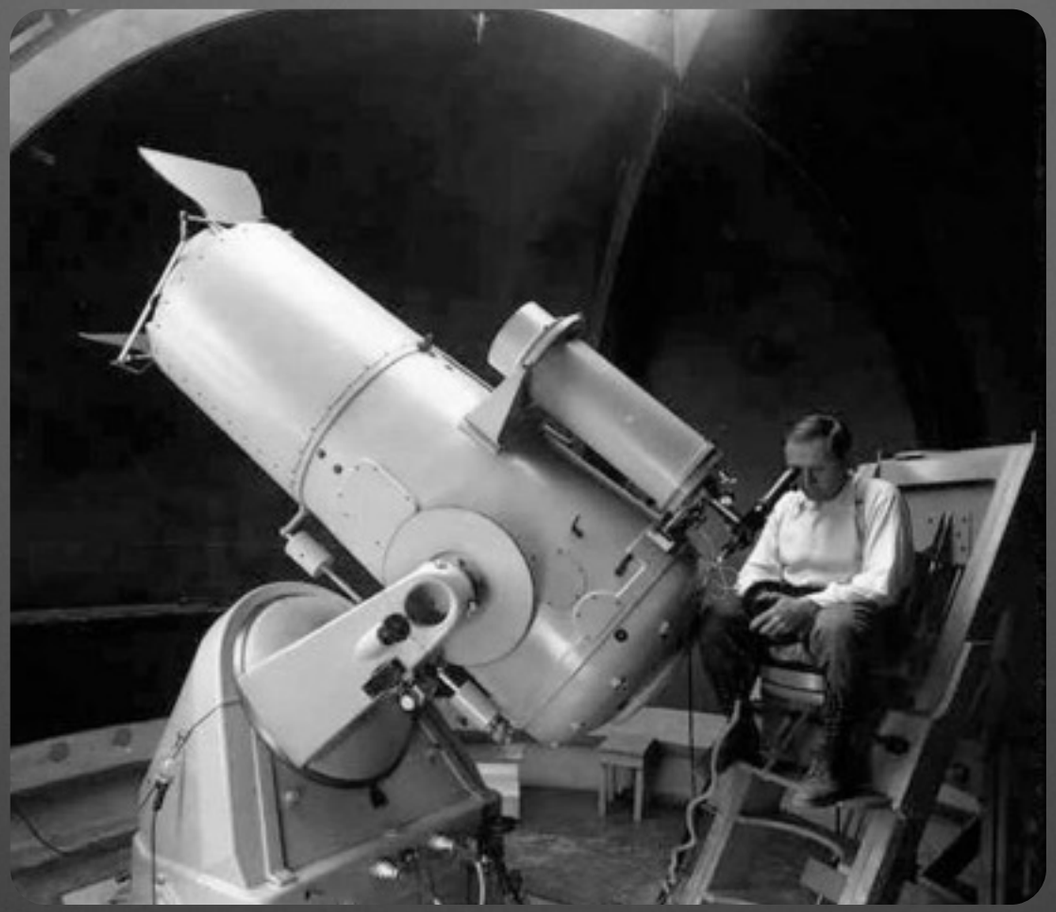
The PTF/ZTF Summer Schools



Adam A Miller
JPL/Caltech
NASA Hubble Fellow

.astronomy 8
23 June 2016

Jet Propulsion Laboratory
California Institute of Technology

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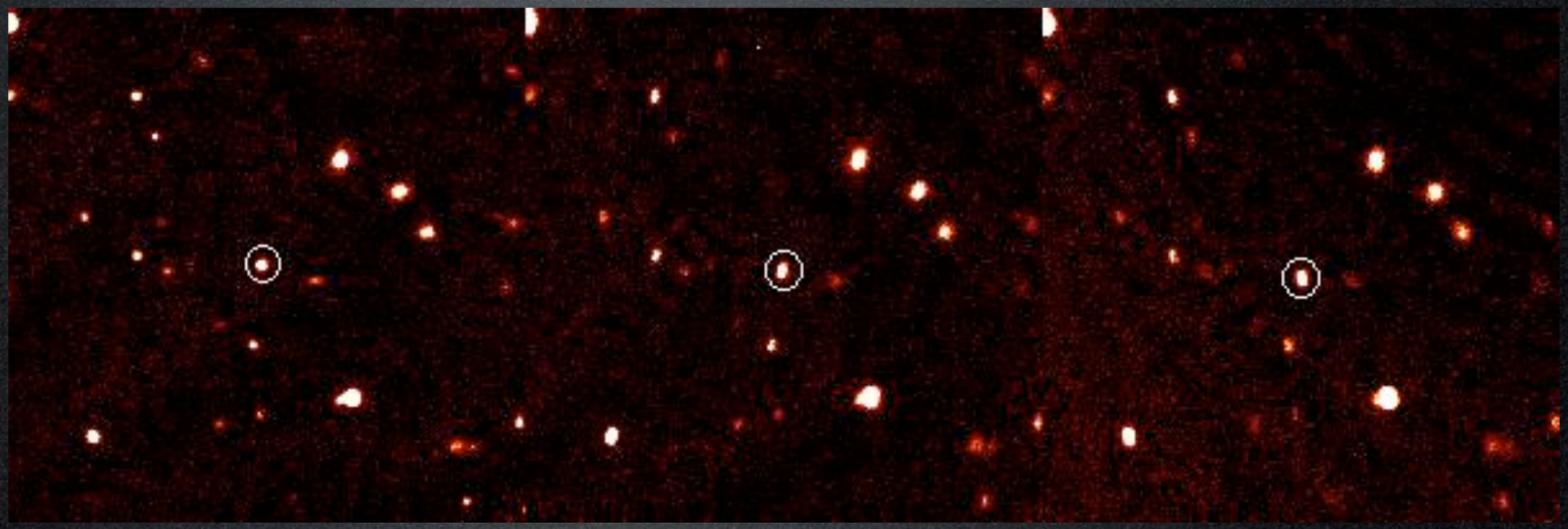
Time-Domain Surveys at Palomar

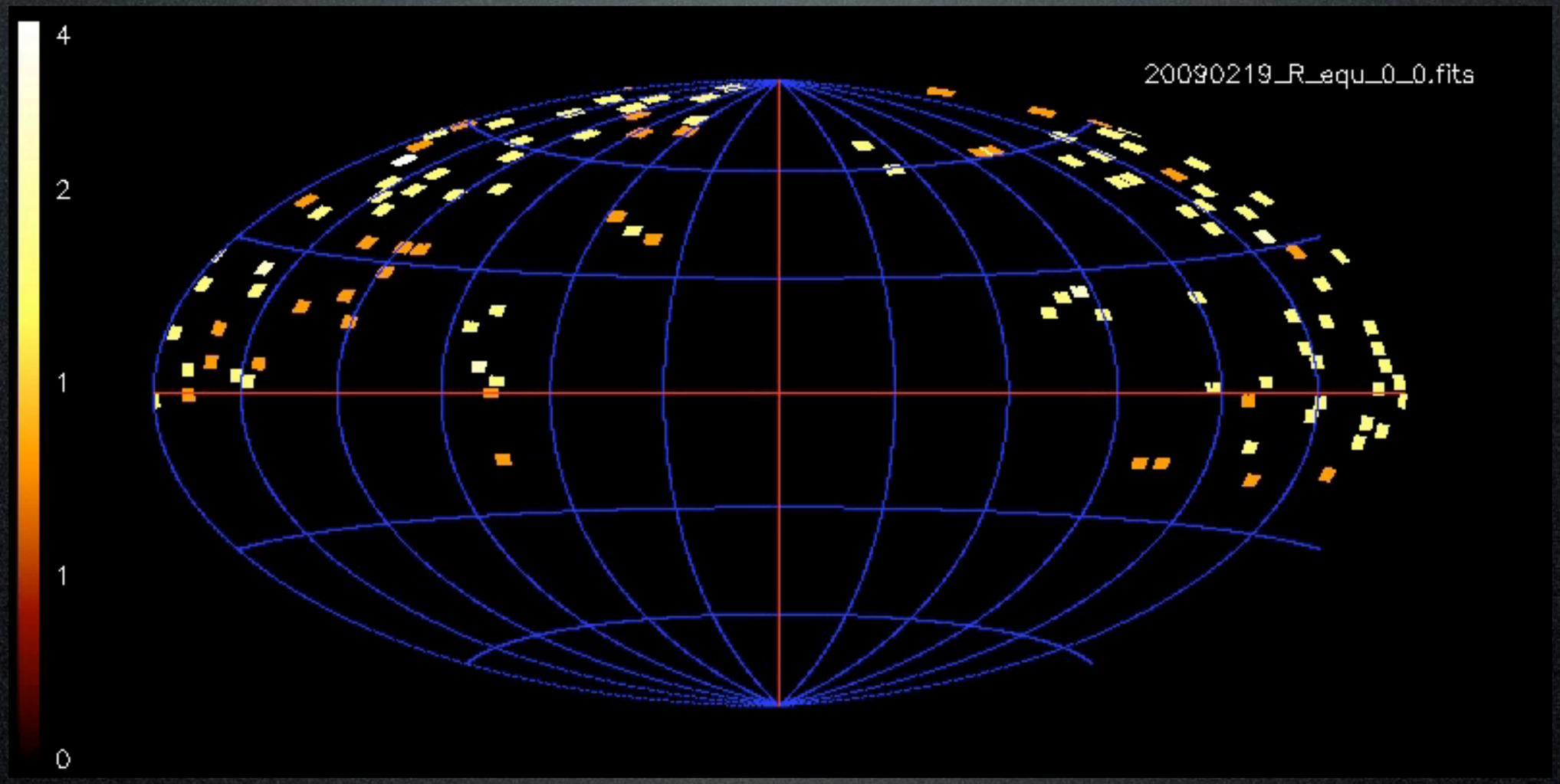
SN 1937A
discovered by F. Zwicky



Dwarf planet Eris
discovered by M. Brown

Introduction to PTF

- **Palomar Transient Factory (PTF) = dedicated time-domain survey**
  - No need to satisfy "static sky" science goals
  - Flexible scheduling for moving objects, variables, transients, etc.

