Exploring the Dynamic Infrared Sky with Spitzer, Gattini-IR, and Beyond

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NASA IRTF Future Directions Workshop

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Talk Outline

• Infrared Time Domain Astronomy

• Revealing Unusual IR transients with Spitzer
  – And in the future with JWST!

• Continuing the exploration of the IR sky with Gattini-IR and IRTF
Why the Infrared?

![Graph showing extinction vs. wavelength in visible and infrared regions.](Image)

Visible

Infrared

Wavelength (μm)

Visible

Infrared

Dust/ISM

Extinction

10^{-20}

10^{-21}

10^{-22}

10^{-23}

10^{-24}

10^{-25}

0.01

0.1

1

10

100

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Optical surveys are ideal for studies of novae and supernovae...
Why the Infrared (for time domain)?

Need IR to reveal “invisible” dusty or red transients and variables!
- Luminous red novae (Stellar mergers)
- Intermediate Luminosity Red Transients (SN2008S)
- EM Counterparts of NS-mergers

Spitzer

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Exploring the Dynamic Infrared Sky With Spitzer

- **SPIRITS** - SPitzer InfraRed Intensive Transients Survey (P.I.: Mansi Kasliwal)
  - On-going since 2014 and will last until end of Spitzer Mission in late 2018
Exploring the Dynamic Infrared Sky With Spitzer

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  *40+ IR transients and 1200+ variables revealed the first year!*

(Kasliwal et al. 2017)
Exploring the Dynamic Infrared Sky With Spitzer

- SPIRITS - SPitzer InfraRed Intensive Transients Survey (P.I.: Mansi Kasliwal)

New class of mysterious IR transient discovered in SPIRITS!

(Kasliwal et al. 2017)
eSPecially Red Intermediate-luminosity Transient Events (SPRITEs)

Messier 101
(Spitzer/IRAC)

SPIRITS 14aje
Ref
(2004 Mar 03)
New
(2014 Apr 14)
Ref Subtracted

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eSpecially Red Intermediate-luminosity Transient Events (SPRITEs)

IR Transient Light Curves

- Supernovae
- Type Ia (SN2014J)
- Type IIb (SN2011dh)
- Intermediate Luminosity Red Transients (SPRITE)
- Novae
  - dust-dominated (V1668 Cyg)
  - metal-dominated (QU Vul)

Kasliwal et al. (2017)
What are SPRITEs?

Stellar merger?
(Tylenda et al. 2011)

Highly Obscured SN?
(Jencson et al. 2017)

Lifetime of a star...

Young

Birth of massive star binary?
(Bally et al. 2015)

Obscured High-mass X-ray binary outburst?
(e.g. Lau et al. 2016b)

Evolved

Young

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Evolved
What are SPRITEs?

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(Tylenda et al. 2011)

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Lifetime of

JWST GTO Plan: Follow-up 3 SPRITEs as ToOs in  
Cycle 1 for 3 – 28 μm coverage.  
(PI – M. Ressler)

Birth of massive star binary?  
(Bally et al. 2015)

Obscured High-mass X-ray binary outburst?  
(e.g. Lau et al. 2016b)
Follow-up Characterization with the James Webb Space Telescope
The James Webb Space Telescope

**Cryogenic** temperature (< 50 K) telescope and instruments passively cooled by 5-layer sunshield (MIRI cooled to 6.7 K)

**Deployable** IR telescope w/ 6-m diameter segmented primary mirror

Will be the most sensitive infrared observatory between 1 – 28 μm
The James Webb Space Telescope

Cryogenic temperature (< 50 K) telescope and instruments passively cooled by 5-layer sunshield (MIRI cooled to 6.7 K)

Deployable IR telescope w/ 6-m diameter segmented primary mirror

Planned for Mid 2019 Launch - 5 yr science mission (10 yr goal)
JWST Instrumentation

- **NIRCAM** – Near-IR Camera
  - $\lambda$: 0.7 - 4.8 $\mu$m
  - Large field of view (2’ x 4’)
- **NIRISS** – Near-IR imager and slitless spectrograph
  - $\lambda$: 1 - 5 $\mu$m
  - Capable of highest spatial resolution on JWST
- **NIRSPEC** – Near-IR Spectrograph
  - $\lambda$: 1 - 5 $\mu$m
  - Capable of multi-object R ~ 3000 spectroscopy
- **MIRI** – Mid-IR Instrument
  - $\lambda$: 5 - 28 $\mu$m
  - Imaging and spectroscopy out to longest wavelengths on JWST

JWST in test chamber at Johnson Space Center for cryo vac test
Follow-up 3 SPRITEs identified by Spitzer as Targets of Opportunity for 3 – 28 μm coverage. (PI – M. Ressler)
After Spitzer... Continuing the Exploration of the Infrared Sky
Gattini-IR, an Upcoming Near-IR Survey Telescope (On-sky Spring 2018)

- Wide-field J-band survey from Palomar with 0.3 m telescope
  - PI’s: M. Kasliwal (Caltech) & A. Moore (ANU)

- 25 sq. degree imager to survey observable sky to $15.5 \text{ mag}$ every night ($5\sigma$ in 30s)
  - 8.6” pixel scale

- “2MASS every month”

(Moore et al. 2016)
A Nightly Cadence Near-IR Survey

Gattini-IR Science Cases

- Supernovae
- Classical novae
- Massive YSO outbursts
- EM counterparts of NS-mergers
8.6” pixels, a major challenge...

(Resampled)
Find the Supernova! (SN2017eaw)

Need to resolve and verify Gattini-IR transients

(Resampled WIRC images)
An IR Transient Network: Gattini-IR, IRTF, and JWST

Characterizing unusual transients

Transient Discovery

Rapid IR follow-up (Robo-AO & SPECTRE)

JWST

Gattini-IR

IRTF
Characterizing unusual transients

IR surveys are crucial for revealing “invisible” dusty or red transients (like SPRITEs!)

Synergies between Gattini, IRTF and JWST are key for a transient discovery and follow-up network