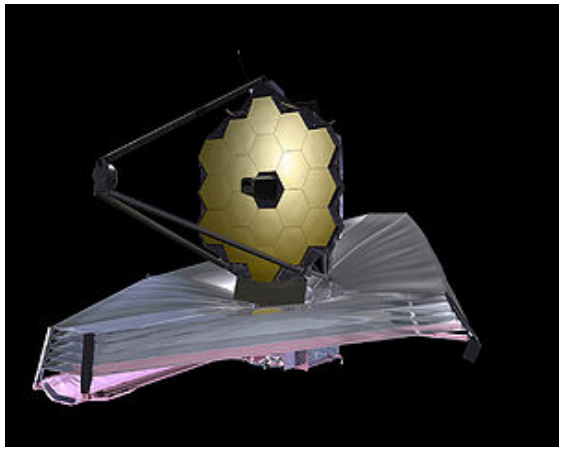
Type II Superluminous Supernovae from PTF

Giorgos Leloudas

VILLUM FONDEN

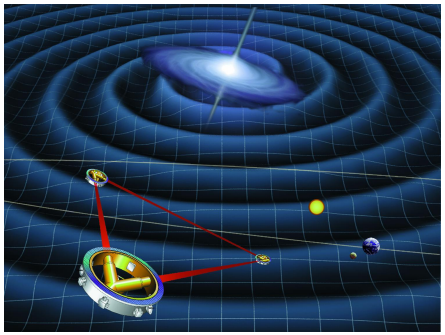
DTU Space
National Space Institute

DTU Space



- DTU Space is **Denmark's national competence centre for space science & technology.** It is one of the 19 institutes at the Technical University of Denmark (DTU) an international elite university with some 11,000 students and 6,000 employees.
- DTU Space has **150 employees (50 % scientists). 270 students are studying Earth and Space Physics & Egineering.** The **turnover is 15.5 Million Euro** a year.
- We have participated in **100 + space missions** during the last 50 years with ESA, NASA and national space agencies.

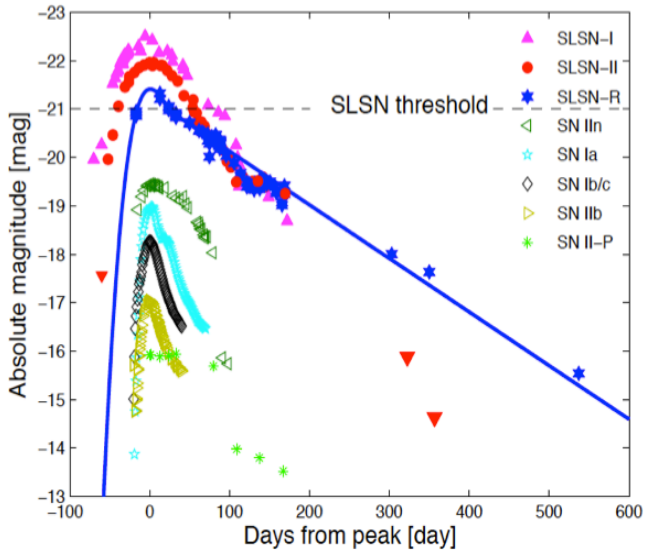
- We publish about **150 scientific articles** and research publications a year.
- We provide **research-based monitoring, advice and consulting** for state institutions.
- And we work on spinouts and **cooperation with private sector companies**.