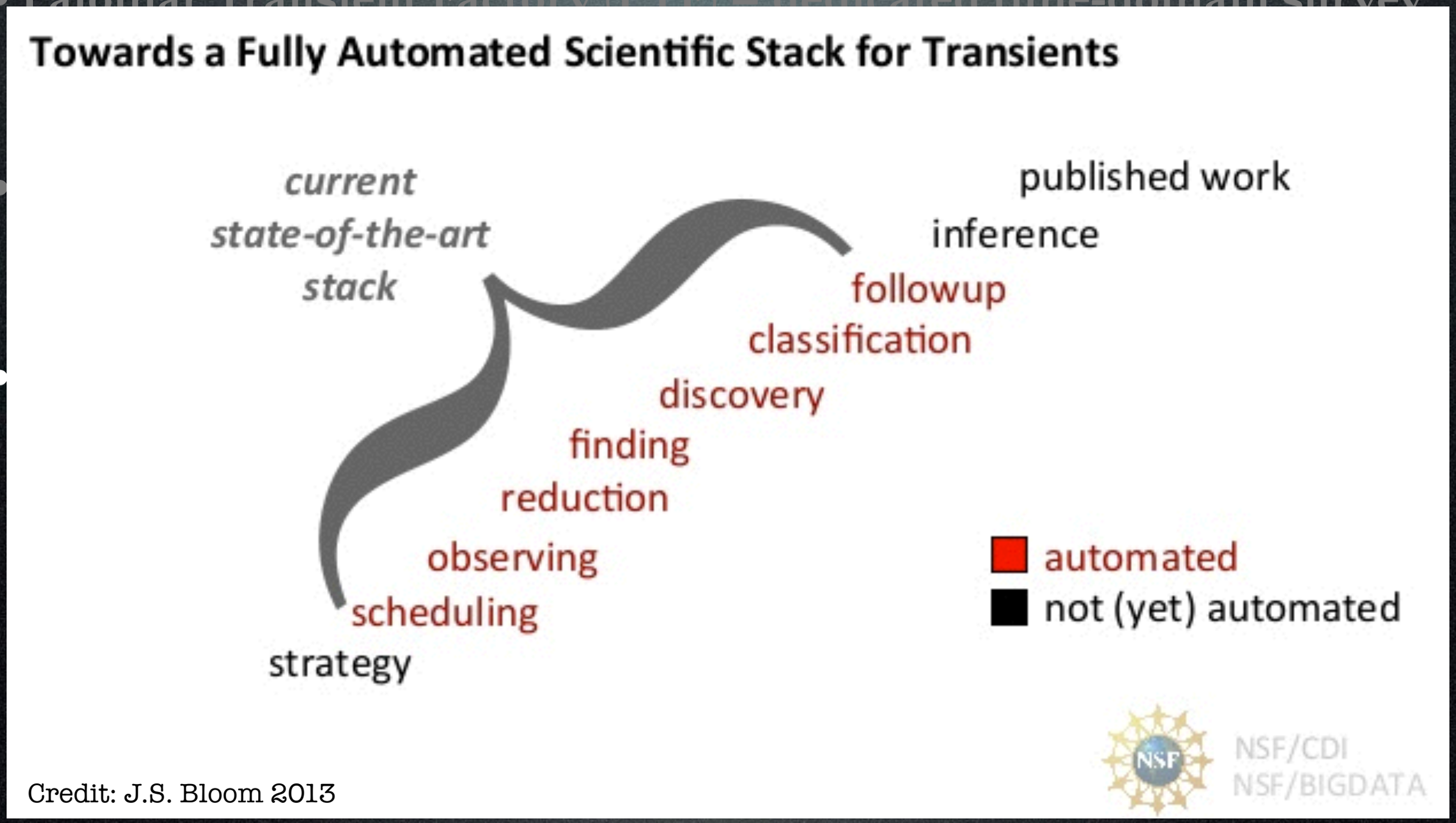


Introduction to PTF

The PTF camera field of view

Introduction to PTF

- Palomar Transient Factory (PTF) = dedicated time-domain survey

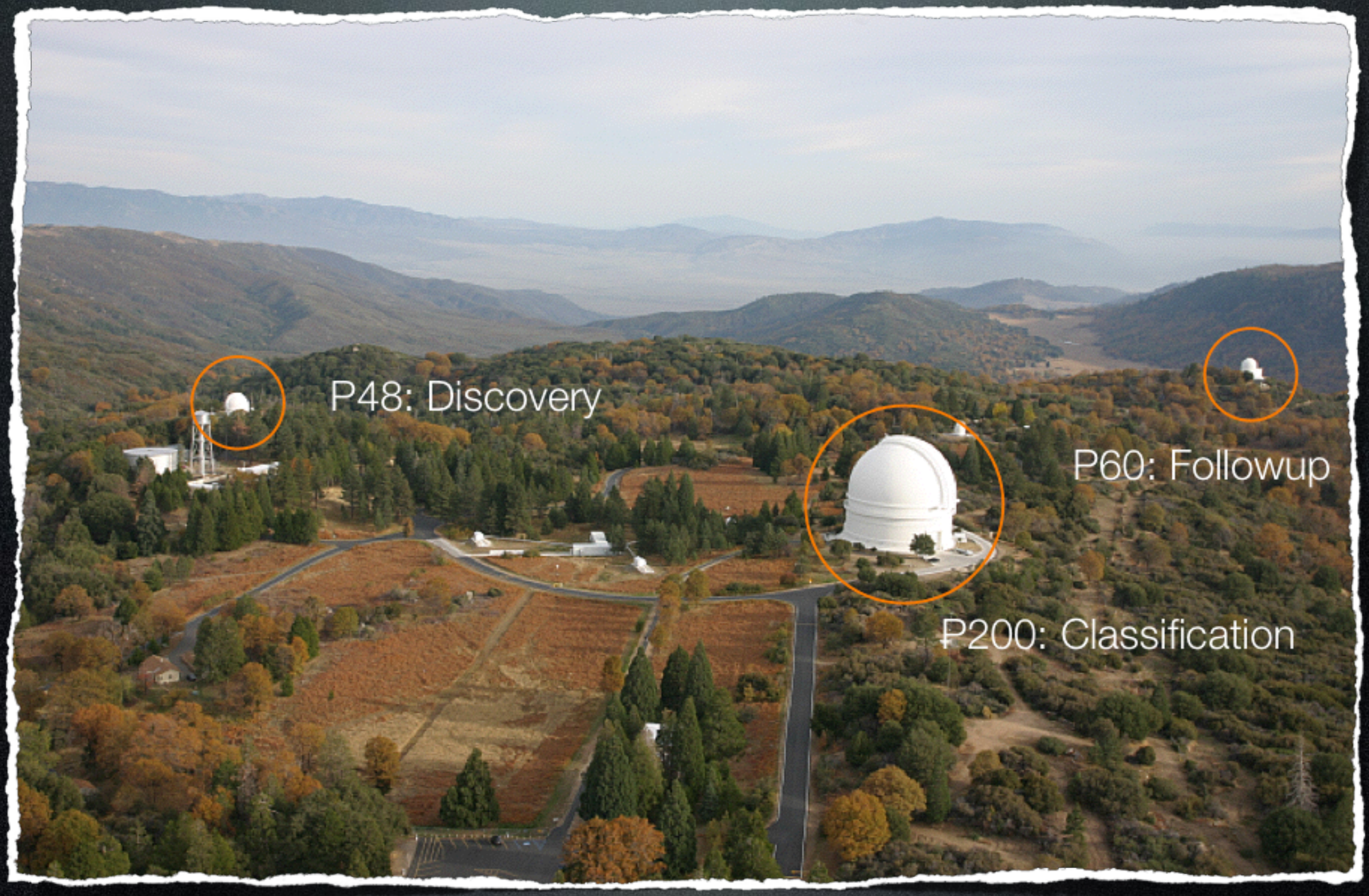


Credit: J.S. Bloom 2013

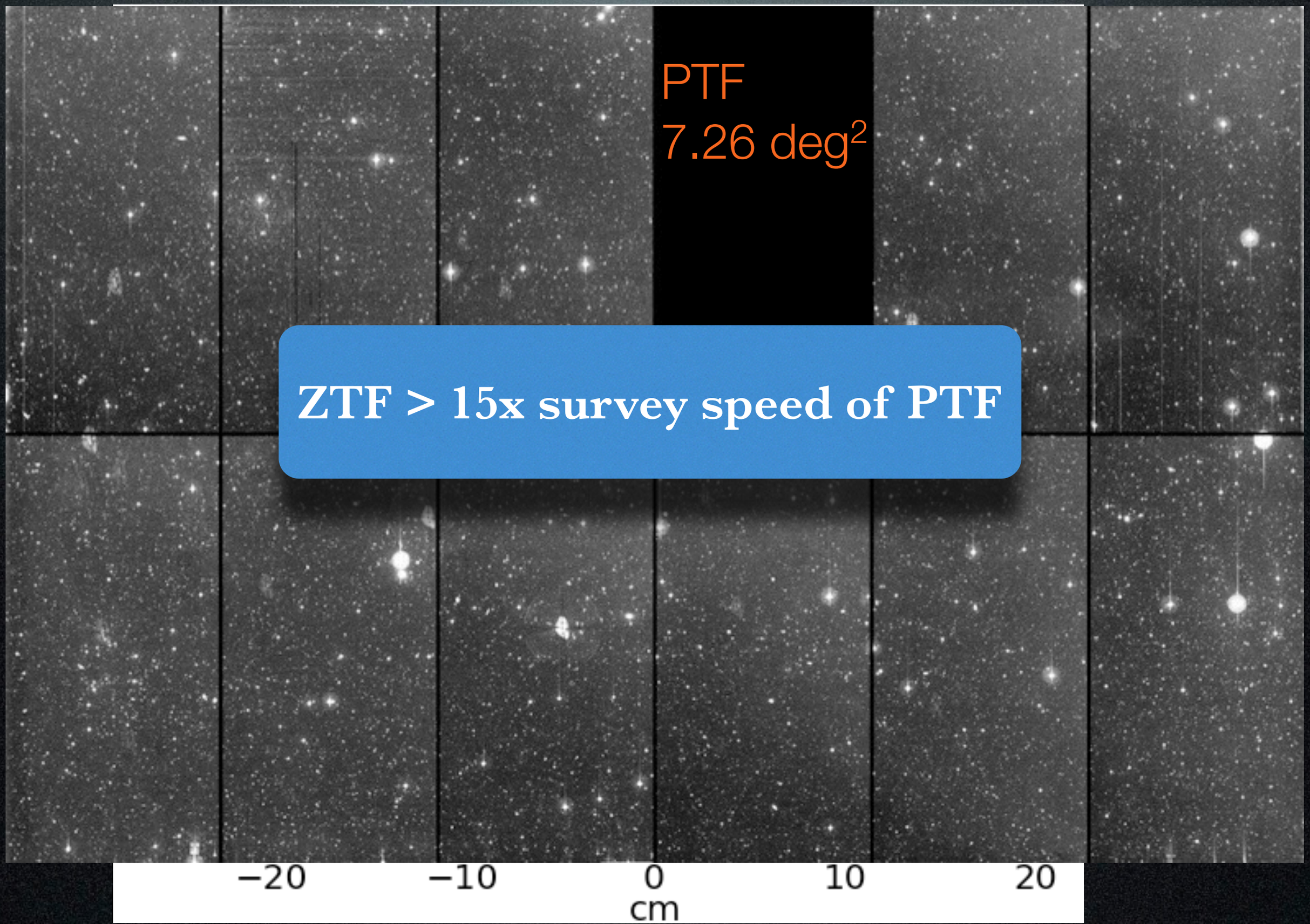
Introduction to PTF

- **Palomar Transient Factory (PTF) = dedicated time-domain survey**
  - No need to satisfy "static sky" science goals
  - Flexible scheduling for specific time-domain science
- **PTF employs a wide-field camera on a 48-in telescope (P48)**
  - FOV = 7.26 deg^2
  - g and R filters
- **Automated processing, candidate ID, follow-up/classification**
  - New transients are identified (sometimes classified) within ~20 min of observation
  - Machine learning has played a vital role in properly vetting candidates
- **Vertically-integrated telescope resources**
  - Seamless follow-up of newly discovered transients
  - P60 = colors; P200 = spectroscopy

Vertically Integrated Discovery/Follow-up



Zwicky Transient Facility



ZTF > 15x survey speed of PTF

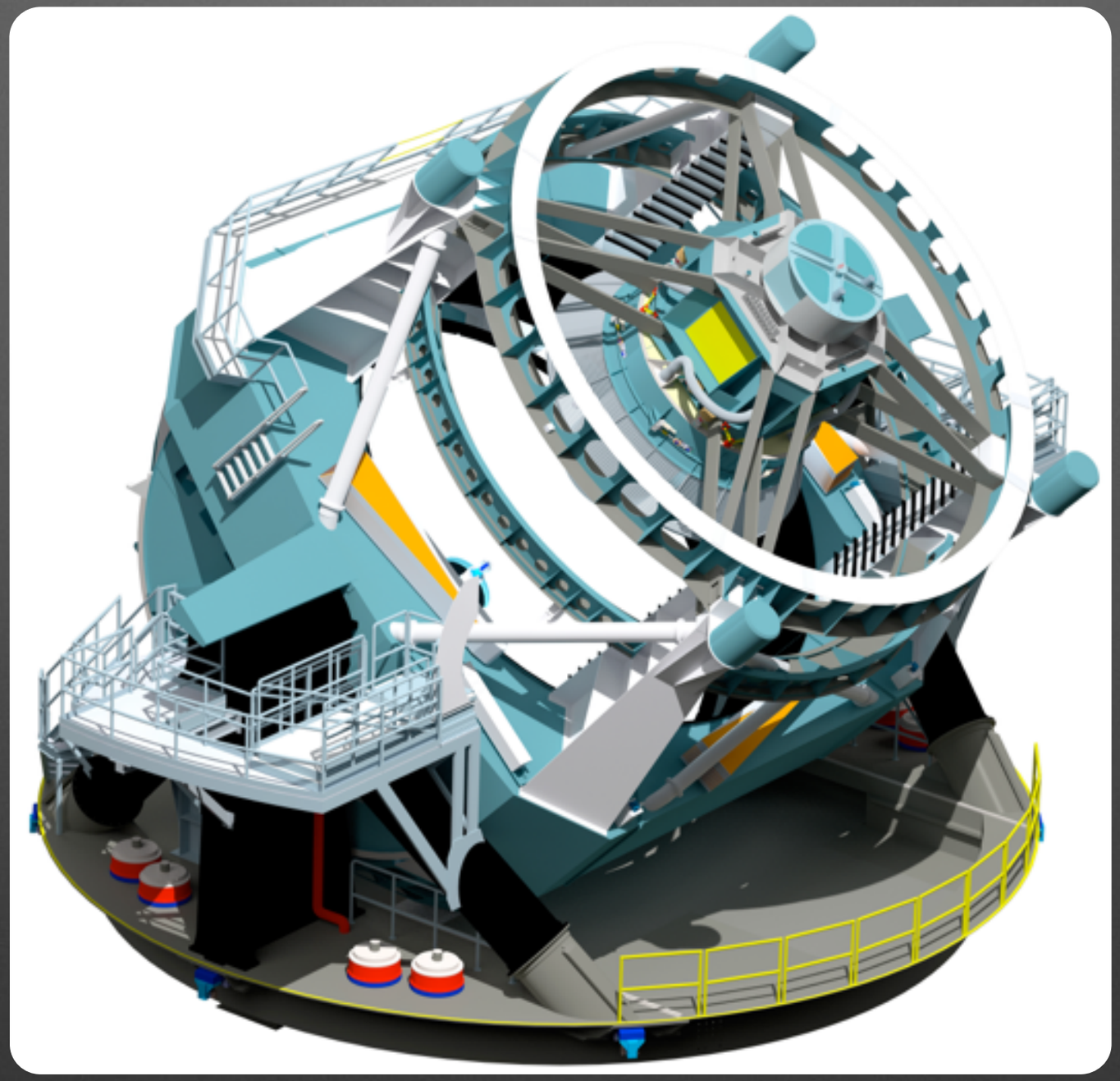
Why Host a TDA Summer School?

TDA = Time-Domain Astronomy*

*there is somewhat of a bias in PTF towards transients

- Little (USA) exposure to public TDA data sources
  - Few surveys (exception - CRTS) good about releasing data
  - ZTF will feature largest releases, along with most complete data products
- Opportunity to develop skills using actual data (warts and all)
  - Workshop is project centered: all exercises utilize PTF data
- Educate on tools for Big Data + TDA
  - Emphasis on machine-learning applications for TDA
  - Participants leave with skills necessary to conduct their own research
- Summarize most-exciting ongoing research areas
  - Science talks from leaders in the field coupled to hands-on problems
- Expose community to different tools available for TDA
  - Instruction on ToOs and multi-wavelength follow-up
- Increase Exposure for the PTF public data releases
  - Lots of misconceptions that PTF is *fully* private
  - ZTF will feature 2 massive public surveys

Why Host a TDA Summer School?



Credit: LSST.org

The 800 lb gorilla in the TDA room…

PTF Summer School - Five Ws

Who, What, Where, When, Why

PTF Summer School - Five Ws

Who, ~~What~~, Where, When, ~~Why~~

PTF Summer School - Five Ws

Who, ~~What~~, Where, When, ~~Why~~

Instructors: PTF team members (mostly Caltech based)

