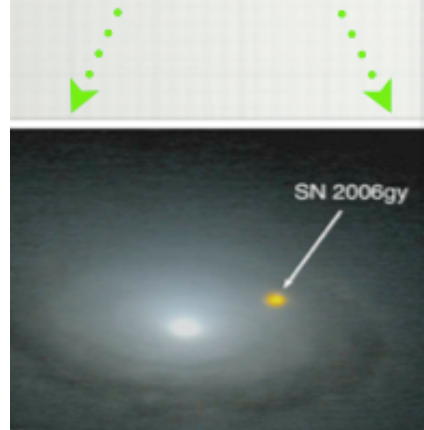
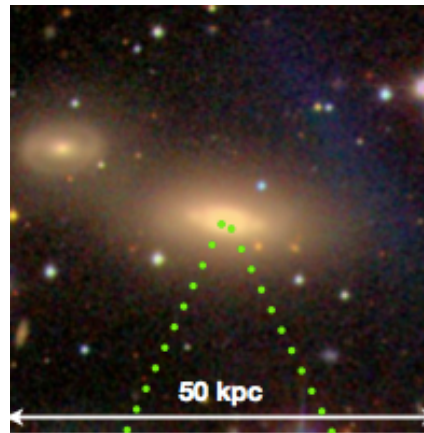
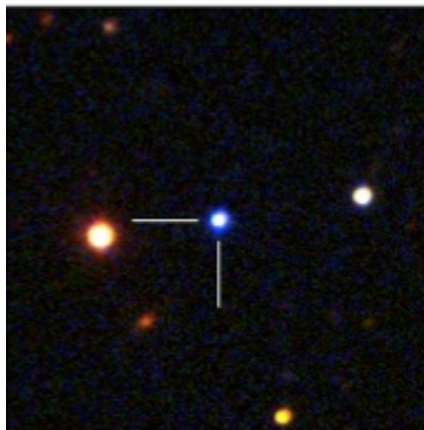
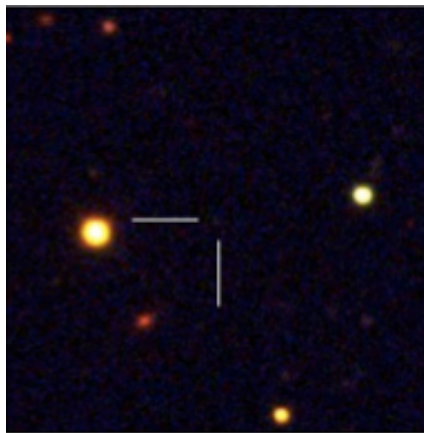
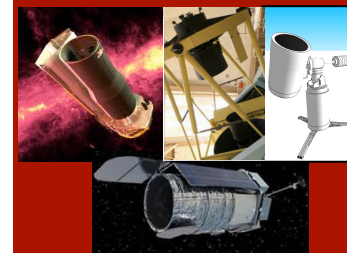
Helou et al. 2013

See also:

SN + CSM:  
Fox et al.  
2011, 2013

SN Ia:  
Johansson et al.  
2014

# Super Luminous Supernovae: Pushing to higher redshift



SLSN-I

Magnetars? PPI?

e.g. Quimby et al. 2011

Mansi M. Kasliwal / The Dynamic Infrared Sky

SLSN-II

CSM Interaction

e.g. Ofek et al. 2008

SLSN-R

Pair Instability

e.g. Gal-Yam et al. 2009



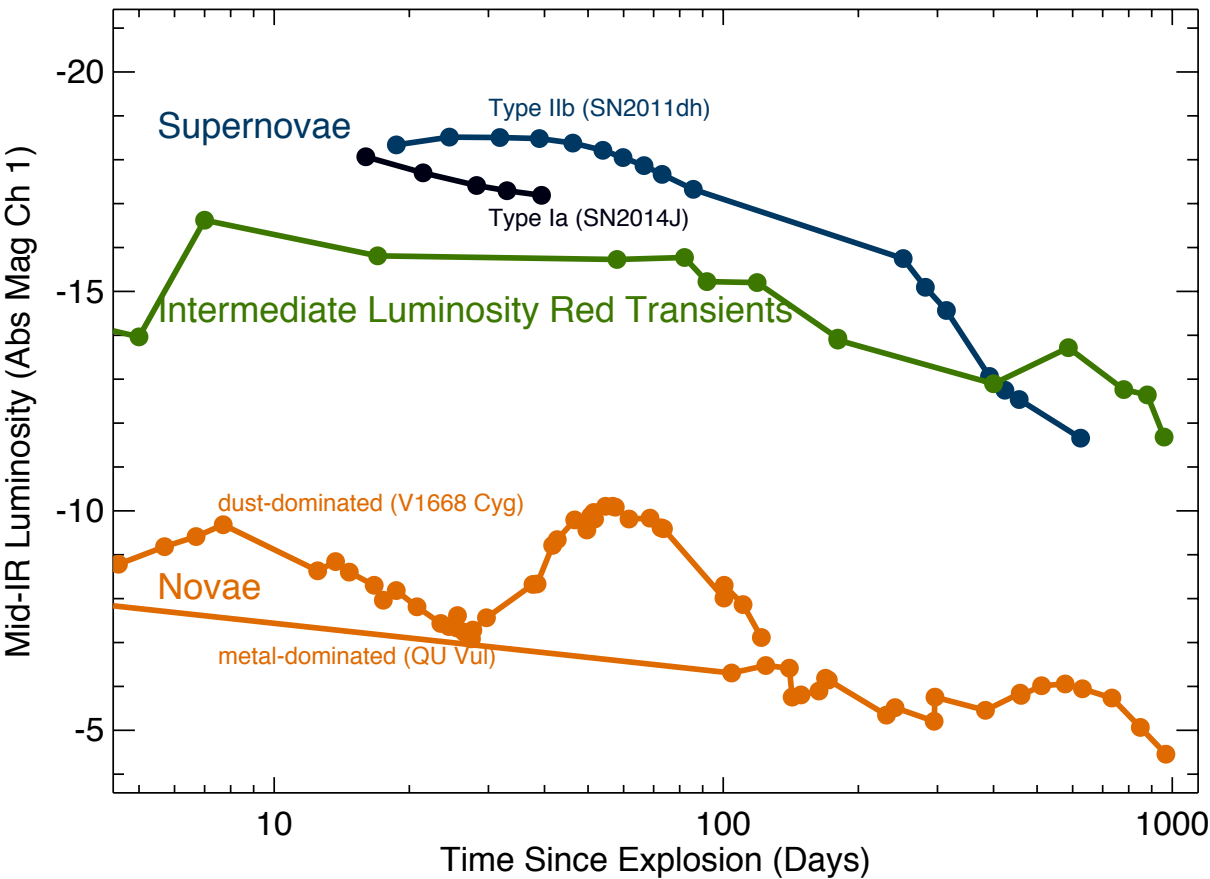
# Step 2:

