Current Status of JINGLE

Hwang, Ho Seong

(Korea Institute for Advanced Study)

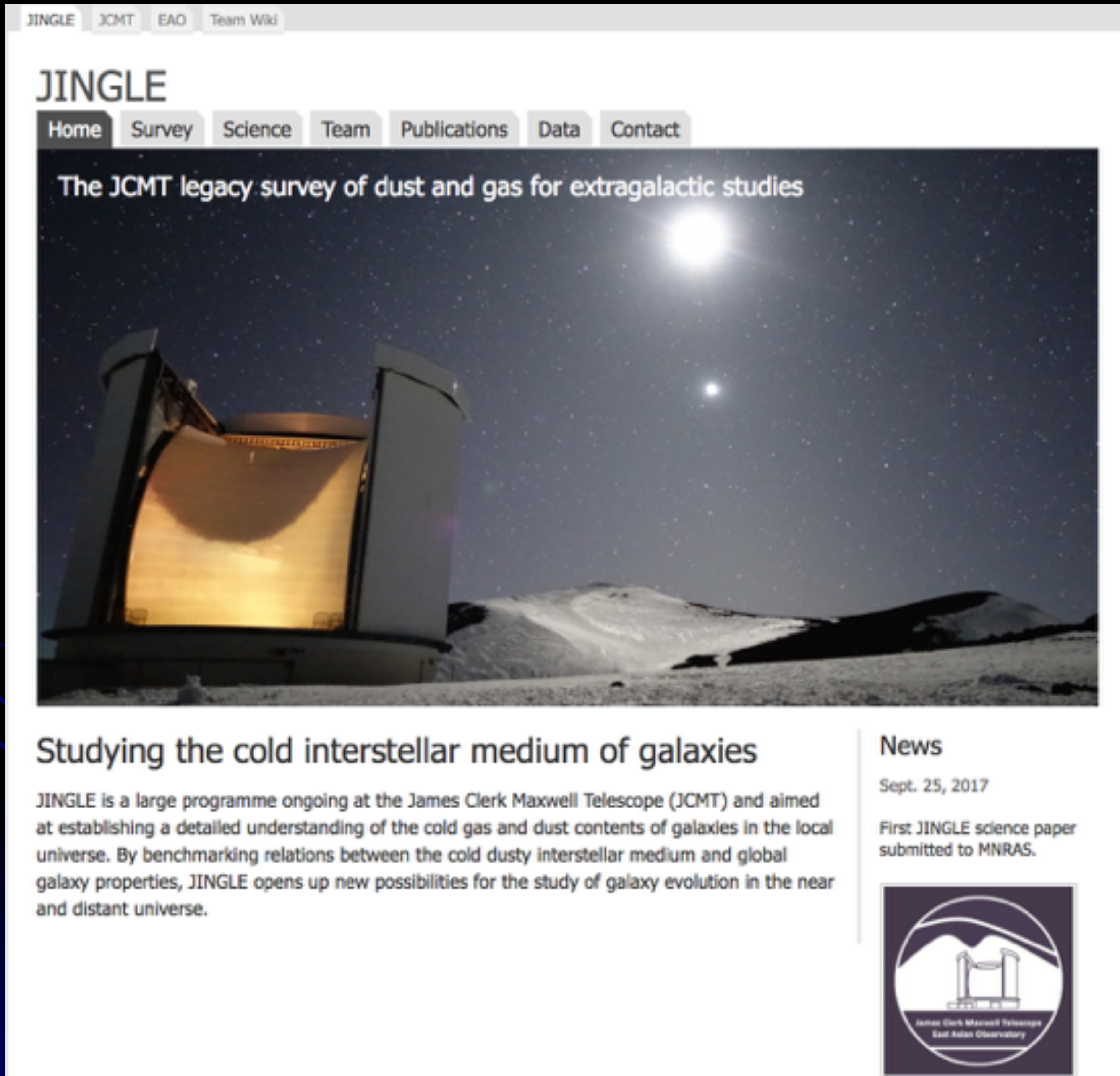
Coordinators: Amelie Saintonge (UCL), Mark Sargent (Sussex), Christine Wilson (McMaster), Ting Xiao (Zhejiang), Lihwai Lin (ASIAA), Tomoka Tosaki (JEUN)

On behalf of the JINGLE Team

February 1, 2018

JCMT Users Meeting 2018

JINGLE web page: http://www.star.ucl.ac.uk/JINGLE/


JINGLE | JCMT | EAO | Team Wiki

JINGLE

Home | Survey | Science | Team | Publications | Data | Contact

The JCMT legacy survey of dust and gas for extragalactic studies

Studying the cold interstellar medium of galaxies

JINGLE is a large programme ongoing at the James Clerk Maxwell Telescope (JCMT) and aimed at establishing a detailed understanding of the cold gas and dust contents of galaxies in the local universe. By benchmarking relations between the cold dusty interstellar medium and global galaxy properties, JINGLE opens up new possibilities for the study of galaxy evolution in the near and distant universe.

News

Sept. 25, 2017

First JINGLE science paper submitted to MNRAS.

