First analysis of LSST Supernovae Ia data with a focus on measuring the growth rate of structures

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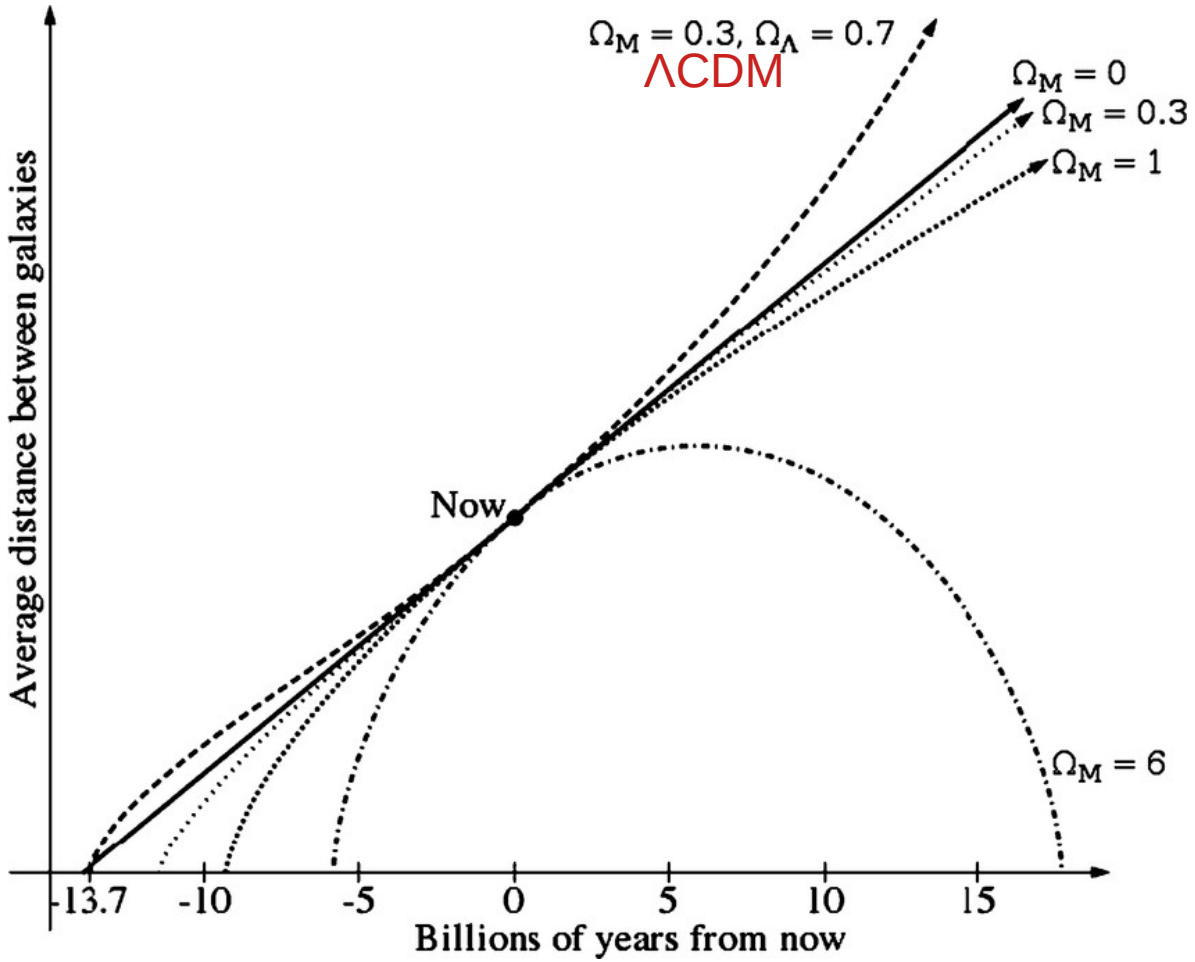
LSST DESC
Dark Energy Science Collaboration