## Infrared Discovery

*(targeting nearby galaxies)*

# SPIRITS:

## SPitzer InfraRed Intensive Transients Survey



Ongoing in Cycle 10 (2014)

190 Galaxies x 3 epochs

338 hours of Spitzer mid-IR

110 nights of near-IR imaging

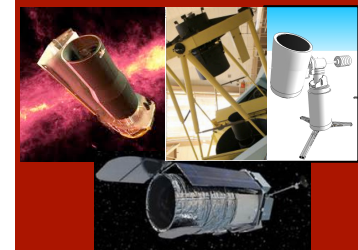
66 nights of optical imaging

33 nights of spectroscopy

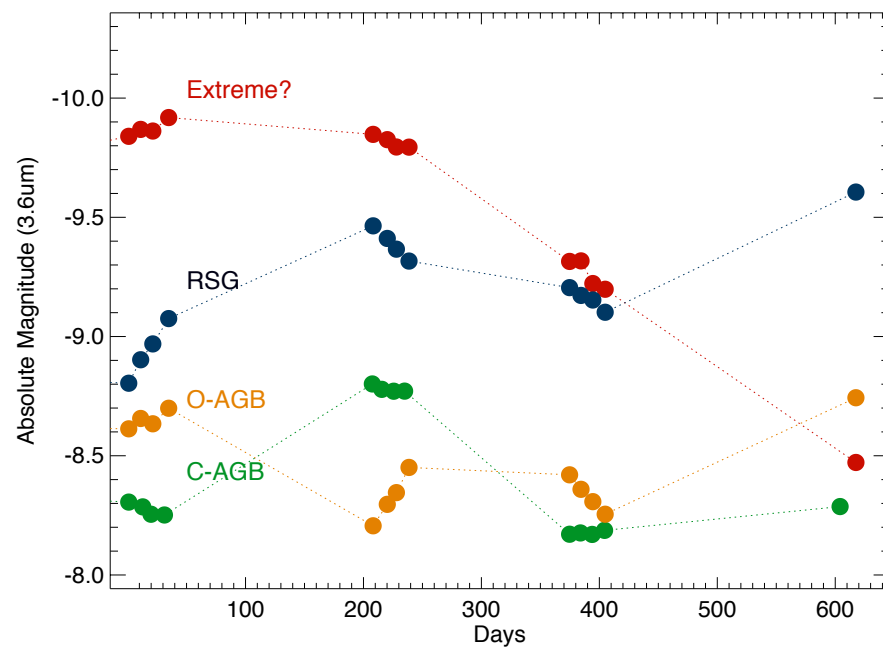
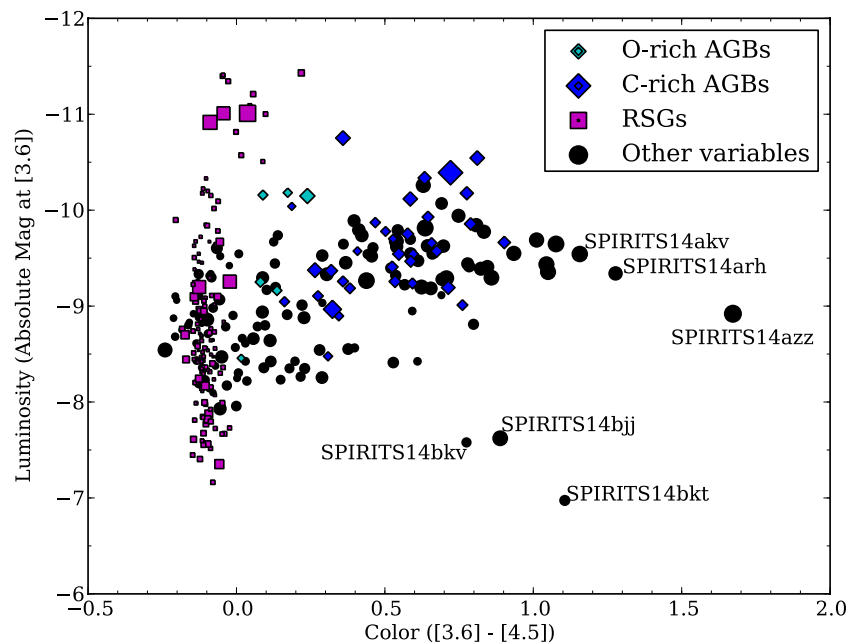
PI Kasliwal

40+ transients

1200+ variables



# 1200+ Strong Variables

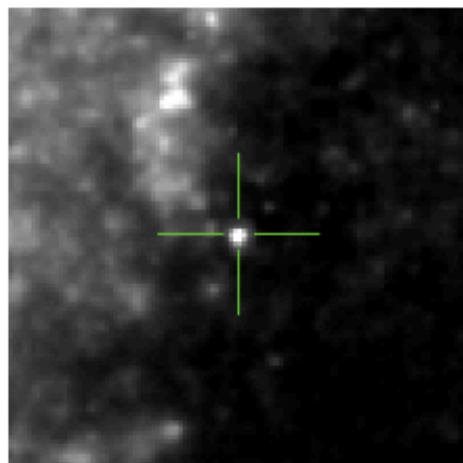




# 40+ infrared transients

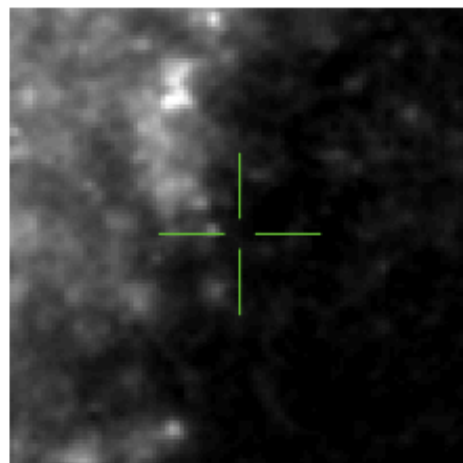
(21 supernovae, 4 novae, 15 mysteries)