JINGLE: the JCMT dust and gas in Nearby Galaxies Legacy Exploration

JINGLE
780h legacy survey

SCUBA-2

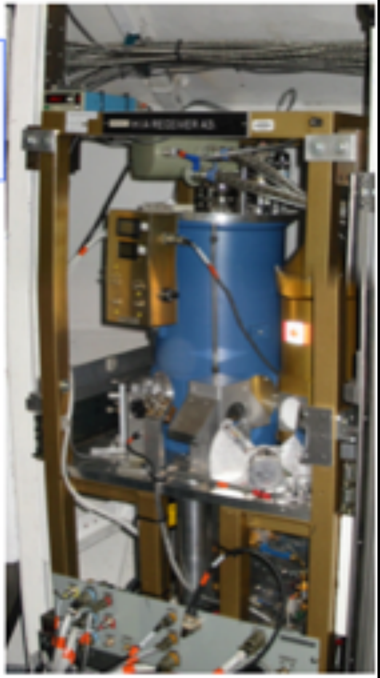
250 h, weather bands 2-4
850μm observations of 193 galaxies

- 10000 pixel camera
- FOV: 45 arcmin^2
- beam size: 13 arcsec at 850 μm
- 450 μm, 850 μm

RxA3m

530 h, weather bands 4-5
CO(2-1) observations of 97 galaxies

CO (J 2-1): 230 GHz
beam size: 20” (HPBW)



Survey Objectives

JINGLE
780h legacy survey

SCUBA-2
250 h, weather bands 2-4
850μm observations of 193 galaxies

RxA3m
530 h, weather bands 4-5
CO(2-1) observations of 97 galaxies

+ MaNGA

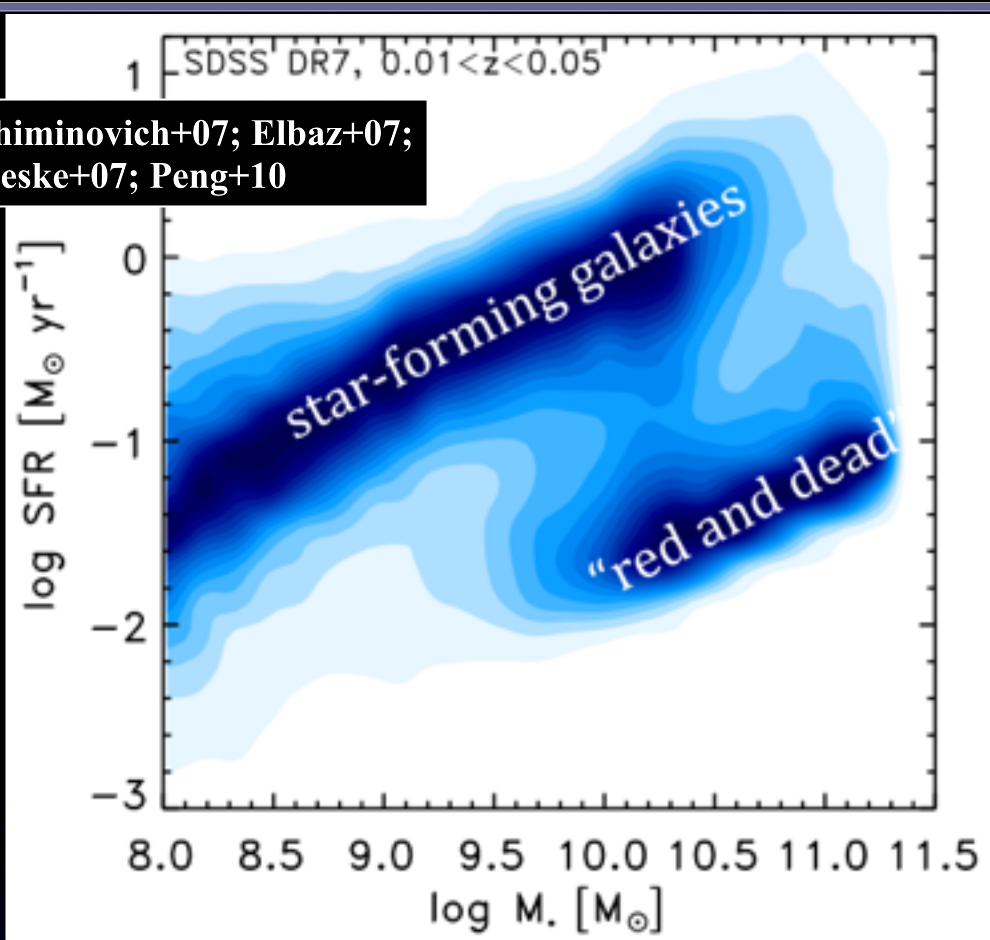
Dust:
2) Dust mass and dust scaling relations