Aix*Marseille université

Cosmological Model

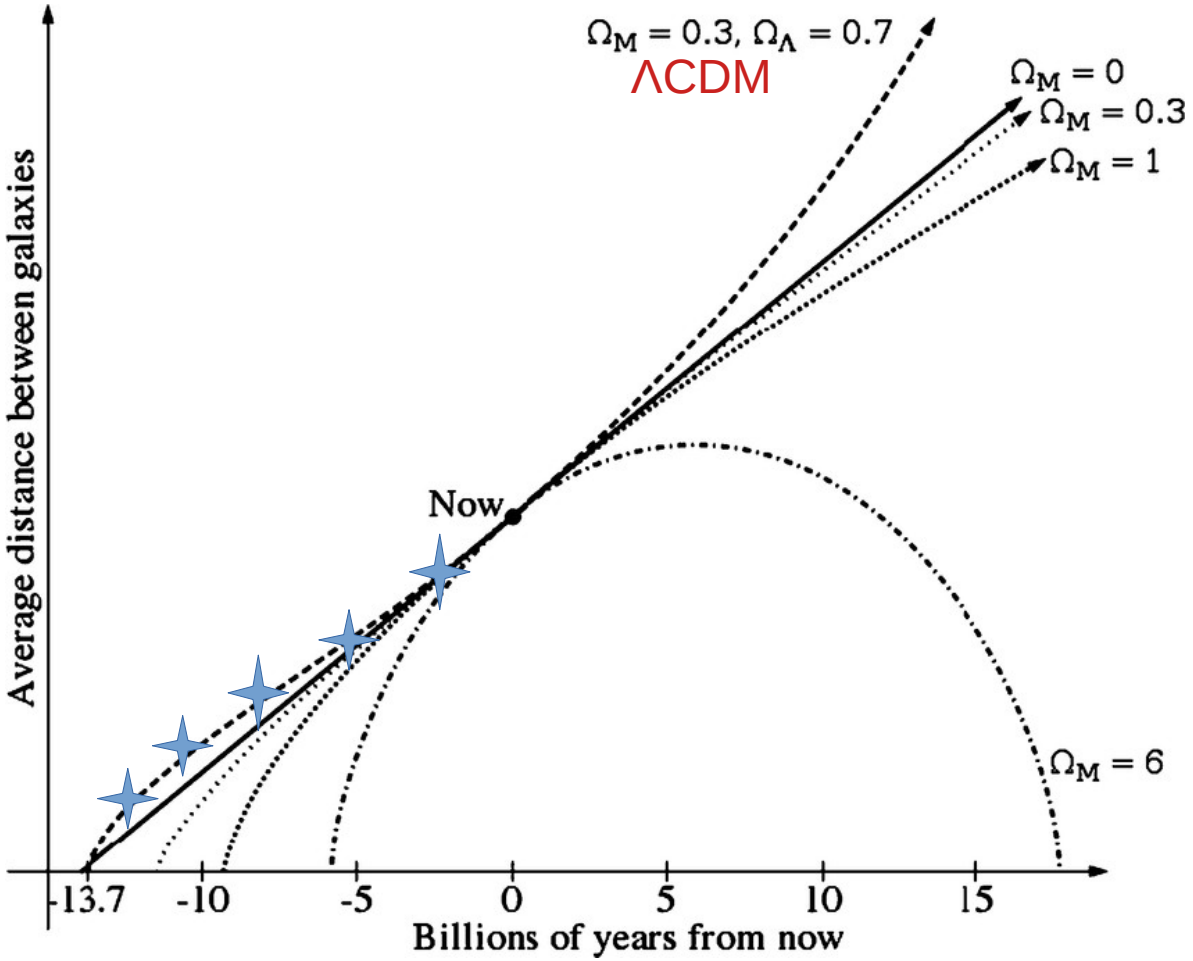


credit: J.Casado 2013

Observing the Universe
We observe the redshift of the objects

redshift + Cosmological Model:
Convert redshift into distances

Cosmological Model



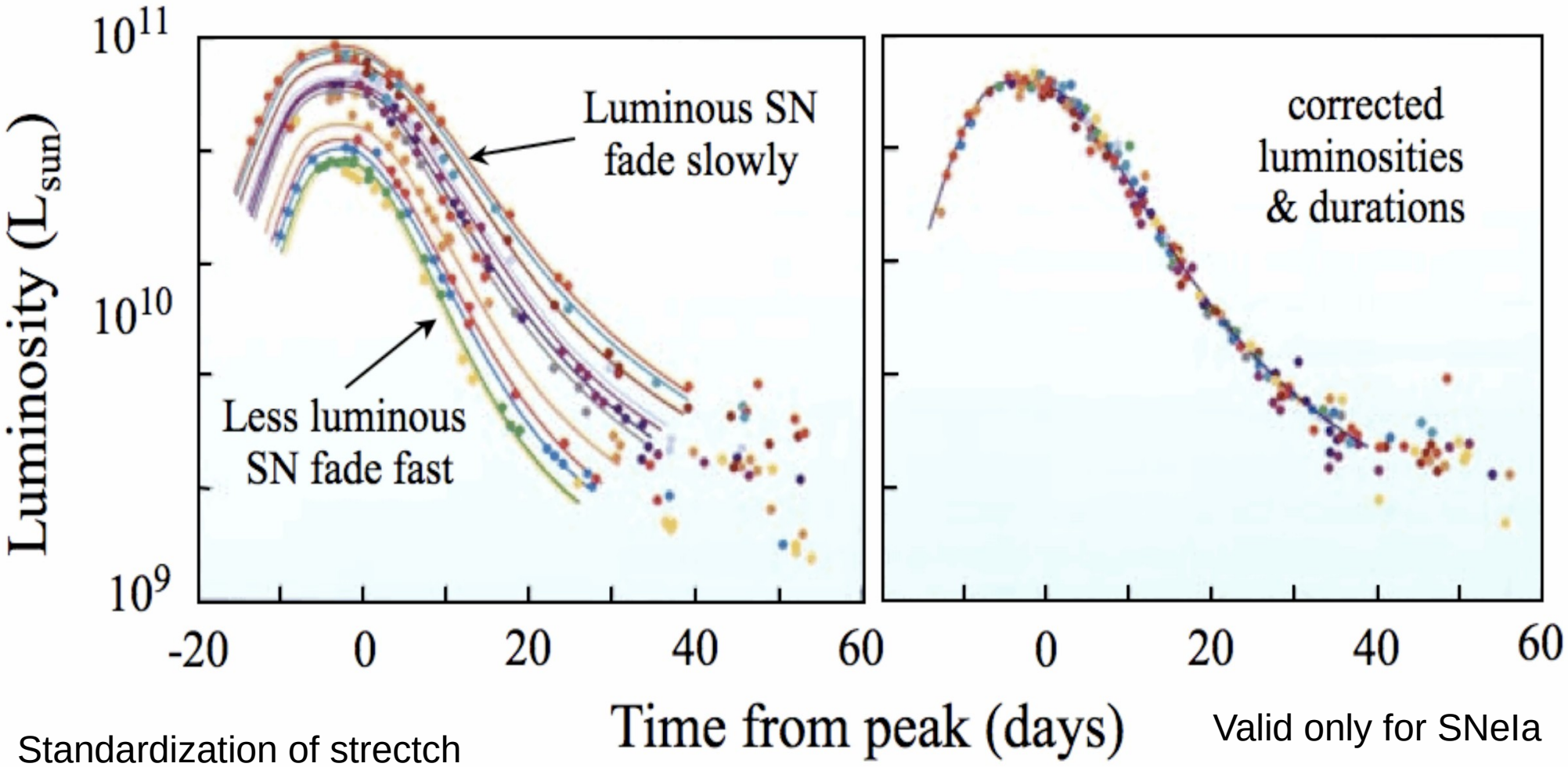
Standard Distance Indicators:
Distance measurements, then
Constrains on cosmological model

Data show accelerated expansion:

- **GR + Dark Energy Component**
  (what is dark energy?)
- **General Relativity doesn't work on cosmological scale**
  (alternative gravity theories?)

Supernovae Ia are Standard Candels,
We 'know' their intrinsic luminosity
We use them to measure the luminosity distance

Cosmology with Supernovae

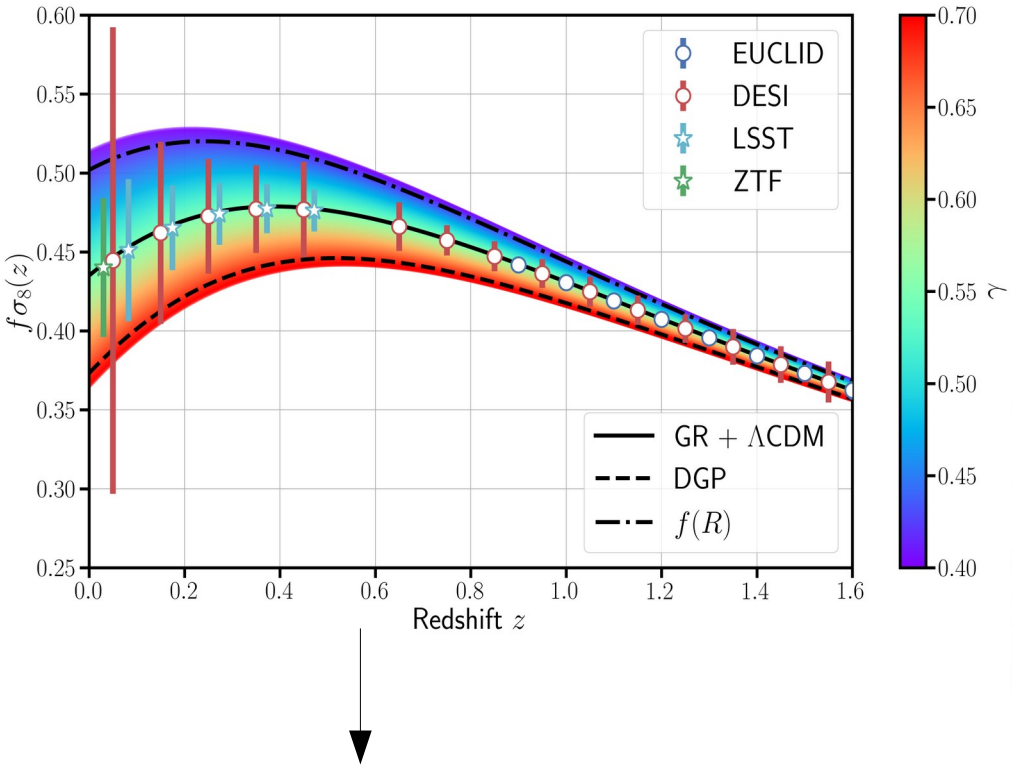


Standardization of strectch and colors (Empirical formula)