New



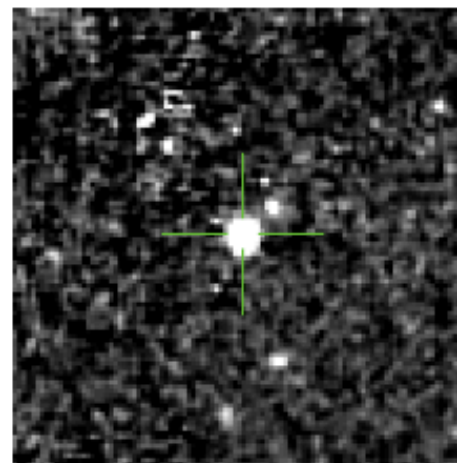
2014-2-27

Ref



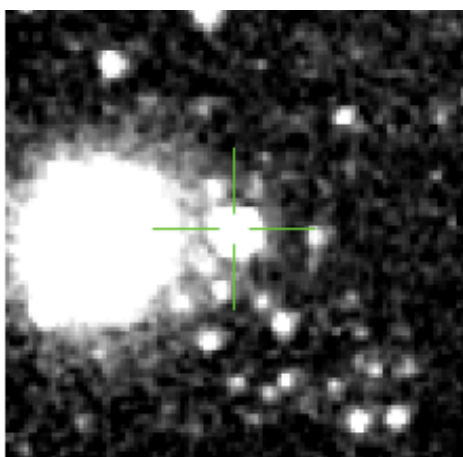
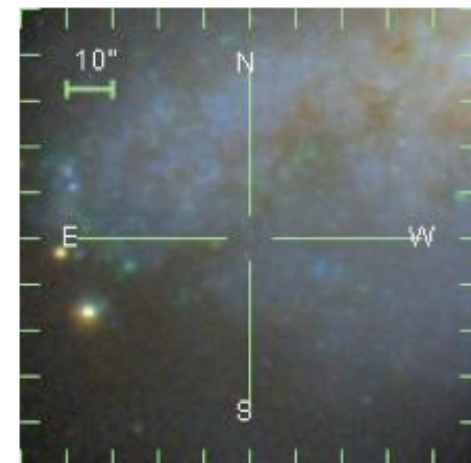
2004-12-17