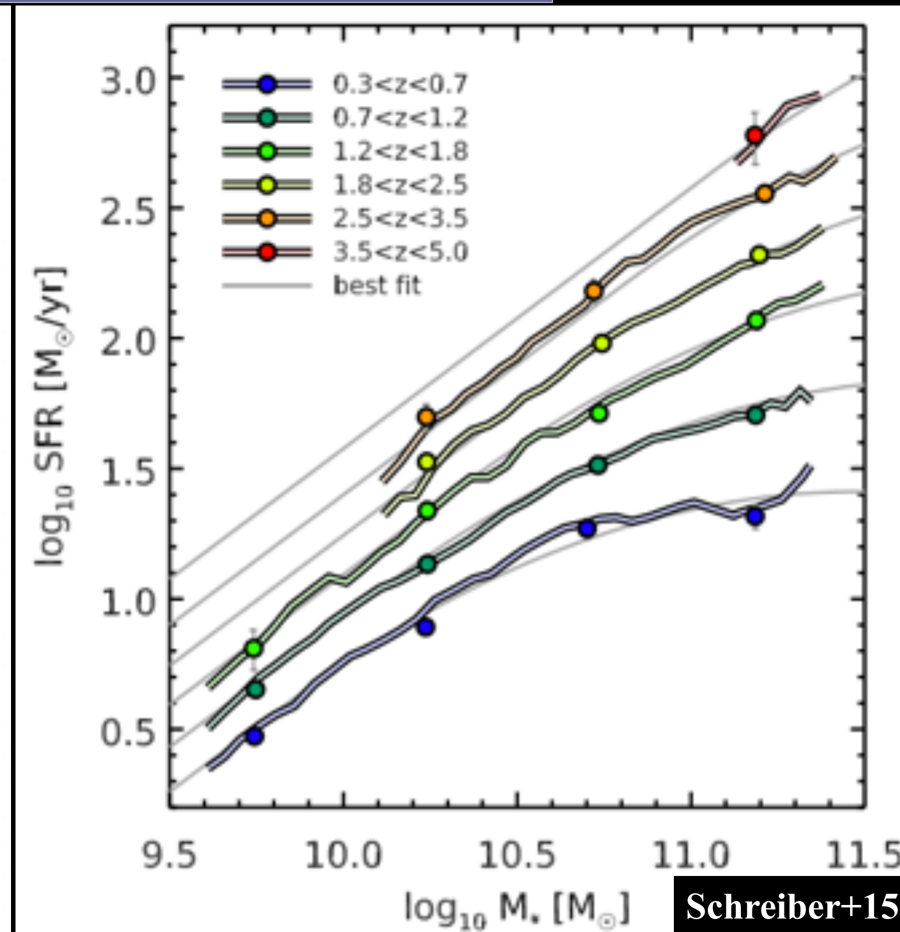
Gas:
1) Star formation, star formation history and the total gas reservoir

