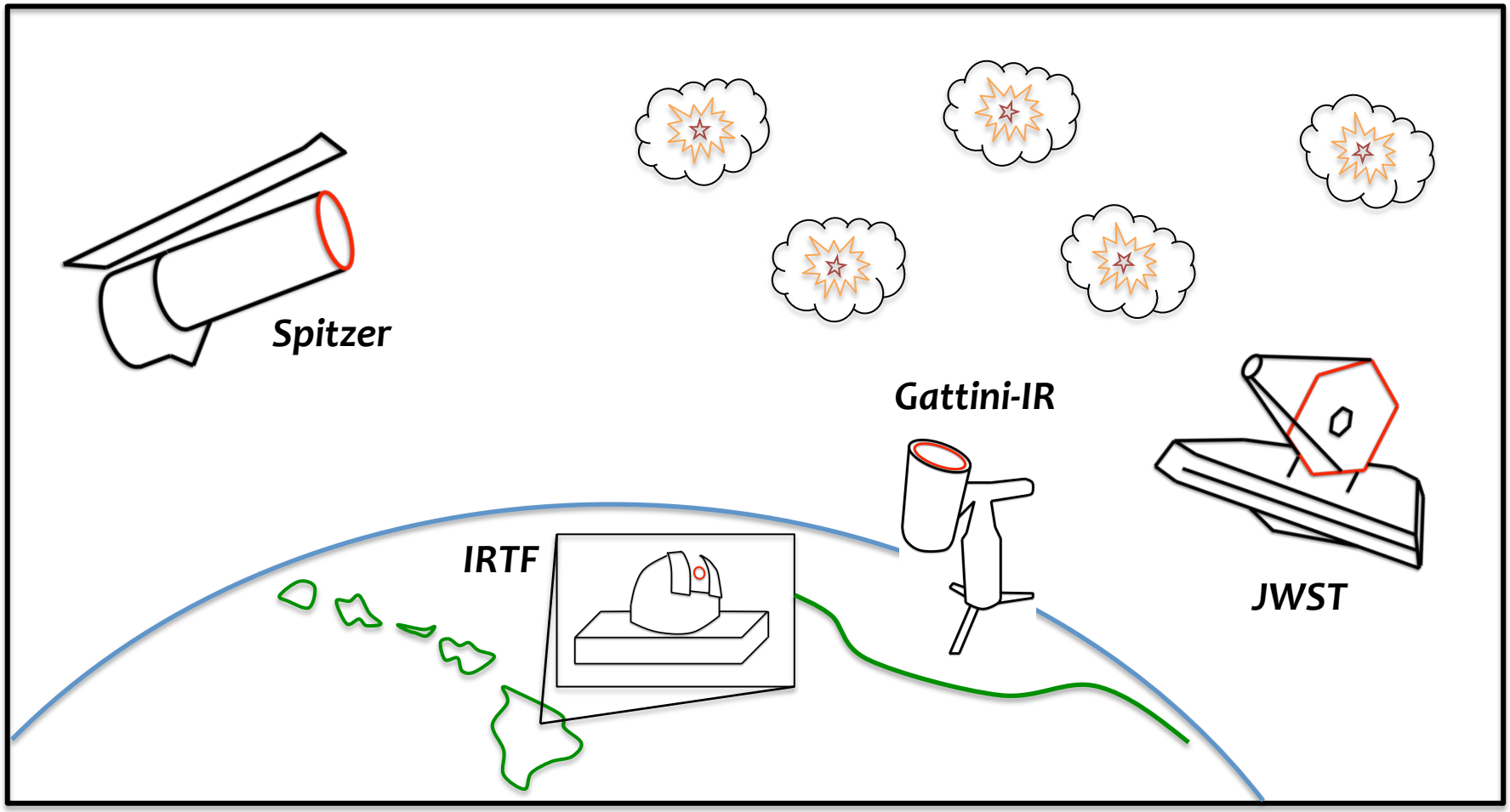
Exploring the Dynamic Infrared Sky with Spitzer, Gattini-IR, and Beyond



Ryan M. Lau (Caltech)

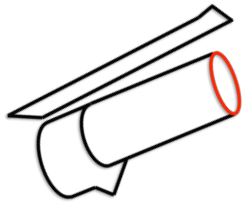
Collaborators: Mansi Kasliwal (Caltech), Anna Moore (ANU), Mike Ressler (JPL), Jacob Jencson (Caltech), Scott Adams (Caltech), and SPIRITS Collaboration

NASA IRTF Future Directions Workshop
Tucson, AZ
Feb 14, 2018

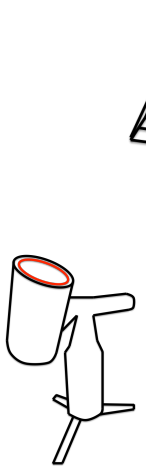
Talk Outline

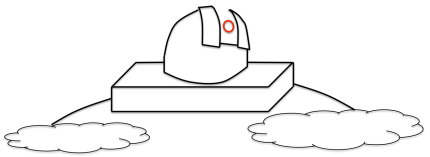
- Infrared Time Domain Astronomy

- Revealing Unusual IR transients with **Spitzer**
  - And in the future with **JWST**!

