The KMTNet Supernova Program

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KMTNet Supernova Program (KSP)

Main Scientific Objectives:

- ✓ Infant/Early (stellar) explosions (focusing on supernovae)
- ✓ Fast, rare optical transients
- ✓ Various types of variable objects
- ✓ Low surface brightness objects (e.g., dwarf galaxies)
- ✓ And something serendipitous and unforeseen

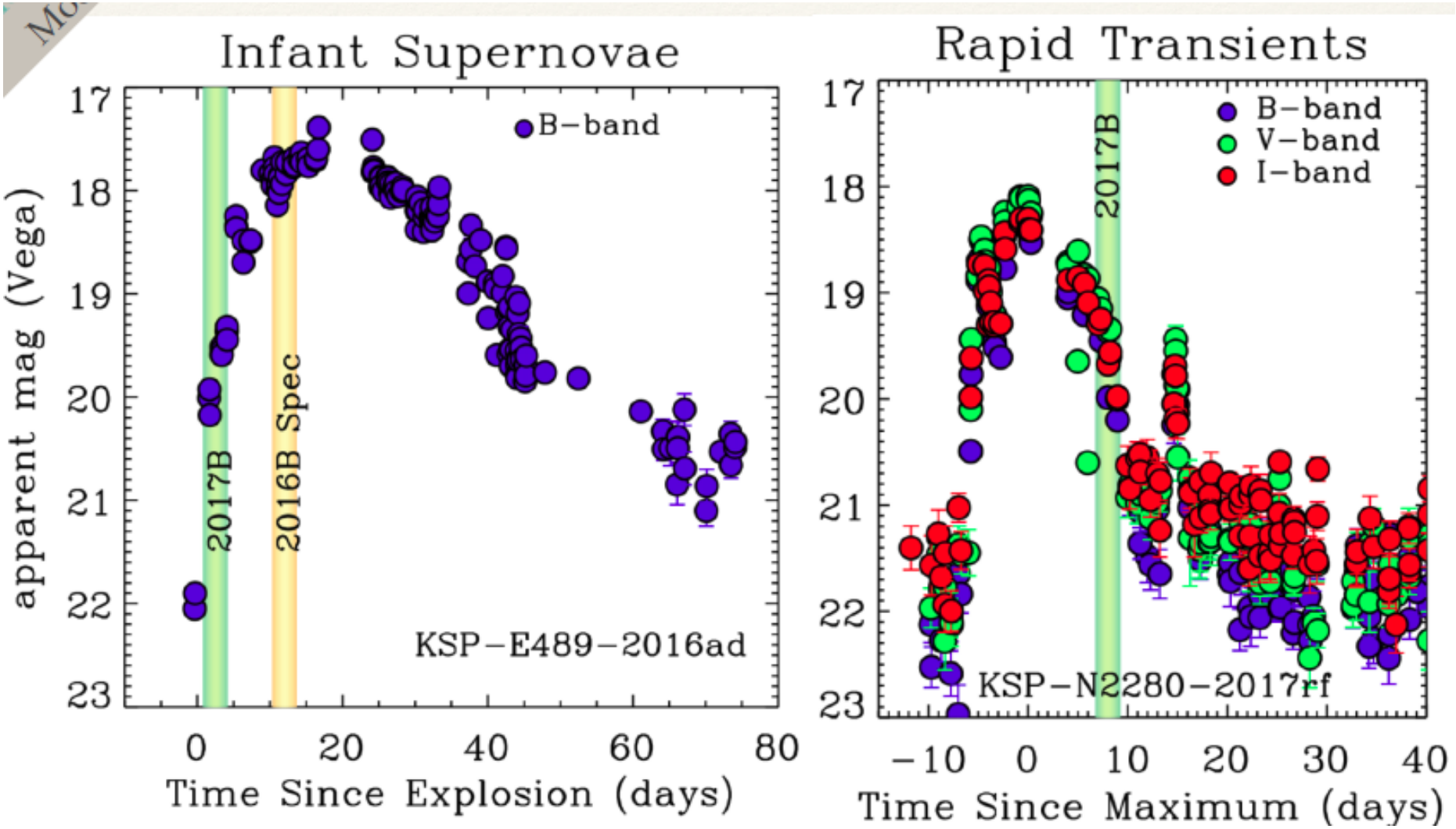
KMTNet Supernova Program (KSP), so far

- **Large (~ 25) collection of KMTNet-discovered early SNe: unique data set with 3 color information (this includes the earliest SN ever detected in the visible) + ToO spectra & multi-wavelength observations**

- **Many interesting and peculiar optical transients (e.g., novae, LBVs, long-term variables, etc)**

- **Numerous low-surface brightness objects (e.g., dwarf galaxies) detected in deep stack KSP images**

ToO Triggers of KSP Transients (Gemini & Other Facilities)



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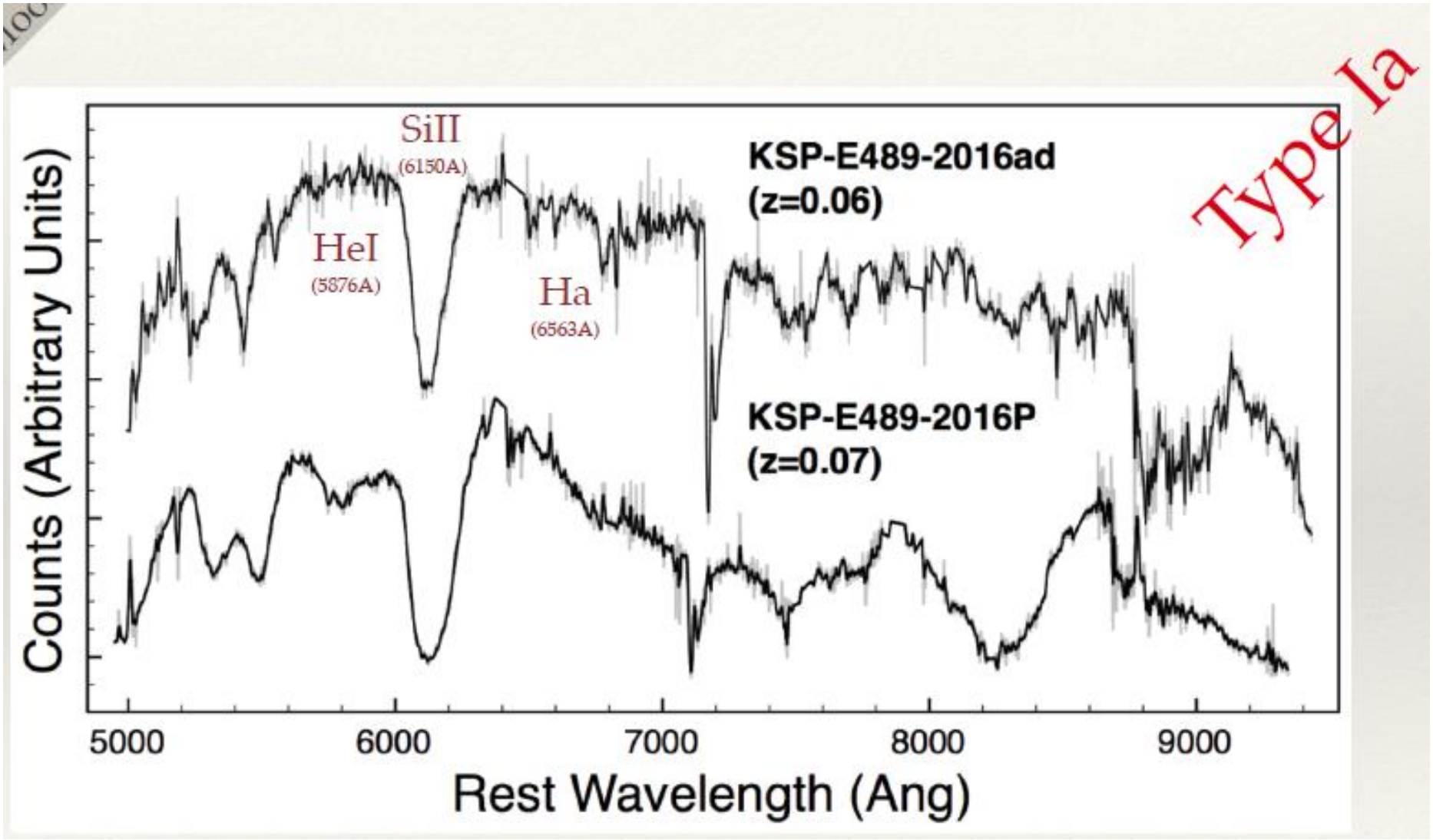
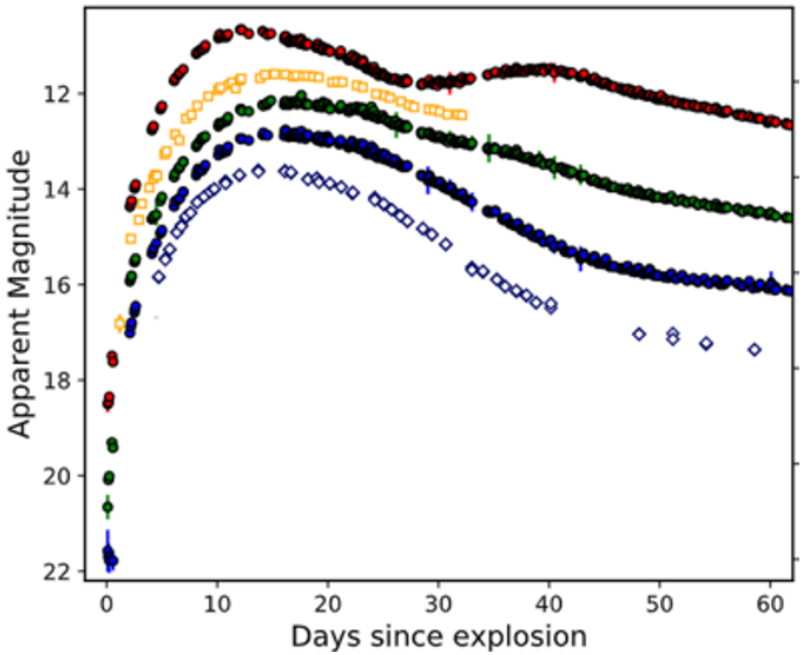
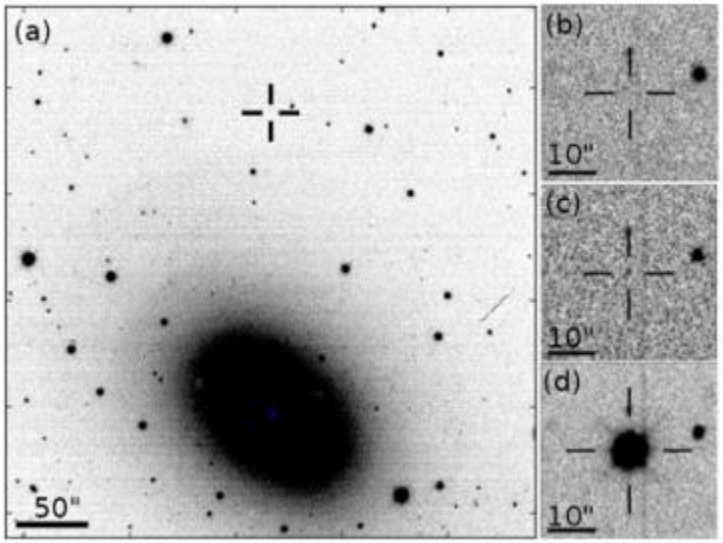