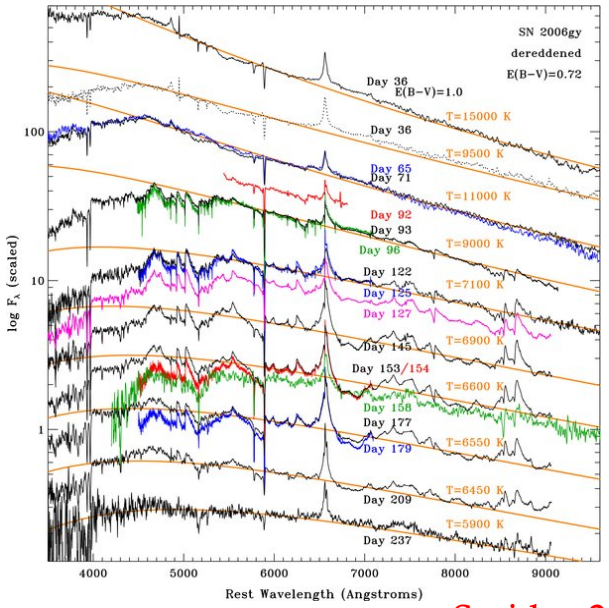
- We work in **three main fields**: Space Instrumentation and Technology Systems. Earth observation via satellites, drones and aircrafts. Space Science, exploring the early universe, our solar system and phenomena in the Milky Way.
- PhD and Post-Doc positions in Transient Astrophysics available !

Short Introduction

- SLSNe can be divided in Type I and Type II
- Large SLSN I samples have been compiled
- Type II studies restricted to individual objects
- SLSNe II are usually SN IIn showing strong CSM interaction
  - But see Inserra+ (2018)
- PTF discovered 12-15 SLSNe II between 2009-2012
- The first sample study Leloudas+ in prep.



Gal-Yam 2012

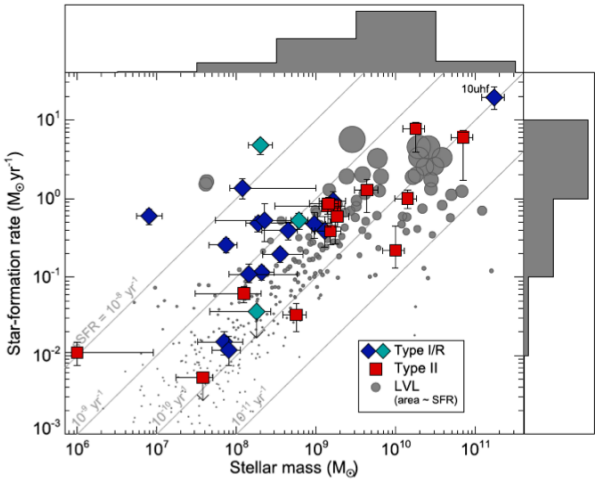


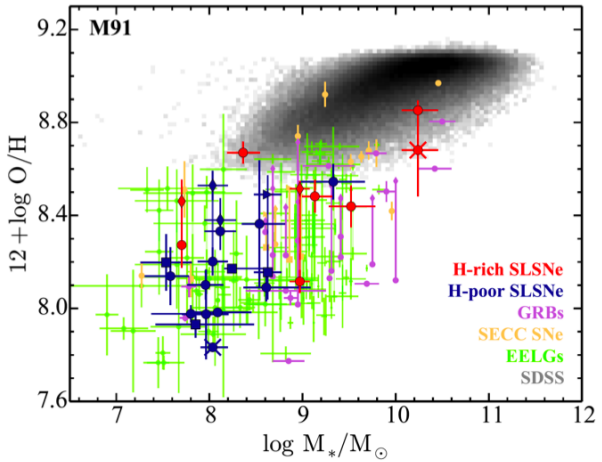
Smith+ 2010

Fundamental questions

- Are SLSNe II and SLSN I related ?
- Are SLSNe IIn just bright SNe IIn ?
- Statistics, rise times, …