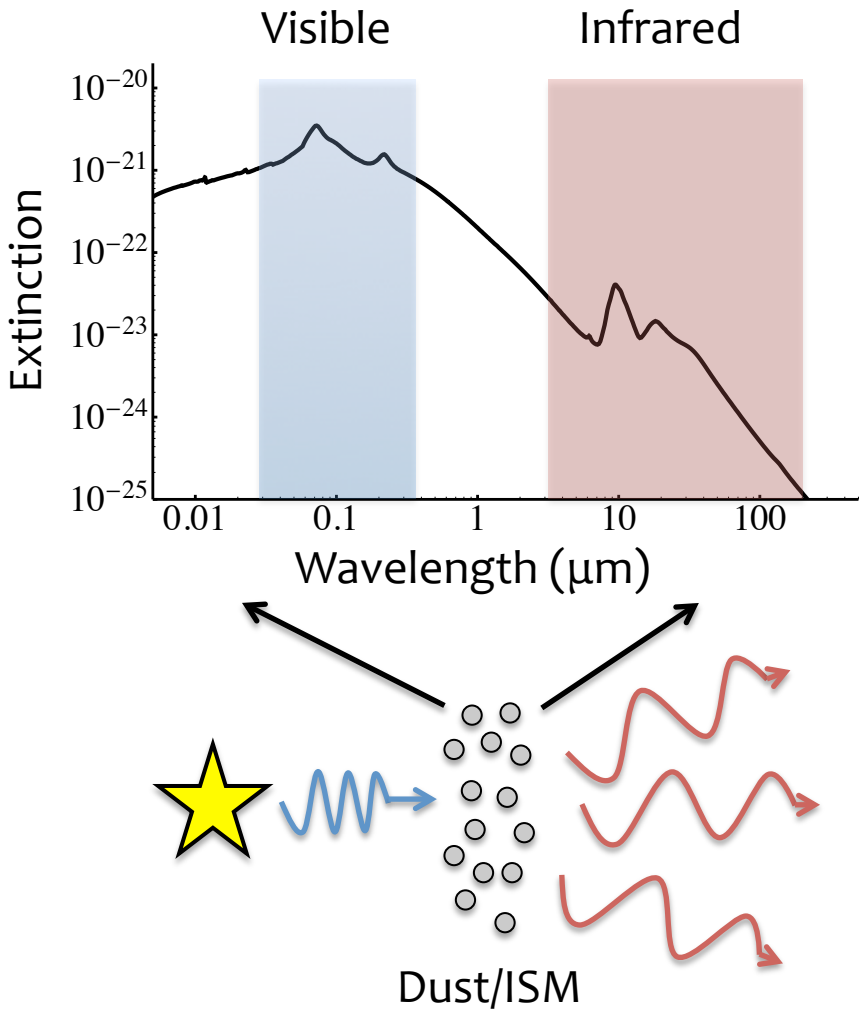


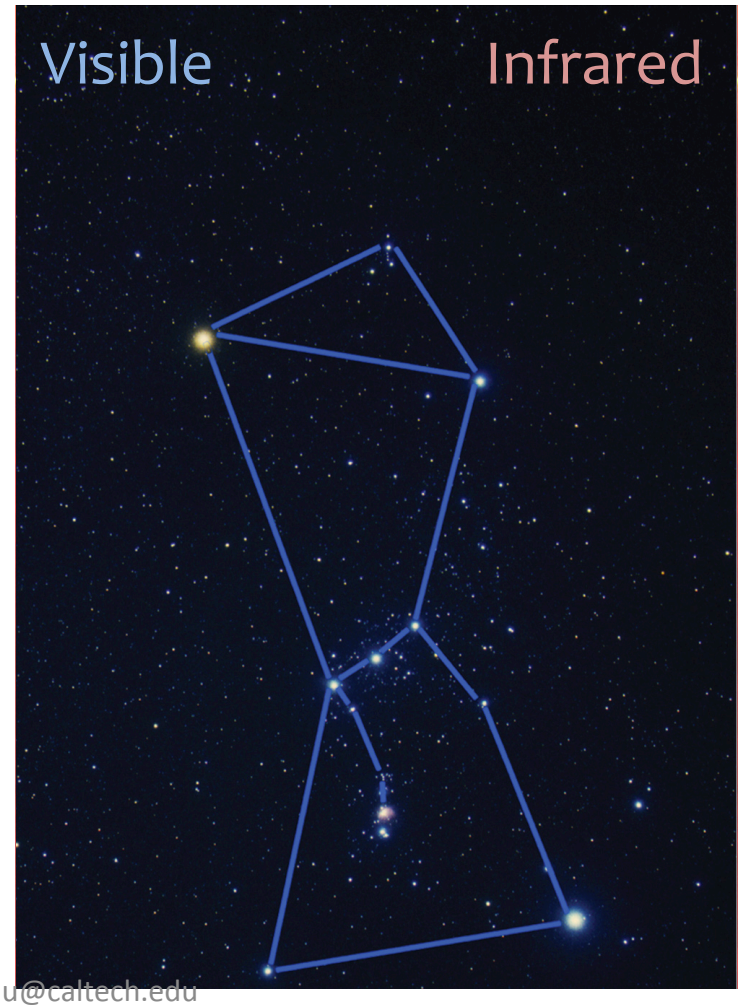
- Continuing the exploration of the IR sky with **Gattini-IR** and **IRTF**



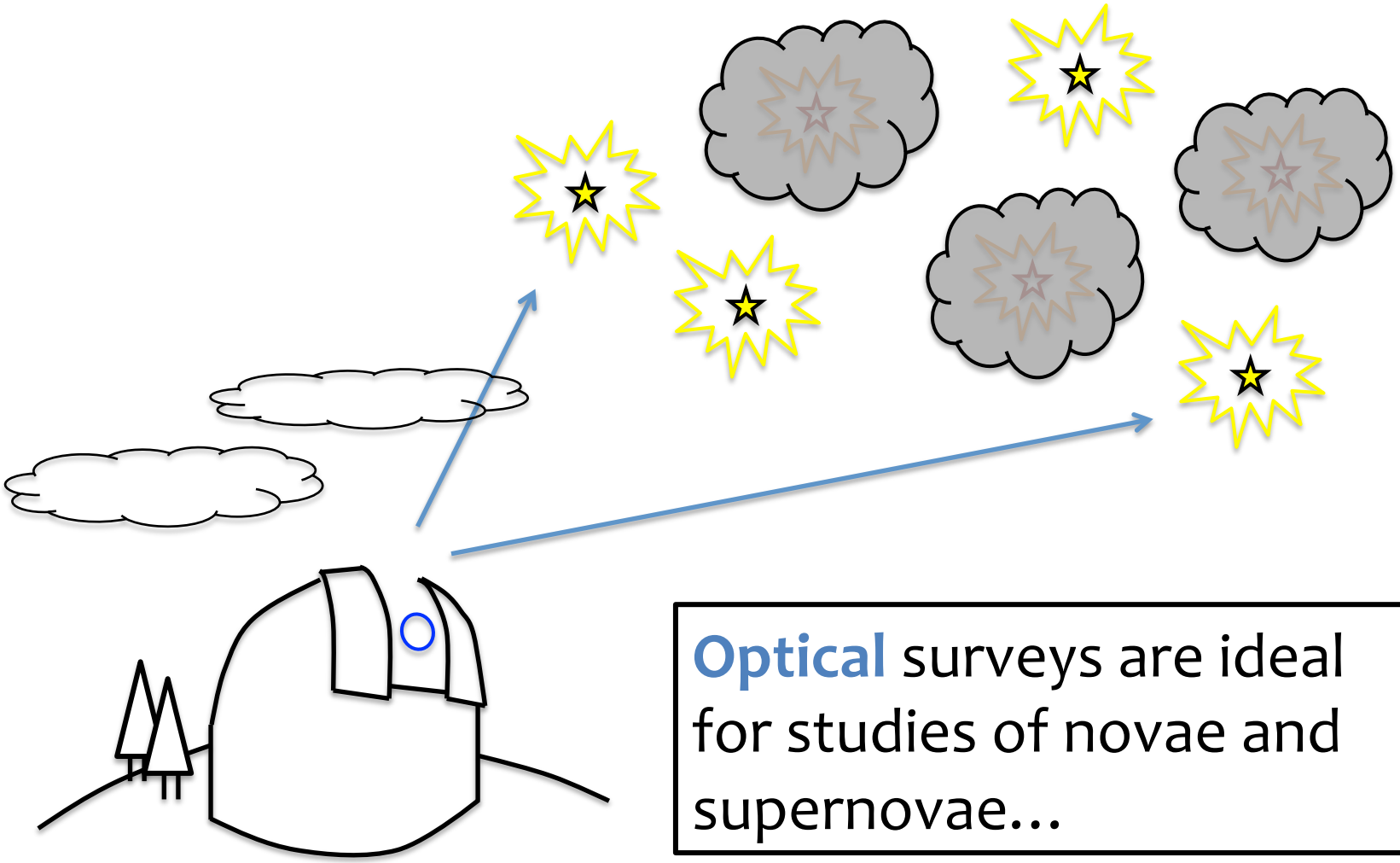


Why the Infrared?



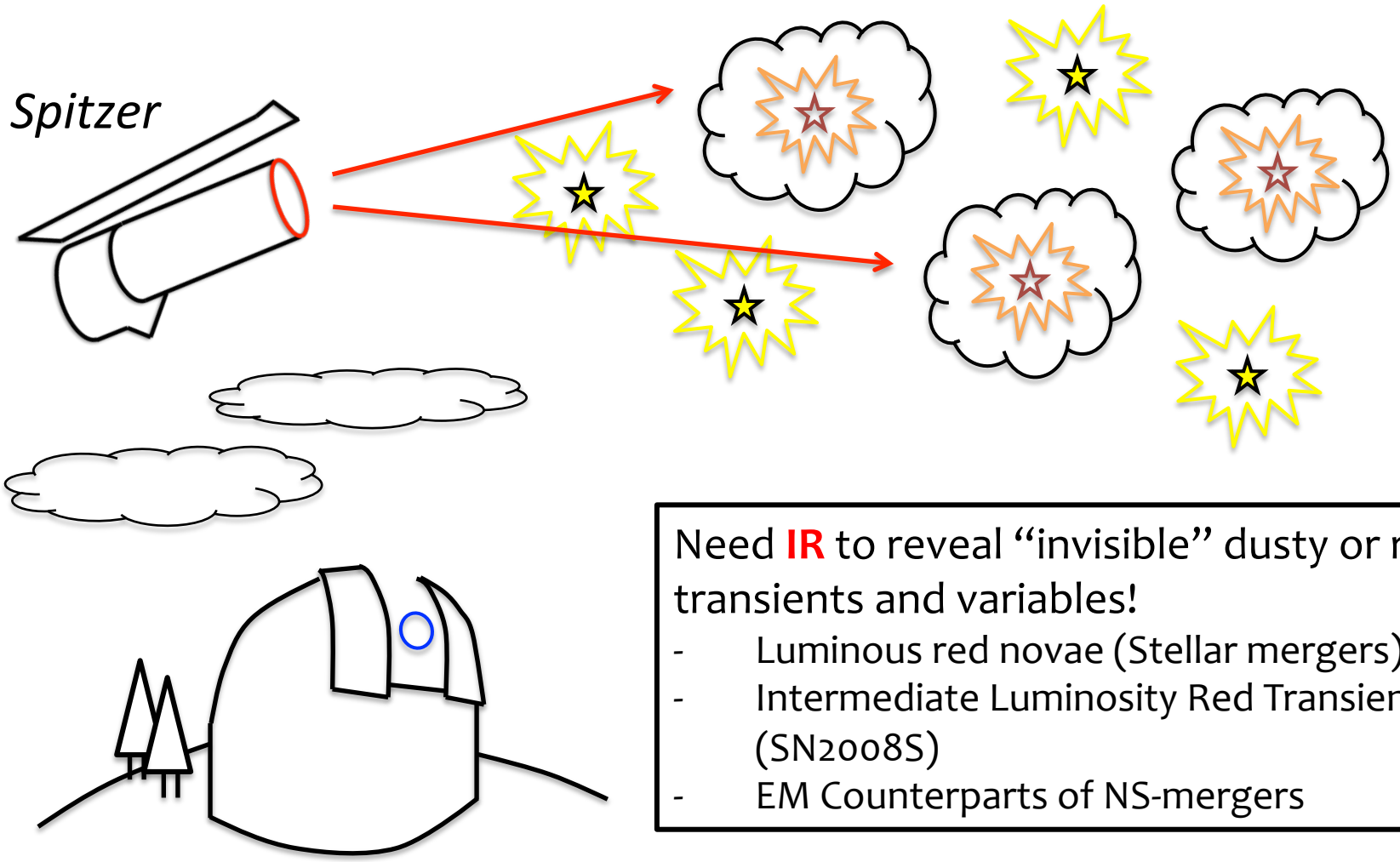


Why the Infrared (for time domain)?