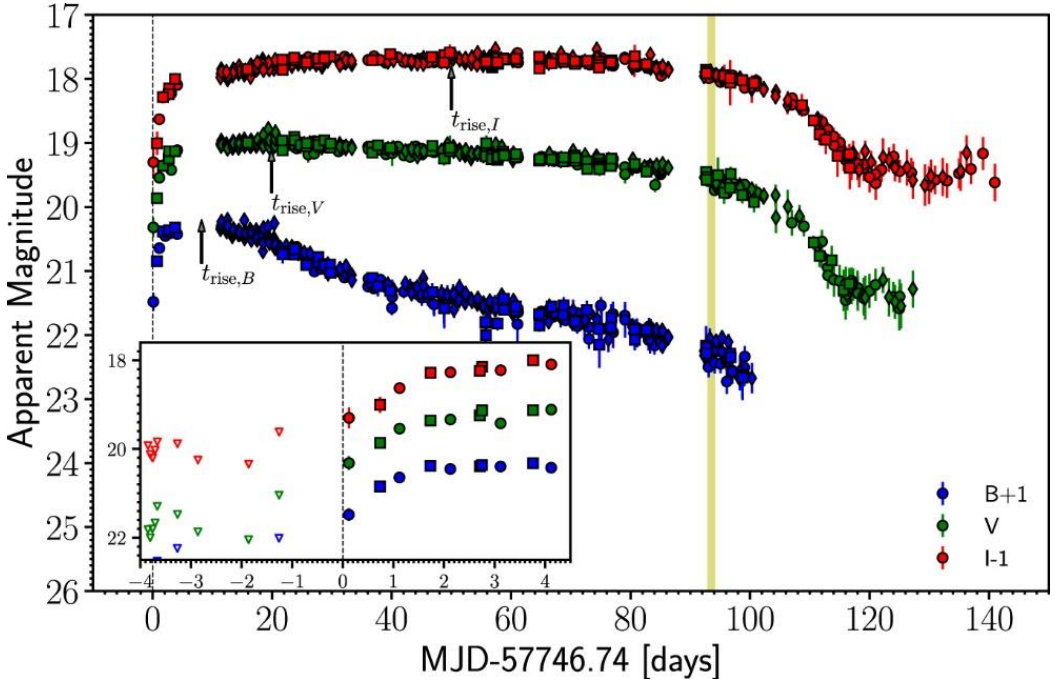
KSP Results on Supernovae: Observational Examples

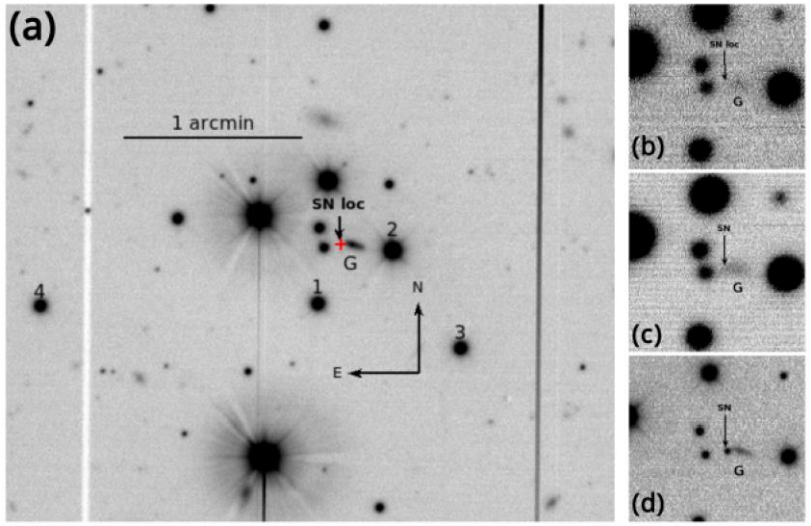
Earliest Type Ia (1 hour)