Participants: Students/Postdocs from across the globe

Lecturers: ZTF Community Science Advisory Board

2014 Participants

ZTF Community Science Advisory Board

Advise PTF/ZTF on science priorities

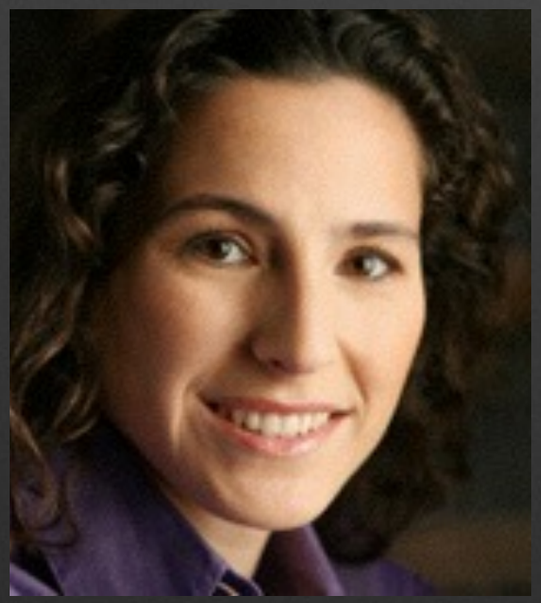
Marcel Agueros
Columbia

Todd Boroson
LCOGT

Dale Frail
NRAO

Neil Gehrels
GSFC

Mario Juric
LSST/UW



Juna Kollmeir
Carnegie

Marc Pinsonneault
OSU

Allen Shafter
SDSU

Paula Szkody
UW

Steve Ridgway
NOAO

PTF Summer School - Five Ws

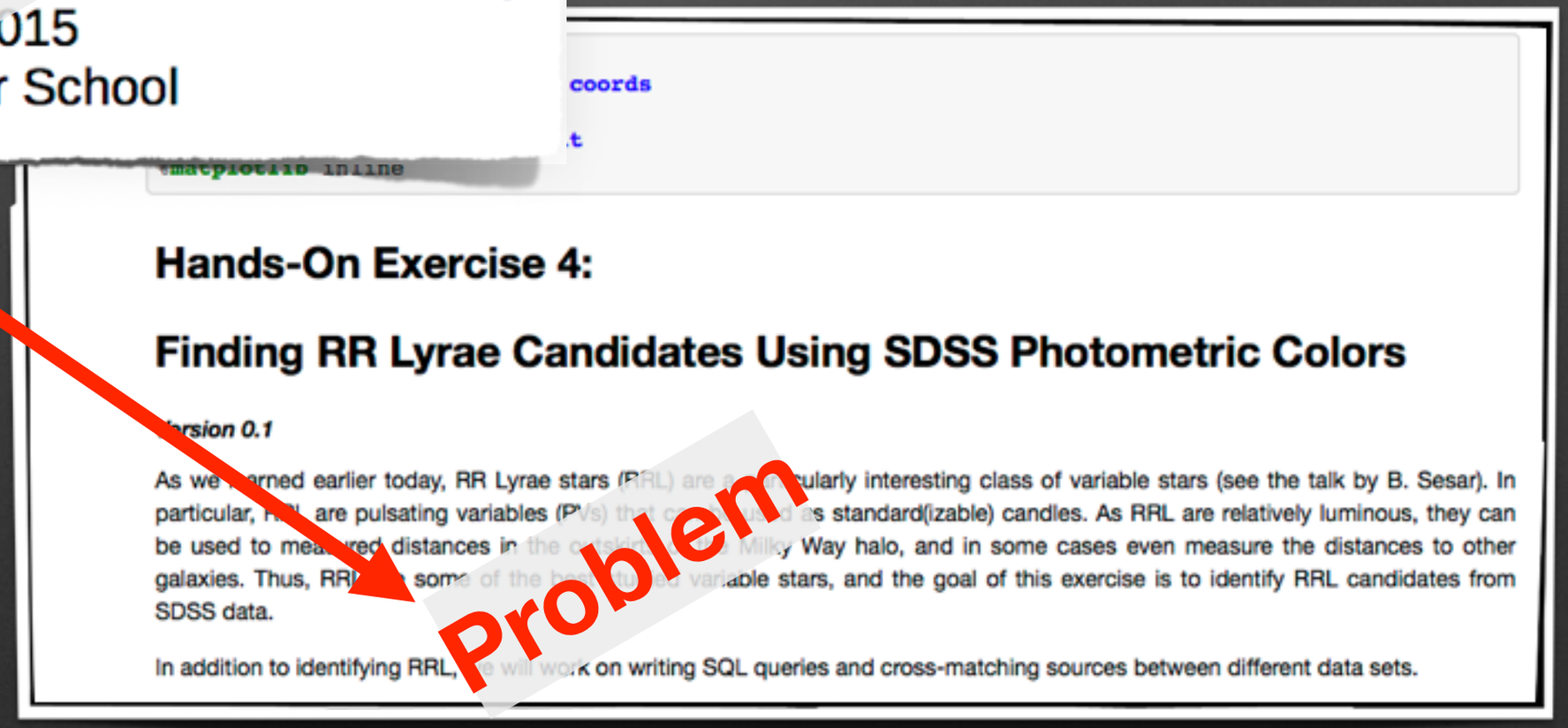
~~Who~~, ~~What~~, Where, When, ~~Why~~

Caltech - every summer for (at least) next 4 yr

Credit: Lin Yan

PTF Summer School - In practice

- General structure: science talk, then related “hands-on” session
  - e.g., stellar pulsations talk followed by search for RR Lyrae variables
  - Hands-on sessions utilize publicly available PTF data
  - Problems are written in iPython Notebooks



PTF Summer School - In practice

- G "hands-on" session
  - e variables
  - H
  - F
- P
  - E

```
import numpy as np
import astropy.coordinates as coords
import astropy.units as u
import matplotlib.pyplot as plt
%matplotlib inline
```

Hands-On Exercise 4:

Finding RR Lyrae Candidates Using SDSS Photometric Colors

Version 0.1

As we learned earlier today, RR Lyrae stars (RRL) are a particularly interesting class of variable stars (see the talk by B. Sesar). In particular, F
be used to
galaxies. Th
SDSS data.

In addition

Hands-On Exercise 5:

Identifying RRL and QSO Candidates Via Machine Learning

Version 0.1

Yesterday we saw the importance of RR Lyrae stars, and earlier today we heard about active galactic nuclei (AGN). The most luminous
known Q
meaning
to identif

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Hands-On Exercise 6:

Building a Machine Learning Classifier to Identify RRL and QSO Candidates Via Light Curves

Version 0.1

We have spent a lot of time discussing RR Lyrae stars and QSOs. The importance of these sources will not be re-hashed here, instead we will jump right into the exercise.

Today, we will measure a large number of light curve features for each PTF source with a light curve. This summer school has been dedicated to the study of time-variable phenomena, and today, finally, everything will come together. We will use machine learning tools to classify variable sources.

PTF Summer School - In practice

- General structure: science talk, then related “hands-on” session
  - e.g., stellar pulsations talk followed by search for RR Lyrae variables
  - Hands-on sessions utilize publicly available PTF data
  - Problems are written in iPython Notebooks
- Program is integrated from start to finish
  - Each problem builds on, and utilizes, skills from previous problem
- Program is dynamic: Lectures and exercises updated each year
  - student feedback is incorporated to improve overall curriculum
  - e.g., significant ML additions after yr 1; SNe additions after yr 2

*no official hacking at the school

- hope to incorporate in the future, resources/logistics may not allow this

Lessons Learned

Credit: Lockhart Catering

Lessons Learned

- Marketing is important
  - know who you would like to attend the school
- Size is crucial - for both instructors and participants
  - PTF goal: ~100 [probably too large]
- Curriculum updates are necessary for multi-yr program
  - summer programs should supplement traditional courses
  - field moves quickly; lecture topics and problems need to be updated
- Identify who cares [w/in organizers]; exclude those that don't
  - too many cooks create a non-coherent program
- Major breakthrough: build a top down program
  - school sig. improved when we considered day 0—5 a single unit
  - (in hindsight, this is somewhat obvious)

Conclusions

- Explosion of TDA surveys during the past/future decade
  - studies from ground and space across EM spectrum (incl. multi-messenger)
  - e.g., CoRoT, CRTS, PS1, PTF, Kepler, TESS, ZTF, WFIRST, LSST
- ZTF will provide the most LSST-like TDA data set
  - we have developed a school to train young astronomers in advance of LSST
- School w/ topical lectures + hands-on data experience
  - training entirely in Python; focus on ML and time-series techniques
- School is updated every year to reflect new trends in TDA
  - dynamic topics are actually influenced by the students

Conclusions

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  - training entirely in Python; focus on ML and time-series techniques
- School is updated every year to reflect new trends in TDA
  - dynamic topics are actually influenced by the students
- **Registration is open - you can still apply**
  - **Deadline is July 1; School is July 18 — 21 in Pasadena, CA**
  - http://www.astro.caltech.edu/iptf-2016

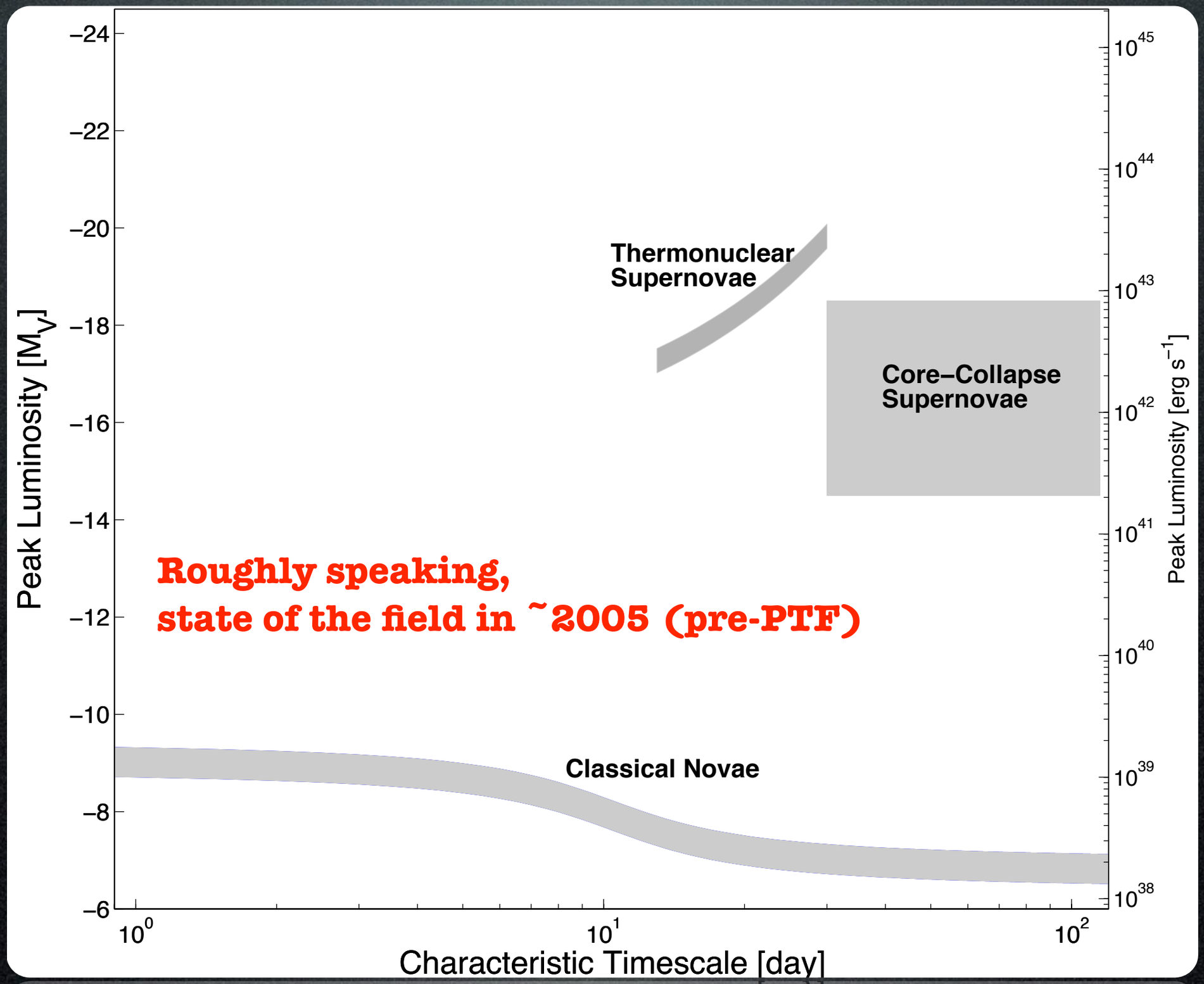
Awwwwwwwww

SNAP!

