Tuesday, 23 June 2020: Panel discussion

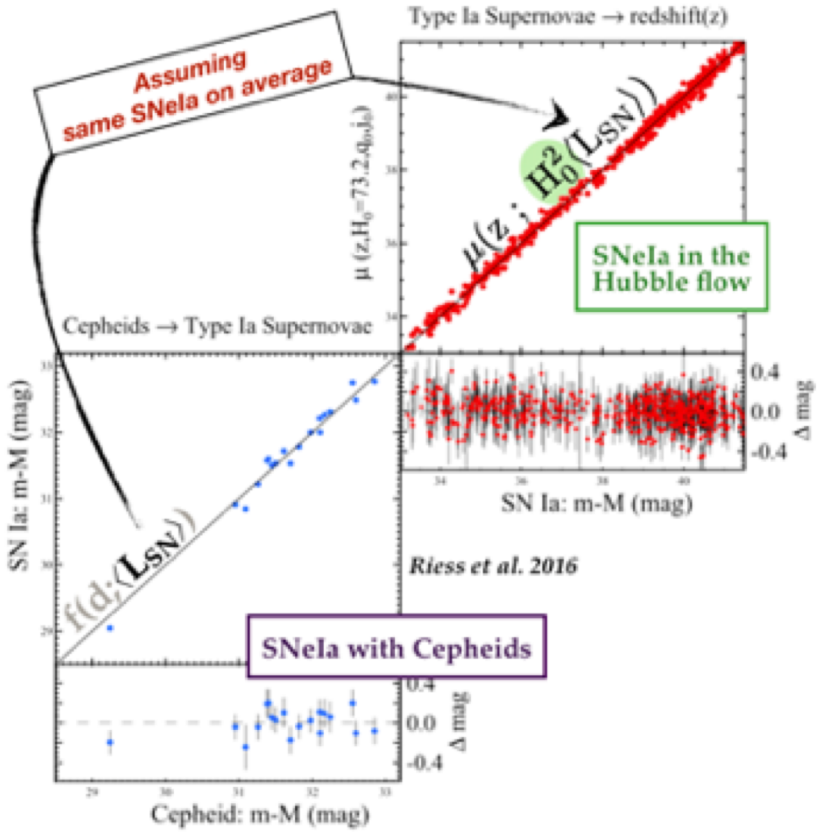
Panelists: Pierre Kervella, Dan Scolnic, Richard de Grijs, Mickael Rigault, Marina Rejkuba

Speakers: Lennart Lindegren, Grzegorz Pietrzynski, Caroline Huang, Bruno Leibundgut

Discussion topics

- Connecting topics presented during the session
  - How do different techniques complement each other?
- Is it important (or not) to obtain absolute distances to Cepheids / TRGB / Miras in different environments?
- Sample biases
- Metallicity effect on Cepheids
- Gaia parallaxes comparison with the best PLRs
- Interstellar extinction and reddening laws

Type Ia Supernovae | *Scolnic & Rigault*



Systematic sensitivity due to *not averaging the same SNeIa*

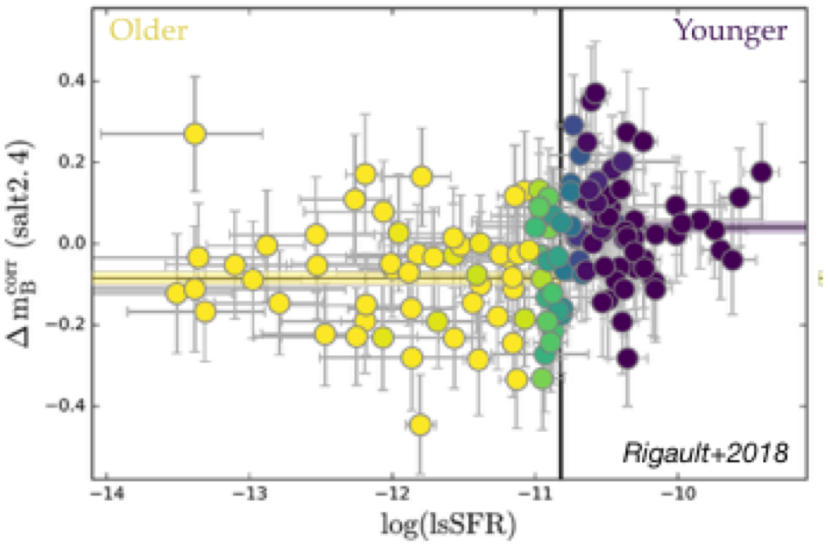
Caveat:
Cepheid-host favour young env.