Sub

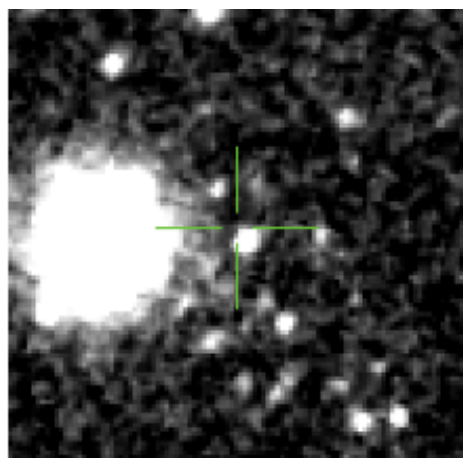


Positive

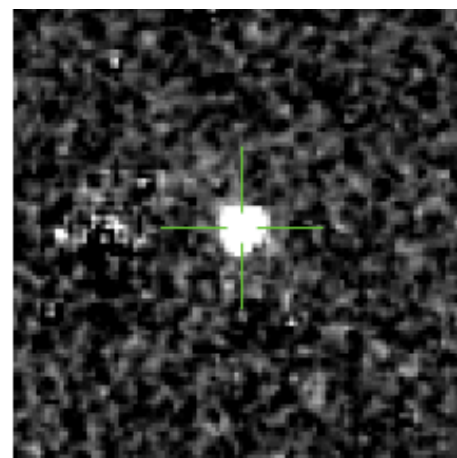
SDSS



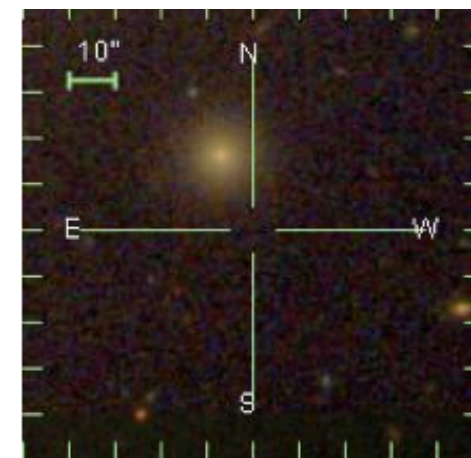
2014-4-12



2011-7-22

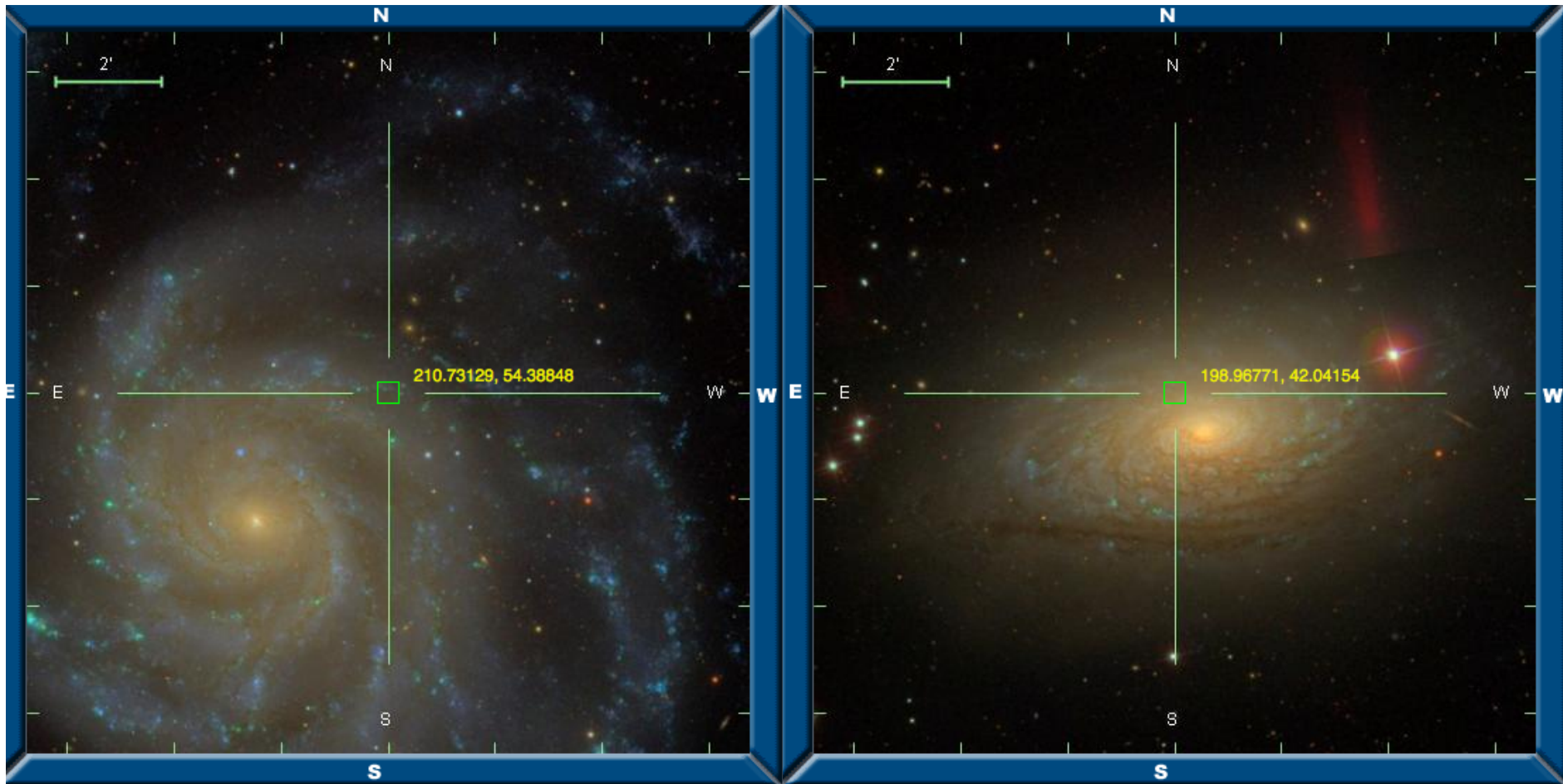
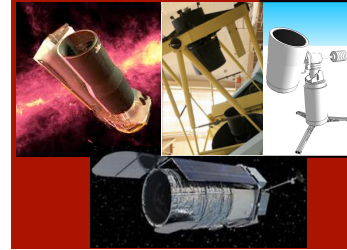


Positive



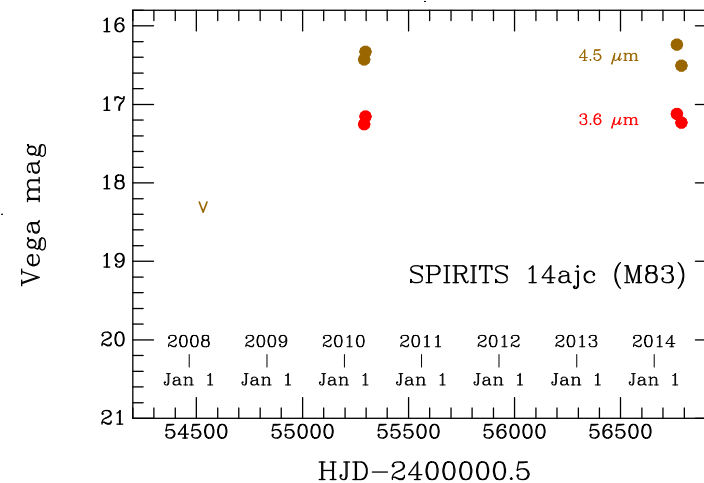
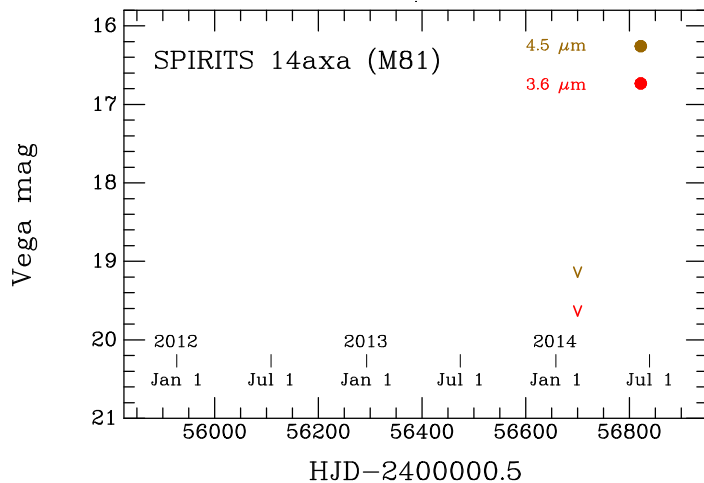
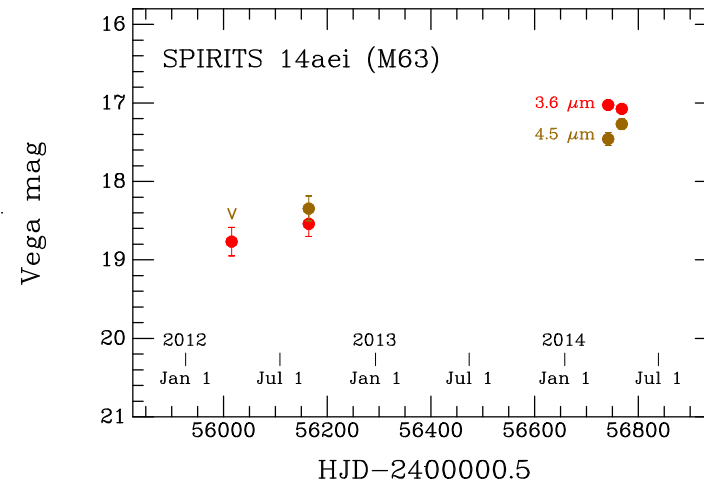
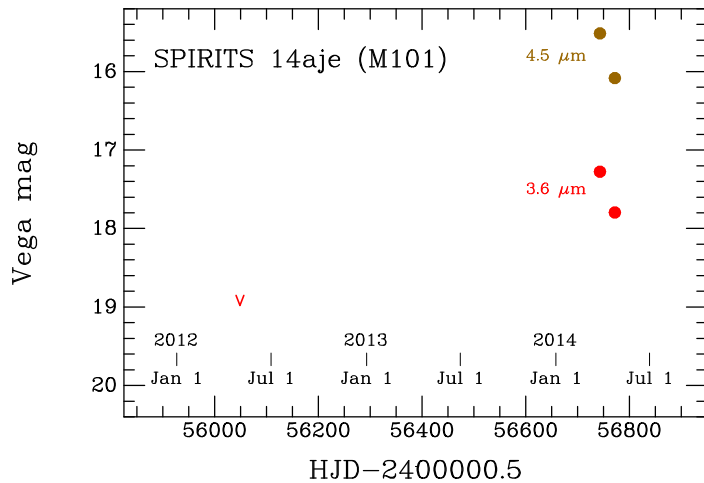