You just asked a dope question!

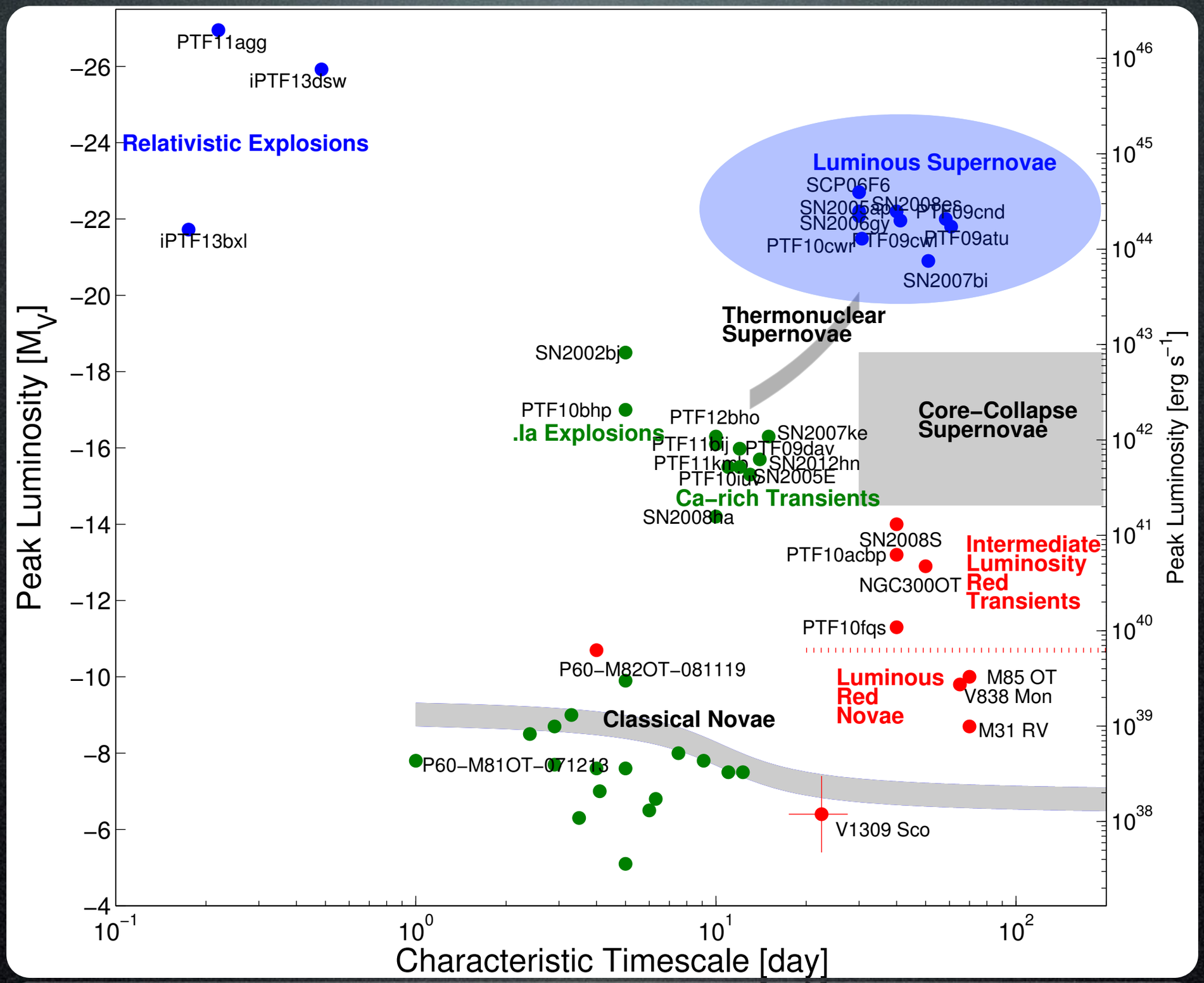
Phase Space for Optical Transients

i.e. Scientific motivation for PTF



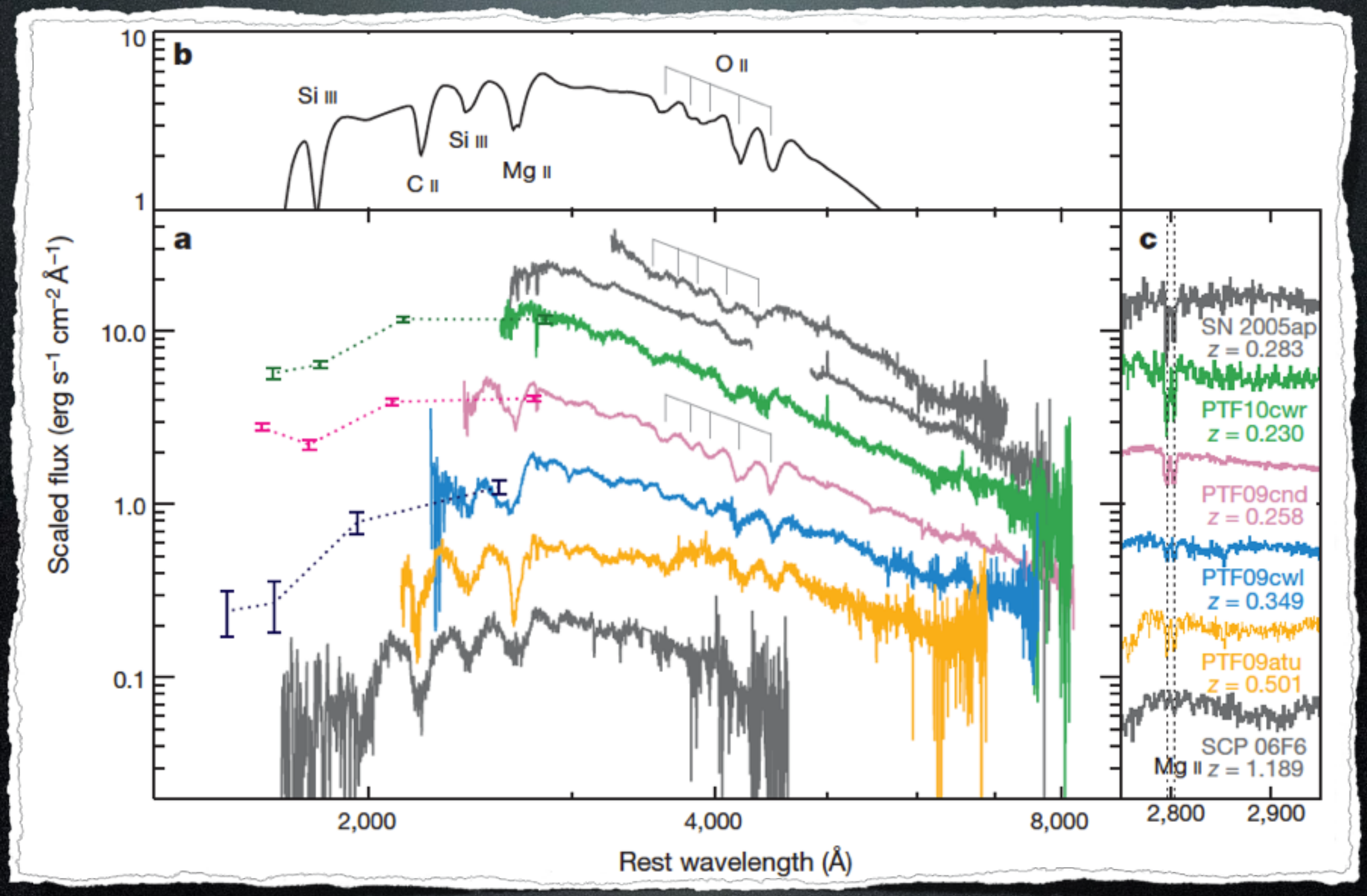
Phase Space for Optical Transients

State of the field post-PTF