+

Dust + Gas:
3) The relation between molecular gas and dust

Context: the current view on galaxy evolution

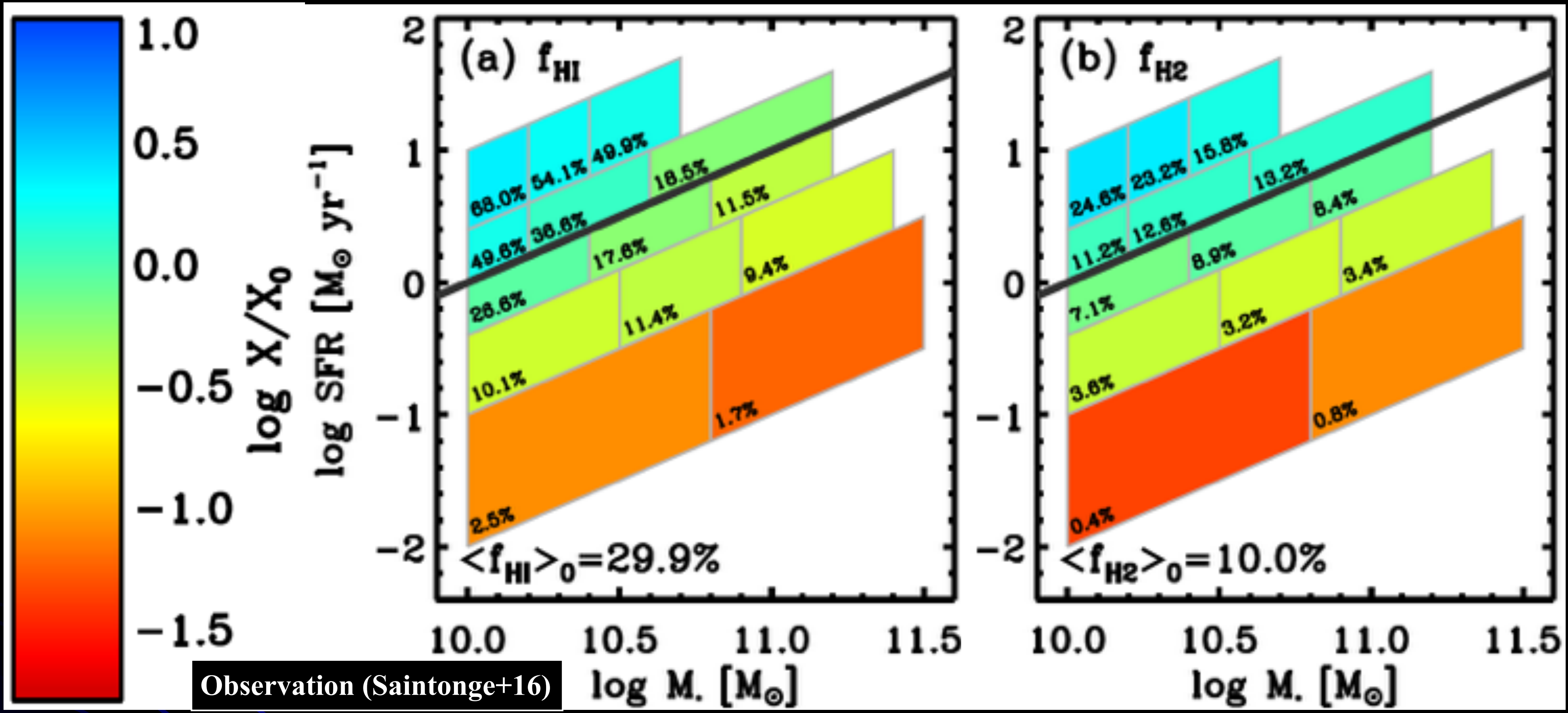




$SFR \sim M_{*}^{a}(1+z)^{b}$, where $a \sim 0.8$, $b \sim 2.5$

- **Galaxies on the main sequence (MS) contribute ~90% of the star formation.**
- **Duty cycles on the MS are high (40-70%) => "catastrophic" events like major mergers cannot be the main agent responsible for regulating star formation.**

Context: the current view on galaxy evolution

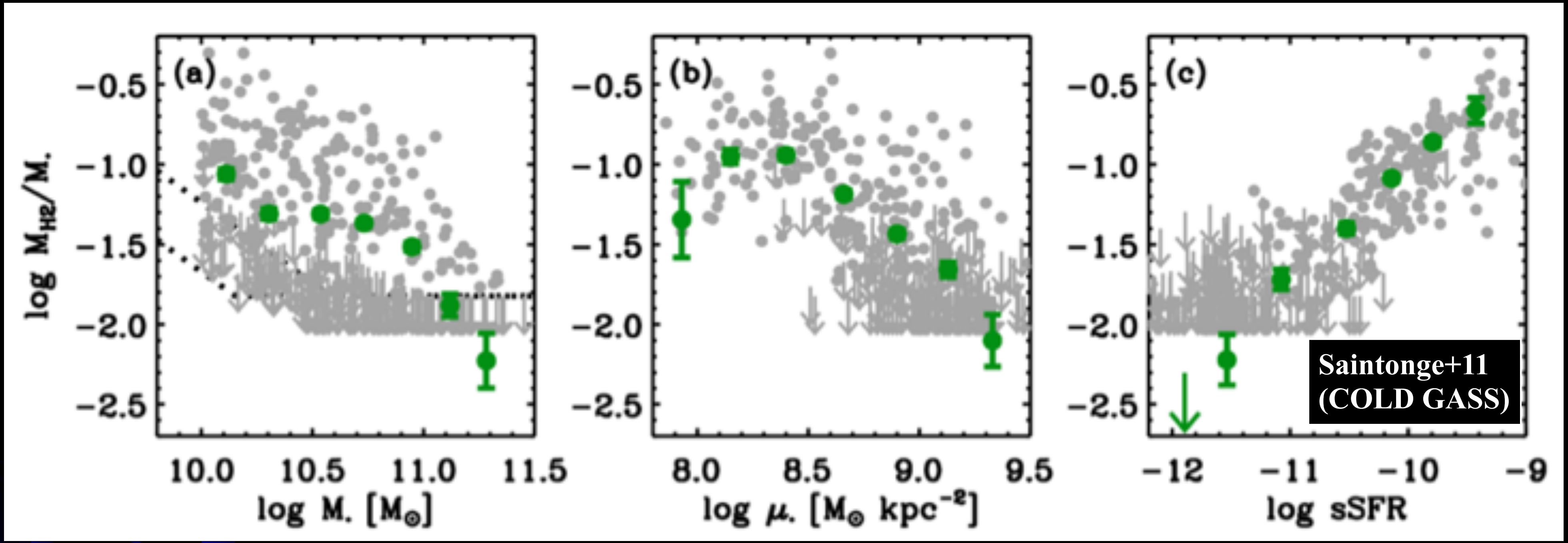


Cold GAS!

We must improve our understanding of the properties of the cold ISM across the entire galaxy population!