Suggested Impact of H0 up to 3%
Δmag=0.15 &
anchoring sample 100% young
Rigault+2015,2018

But: SH0ES selecting only late-type galaxies in the Hubble flow finds: H_0=**73.7** km s^{-1} Mpc^{-1}

Why ? 1) smaller step &
2) more « old » env. SN In cepheid hosts
3) Mass step accounted for
Jones+2015,2018,Riess+2016

Young environment SNeIa are fainter
vary from 0.05 to 0.15 mag depending of lit.



« Sample selections and host correlations are the most looked at issues in the SNeIa community now. »

— See also Brout&Scolnic2020 suggesting dust is the root cause of the effect —

✓ **Full covariance matrix propagation**
Dhawan+2020
vs. alternative analyses in SH0ES

✓ **Calibration across surveys**
Scolnic+2018

✓ **Redshift uncertainties**
Scolnic+2018 (see Davis' talk)

✓ **Peculiar velocity & Voids**
Kenworthy+2019

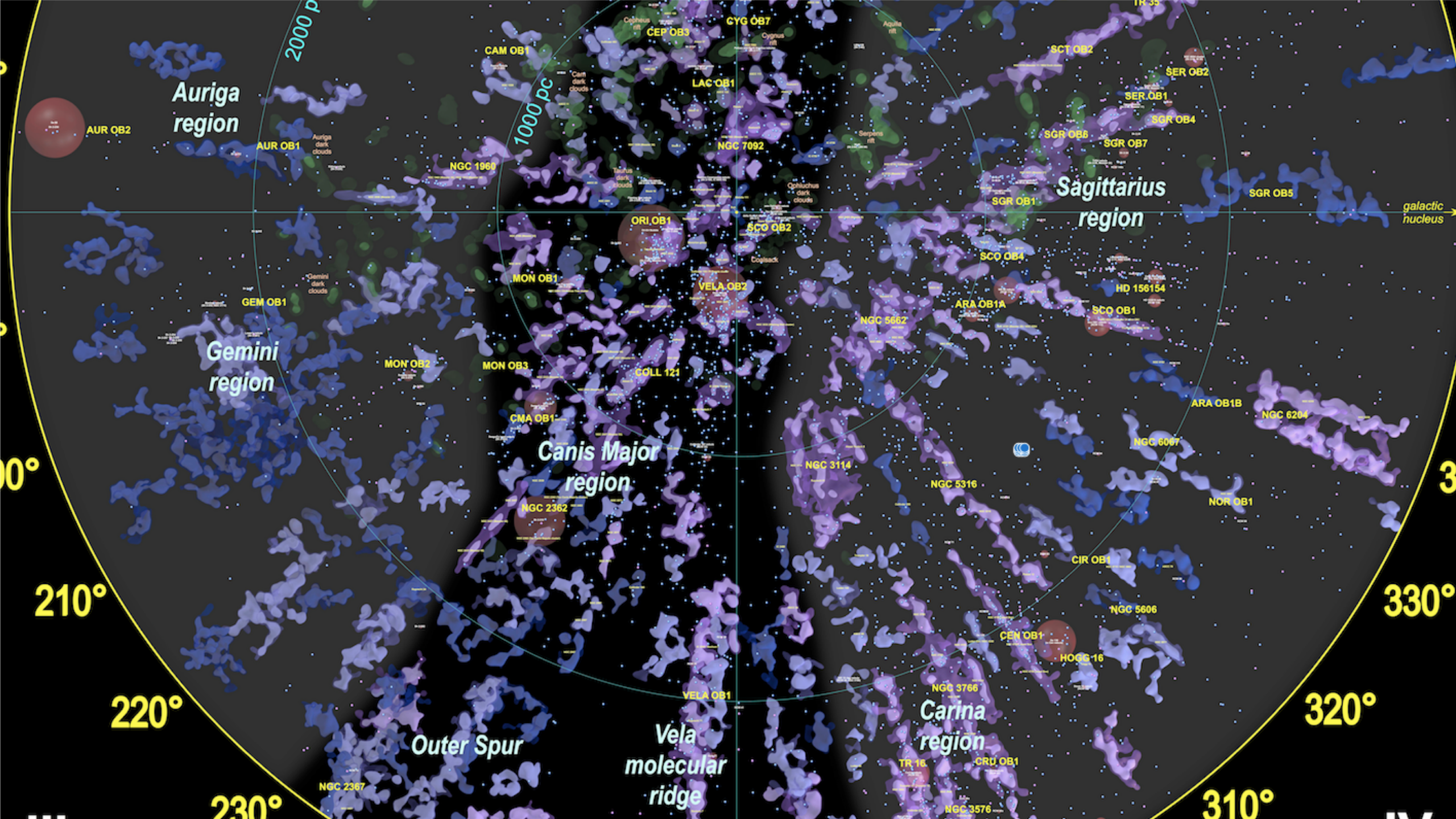
✓ **Negligible cosmological-model sensitivity in methodology**
Brout+2019