Super Luminous Supernovae

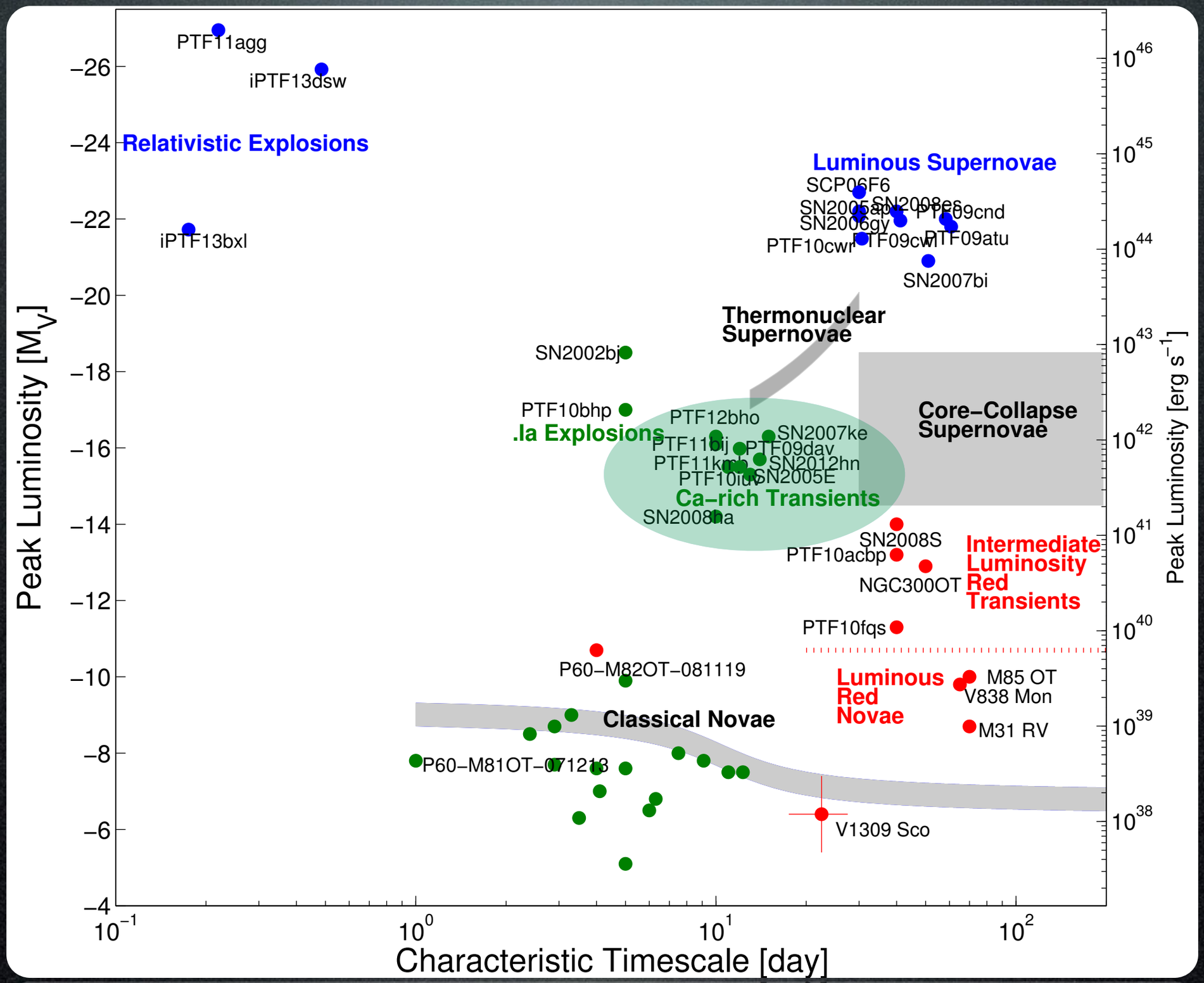
Specifically, SLSNe type I



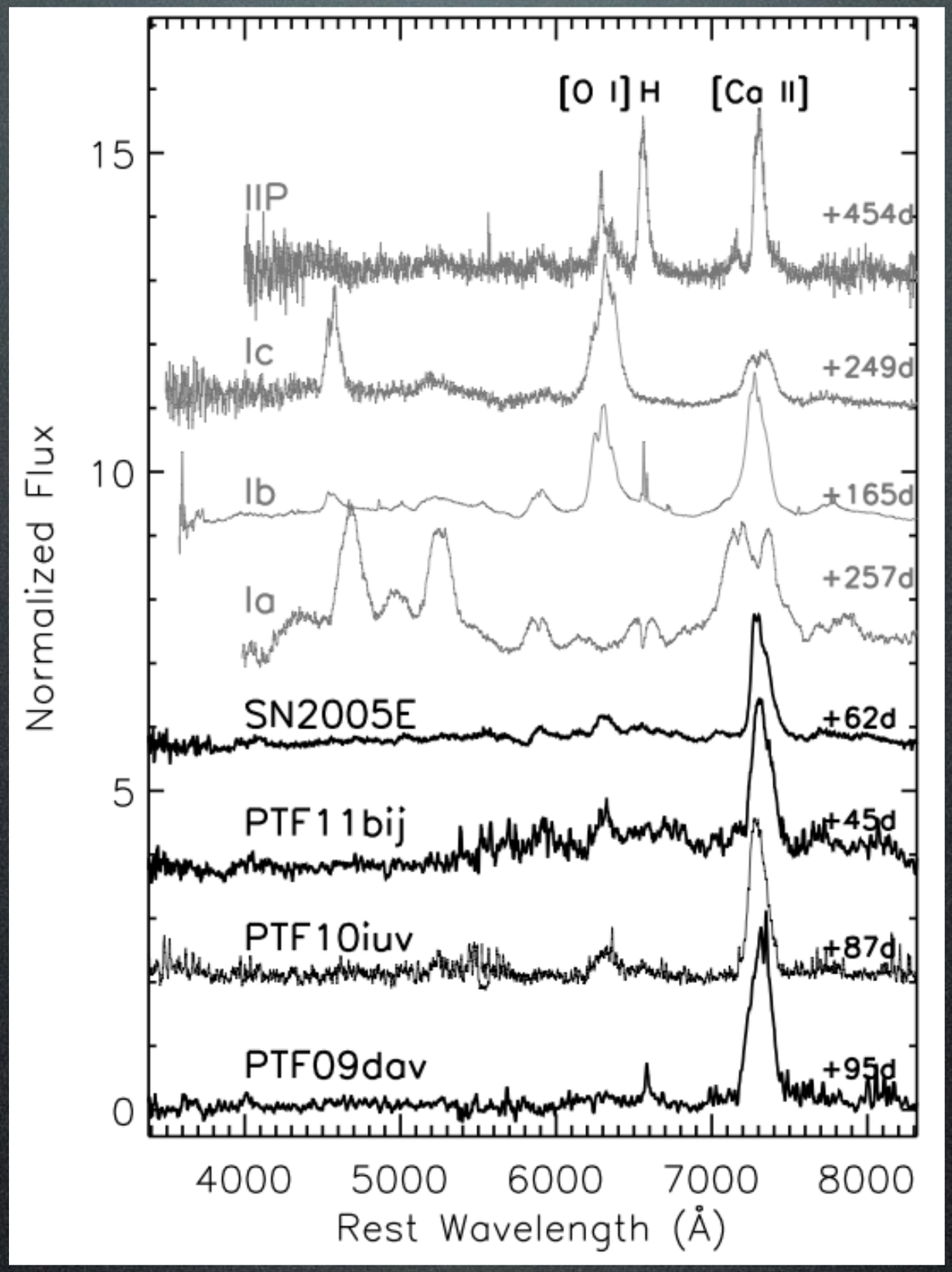
Quimby+11

Phase Space for Optical Transients

State of the field post-PTF



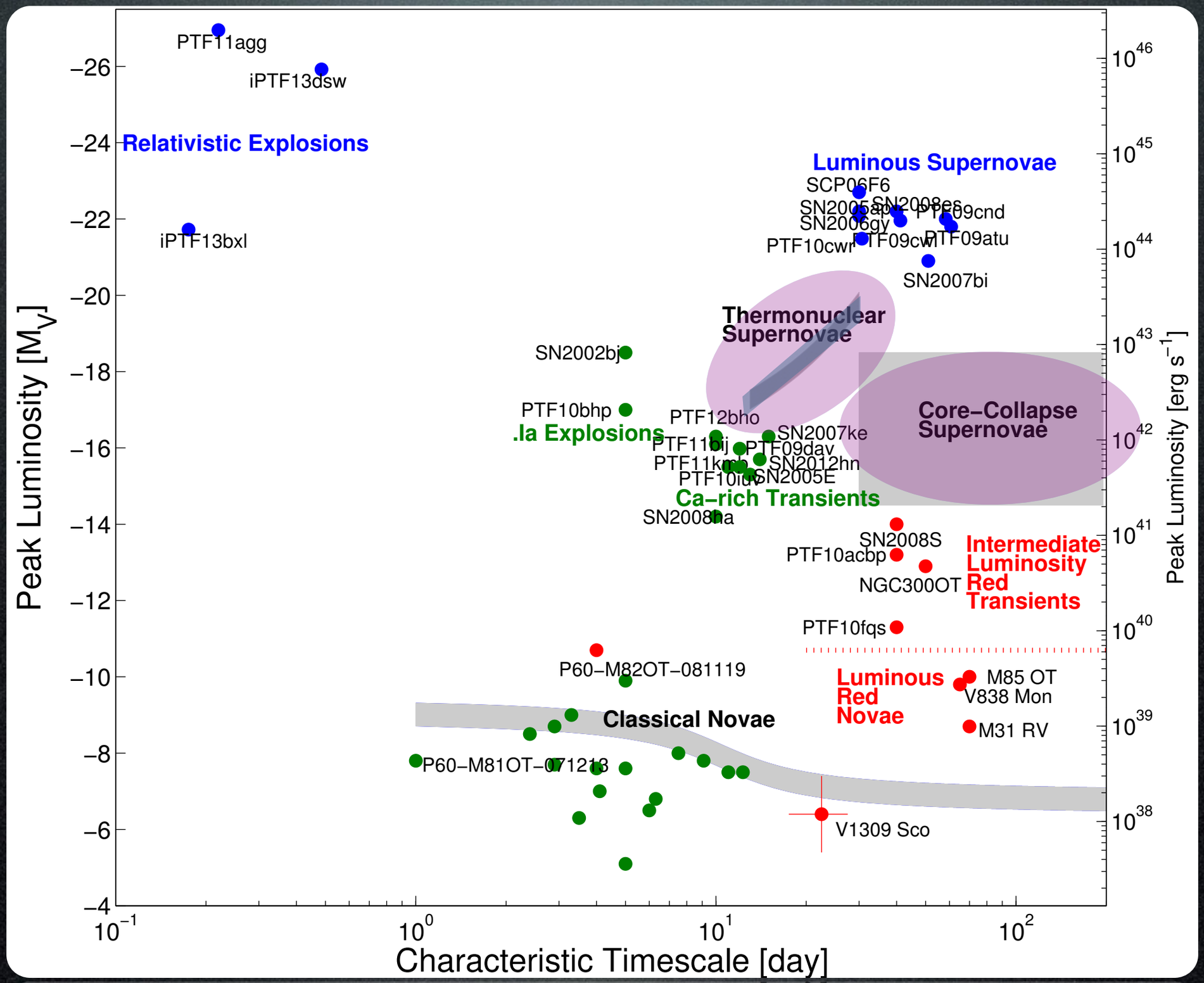
Ca-rich "Gap" Transients