Optical surveys are ideal for studies of novae and supernovae…

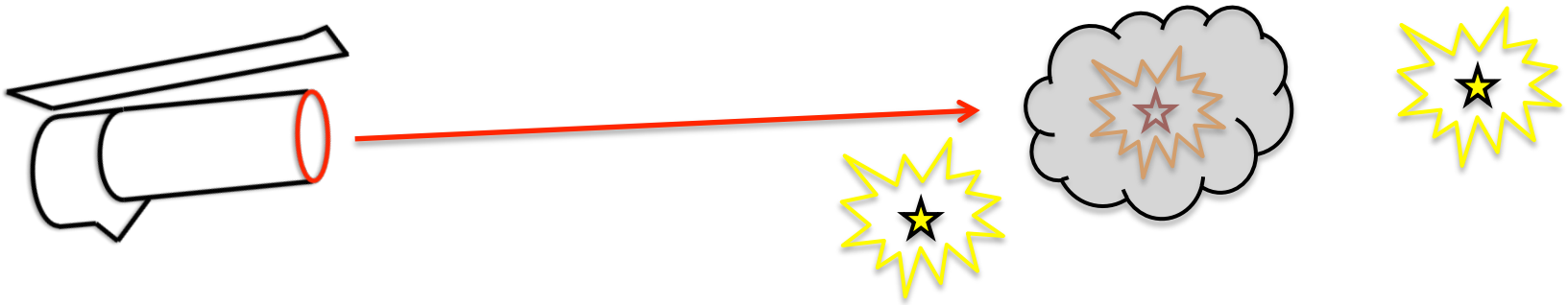
Why the Infrared (for time domain)?



Need **IR** to reveal "invisible" dusty or red transients and variables!

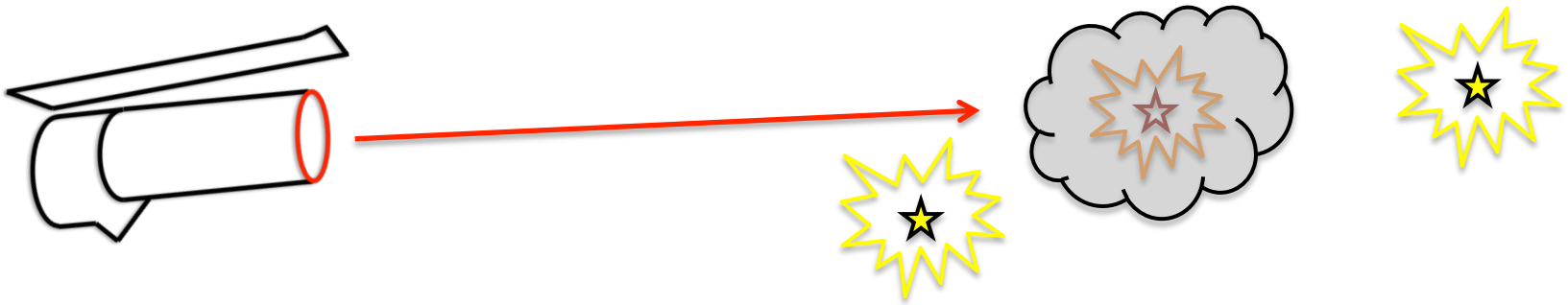
- Luminous red novae (Stellar mergers)
- Intermediate Luminosity Red Transients (SN2008S)
- EM Counterparts of NS-mergers

Exploring the Dynamic Infrared Sky With Spitzer



- **SPIRITS** - **SP**itzer **I**nfra**R**ed **I**ntensive **T**ransients **S**urvey (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



- **SPIRITS** - **SP**itzer **I**nfra**R**ed **I**ntensive **T**ransients **S**urvey (P.I.: Mansi Kasliwal)
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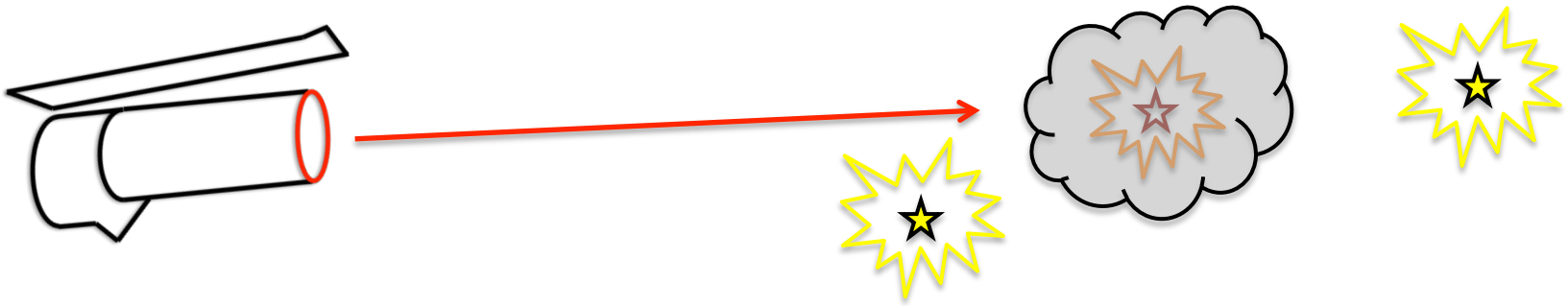
40+ IR transients and 1200+ variables revealed the first year!

(Kasliwal et al. 2017)