# Grand Spiral Host Galaxies





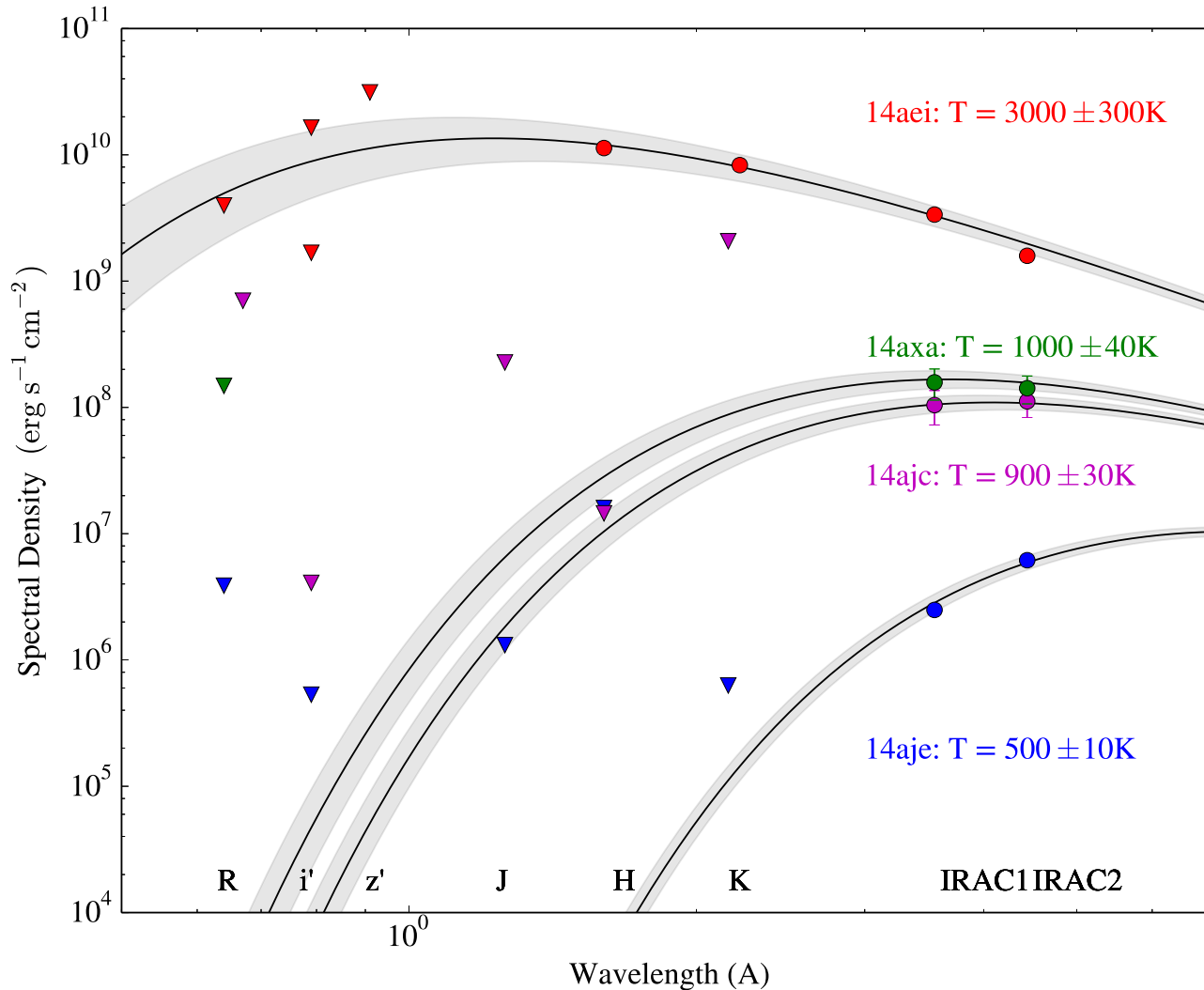
# Diverse Photometric Evolution



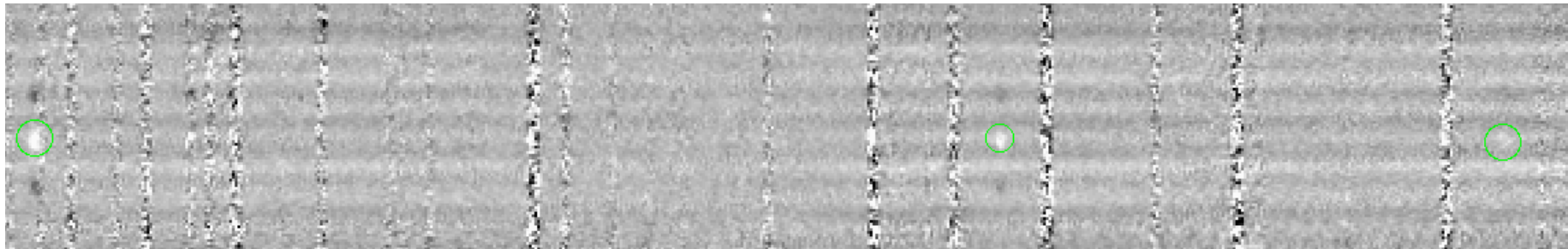
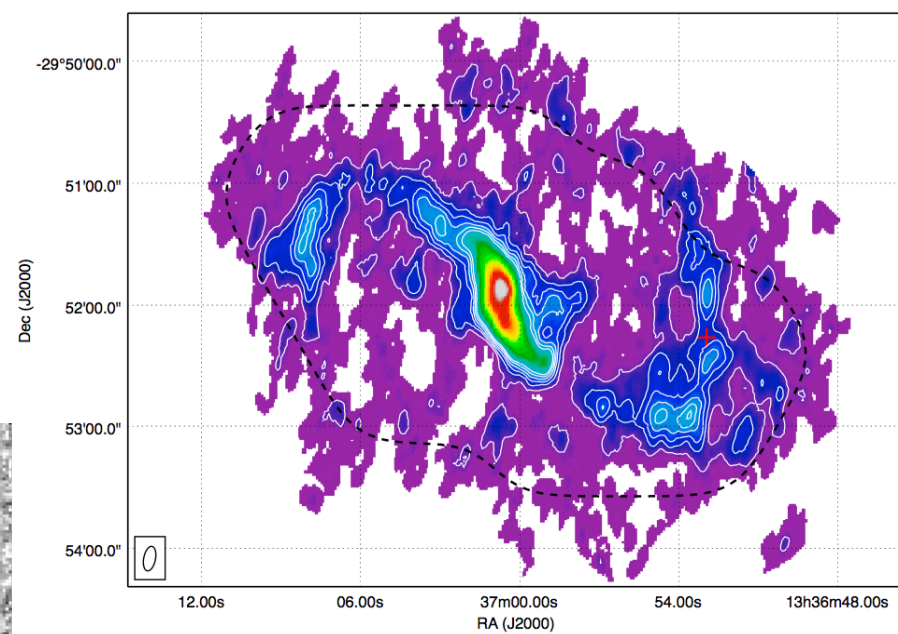
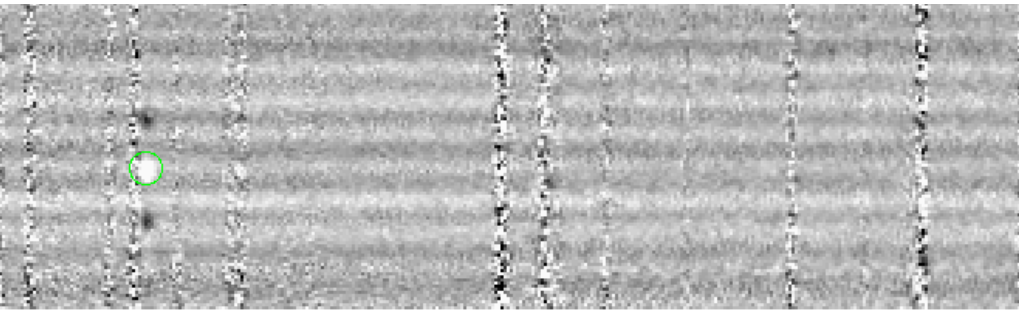