Science Motivation #1: Correlation between molecular gas content with spatially-resolved galaxy properties

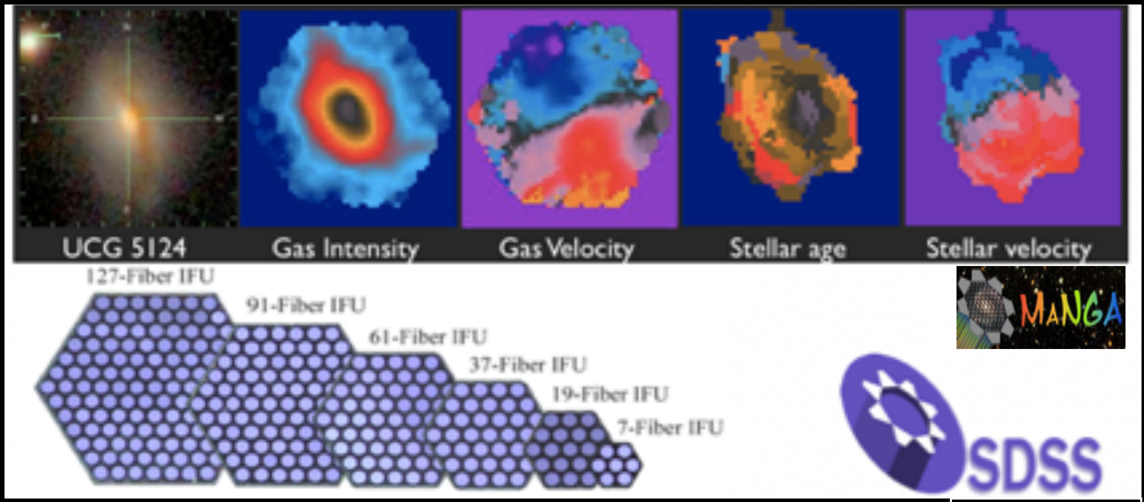
➢ Molecular gas fraction correlates well with stellar mass, stellar mass surface density, and sSFR, though with large scatter in a large complete sample.



➢ To understand the correlations and their scatters, it's important to know the 2D galaxy properties (stellar / ionised-gas); from spatially-resolved optical spectroscopic data (e.g. MaNGA).

Science Motivation #1: Correlation between molecular gas content with spatially-resolved galaxy properties

MaNGA: Mapping Nearby Galaxies at Apache Point Observatory

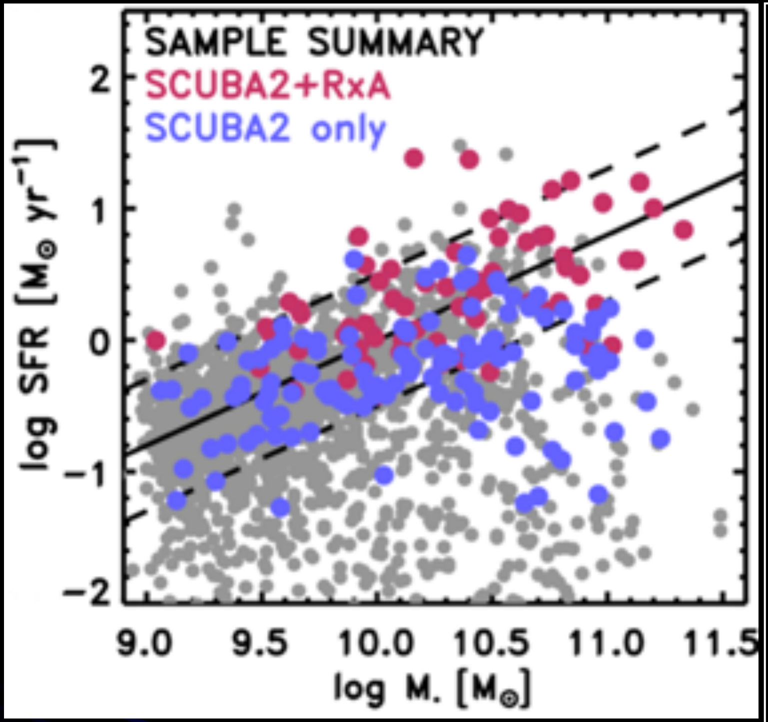


Bundy+15

- 10,000 SDSS galaxies at 0.01<z<0.15
- Mass-limited sample: lg(Mstar)>9.0
- Spatial resolution = 2" (1-2 kpc)
- Spectral resolution = 50-70 km/s
- Spectral coverage: 3600 - 10000 AA
- Spectral S/N = 4-8 at 1.5 Re

➢ **MaNGA key science goals**
  - ➢ **Growth of disk and bulge**
  - ➢ **Star formation quenching**
  - ➢ **Kinematics of stars and gas**
  - ➢ **Rotation curve and dark matter halo**