Exploring the Dynamic Infrared Sky With Spitzer

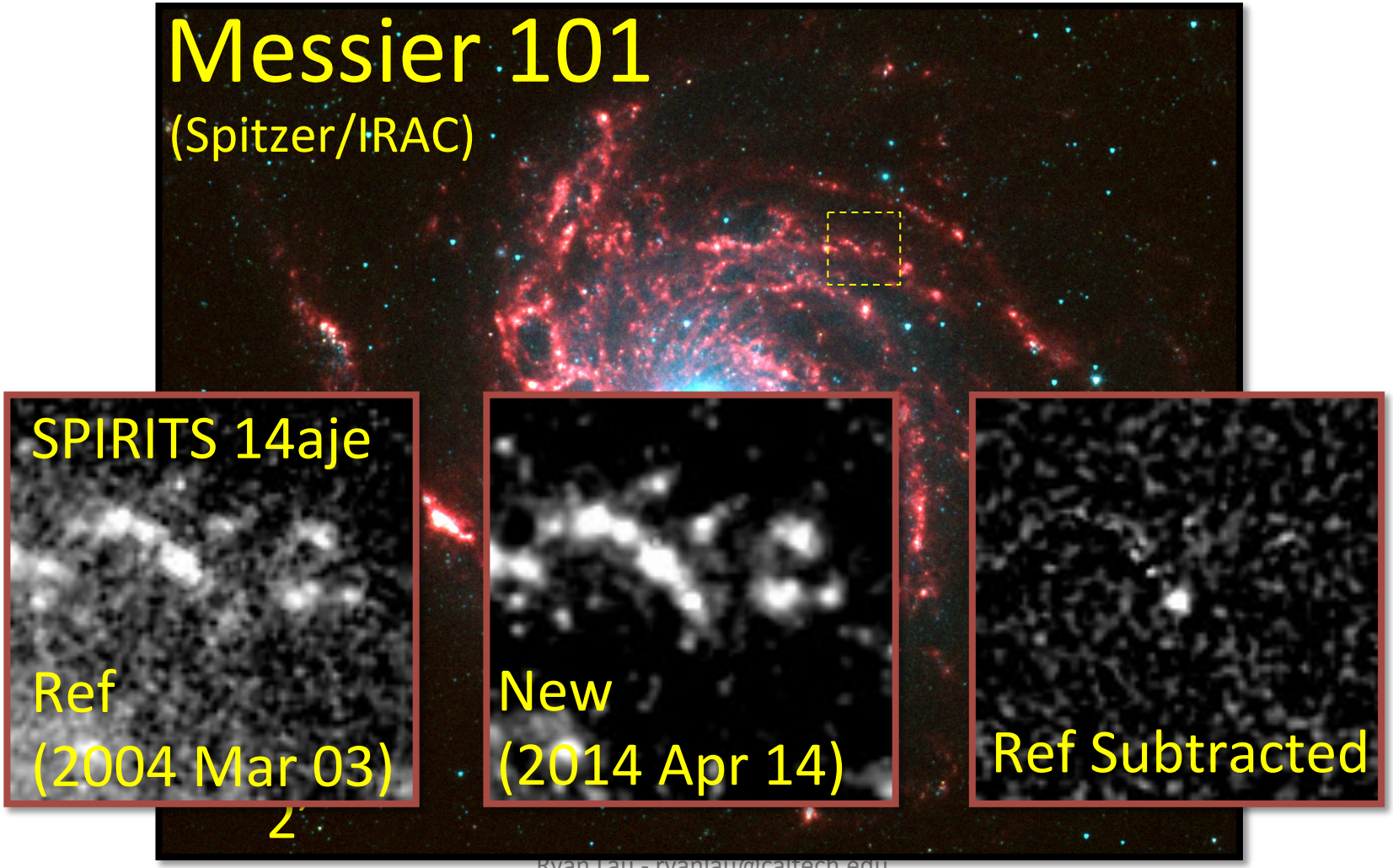


- **SPIRITS** - **SP**itzer **I**nfra**R**ed **I**ntensive **T**ransients **S**urvey (P.I.: Mansi Kasliwal)

New class of mysterious IR transient discovered in SPIRITS!

(Kasliwal et al. 2017)

e**SP**ecially **R**ed **I**ntermediate-luminosity **T**ransient **E**vents (SPRITEs)



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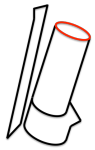
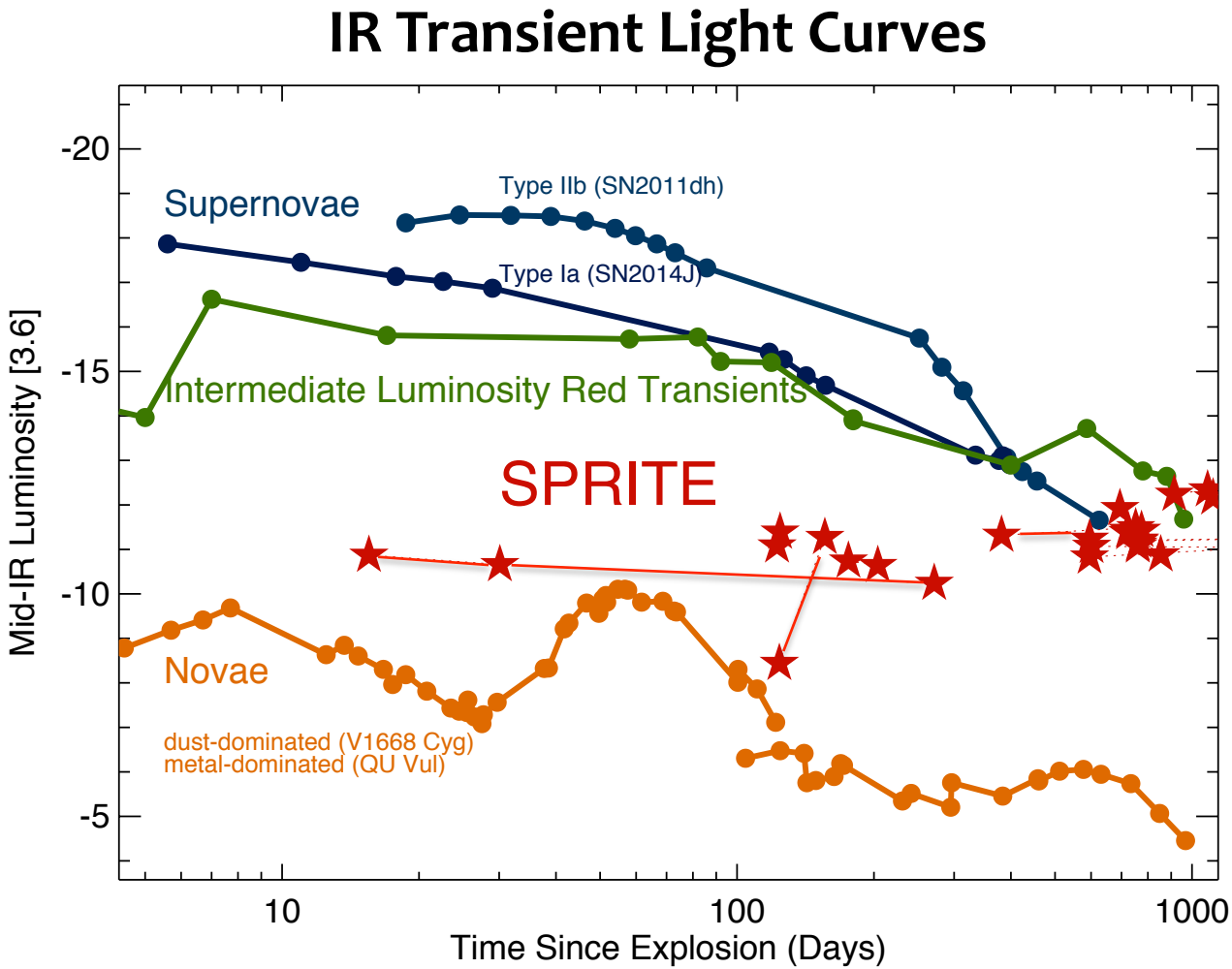
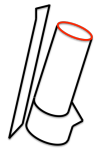
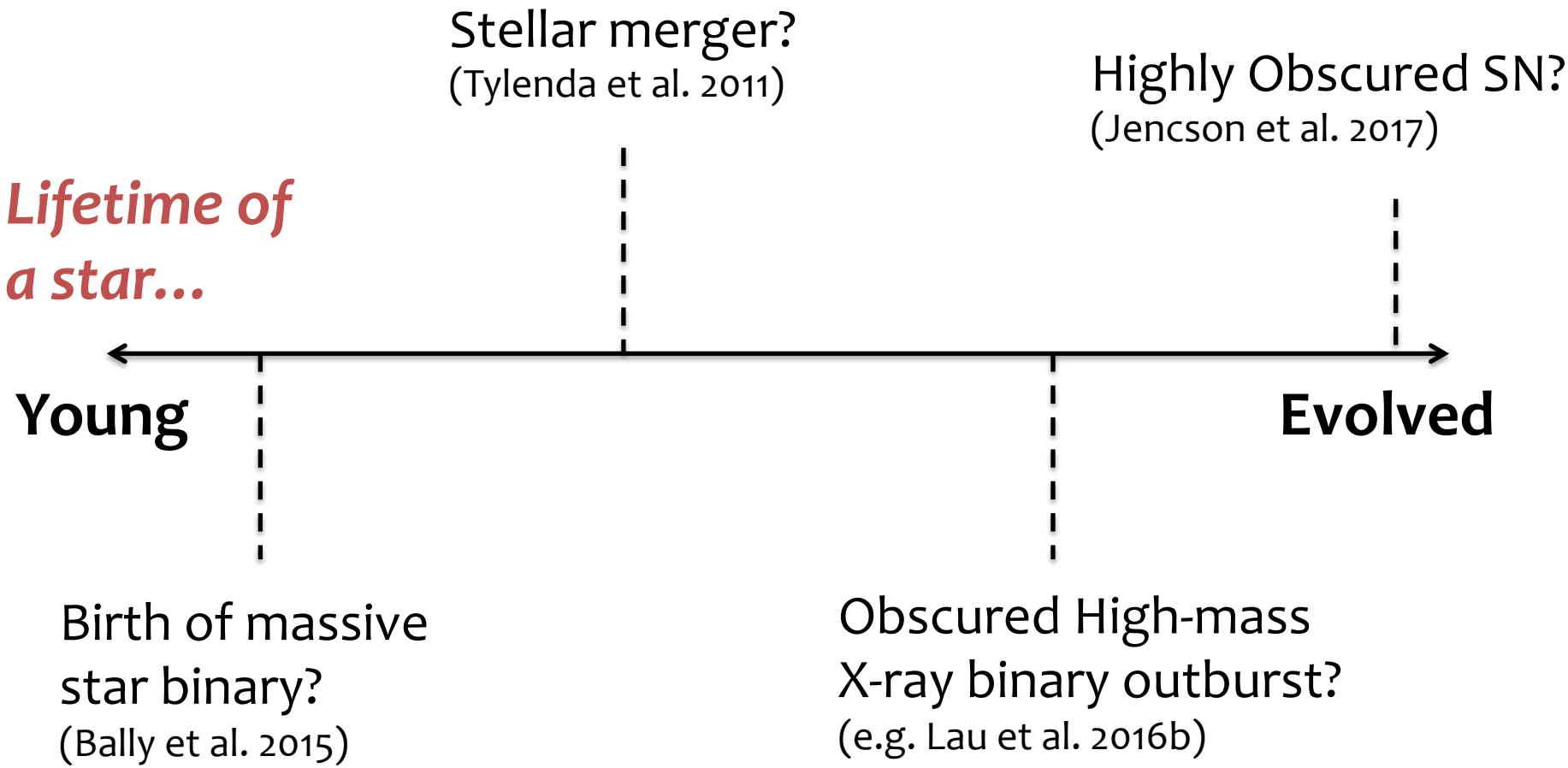




Kasliwal et al. (2017)

What are SPRITEs?