✓ **Various standardisation technics**
Riess+2016,2018

Is Gaia always beating traditional methods?

- Consider distance distribution of different object types
- Parallax uncertainty progressively increases with distance – how do we deal with radial anisotropies in Gaia distances?
- Issues with parallaxes for Galactic Miras

- Is Gaia always better or can we still rely on traditional methods?


2000 pc
1000 pc
Auriga region
Gemini region
Canis Major region
Outer Spur
Vela molecular ridge
Carina region
Sagittarius region
galactic nucleus
AUR OB2
AUR OB1
CAM OB1
CEP OB3
CYG OB7
LAC OB1
NGC 1960
NGC 7092
GEM OB1
MON OB1
MON OB2
MON OB3
ORI OB1
VELA OB2
COLL 121
CMA OB1
NGC 2362
NGC 2367
VELA OB1
SCO OB2
SCO OB4
SCO OB1
ARA OB1A
ARA OB1B
NGC 5662
NGC 6204
NGC 6067
NGC 3114
NGC 5316
NOR OB1
CIR OB1
NGC 5606
CEN OB1
HOGG 16
NGC 3766
TR 16
CRU OB1
NGC 3576
SCT OB2
SER OB2
SER OB1
SGR OB4
SGR OB6
SGR OB7
SGR OB1
SGR OB5
HD 156154
TR 35
210°
220°
230°
310°
320°
330°

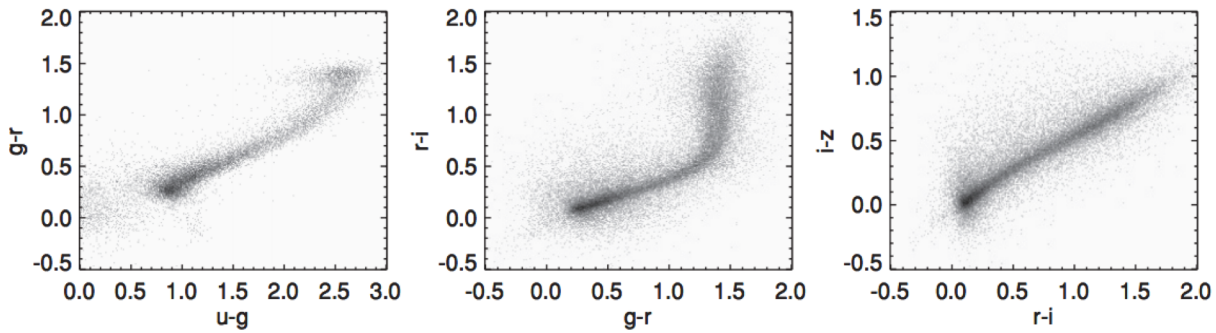
Interstellar extinction & reddening laws