Valid only for SNeIa

Cosmology with Supernovae

Credits Bastien Carrers



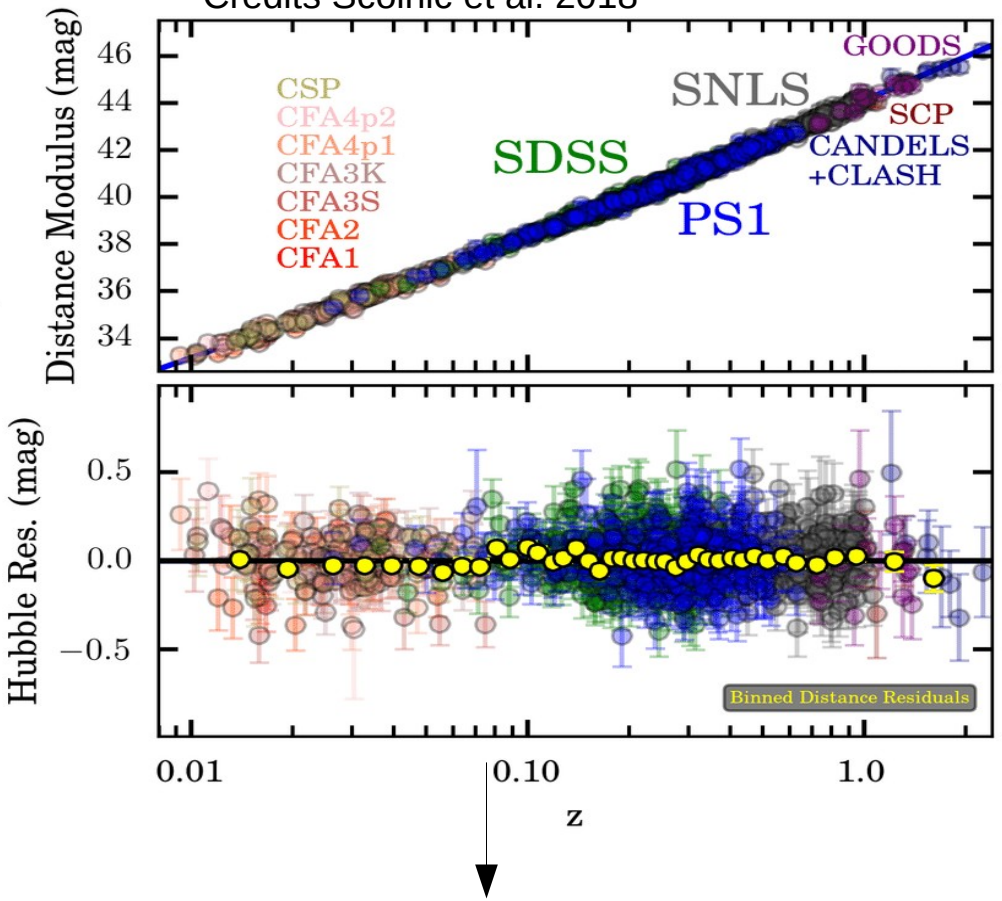
$(1+z)=(1+z_{cos})(1+z_{pec})\ldots$

Recover V_{pec} from HD

measure of growth rate of structure

Test of GR

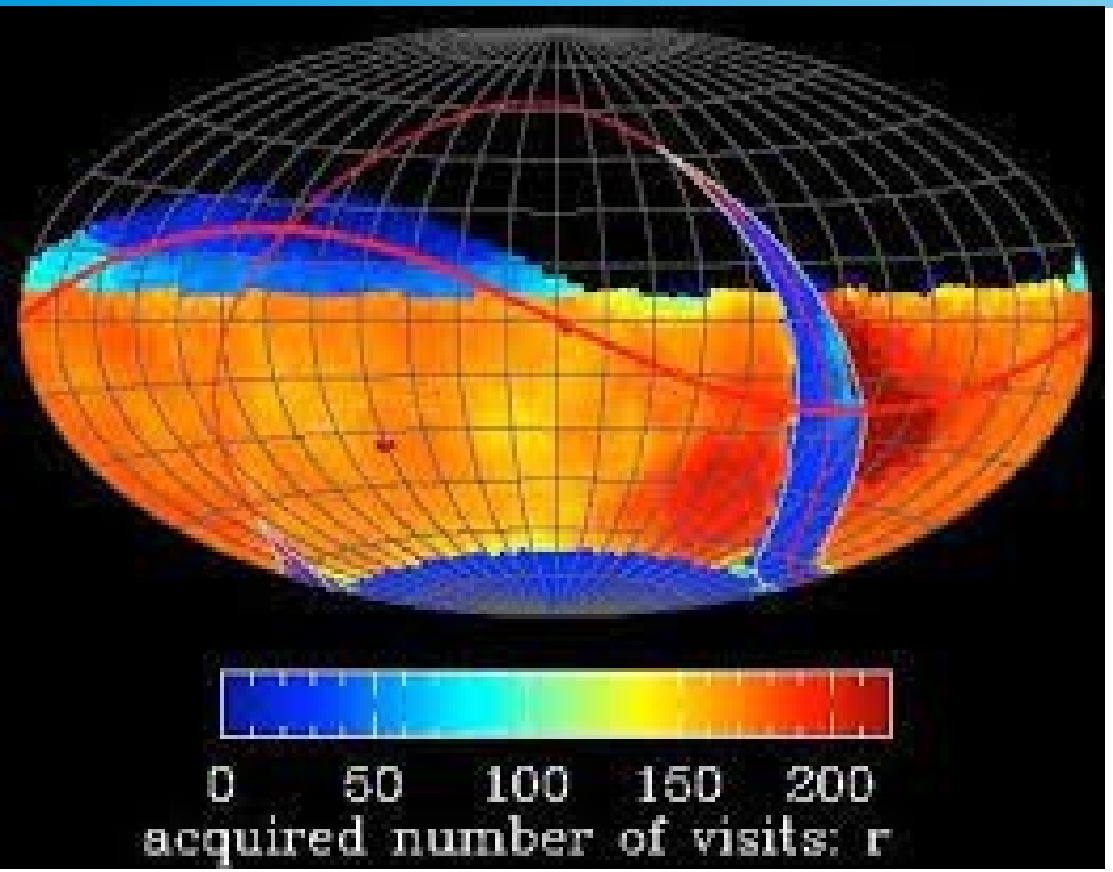
Credits Scolnic et al. 2018



Hubble Diagram (μ vs z):

- cosmological parameter (Ωm…)
- anchor (TRGB,Cepheids) then H_0

Vera Rubin Observatory & LSST