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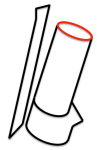
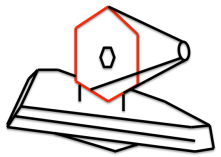


Stellar merger?
(Tylenda et al. 2011)

Highly Obscured SN?
(Jencson et al. 2017)

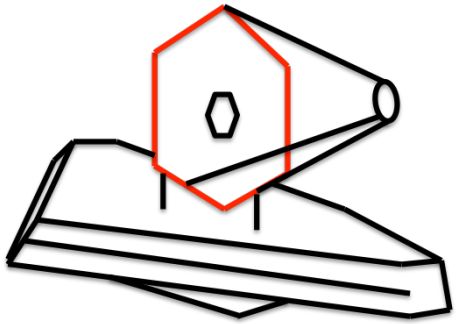
Lifetime of

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



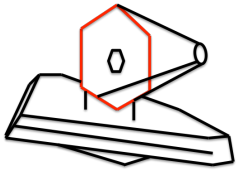
Birth of massive star binary?
(Bally et al. 2015)

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



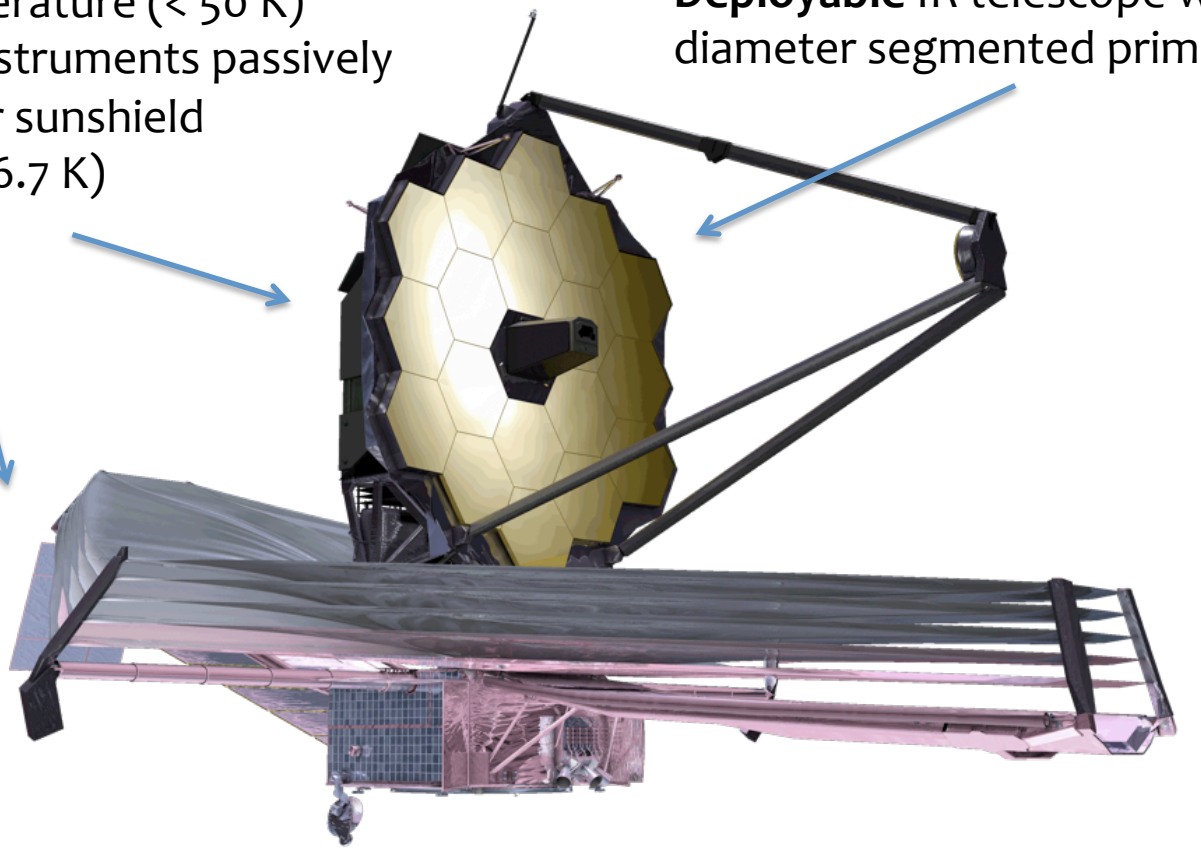
Follow-up Characterization with the James Webb Space Telescope

The James Webb Space Telescope



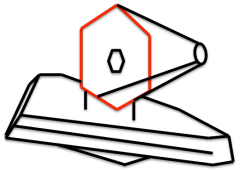
Cryogenic temperature (< 50 K) telescope and instruments passively cooled by 5-layer sunshield (MIRI cooled to 6.7 K)

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



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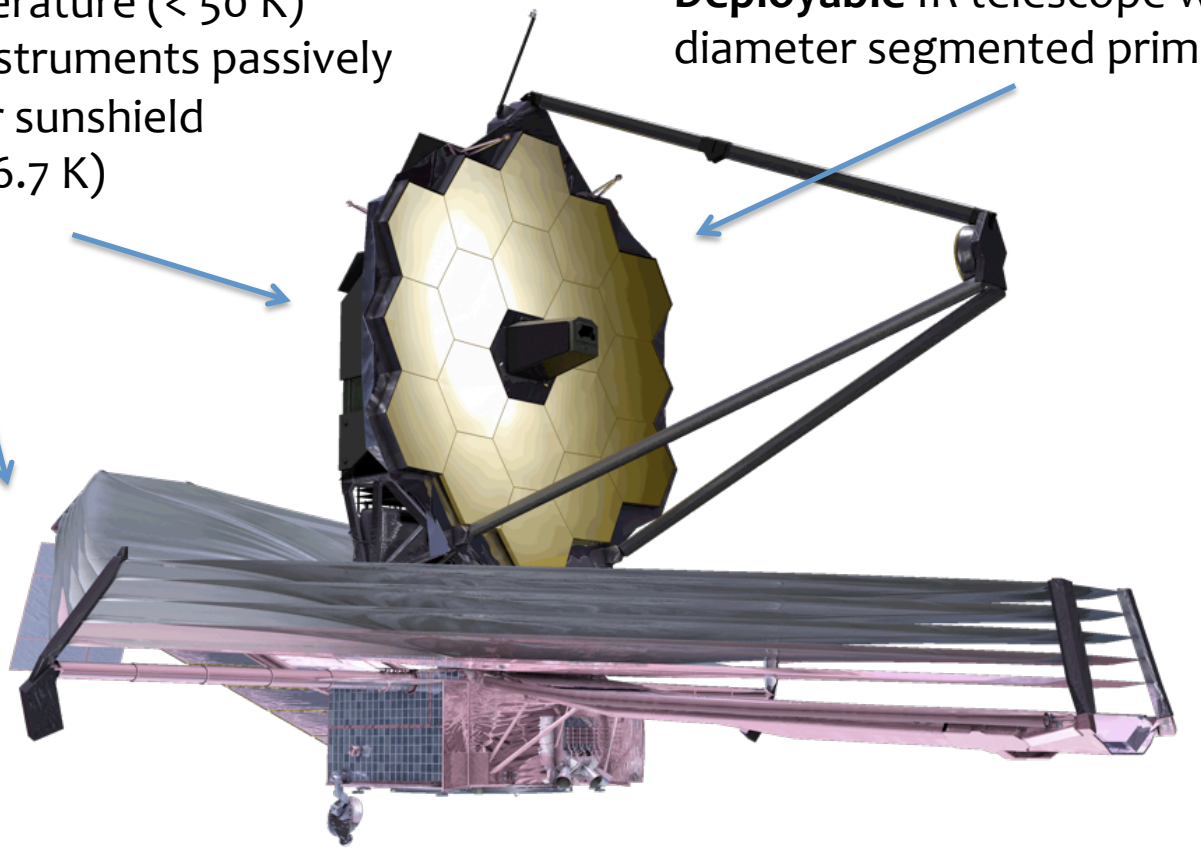
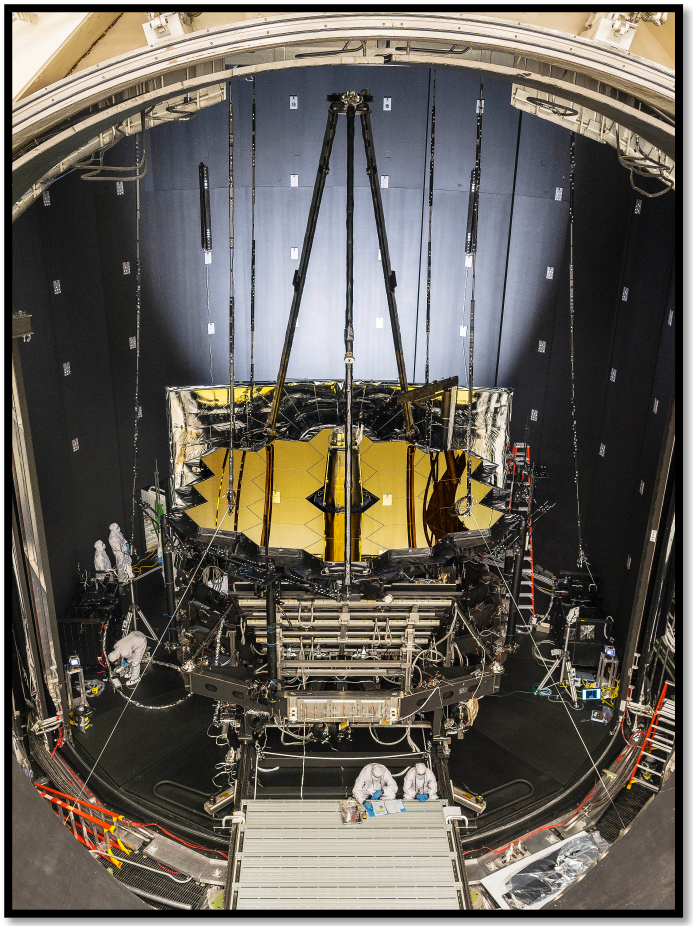