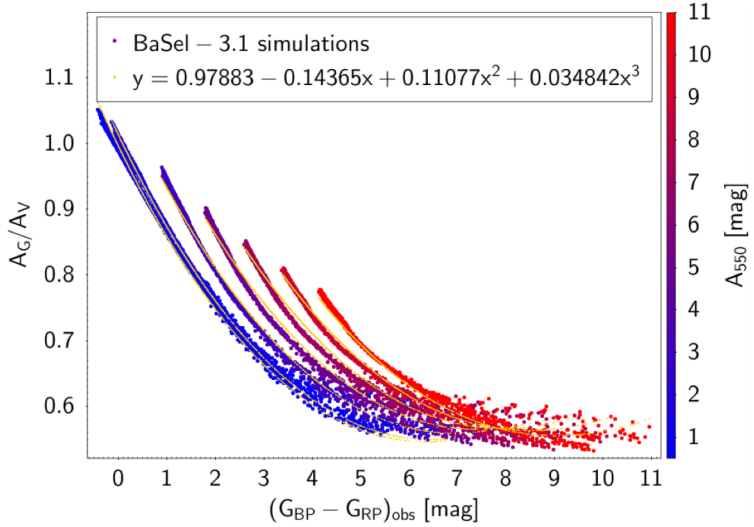
- What is the impact of extinction/reddening on different standar(isable) candles?
- How is reddening to extinction correction implemented?
- How to assess variability of extinction laws?

Reddening laws and extinction

- Reddening laws: O'Donnell 1994, Cardelli+89, Fitzpatrick 1999
- Schlafly et al. 2010: SDSS test of Schlegel et al. (SFD) dust maps
- Schlafly & Finkbeiner 2011: recalibrated SFD *E(B–V)* maps in 88 bandpasses for 4 values of R_V

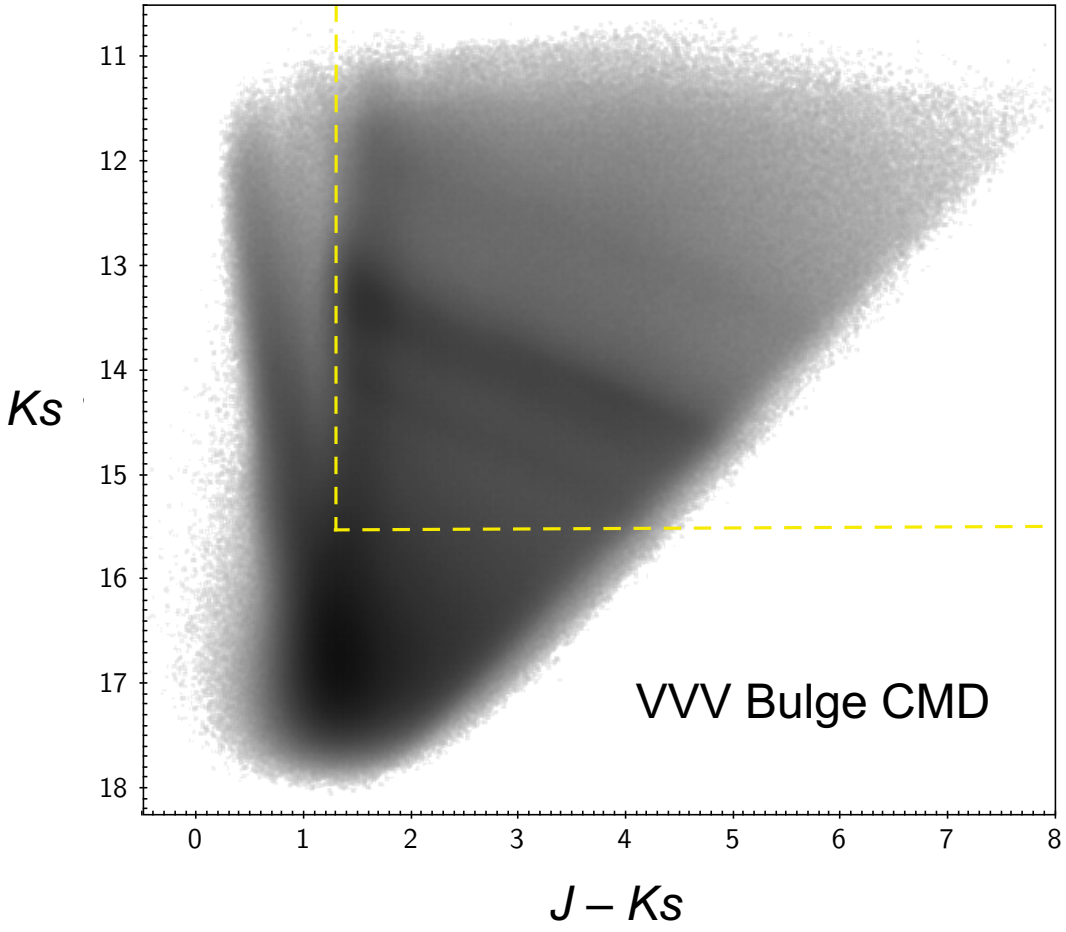
Schlafly+10: color–color diagrams from SDSS
"Blue tip" = sharp cut-off in stellar density
$u - g = 0.8$, $g - r = 0.2$, $r - i = 0.1$ and $i - z = 0.0$