From lsst.org

Vera Rubin Observatory, Chile
Start: end of 2024

LSST: about 18,000 deg2 of the southern sky with 6 filters
r<23.5 wide field
r<24.5 deep fields
z>0.1

About 200000 SneIa in the next 10 years
(up today about 5000 SneIa)

Impossible to have a complete spectroscopic follow-up of Sne

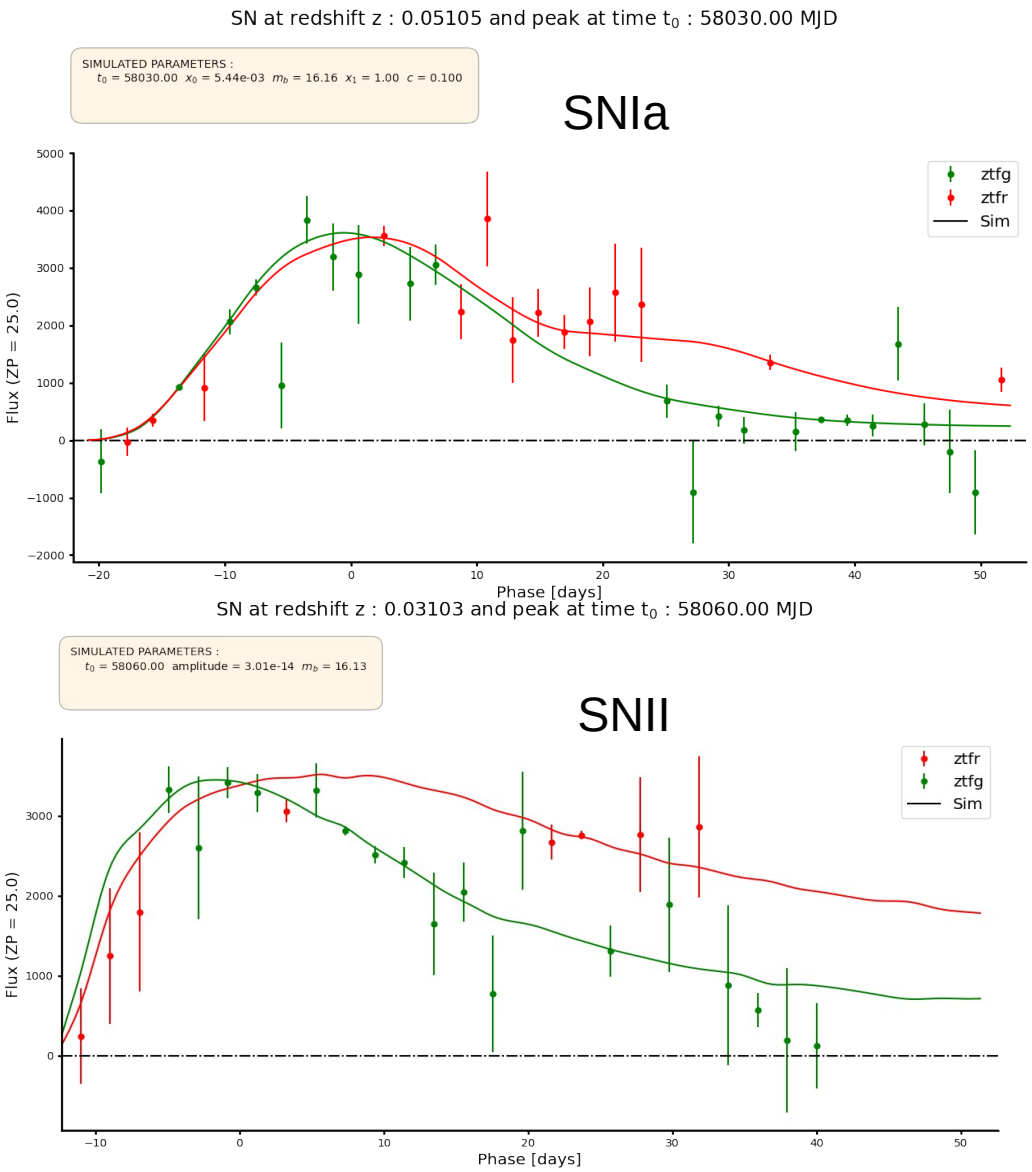
(no spectroscopic typing, no spectroscopic redshift for all the objects)