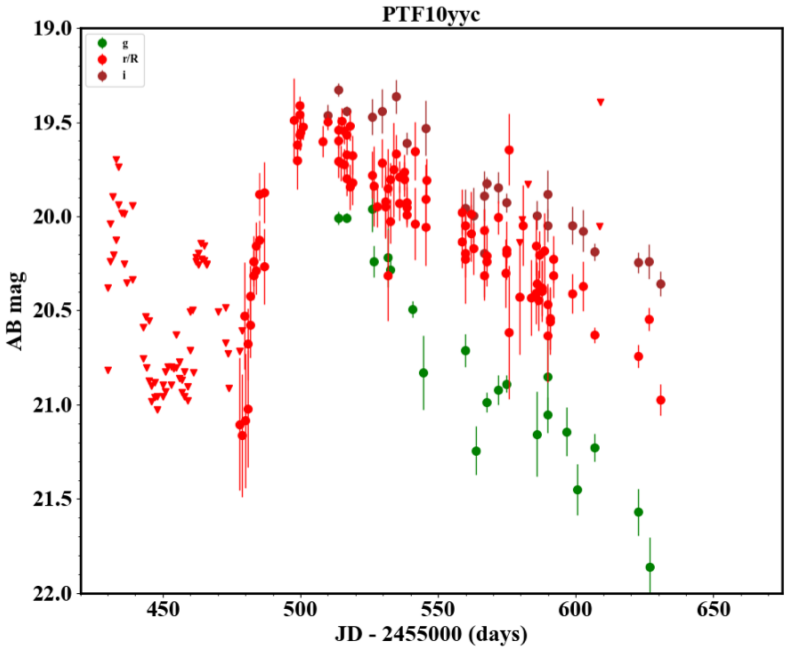
Host galaxy studies suggest different environments for I & II