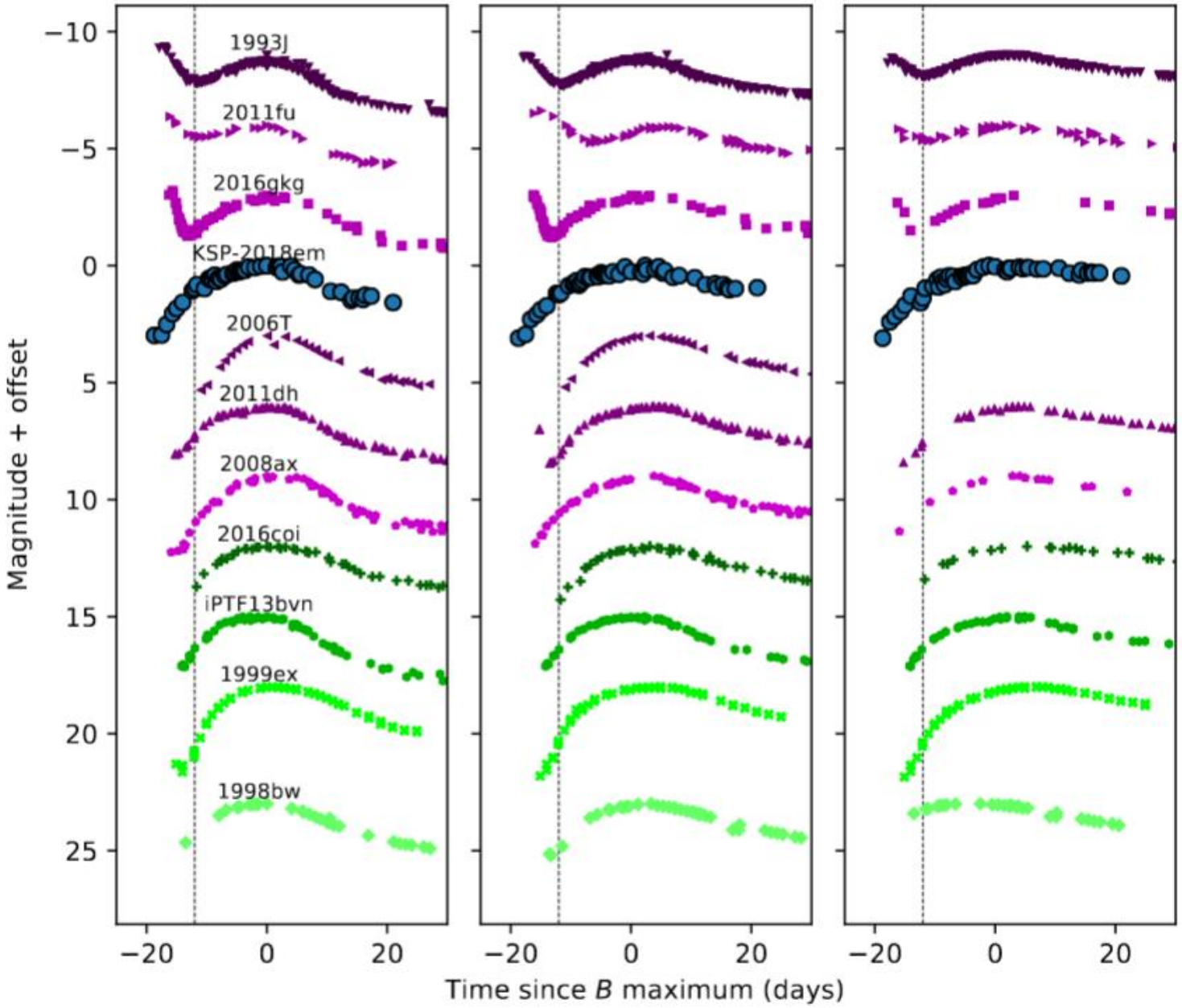


Infant Type IIP



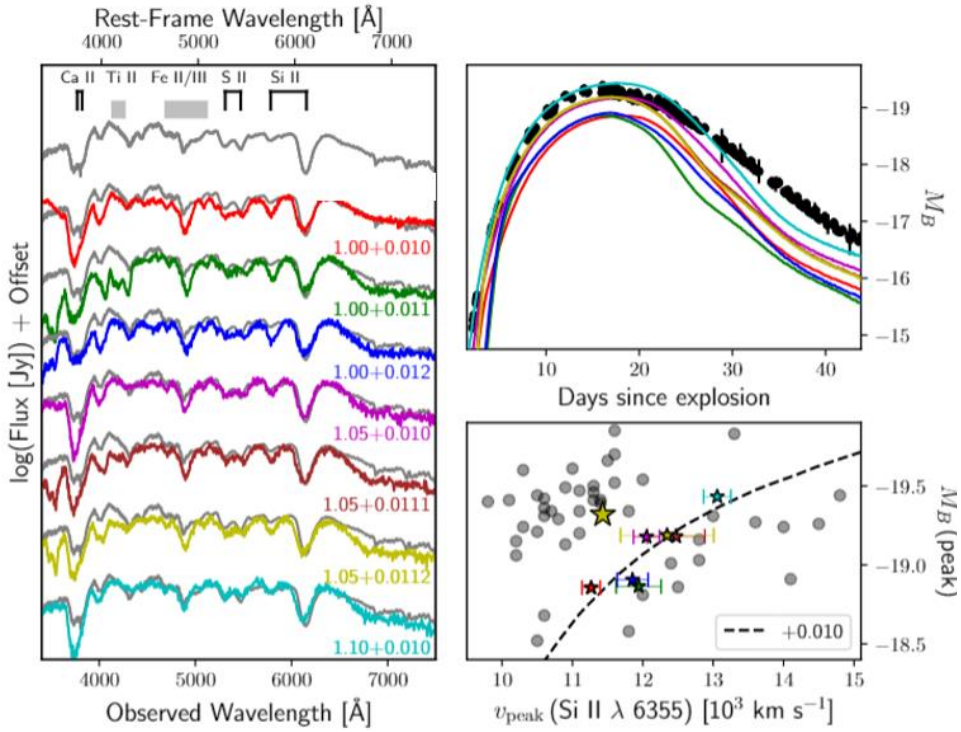


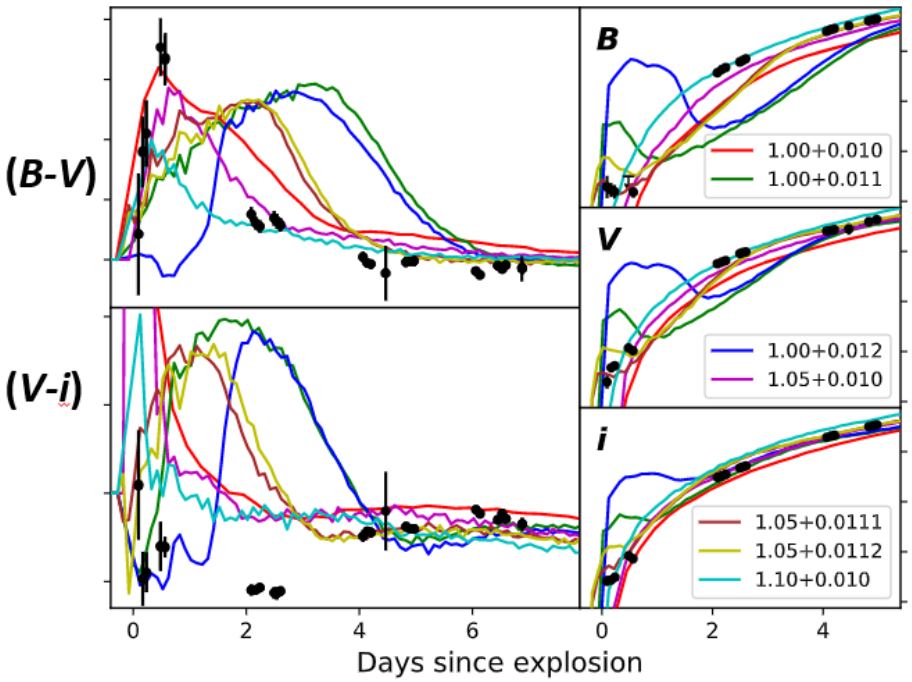
KSP Results on Supernovae: Observational Examples