Planned for Mid 2019 Launch - 5 yr science mission (10 yr goal)

JWST Instrumentation

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

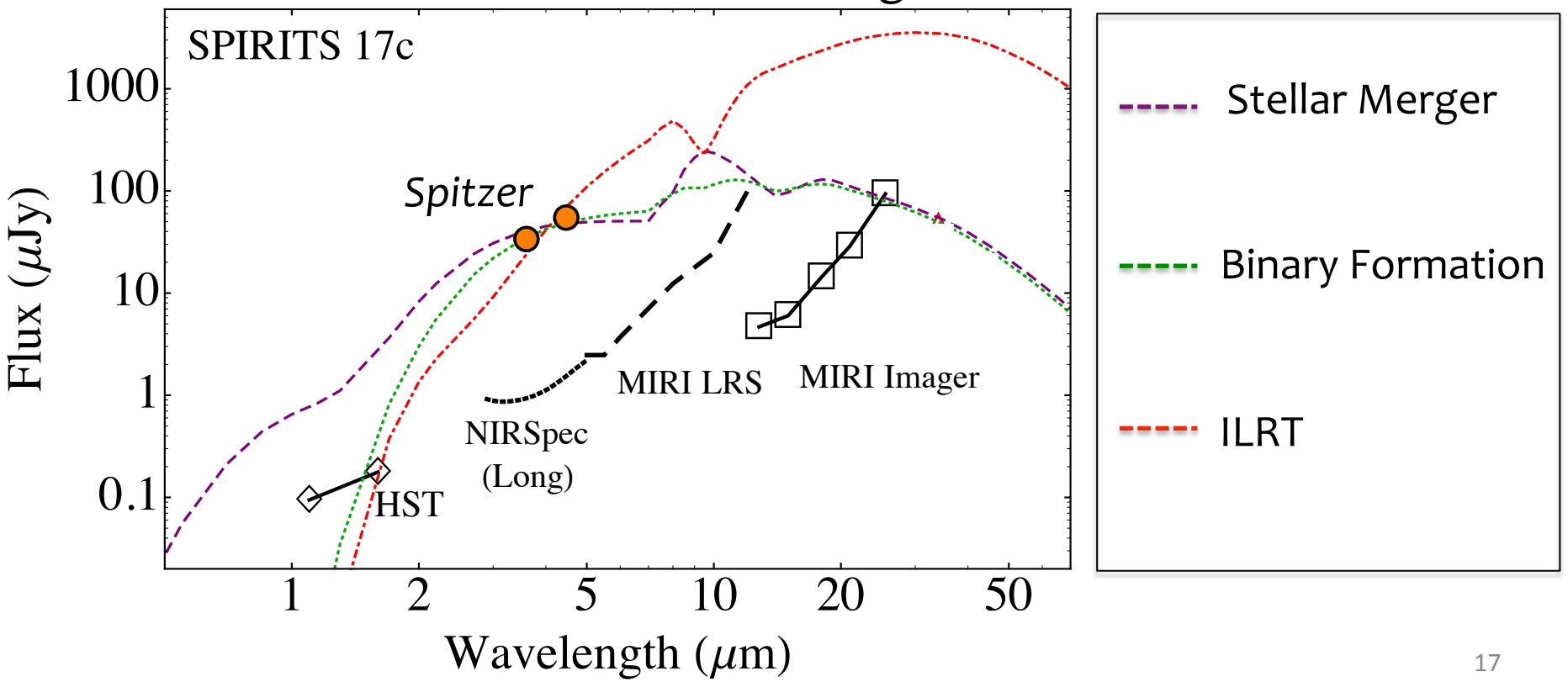


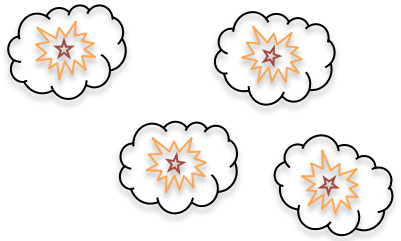
JWST in test chamber at Johnson Space Center for cryo vac test

JWST GTO Program: SPRITE Follow-up

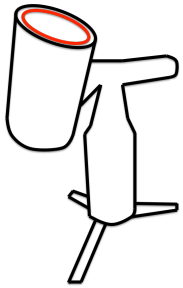
Follow-up **3** SPRITEs identified by *Spitzer* as Targets of Opportunity for **3 – 28** μm coverage. (PI – M. Ressler)