Kasliwal+12

Phase Space for Optical Transients

State of the field post-PTF



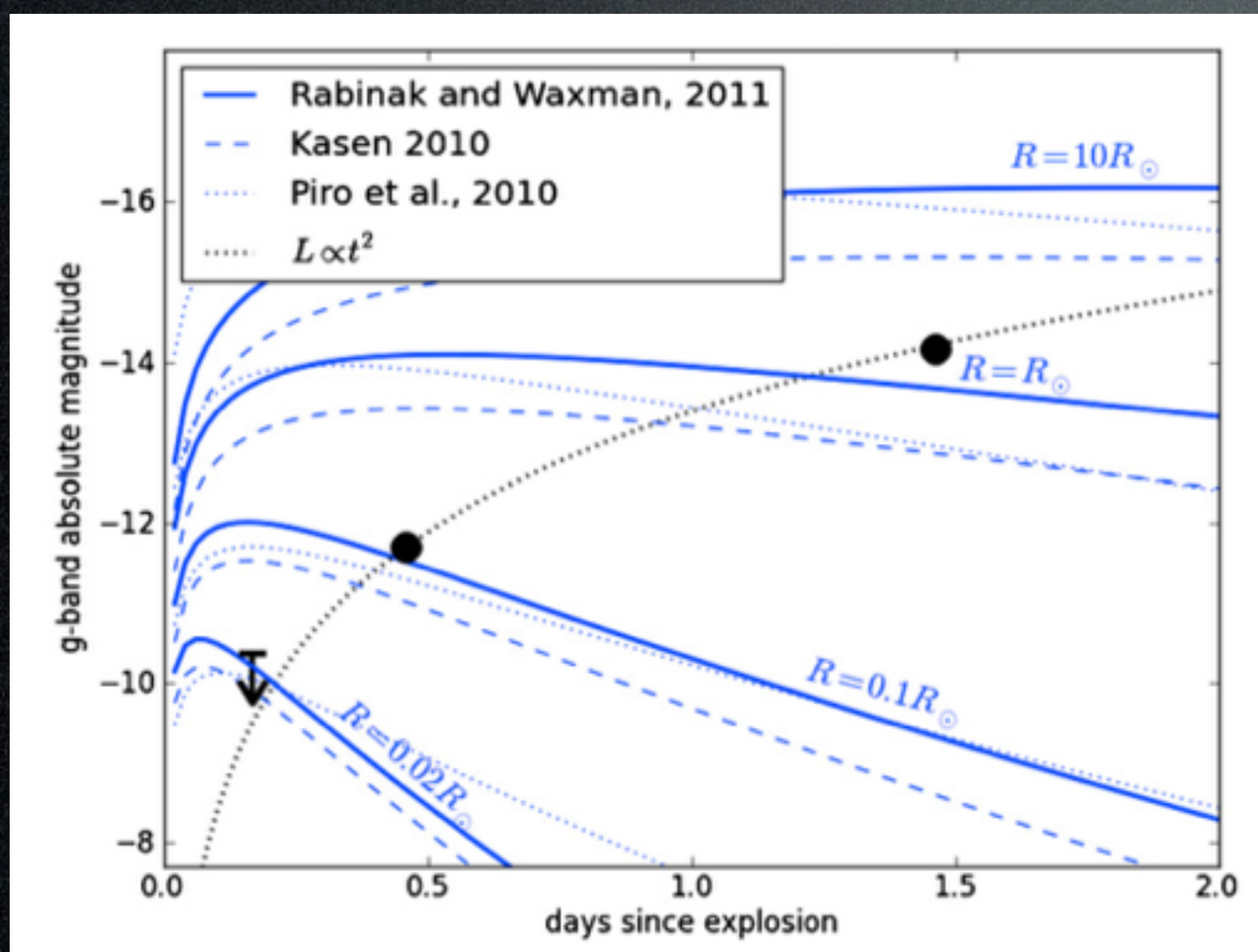
Normal SNe - observed early

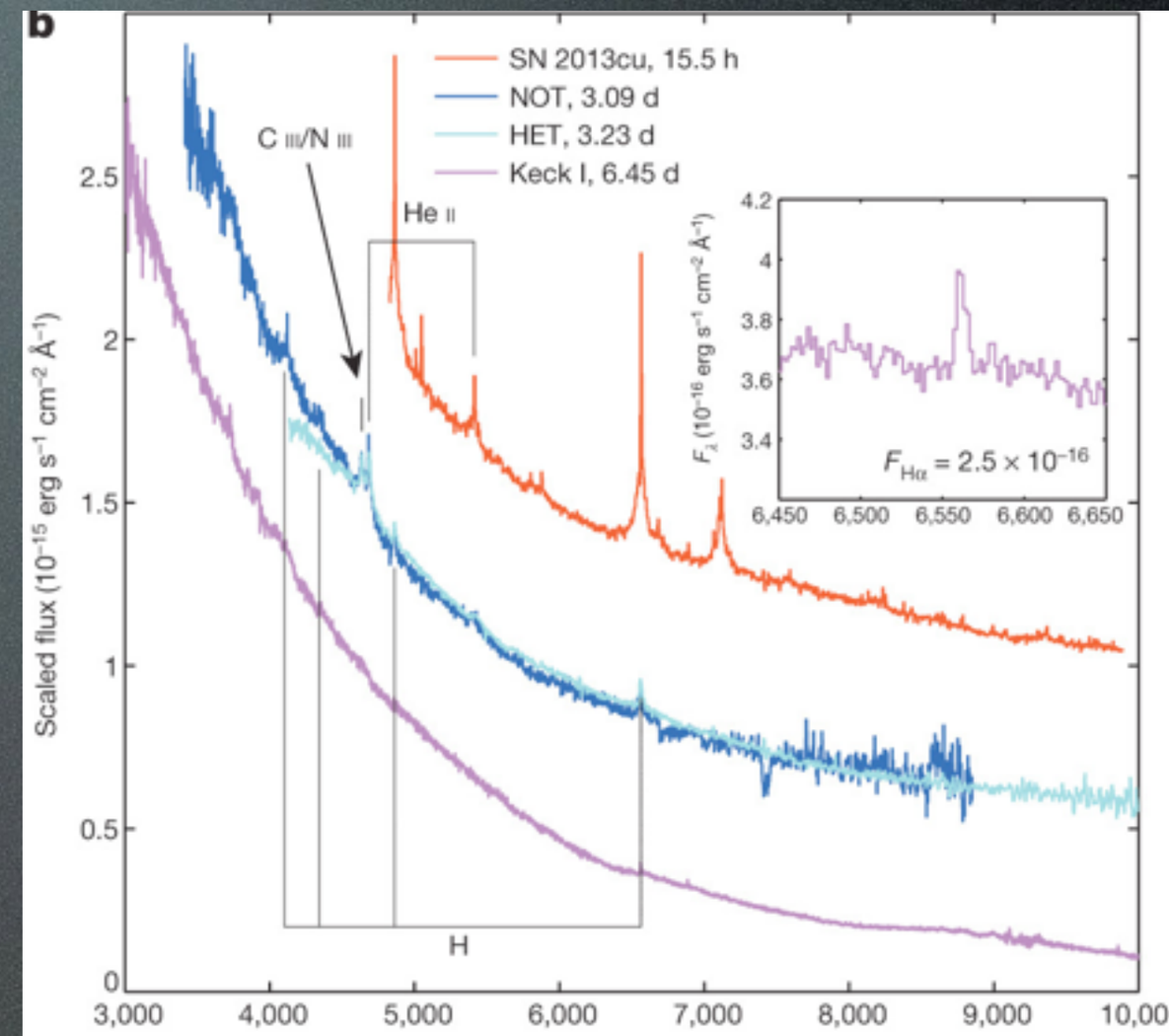
Phot/Spec taken hr after explosion reveals interesting physics