Early detection of a transitional type between Type Ib and Type IIb

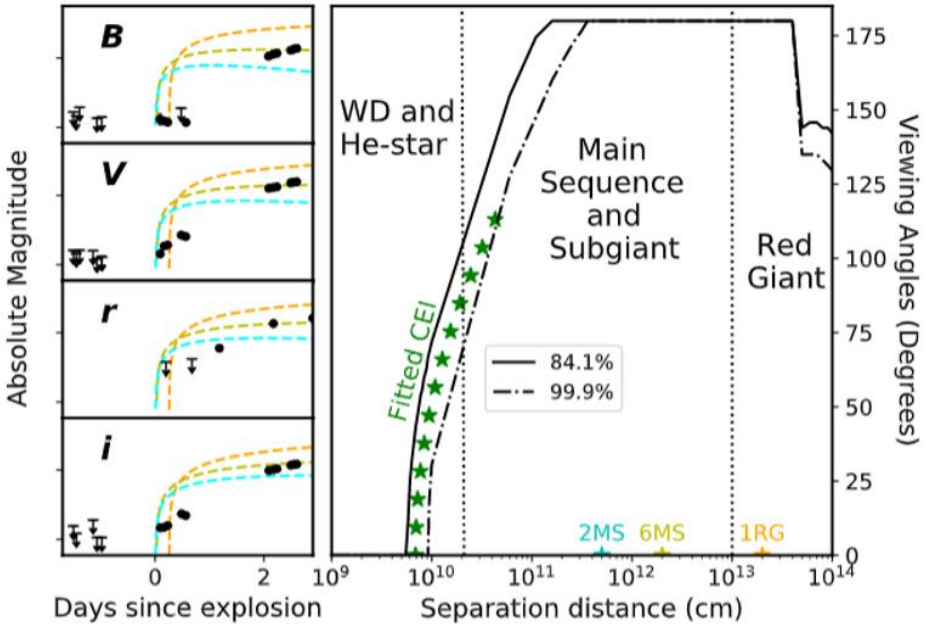
KSP Results on Supernovae: Analysis Examples

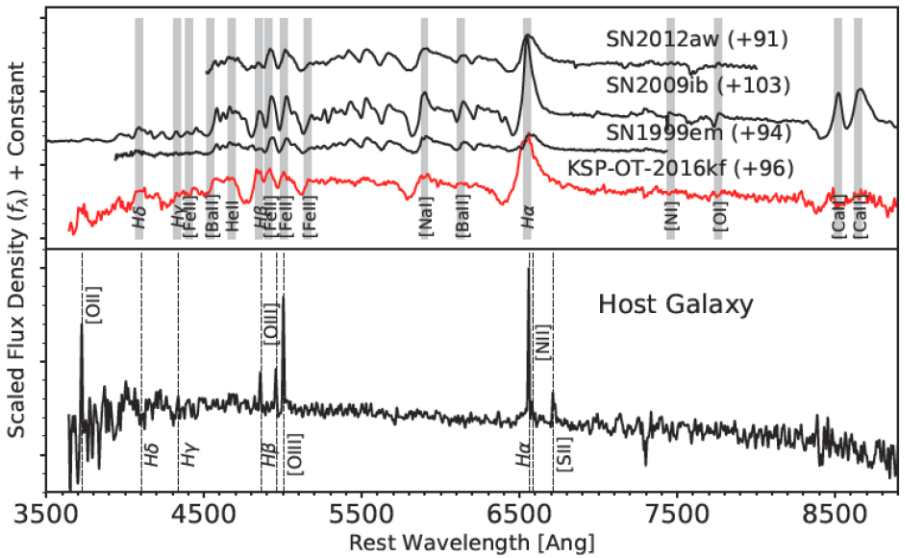




Infant Type Ia supernova emission is compared with model predictions based on He-shell Double Detonation

KSP Results on Supernovae: Analysis Examples



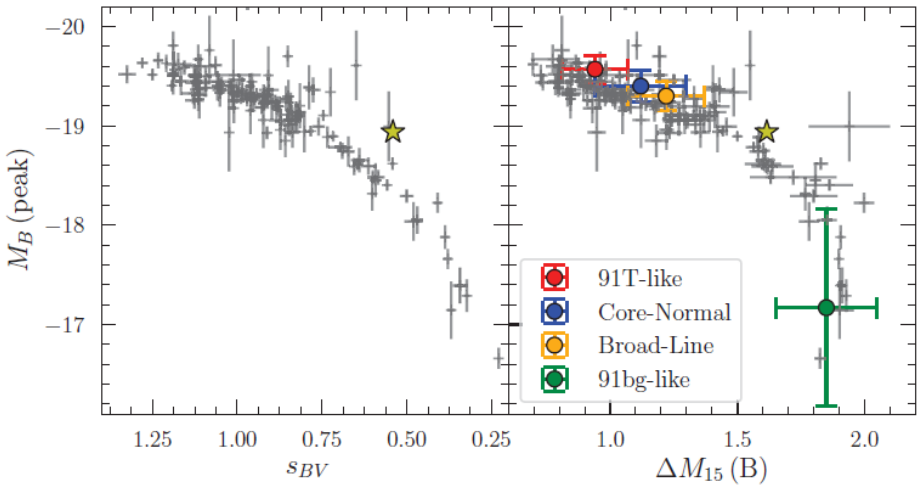


Infant Type Ia supernova emission is compared with model predictions based on the shock interactions between the ejecta and companion

Spectroscopic follow-up observations to understand the nature of supernovae and their host galaxies

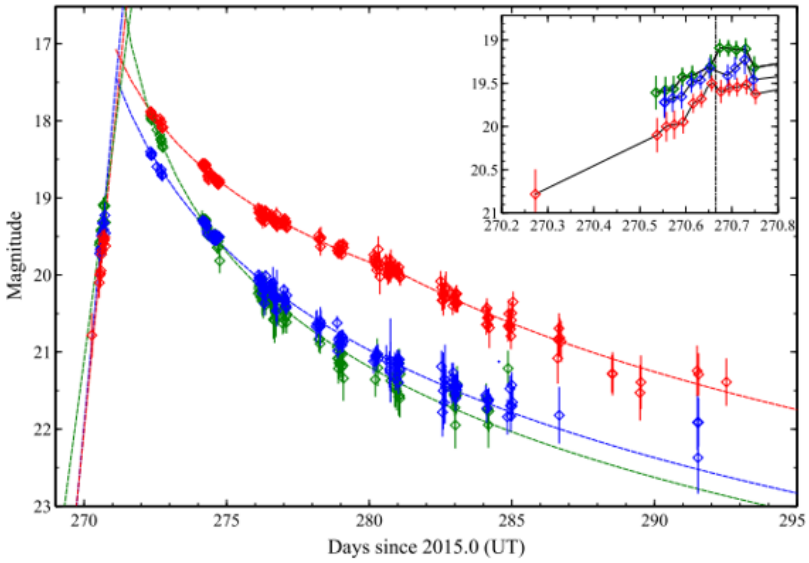
KSP Results on Supernovae: Example Highlights

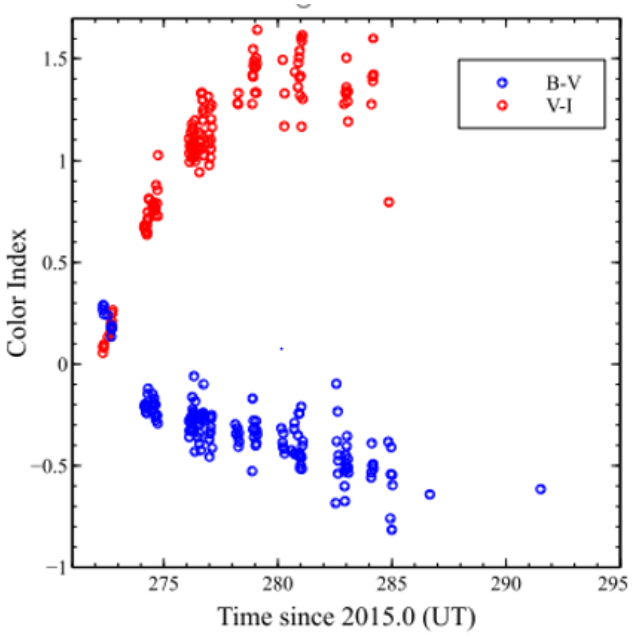
- **Infant Type Ia supernova emission compatible with the D^6 process for the origin of normal Type Ia: dynamically-driven double-detonation and double-degeneracy scenario;**
- **Hostless Transitional Type Ia Supernova with a shallow ^{56}Ni distribution;**
- **RSGs with > 17 solar mass can indeed explode as a core-collapse supernova (not so much the RSG problem)**
- **The presence of a short period of enhanced pre-SN mass loss prior to core-collapse of a RSG**
- **Transitional Core-collapse SNe btw. Type Ib and IIb**
- **And so on ……**