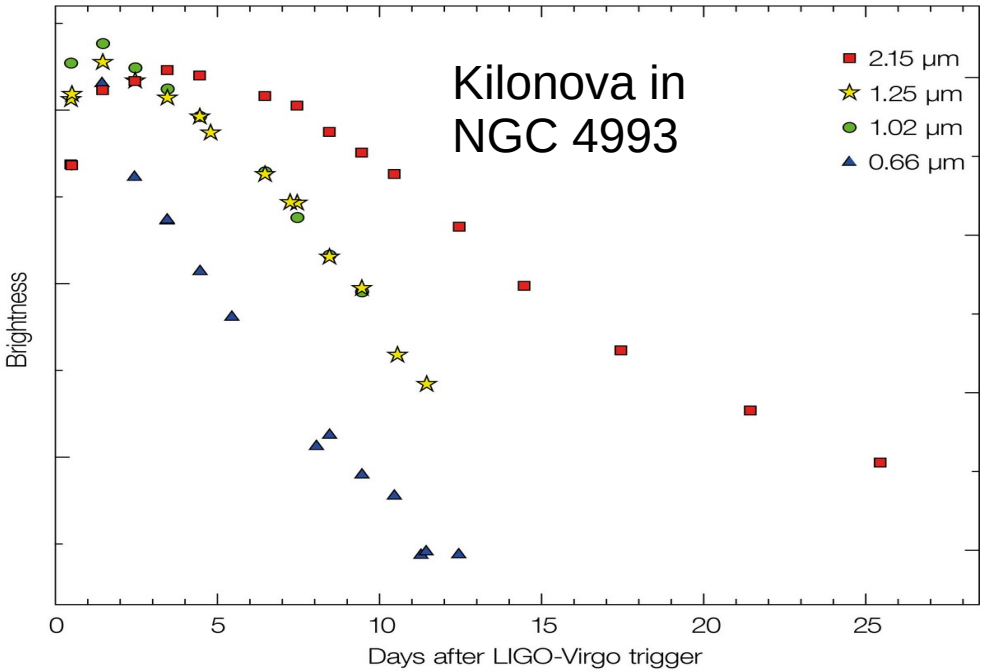
Thesis Project

Preparation for LSST data analysis:

- Phototyping
- Study and correct the bias on $f\sigma_8$ in contaminated sample

SNe Lightcurves & Phototyping

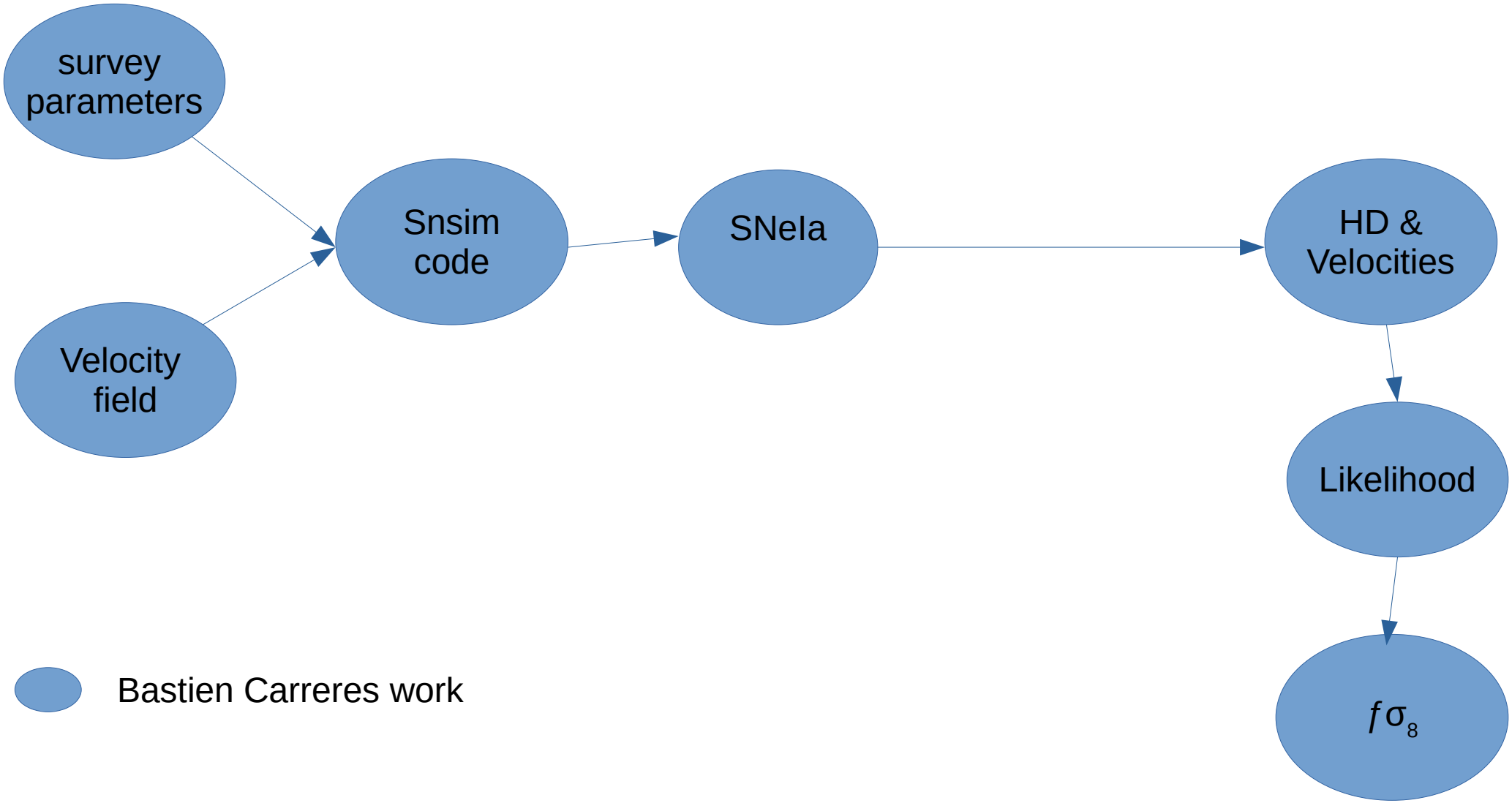




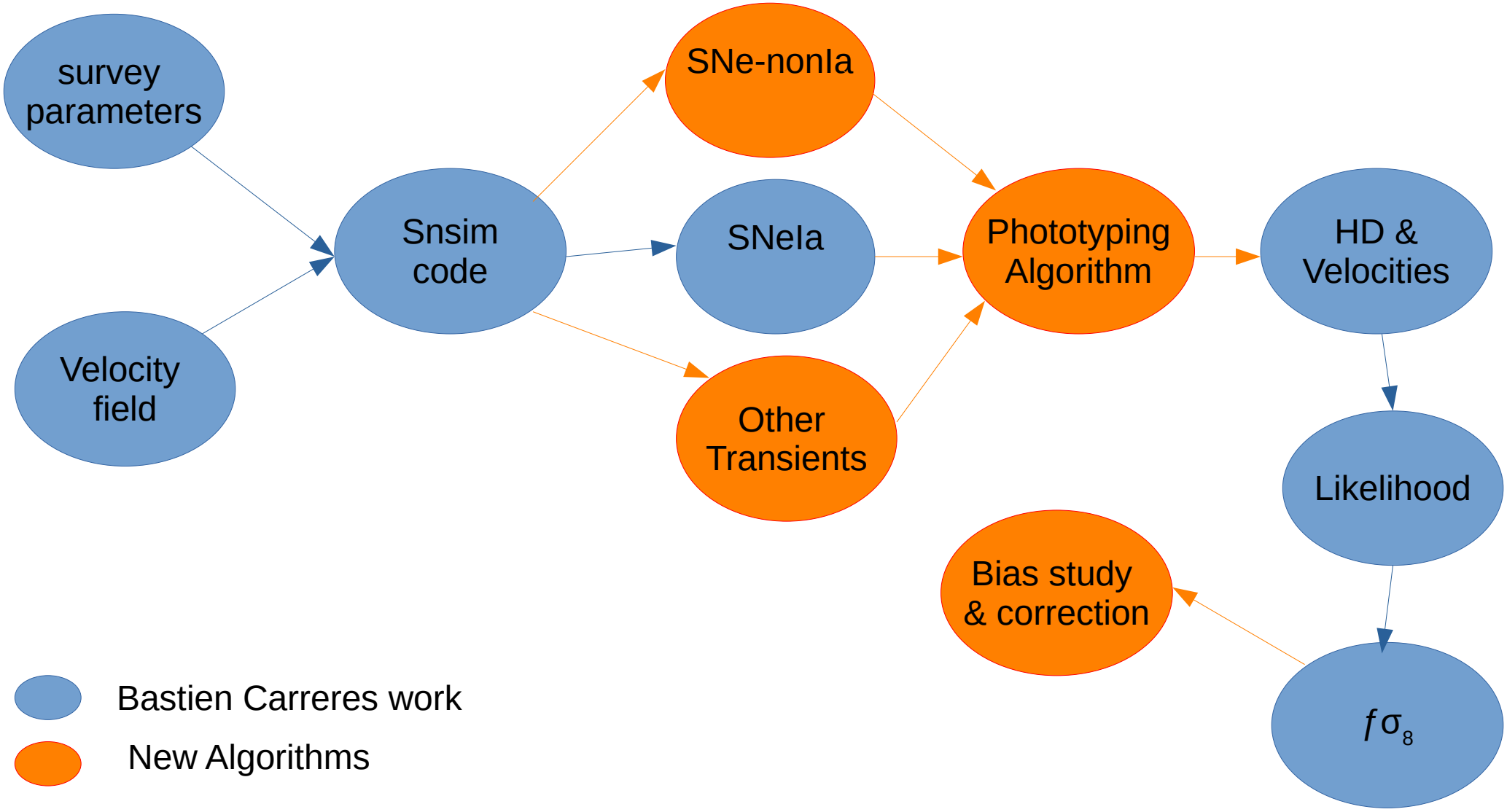
Credit: Tanvir et al.