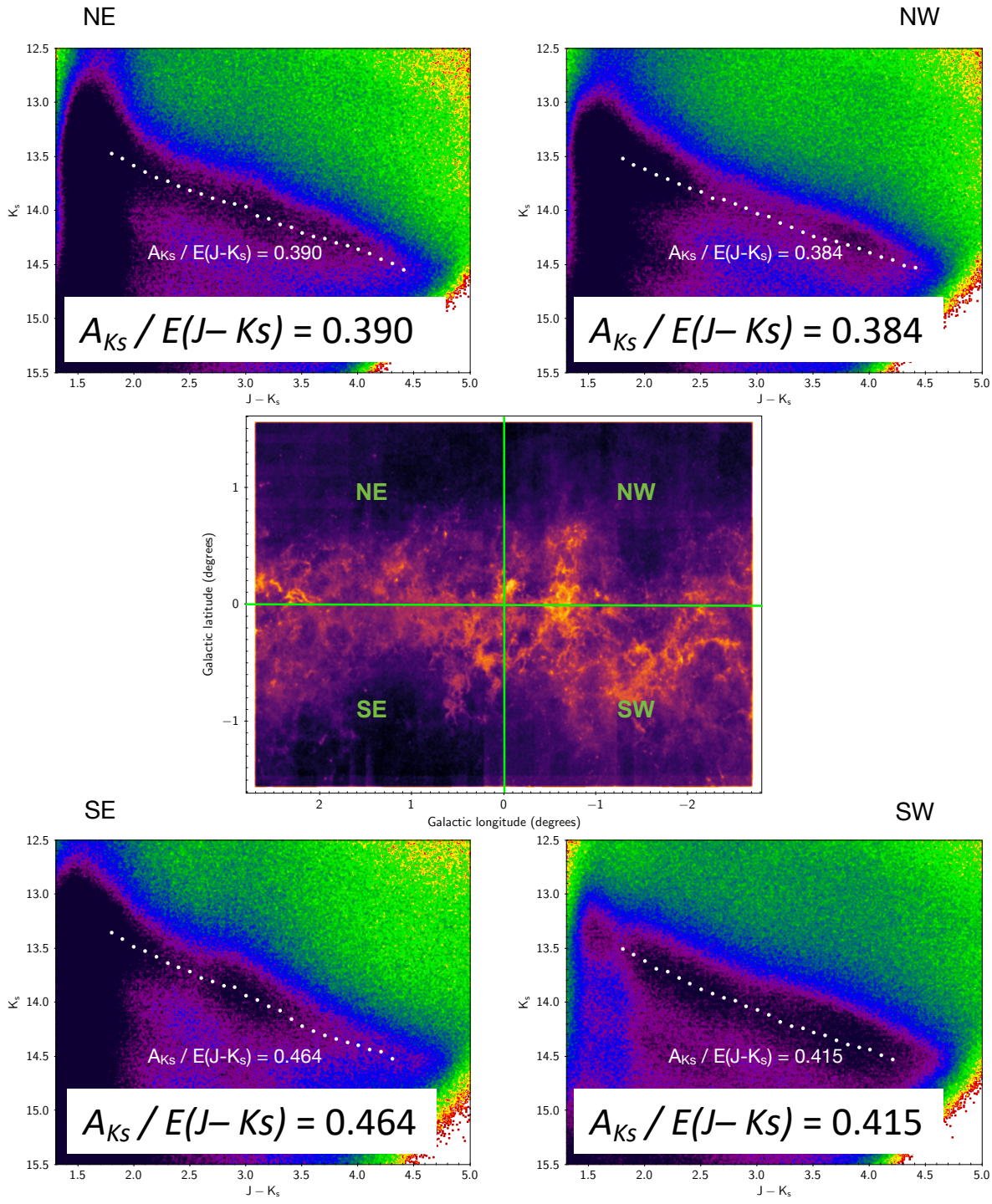


Reddening to extinction for Gaia DR2: Jordi+10
Figure from Ramos+20, passbands from Maiz-Apellaniz & Weiler 2018