Early photometry constrains the radius of the progenitor system

PTF 11kly = SN Ia from a WD

Bloom+12





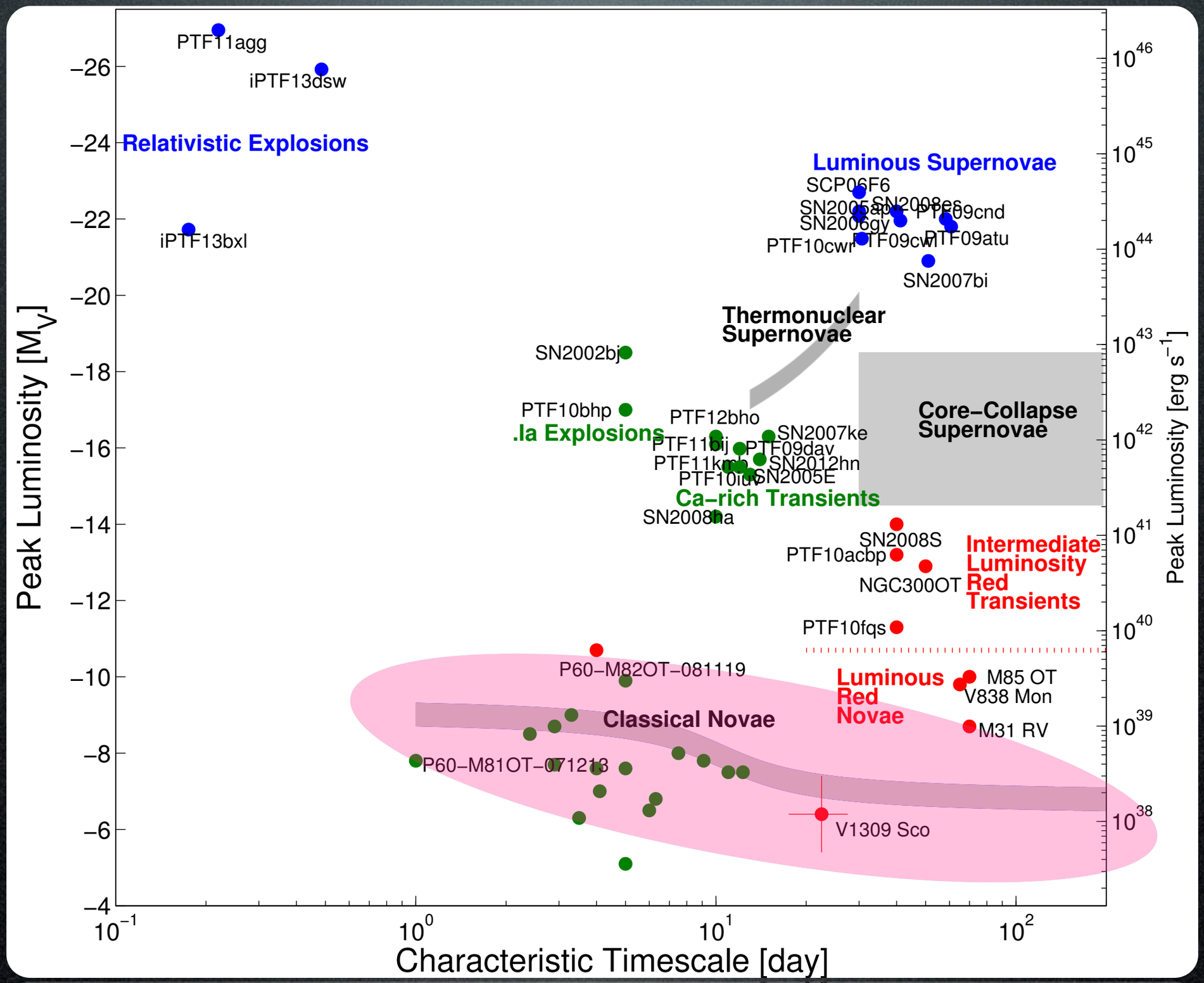
Gal-yam+14

Early "flash" spectroscopy reveals transient high-excitation lines

Enables a detailed study of the CSM

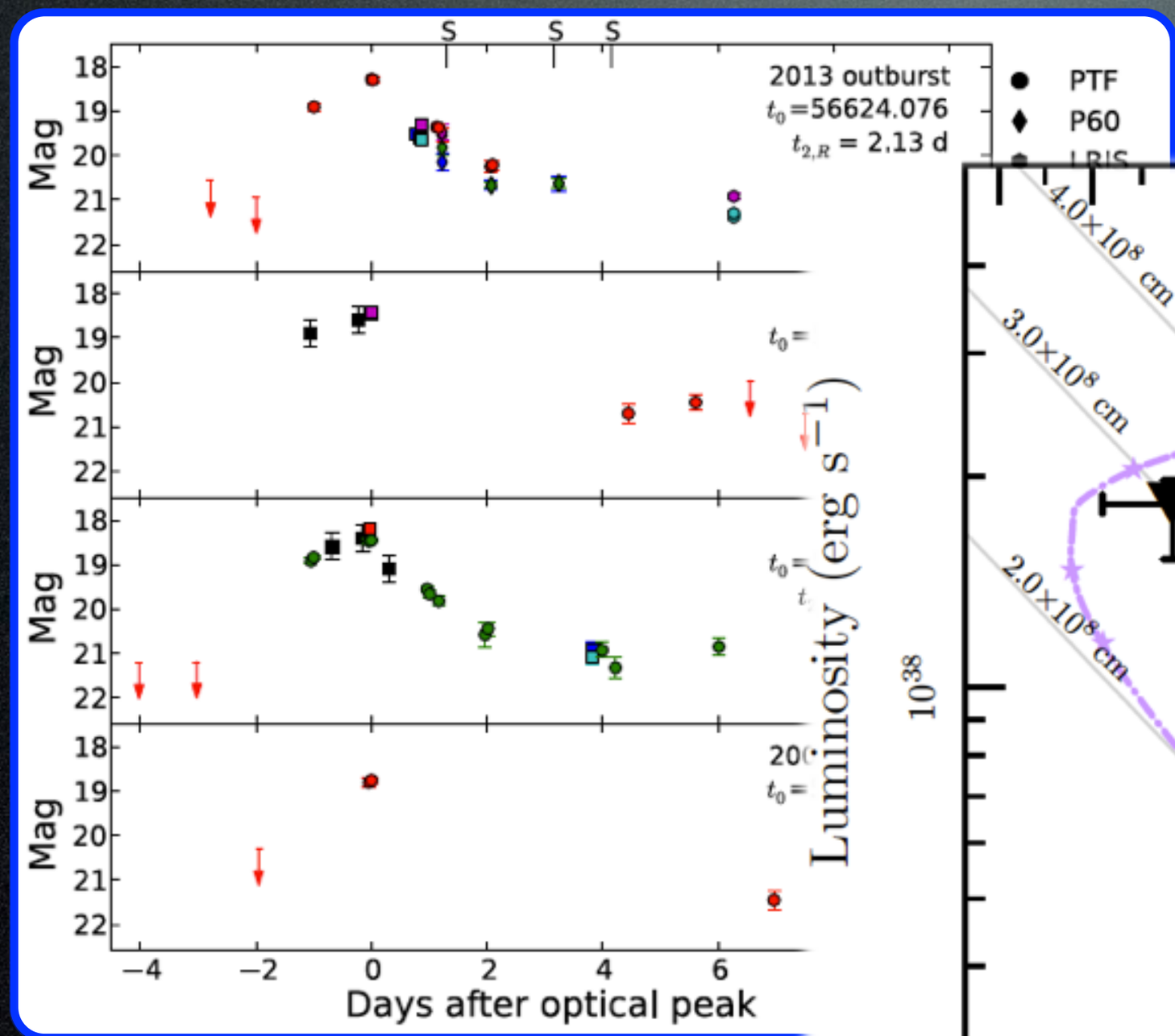
Phase Space for Optical Transients

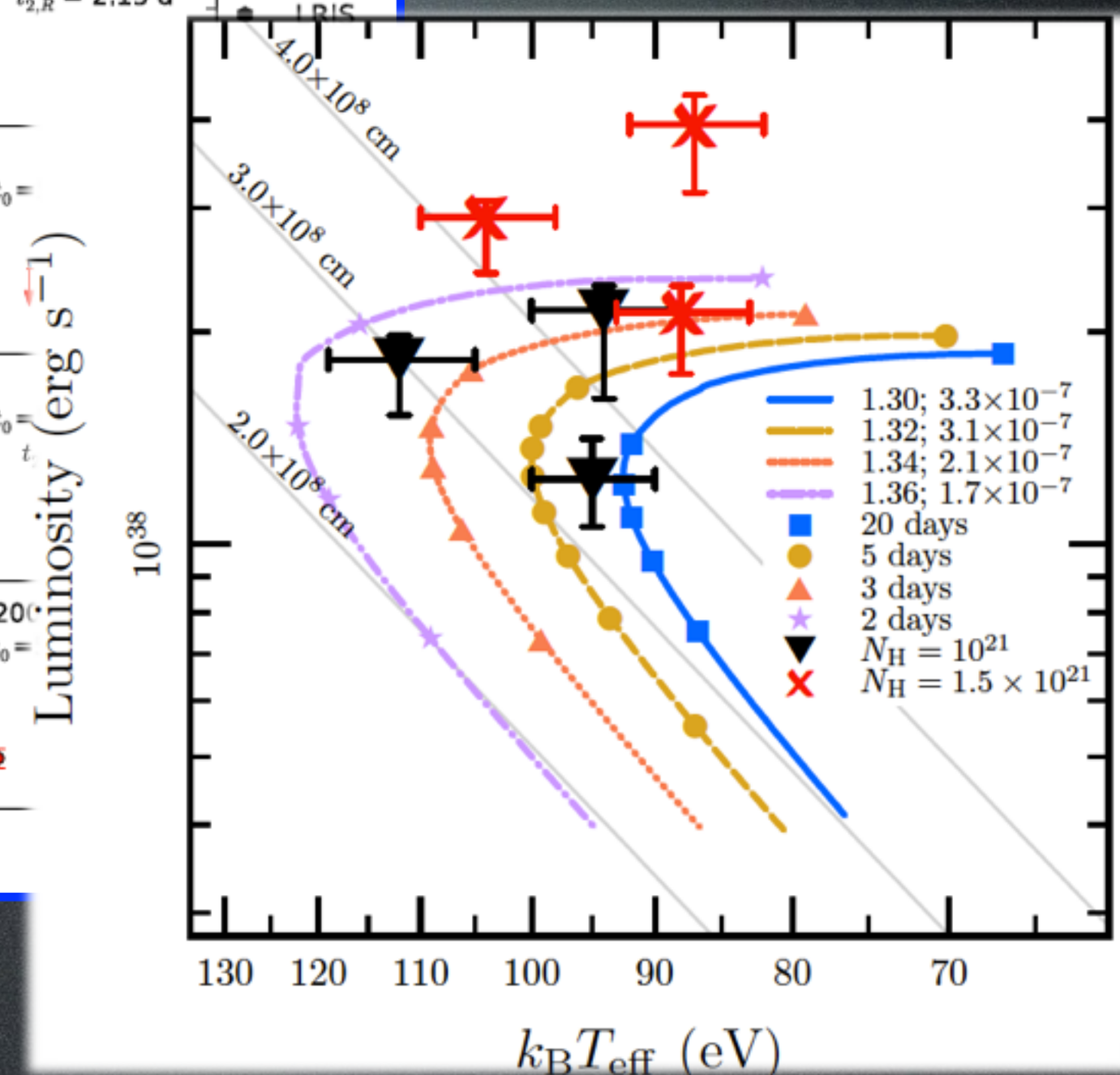
State of the field post-PTF



M31 Recurrent Nova

$\tau_R \sim 1\mathrm{yr}; M_{\mathrm{WD}} > 1.3 M_\odot$





Tang+14