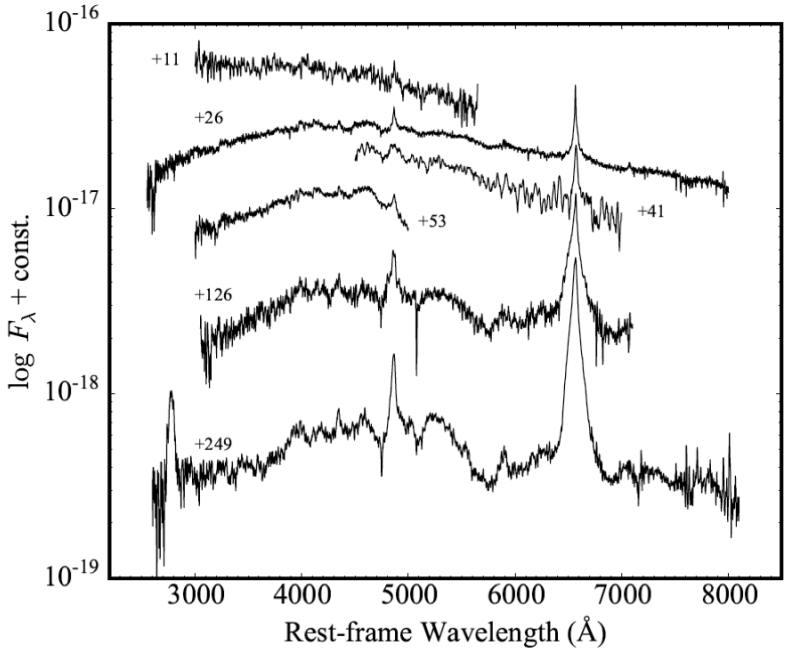




Leloudas+ 2015, Perley+ 2016, Schulze+ 2018

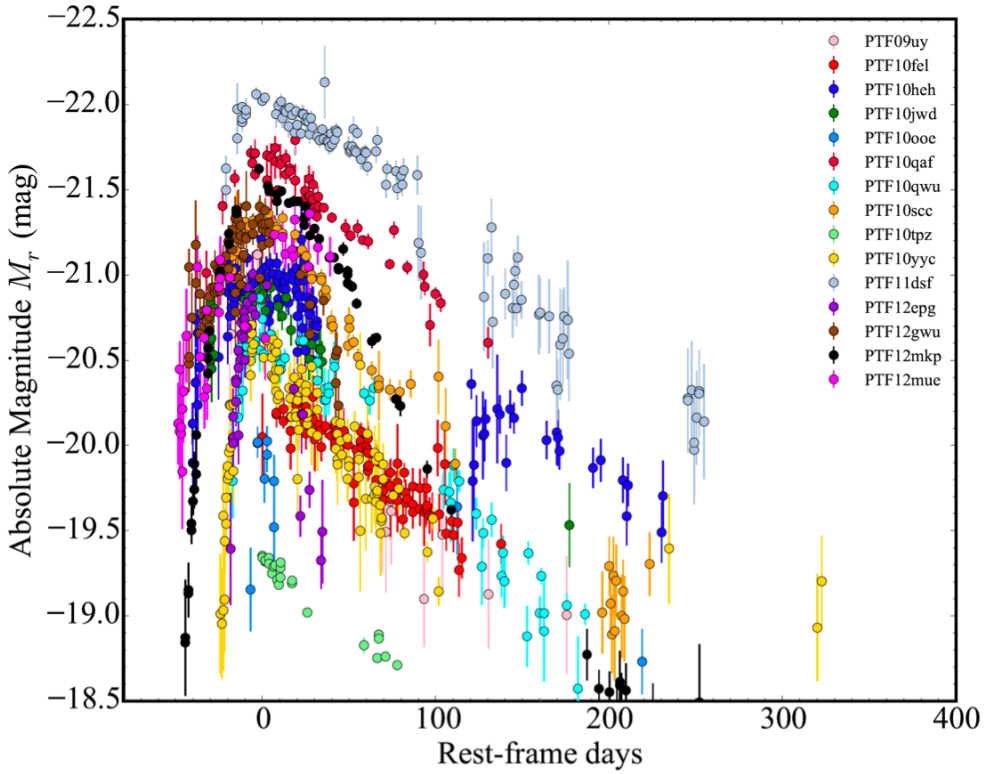
Light curves and spectra





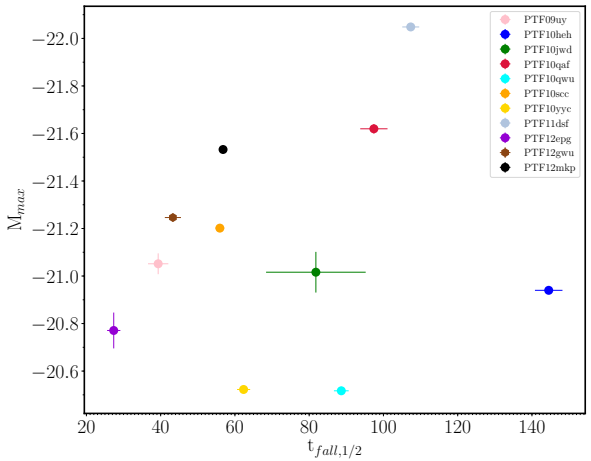
- Light curves cover from rise to a few hundred days
- 50 spectra extending to 300-400 days
- One SLSN II, the rest are SLSNe IIn