# Cold: Nothing in Optical



Samaporn Tinyanont



# SPIRITS 14ajc in M83

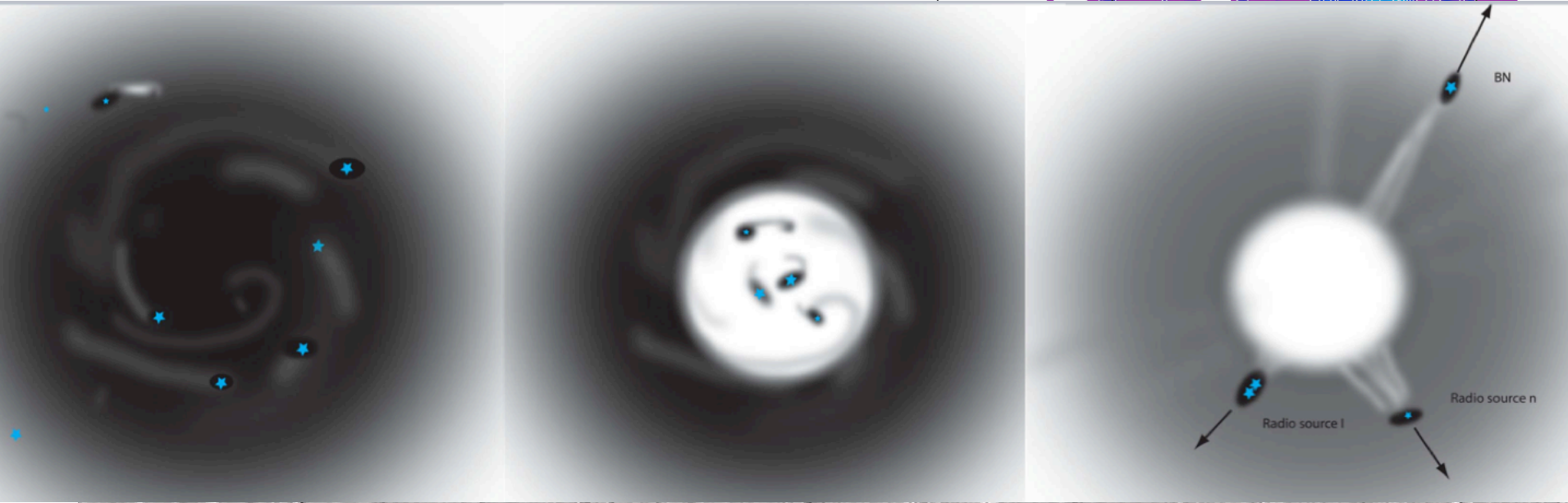
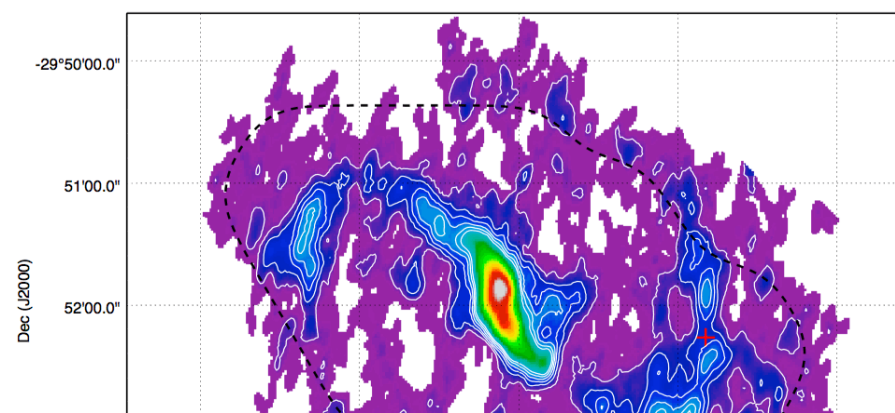


Shock-Excited Molecular Hydrogen Emission!!