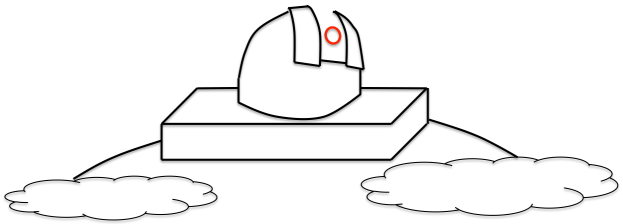
SED of Possible SPRITE Origins



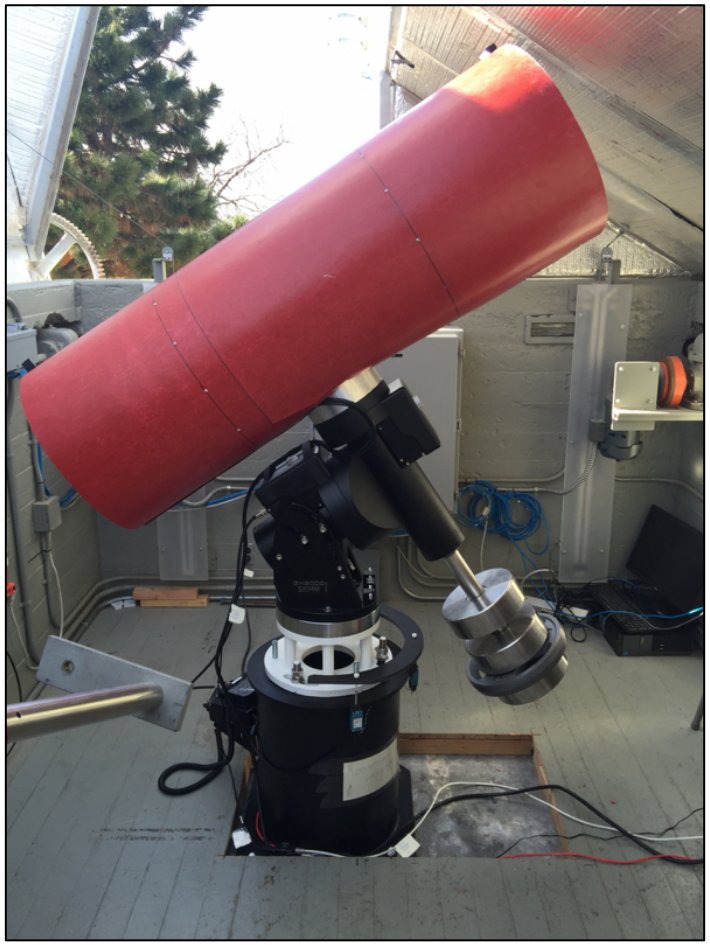


After Spitzer… Continuing the Exploration of the Infrared Sky





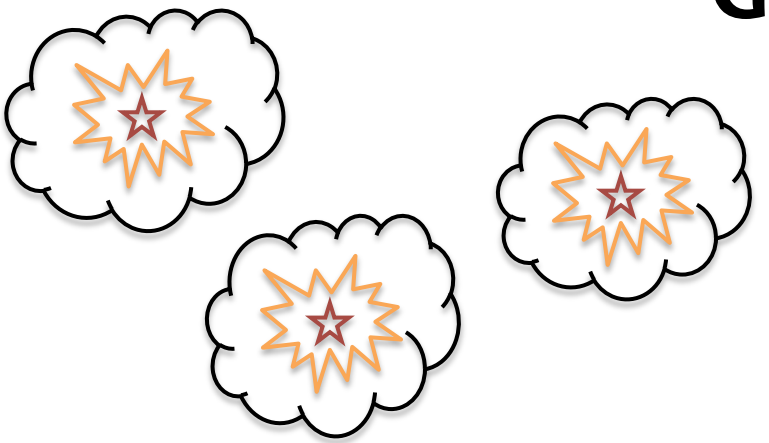
Gattini-IR, an Upcoming Near-IR Survey Telescope (On-sky Spring 2018)

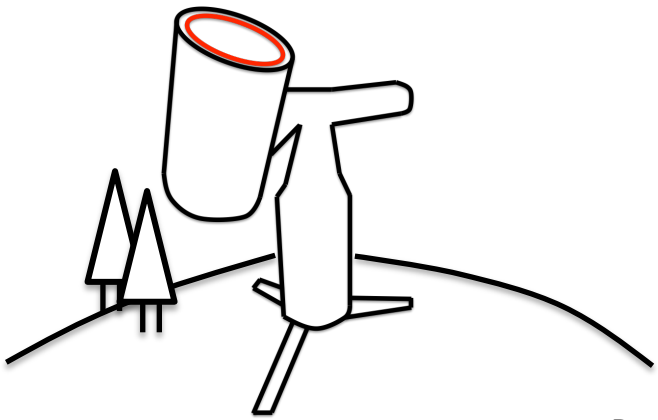


- Wide-field **J**-band survey from Palomar with 0.3 m telescope
  - PI's: M. Kasliwal (Caltech) & A. Moore (ANU)
- 25 sq. degree imager to survey observable sky to **15.5 mag** every night (5σ in 30s)
  - 8.6" pixel scale
- ***"2MASS every month"***

(Moore et al. 2016)

A Nightly Cadence Near-IR Survey



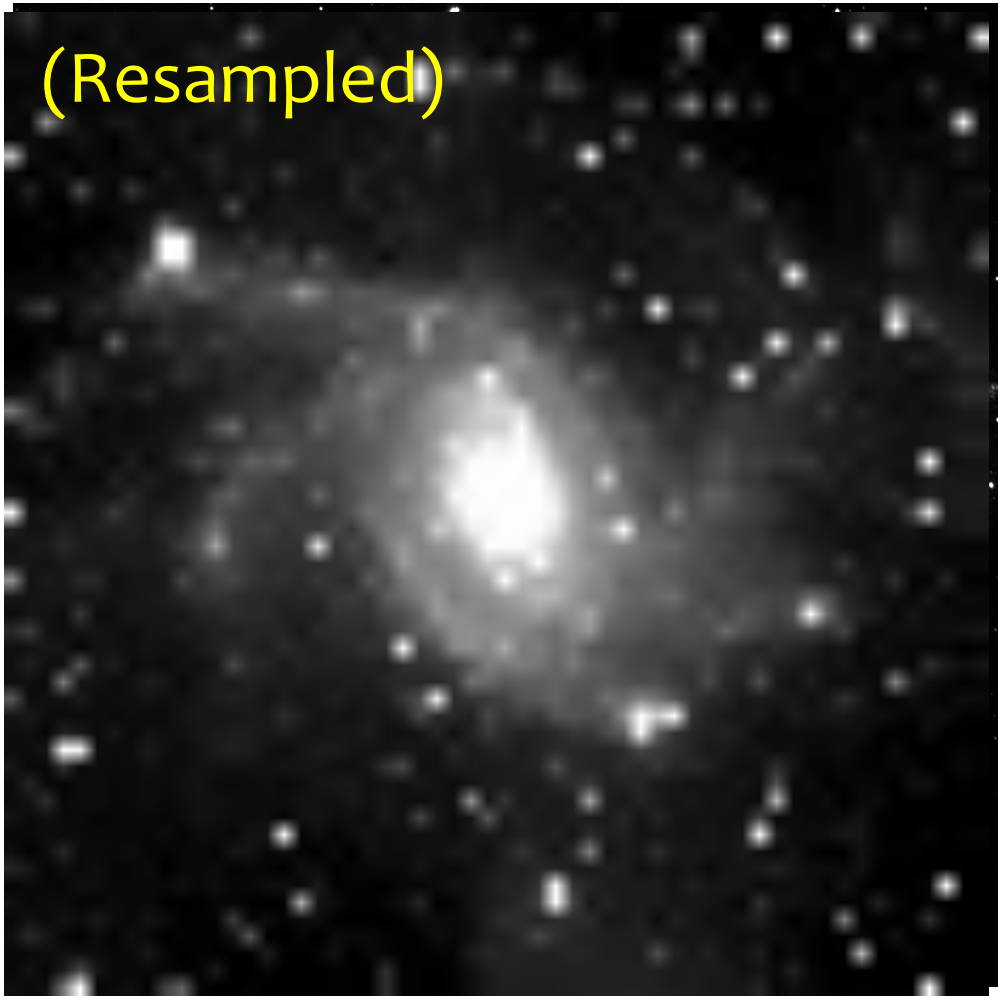


Gattini-IR Science Cases

- Supernovae
- Classical novae
- Massive YSO outbursts
- EM counterparts of NS-mergers

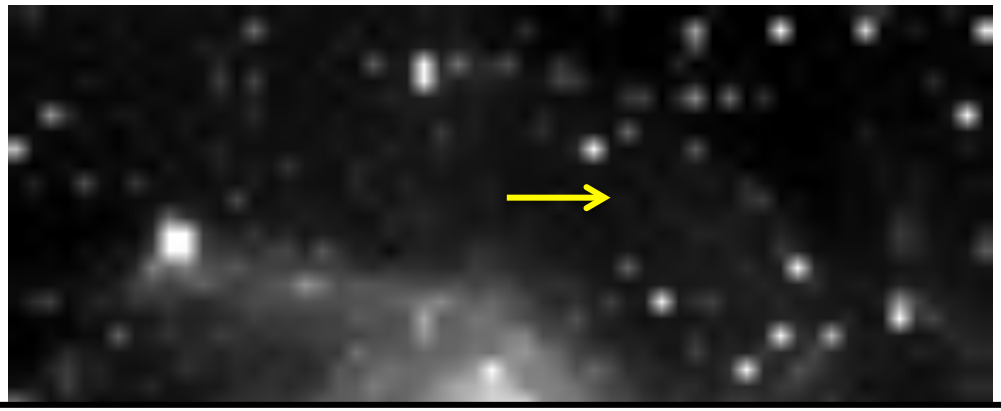
8.6” pixels, a major challenge…

8.7’