Galactic Bulge: Red Clump



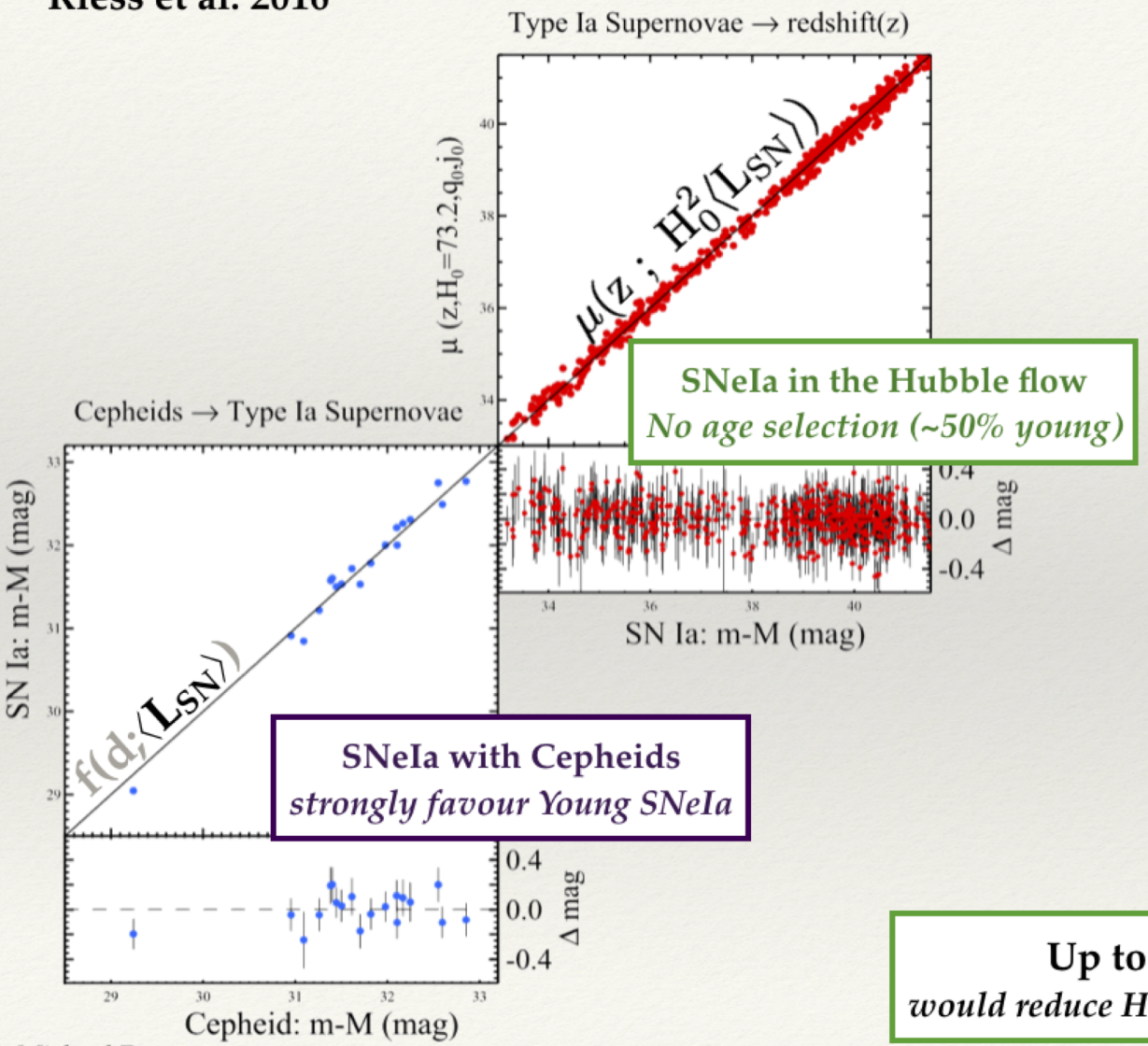
Alonso-Garcia, J., et al. 2017



Additional material

Astrophysical SN bias & the H_0 tension

Riess et al. 2016

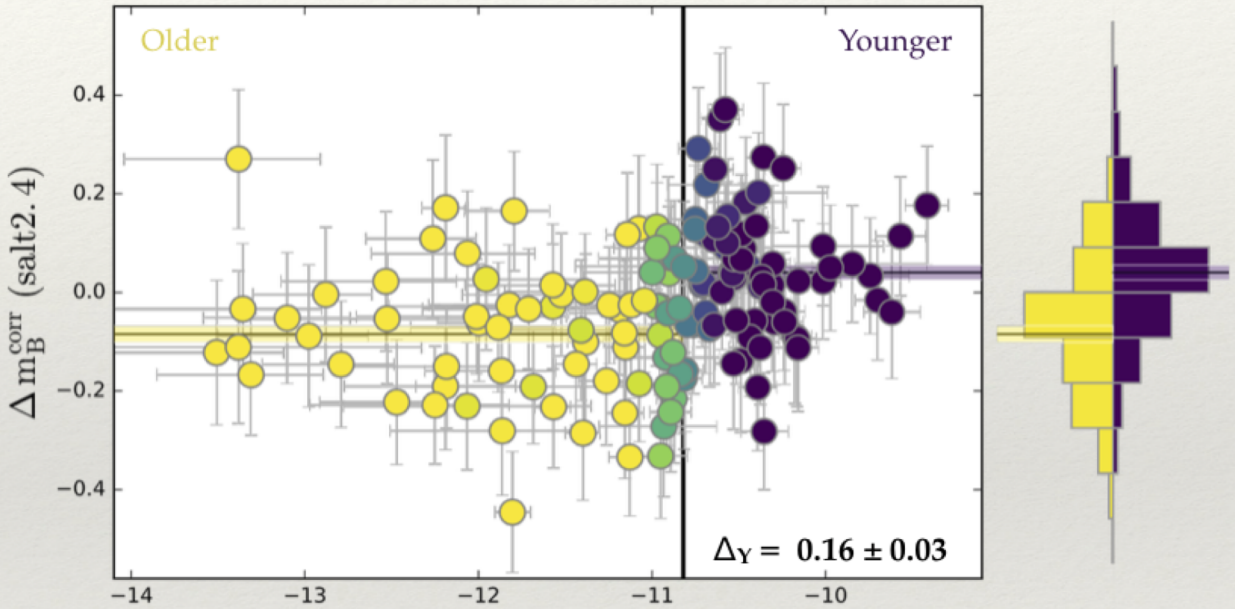


SNeIa in the Hubble flow
No age selection (~50% young)

SNeIa with Cepheids
strongly favour Young SNeIa

Rigault et al. 2015, 2018, in prep

non-zero at ~6σ level | Young SNeIa are 0.16 fainter



local Star formation rate / *local* stellar mass

See also SNLS+SDSS 7 σ step in Roman2018

Up to 3% bias on H_0
would reduce H_0 down to ~71.5 km/s/Mpc

Based on Jones et al. 2018, can estimate impact now (~0.3 dex) , and next round (0.1 dex).

Late-type, star forming only, 38 CC, help motivated by M. Rigault

With next data release -> doubling of the CC sample, and cutting to late-type hosts, cut out red SNe