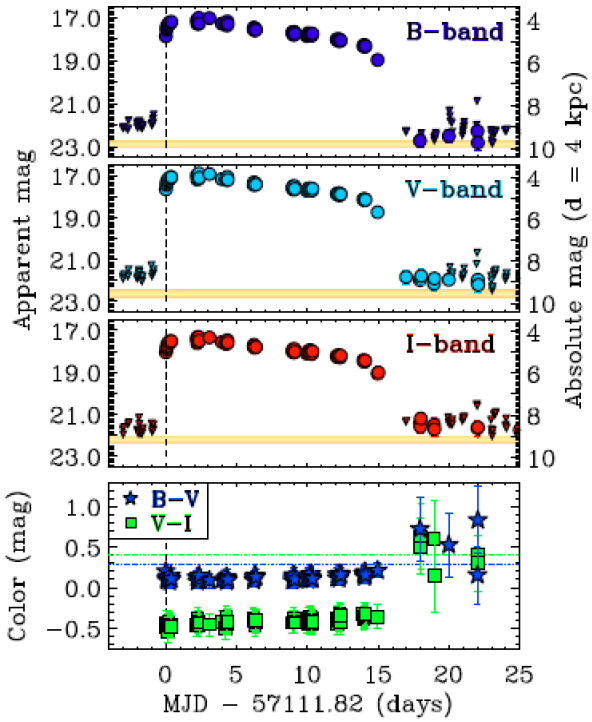
KSP-discovered Transitional Type Ia

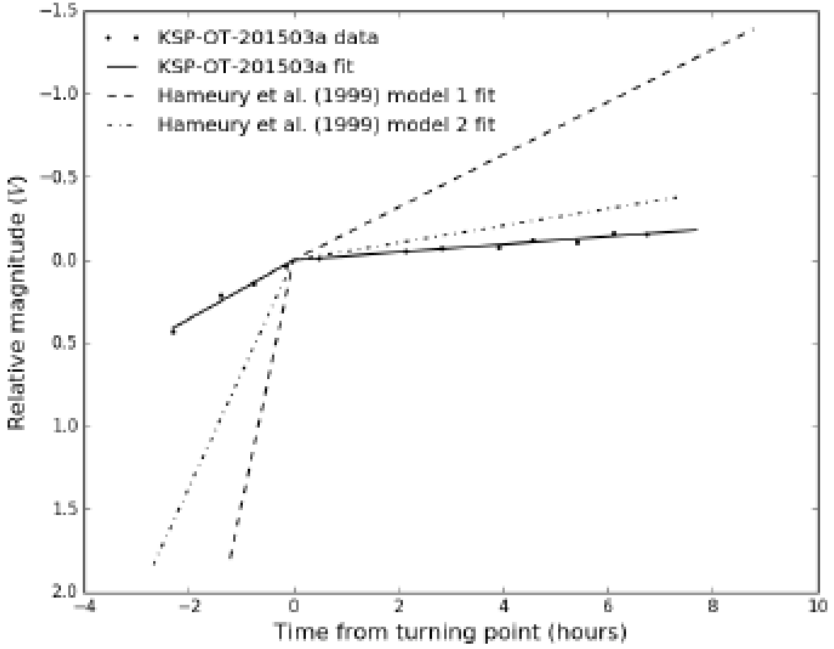
KSP Results on Novae: Examples





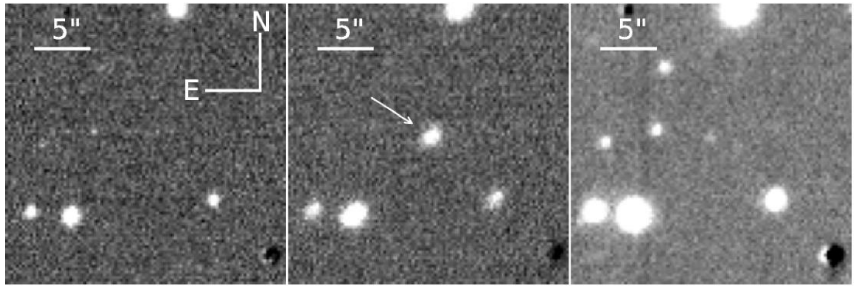
KSP-discovered classical nova resulted from nucleosynthetic process