Phototyping:
Determine the object type through the features of its lightcurve (usually done with machine-learning)

Simulation Pipeline



Simulation Pipeline

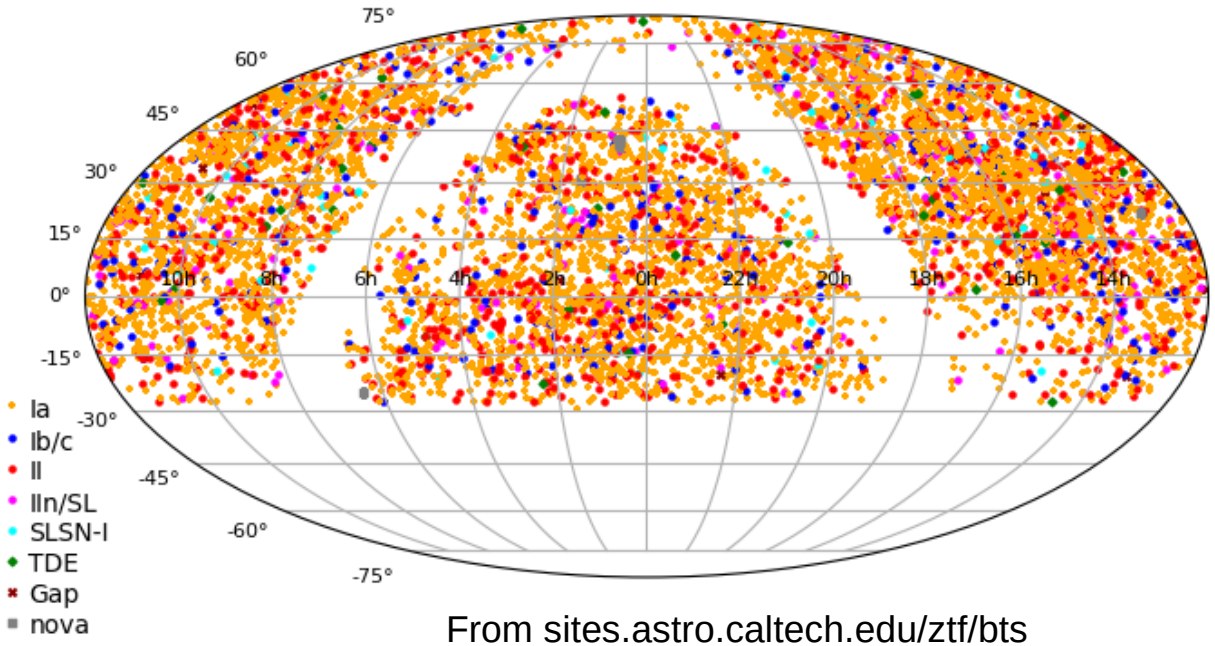


Preparing LSST Data Analysis

- Simulation of realistic surveys

- Confont simulation with real data up

ZTF Bright Transient Survey



From sites.astro.caltech.edu/ztf/bts

North sky coverage in 3 filters
Z<0.1
Automated spectroscopic follow-up

DR2 public soon:
About 3000 typed SNeIa
with spectroscopic redshifts

Preparing LSST Data Analysis

- Test the phototyping algorithm trained on both data and simulations
- Study the impact of the bias on $f\sigma_8$ measurement when only photometric data available (also redshift)
- Correct the Bias
- Develop and Test the complete pipiline for LSST data analysis: focus on measure the growth rate of structures

Thanks for your attention