Sample and Survey strategy



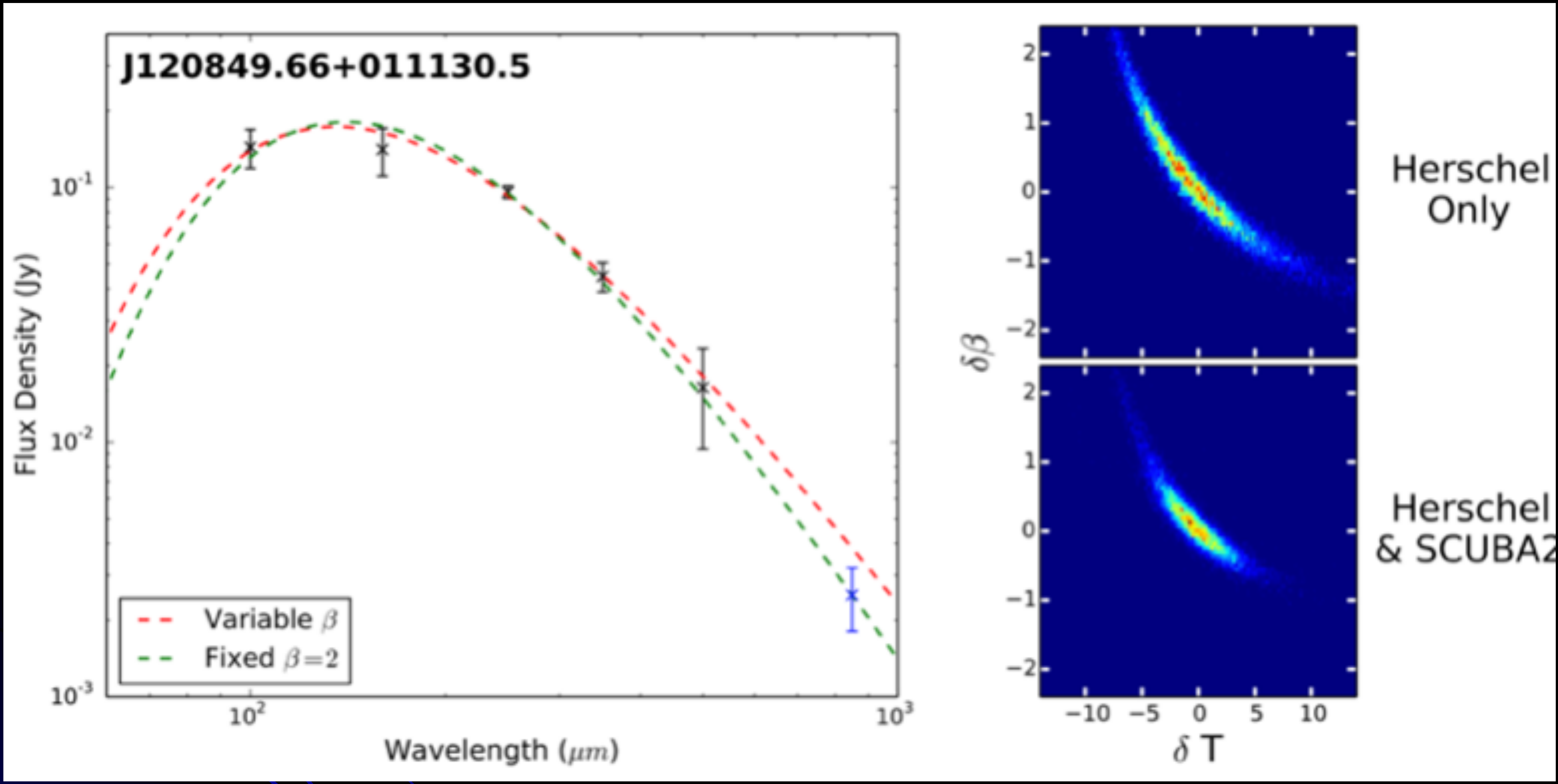
- 0.01<z<0.05
- $M_{star}>10^9$ M_{sun}

Sample builds on multiple surveys

- **H-ATLAS:**
  Herschel PACS+SPIRE photometry
  => dust properties
- **GALEX/SDSS/WISE:**
  UV-to-NIR photometry
  => SED fitting
- **MaNGA/SAMI: optical IFU maps**
  => spatially-resolved stellar/gas quantities
- **Apertif/ASKAP surveys: HI maps**
  => atomic gas properties

- SCUBA-2 (250h): 193 galaxies
  - 187 late- and 6 early-type galaxies
- RxA (530h): 97 galaxies (subset of above)
  - 63 are in MaNGA