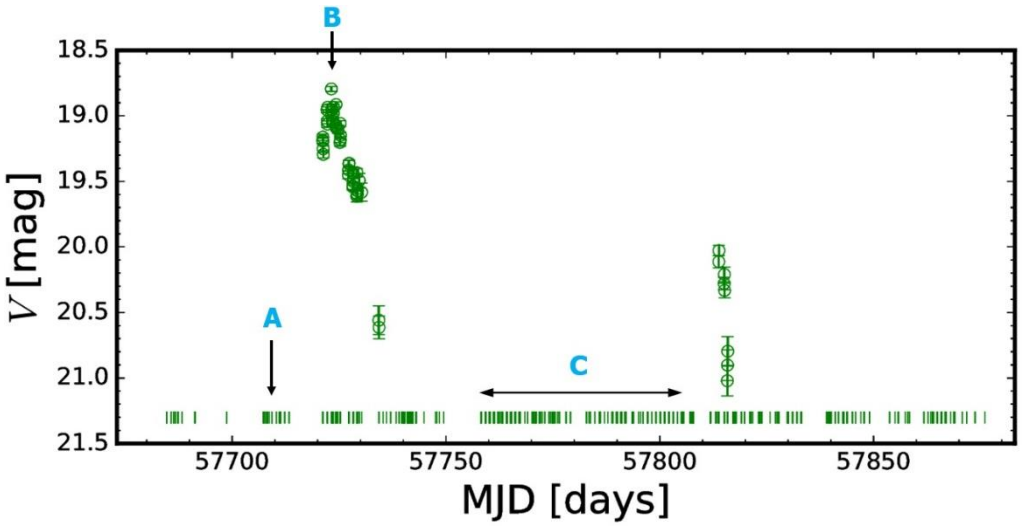


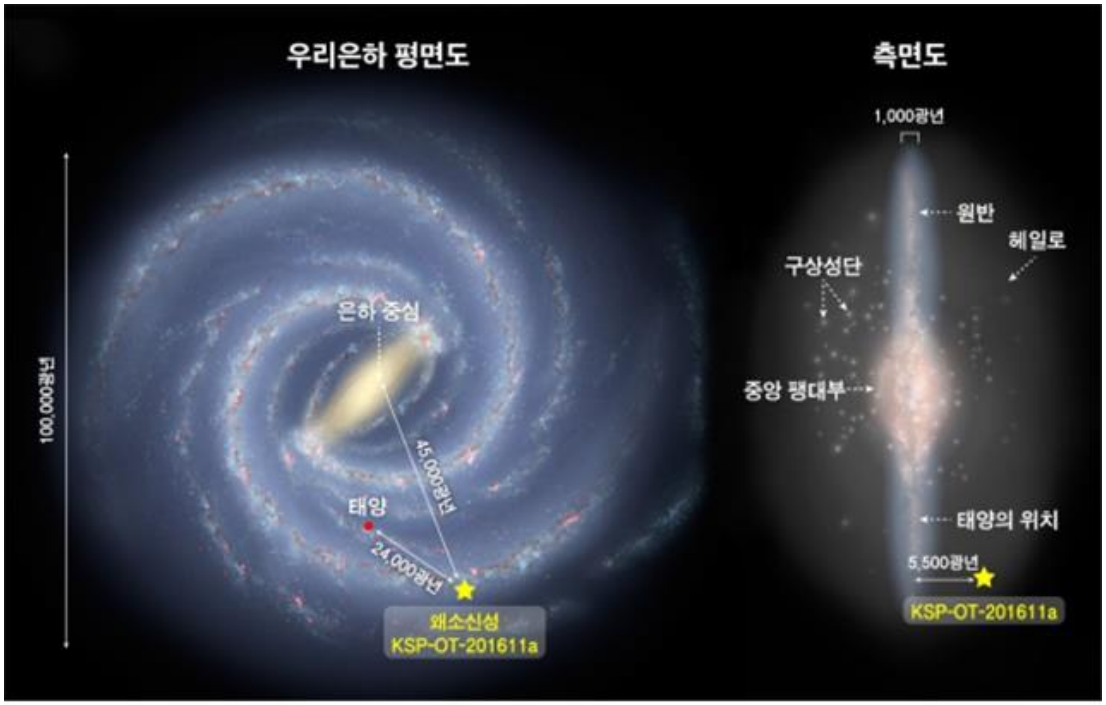


KSP-discovered dwarf nova resulted from accretion disk instability

KSP Results on Novae: Examples

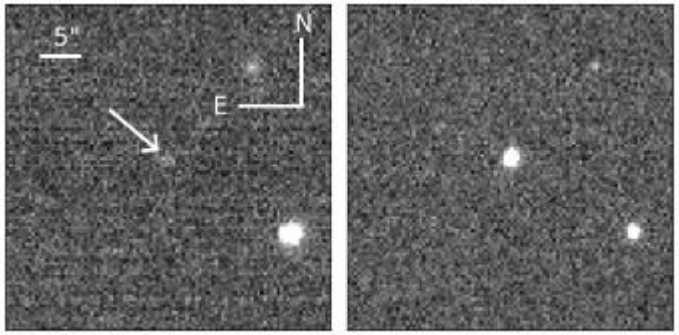


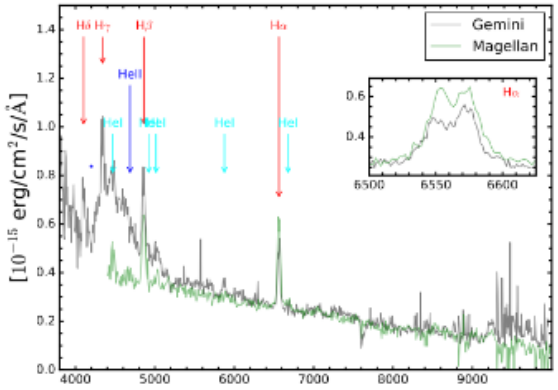


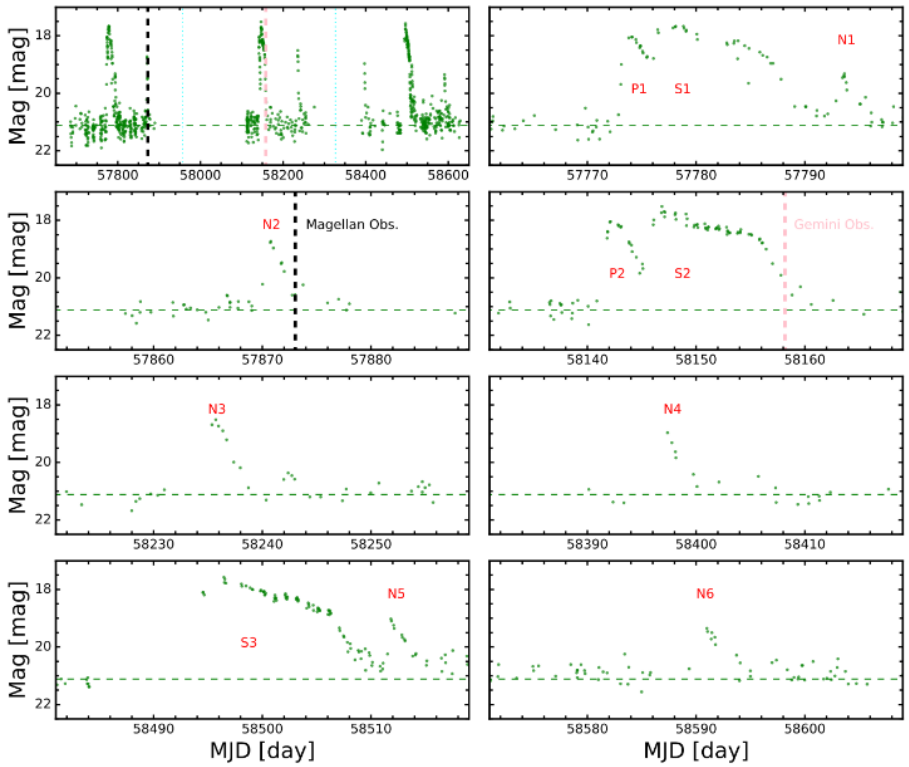


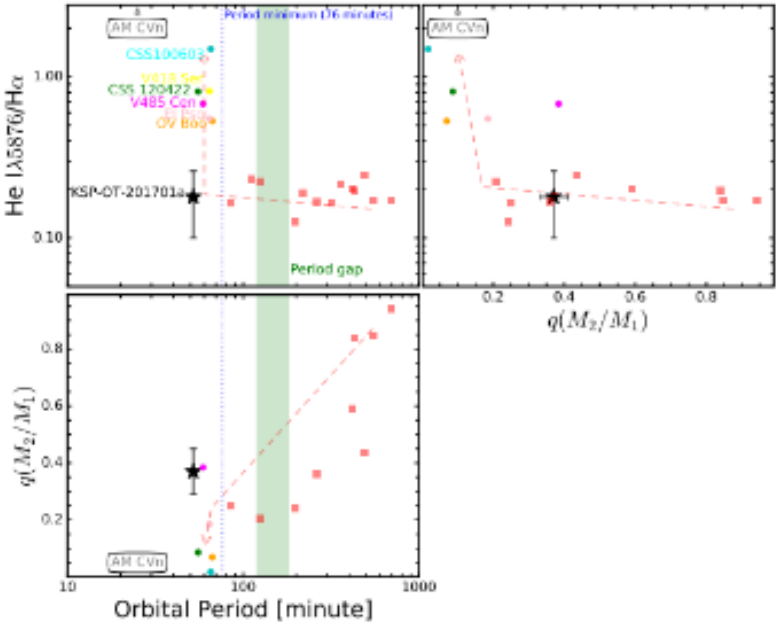
Most distant dwarf nova ever detected; CV binary system in the outer Galaxy