Birth of a massive star binary??

Supernova behind molecular cloud??

# SPIRITS 14ajc in M83

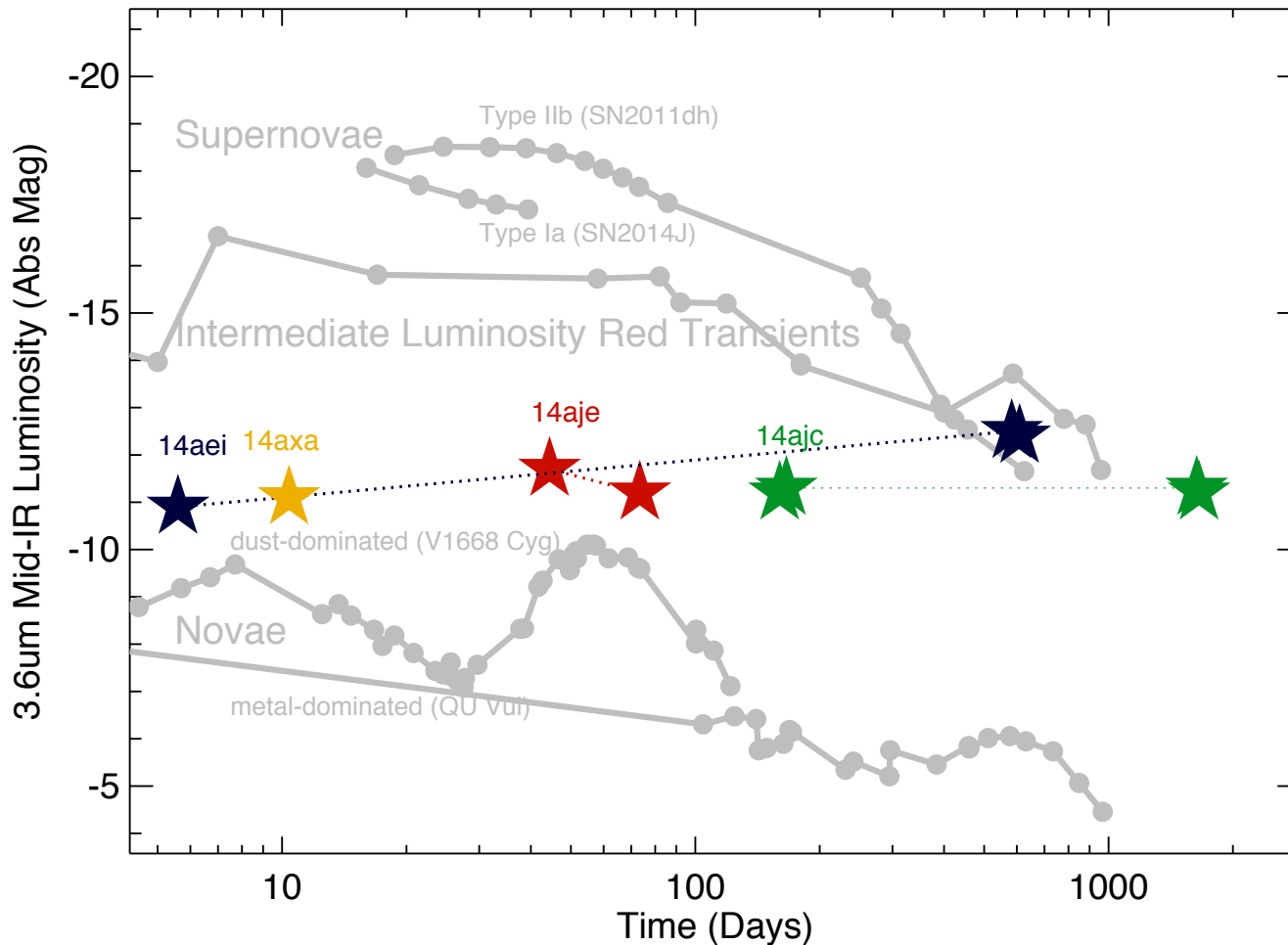


Shock-Excited Molecular Hydrogen Emission!!

Birth of a massive star binary??

Supernova behind molecular cloud??

# Bridging the infrared gap between novae and supernovae





# The Dynamic Infrared Sky Is Ripe for Exploration!

# WFIRST-AFTA systematic search for infrared transients?



- Fast wide-field mapping
  - Cadence choice is critical
  - Trade depth for more epochs
  - Software plan for real-time image-differencing alerts
  
- On-board spectroscopy is fantastic!
  - Combining the power of discovery and follow-up
  - Agility with spectroscopy ToOs