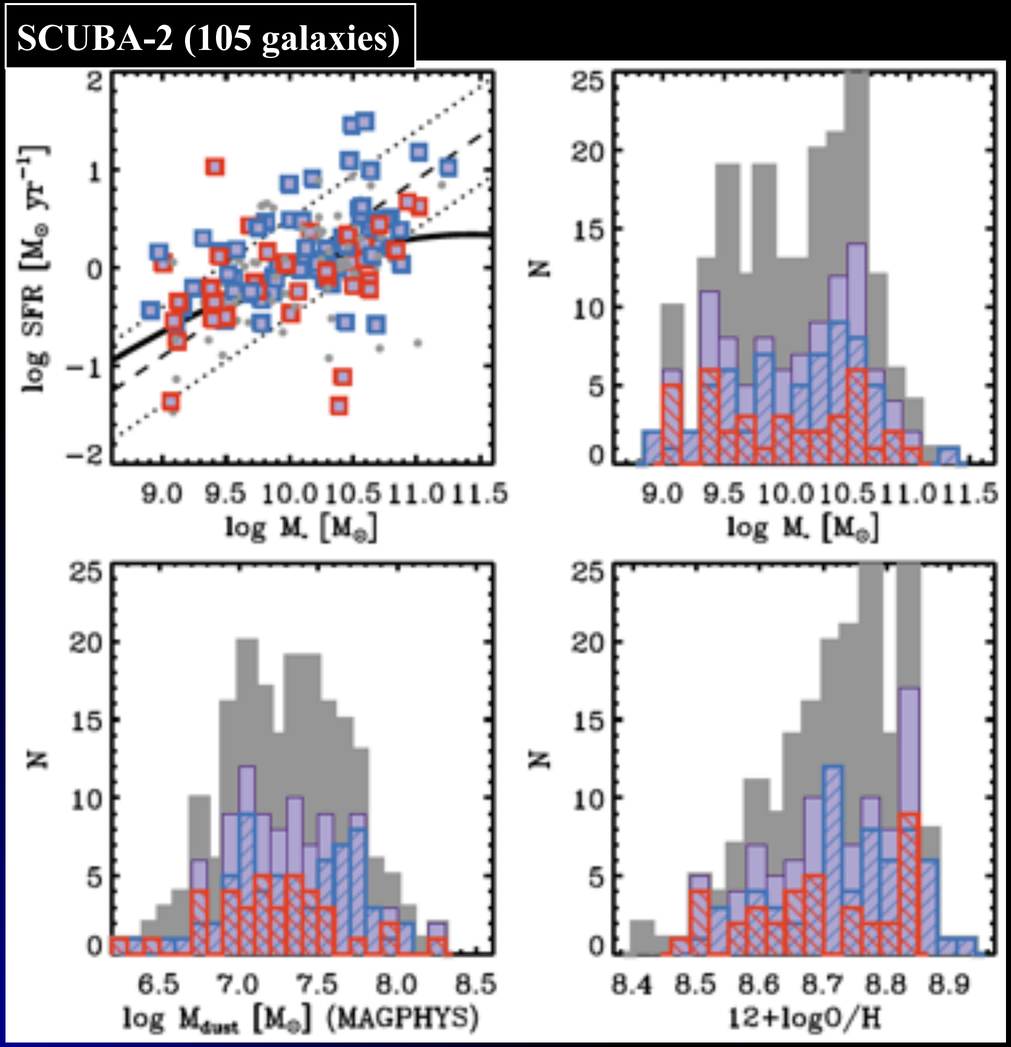
Sample and Survey strategy

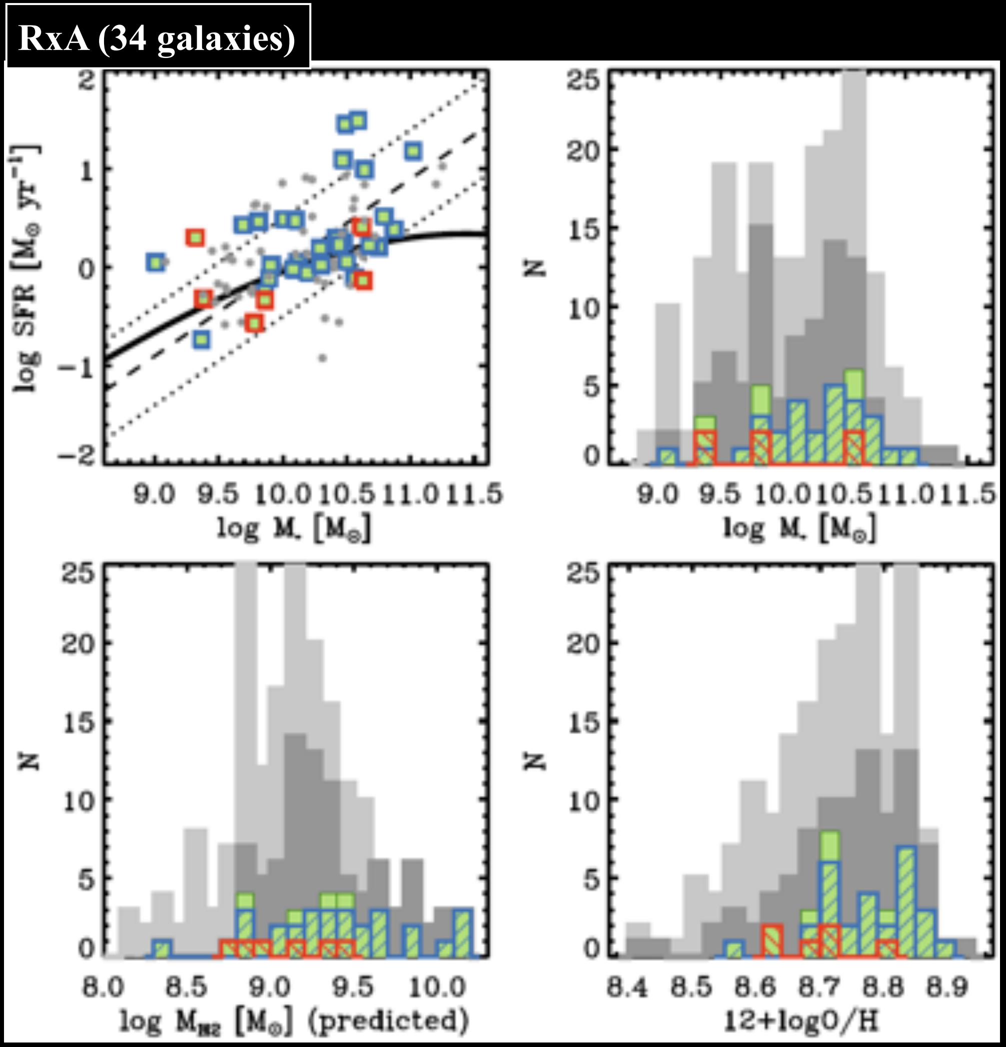


By adding SCUBA-2 data,
we can fit simultaneously for the temperature and emissivity of the dust.