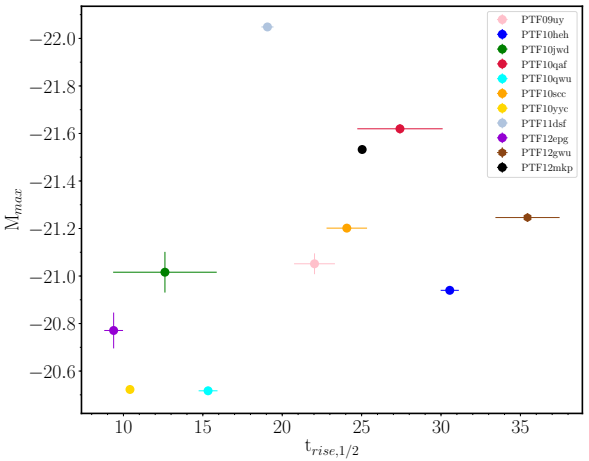
Absolute magnitudes

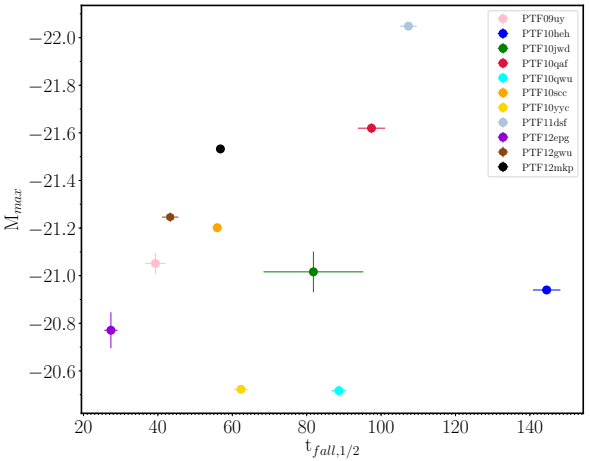


- Definition is always an issue

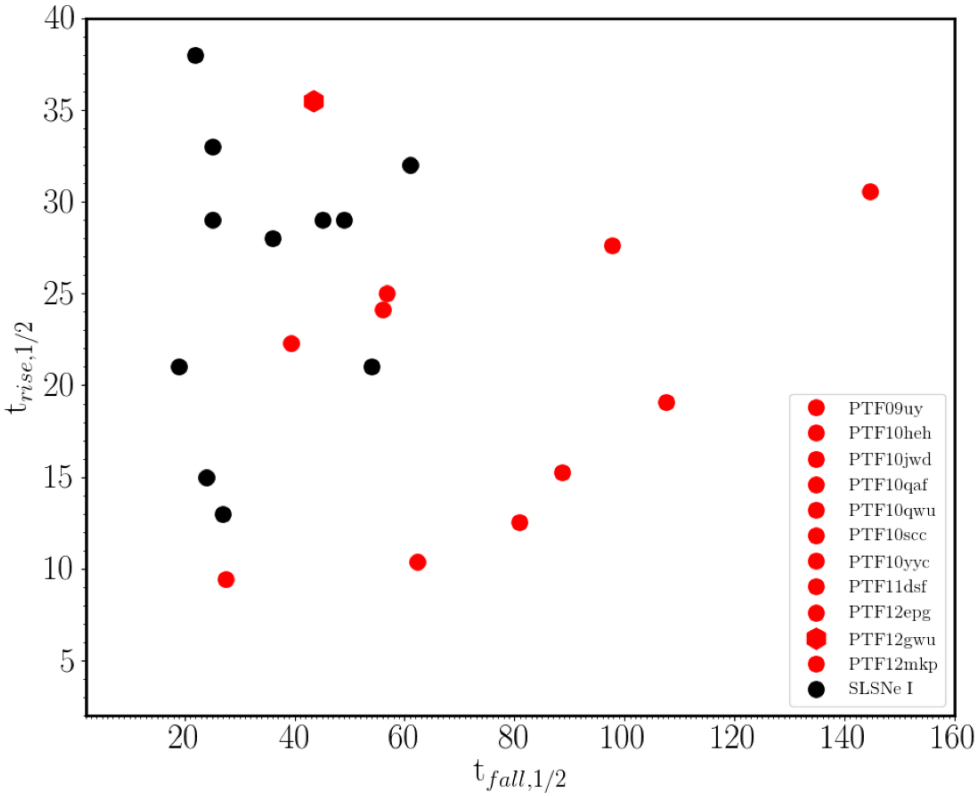
Rise, peak and fall