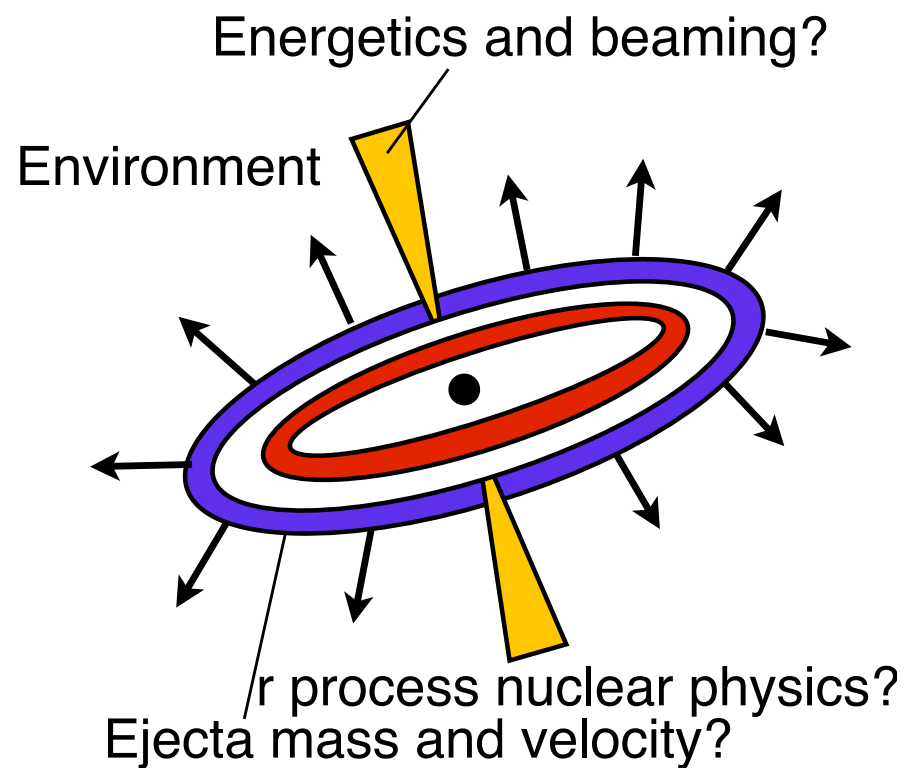
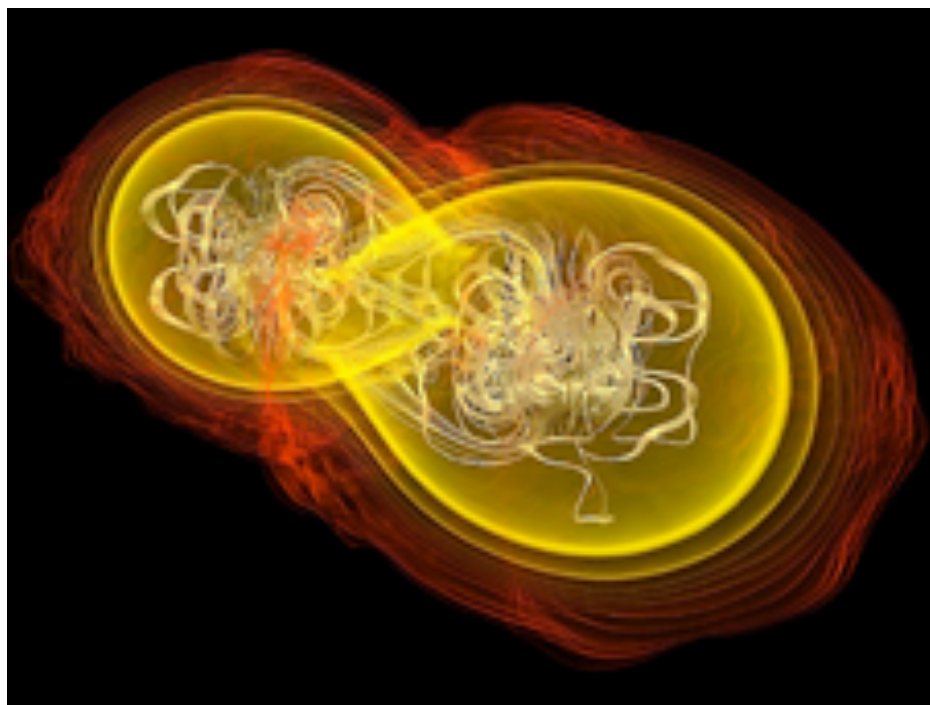


# Seeing the Sound:

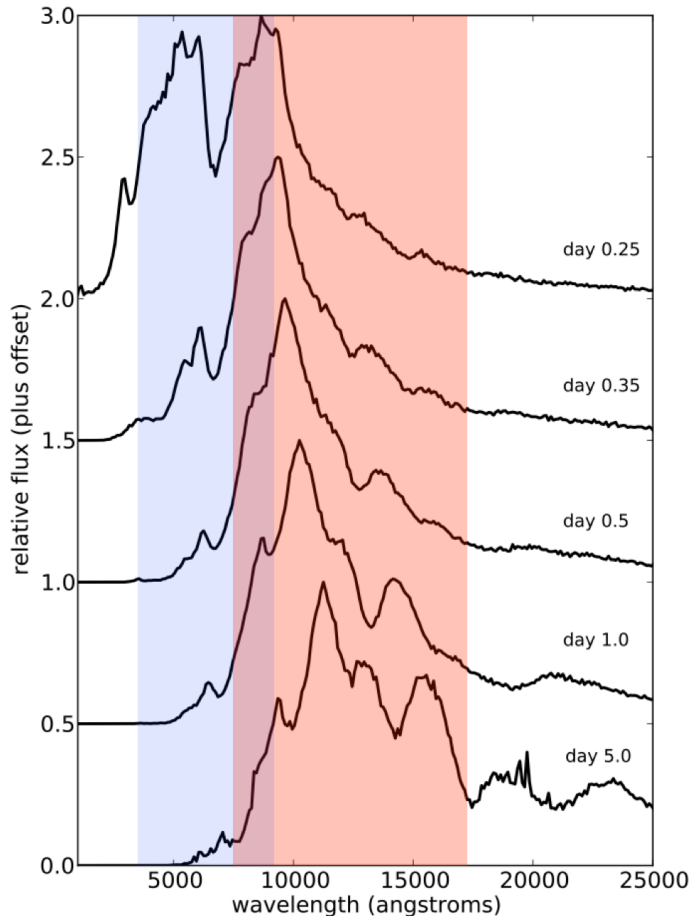
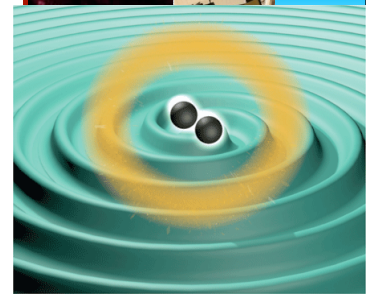
*Bridging Gravitational Wave Physics and  
Electromagnetic Astronomy*



Strong Field Gravity: Masses, Spins, Inclination



# WFIRST-AFTA ToO: Kilonovae from Neutron Star Mergers



Barnes & Kasen 2013, Kasen et al. 2013

A WFIRST-AFTA ToO Trigger:

Era of 3-5 advanced gravitational wave Interferometers at full sensitivity

~30 mergers localized to <6 sq deg in 5 yr

A 27 hour WFIRST-AFTA ToO:

J+H imaging x 5 epochs (24-25 mag)

Grism spectroscopy x 1 epoch (22 mag)

IFU spectrum x 1 candidate (25 mag)

See Hirata, Kasliwal & Nissanke,  
white paper for WFIRST-AFTA



# Summary

- Infrared Sky is Ripe for Exploration  
*Some stellar fates are entirely enshrouded*
- A targeted infrared search with Spitzer/IRAC  
*Mysterious SPIRITS mid-infrared transients*
- A wide-field transient search with WFIRST-AFTA
- Gravitational Wave ToOs with WFIRST-AFTA



Thank You