SN Host Property in R16 (Pantheon z<0.15) sample	Step Size	Step Significance	% HF-CC R16	Delta H_0 R16 (km/s/Mpc)	% HF-CC R20 in prep	Delta H_0 R20 in prep (km/s/Mpc)
Local mass > 8.3 dex	0.055 +/- 0.17	3.2	15.3%	-0.28	-15.2%	+0.28
Global mass > 10 dex	-0.002 +/- 0.018	0.1	22.6%	0.02	-8.7%	0.00
Local u-g > 1.3	0.033 +/- 0.020	1.7	39.5%	-0.44	18.7%	-0.21
Global u-g>1.3	0.035 +/- 0.020	1.8	20.2%	-0.24	17.3%	-0.21
Local sSFR < -10.6	0.035 +/- 0.021	1.7	30.9%	-0.37	15.1%	-0.18
Global sSFR < -10.6	0.029 +/- 0.020	1.4	21.1%	-0.21	19.3%	-0.19

All these differences are >10x smaller than tension with CMB H0. We can cut possible bias on H0 down to 0.1!

Mean=24.9% -0.31
Max=39.5% -0.44
Only Sig=15.3% -0.28

Mean=11.0% -0.10
Max=19.3% -0.21
Only Sig=-15.2% +0.28

Good agreement with NIR H0 measurements (Burns et al. 18, Dhawan et al. 17).