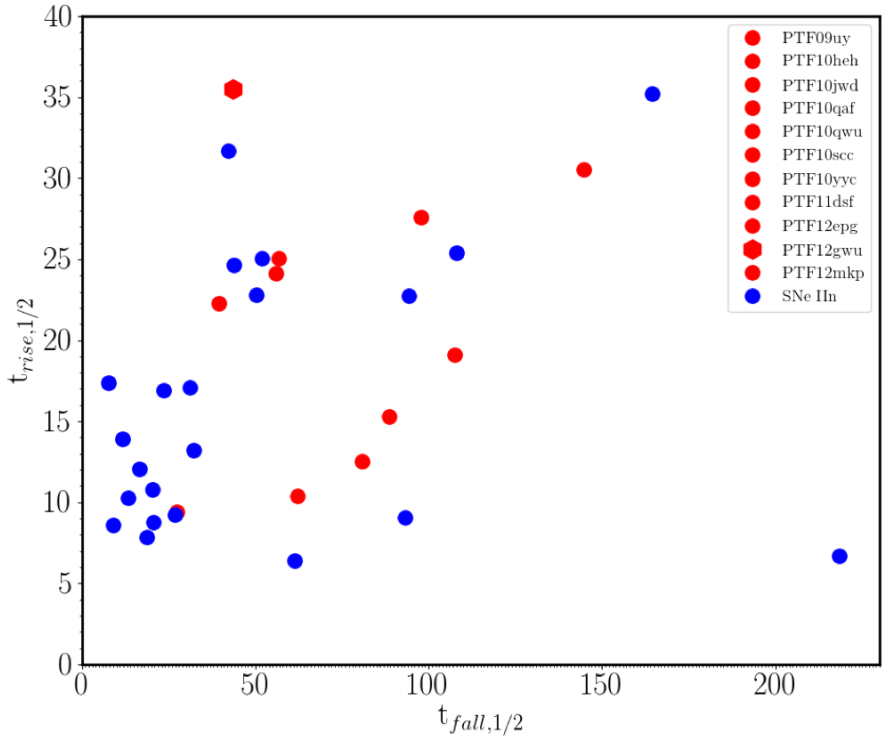


Comparison with SLSNe I



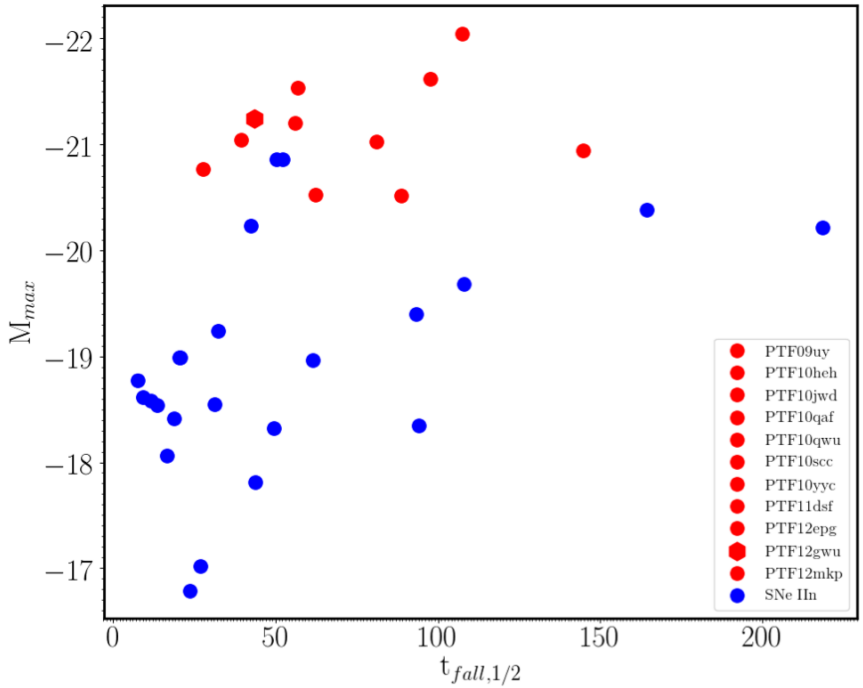
- SLSNe I by PTF. Annalisa De Cia+ 2018
- SLSNe IIn have longer decay times (for same rise time)