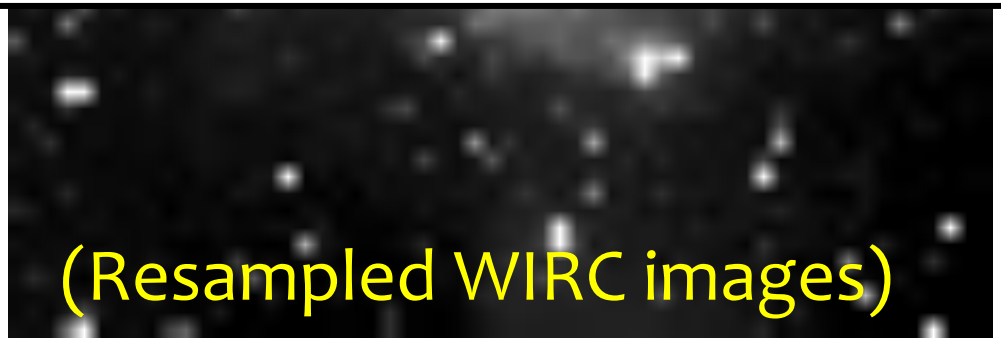


Find the Supernova! (SN2017eaw)

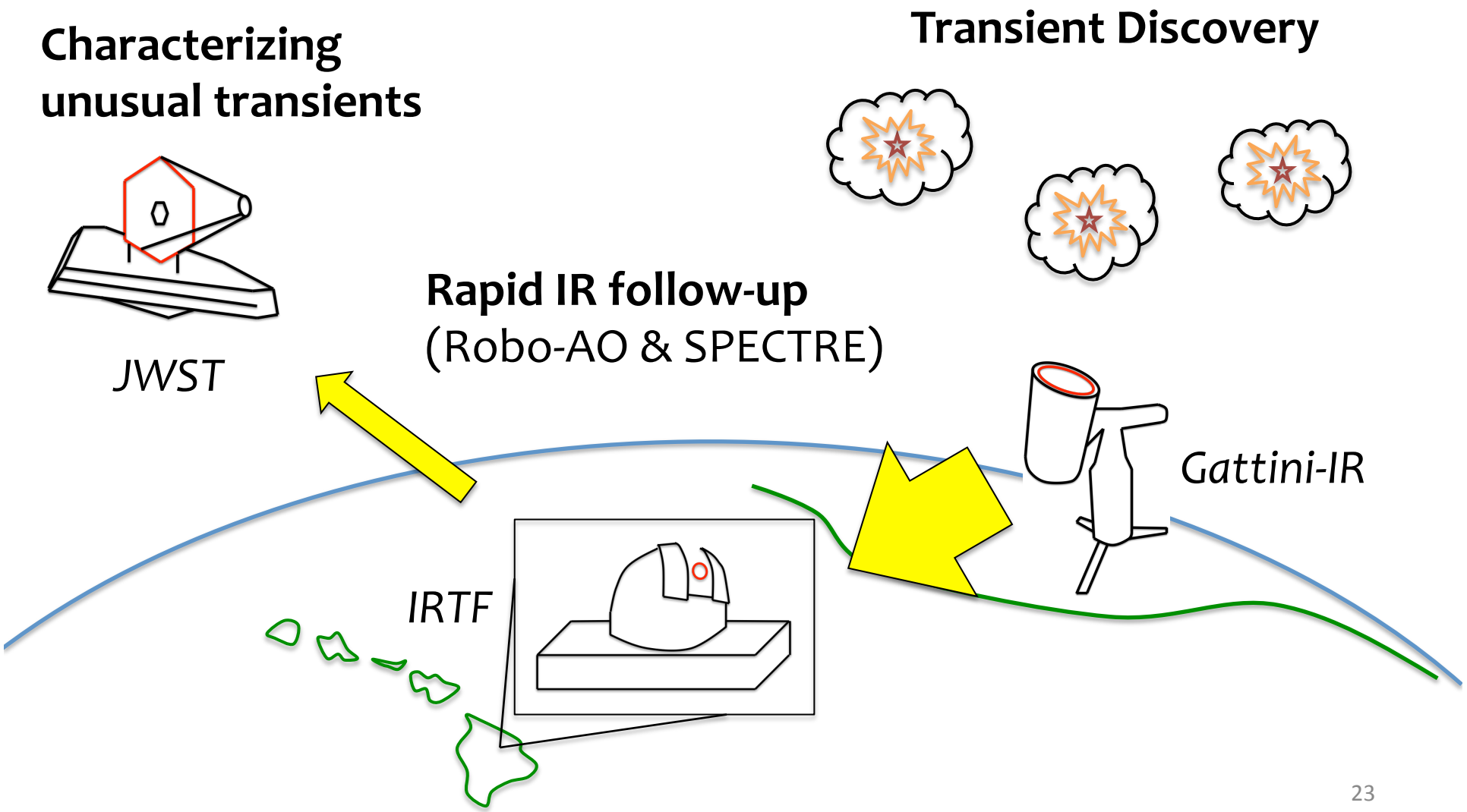
8.7’



Need to resolve and verify Gattini-IR transients



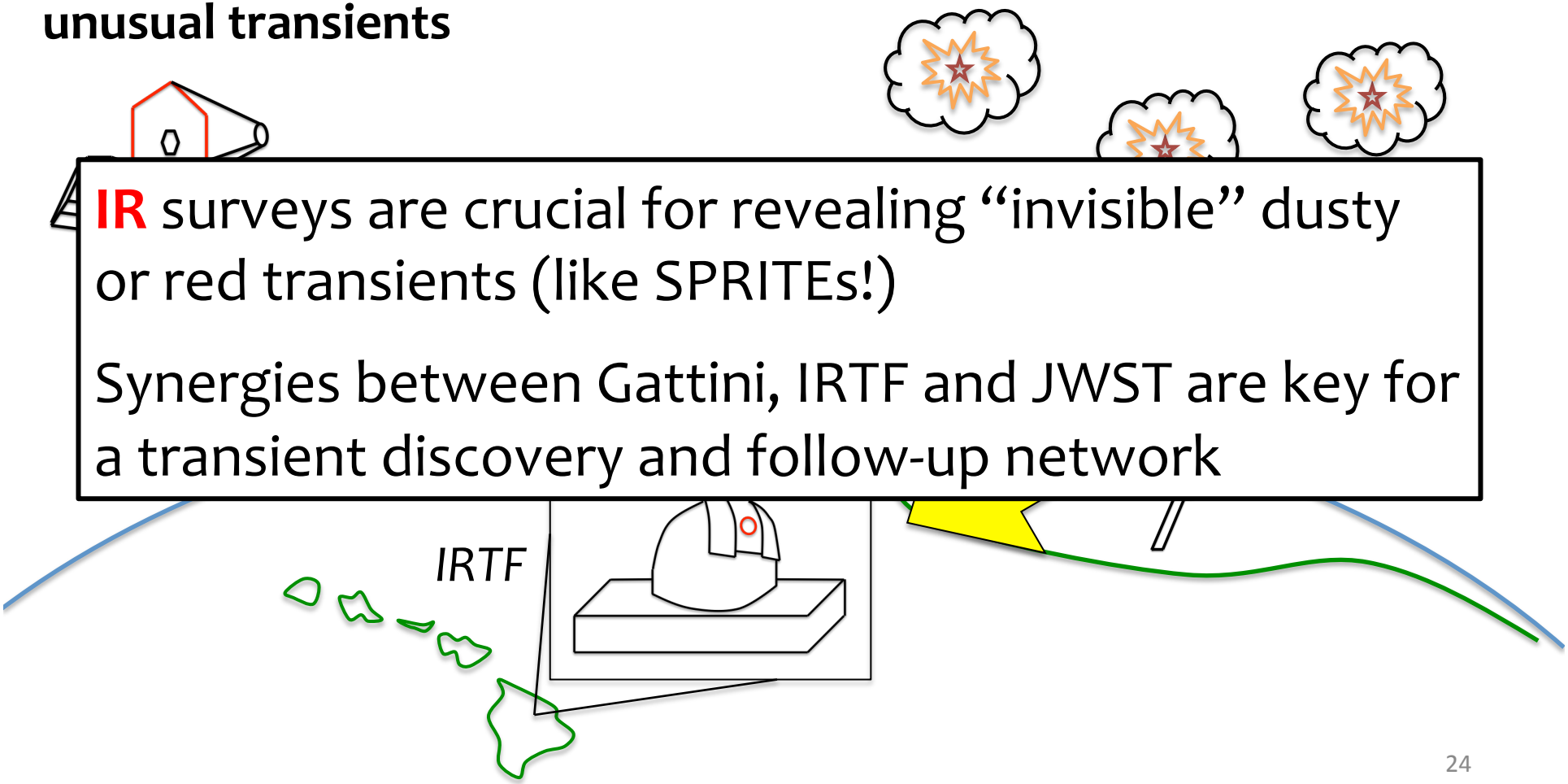
An IR Transient Network: Gattini-IR, IRTF, and JWST



Summary. Thanks!

Characterizing unusual transients

Transient Discovery



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