KSP Results on Novae: Examples



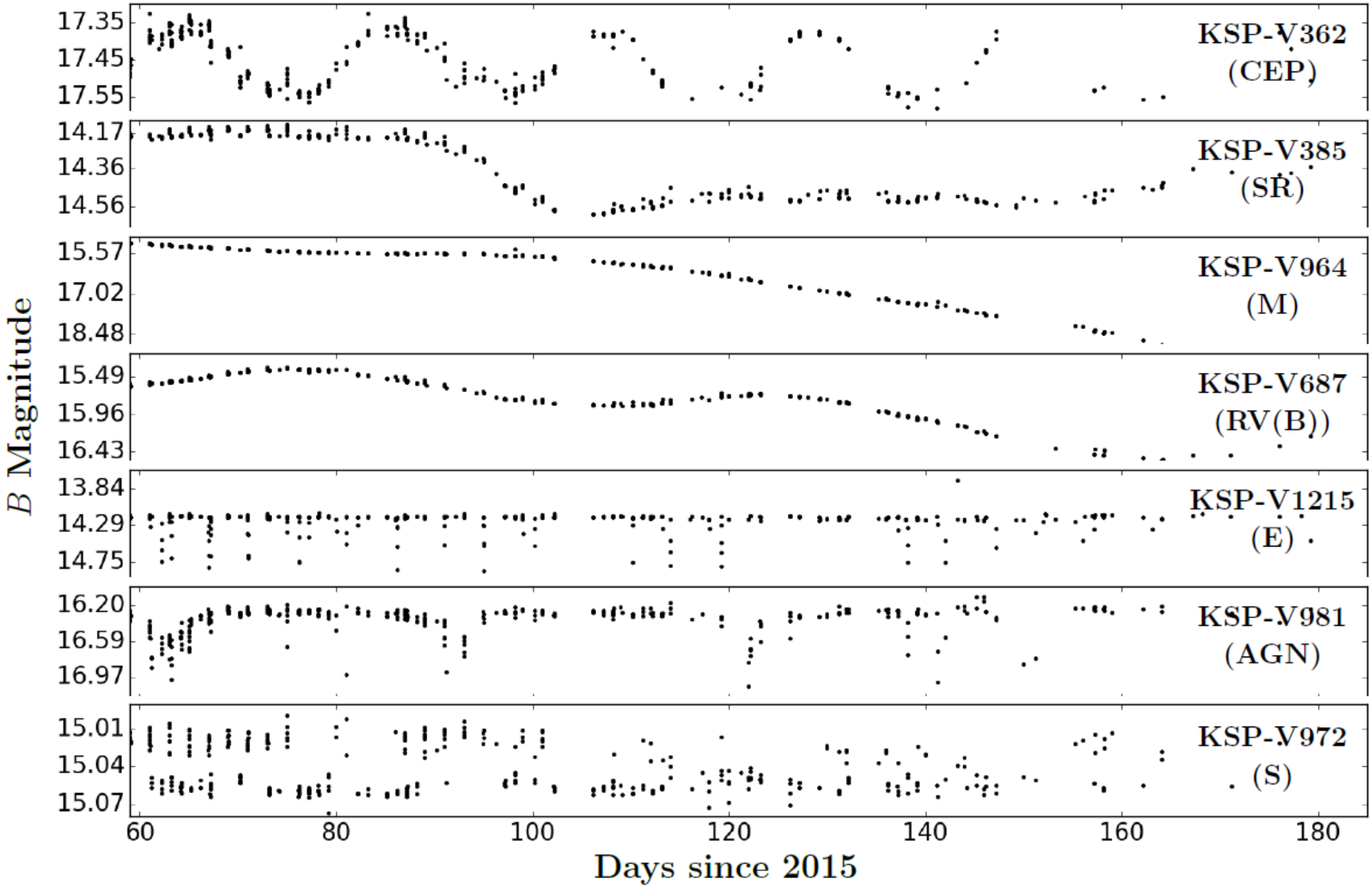




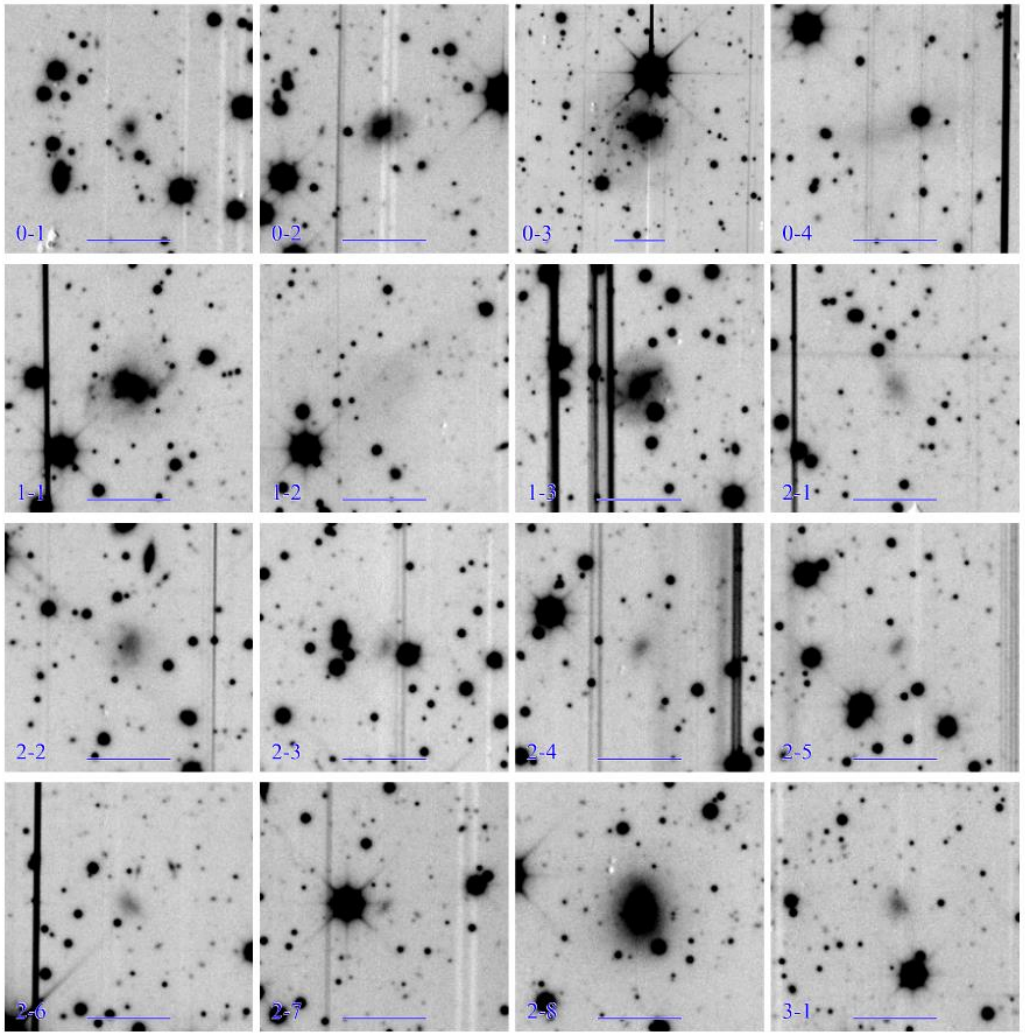


Short-period and Unusually He-deficient Dwarf Nova

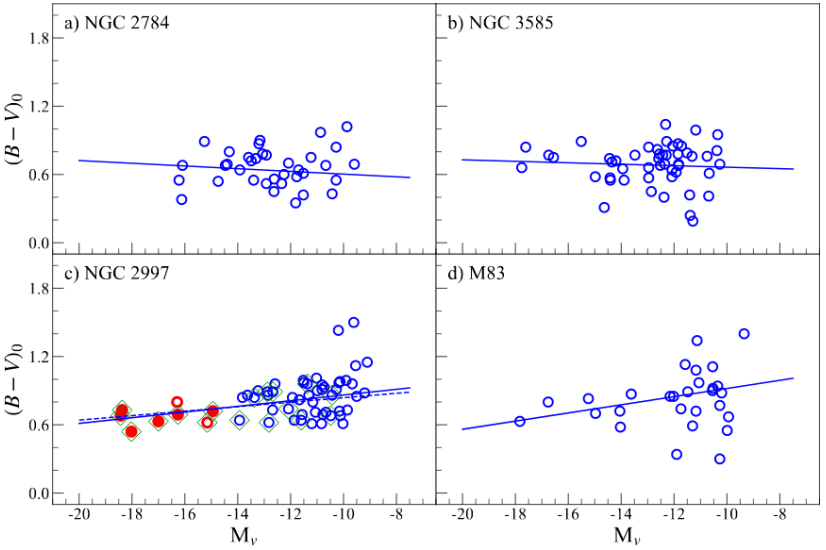
KSP Results on Variable Sources: Examples