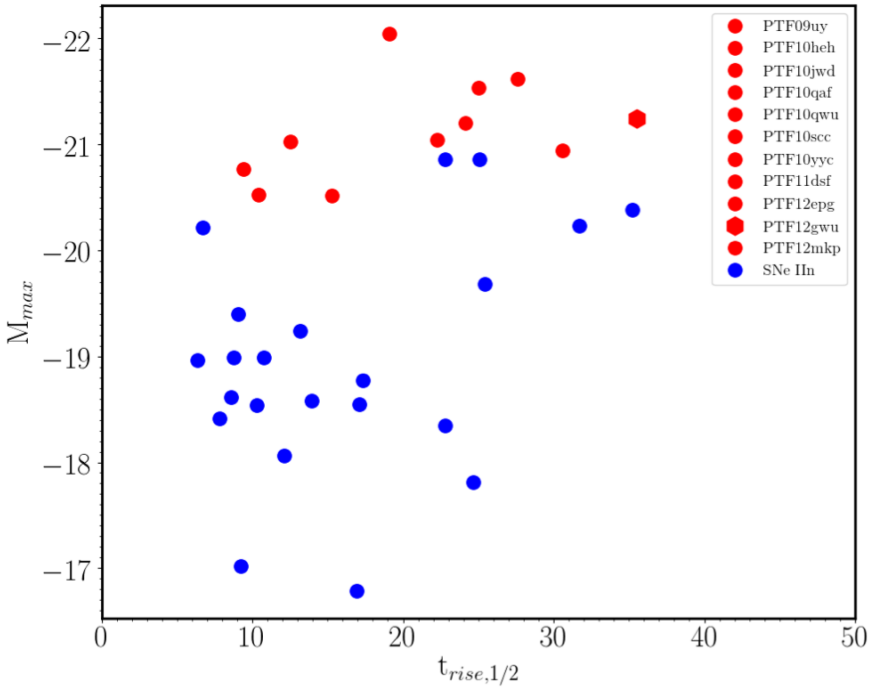
Comparison with SNe IIn



- SNe IIn found by PTF/iPTF. Anders Nyholm in prep.
- No clear separation here

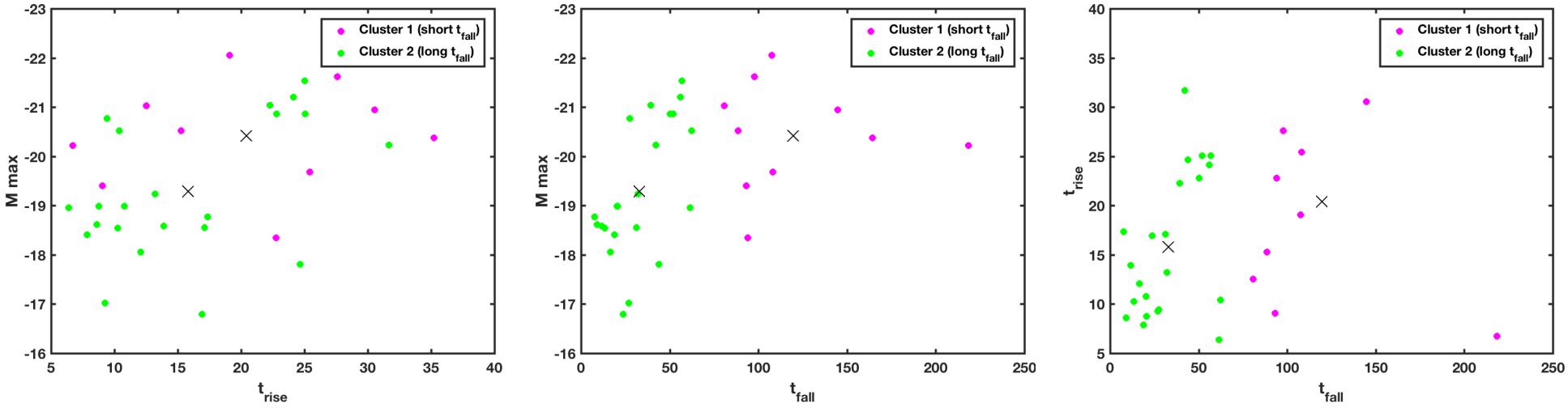
Comparison with SNe IIn – continued





- Here the separation is of course artificial

Cluster Analysis



- Unsupervised cluster analysis – assume two clusters exist
- The selected separation is based on decay time *not* peak mag

The End

Happy Birthday Nidia !