KSP Results on Dwarf Galaxies: Examples

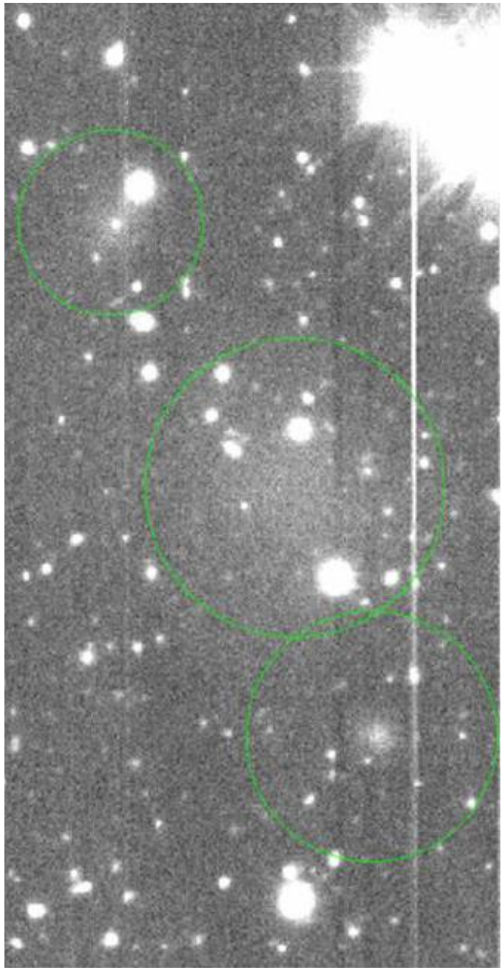


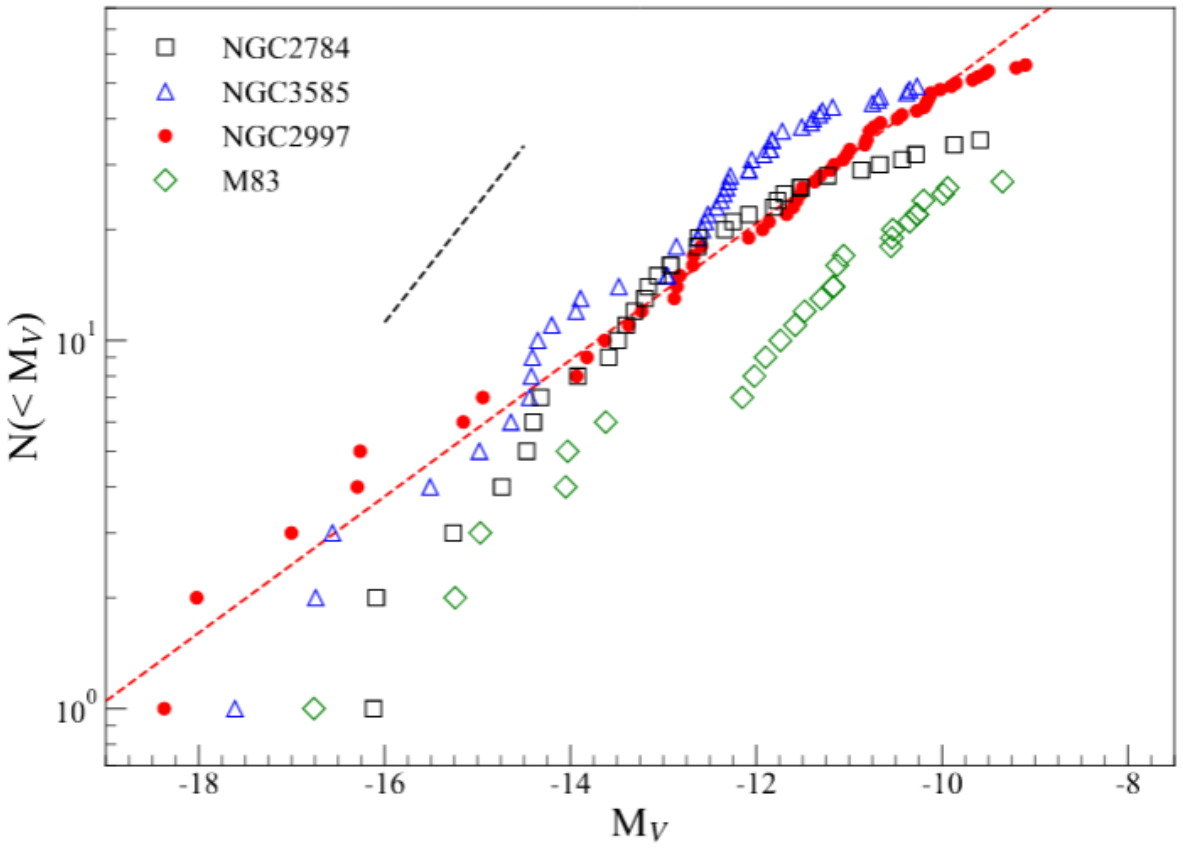
57 Dwarf Galaxies discovered in NGC 2997 Group



Unusual CMR indicates an early evolutionary stage

KSP Results on Dwarf Galaxies: Examples





It is estimated that more than 2000 dwarf galaxies (including ultra-diffuse dwarf galaxies as above) have been discovered in the KSP data, providing an excellent opportunity to study their properties and origin.

Summary

- **Unique data set from KMTNet for studying infant supernovae – it's unrivalled and rewarding!**
- **Statistically significant sample size with interesting individual sources**
- **Already has begun providing new insights into supernova explosion and progenitors**
- **Invaluable data for studying novae, variable sources and dwarf galaxies**
- **Papers have been published/ submitted/ being reviewed/ being prepared and written.**

The KMTNet Supernova Program for Rapid Optical Transients from Stellar End Points: Infant Supernovae, Rapidly-Evolving Transients and Kilonovae

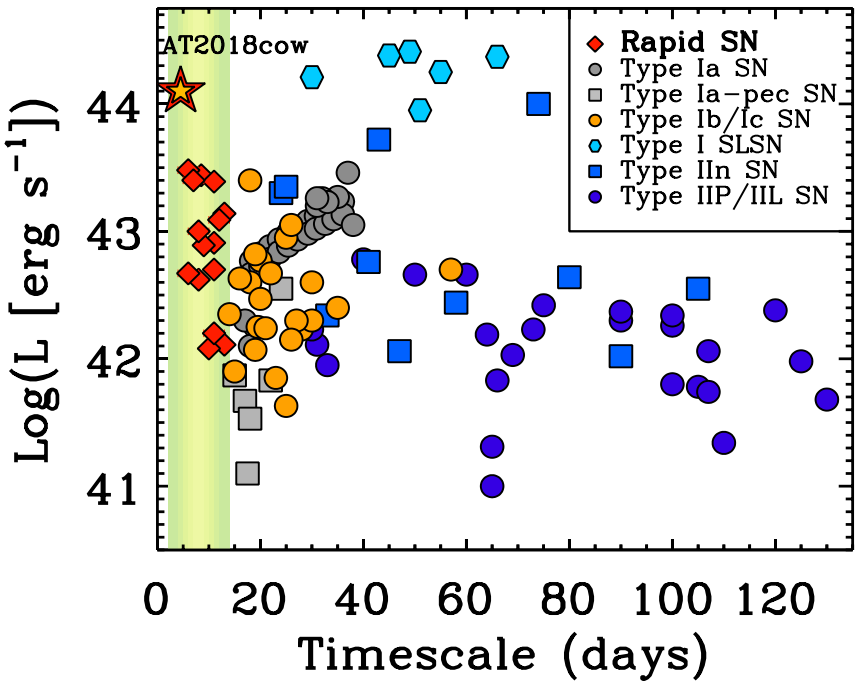
The 2nd Phase of KSP (KSP-2) will be focused on:

(1) Infant Supernovae (by exclusively observing nearby galaxies), there are a lot more to expect;
(2) Rapidly-Evolving Transients (supernovae-like, but not really supernovae, challenging stellar evolution theories);
(3) Kilonovae: EM counterparts of G-wave sources from neutron star collisions (origin of heavy elements).

These will be complemented by other types of variable sources as well as low-surface brightness objects to be discovered by the KSP-2 data.

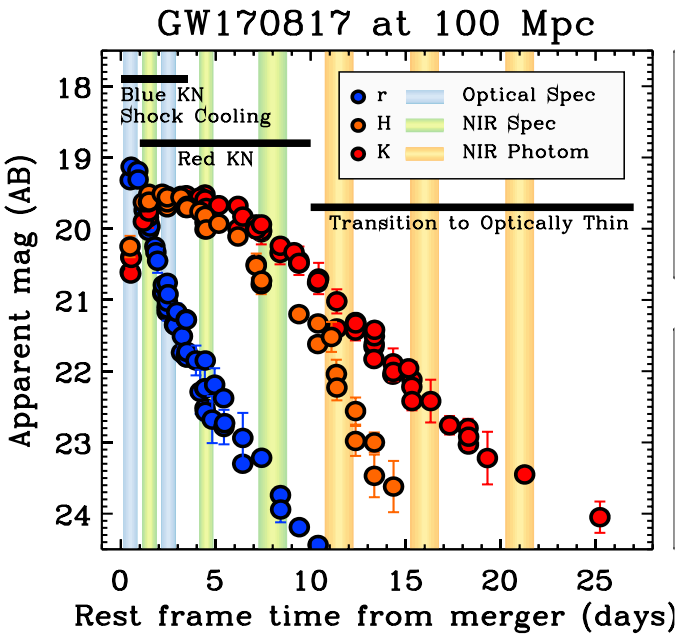
KSP-2: Infant SNe, Rapidly-Evolving Transients and Kilonovae

Rapidly-Evolving Transients (RETs)



Drout et al. (2020, in prep.)

Kilonova



Drout et al. (2017, Science)

Examples of RETs and KN for which KSP-2 ToO mode is designed to be used. (*Left*) Timescale versus luminosity phase space for SN explosions. Red stars (highlighted region) represent the newly discovered, but prevalent, RETs. (*Right*) r−, H−, and Ks−band photometry of GW170817 shifted to a distance of 100 Mpc, more typical of observations that will be obtained by KSP-2. Phases of KN emission are marked by black bands. Shaded regions highlight ideal timescales for observations that will complement KSP light curves.