Status of Observations (as of Jan. 23, 2018)

- SCUBA-2: ~99% complete [191 / 193 galaxies observed (2 in 2018 Feb.)]
- RxA:
  - 79% complete for MaNGA galaxies: 52 / 66
  - 26 non-MaNGA galaxies to observe as "priority 2"
- Next JINGLE observing blocks: 2 x 5 nights in April.





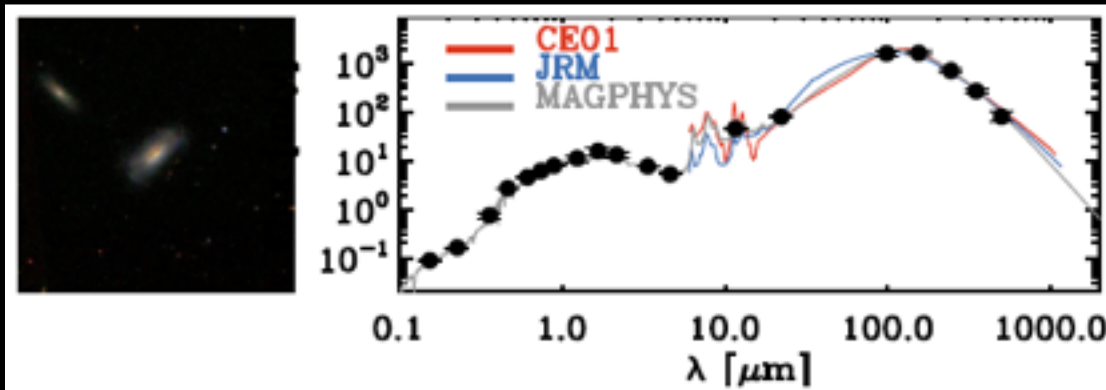
Multiwaveleng Data for JINGLE galaxies: CAAPR photometry

➢ **(Elliptical) Aperture-matched photometry using the Comprehensive Adjustable Aperture Photometry Routine (CAAPR) pipeline (Clark+17)**

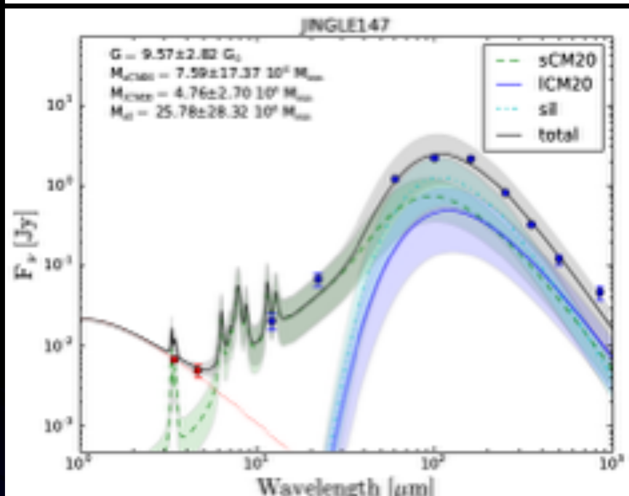
Facility	Effective Wavelength	Band Name	Photometry Present	Pixel Width (″)	Resolution FWHM (″)	Calibration Uncertainty (%)		Data Archive
GALEX	153 nm	FUV	183	2.5	4.3	4.5	a	b
GALEX	227 nm	NUV	185	2.5	5.3	2.7		
SDSS	353 nm	u	193	0.4	1.3	1.3		
SDSS	475 nm	g	192	0.4	1.3	0.8		
SDSS	622 nm	r	193	0.4	1.3	0.8	c	d
SDSS	763 nm	i	192	0.4	1.3	0.7		
SDSS	905 nm	z	193	0.4	1.3	0.8		
VISTA	877 nm	Z	45	0.4	0.8	2.7		
VISTA	1.02 μm	Y	44	0.4	0.8	2.7		
VISTA	1.25 μm	J	12	0.4	0.8	2.7	e	f
VISTA	1.65 μm	H	45	0.4	0.8	2.7		
VISTA	2.15 μm	K_S	47	0.4	2.0	2.7		
2MASS	1.24 μm	J	192	1	2.0	1.7		
2MASS	1.66 μm	H	191	1	2.0	1.9	g	
2MASS	2.16 μm	K_S	192	1	2.0	1.9		
WISE	3.4 μm	(W1)	182	1.375	6.1	2.9		h
WISE	4.6 μm	(W2)	183	1.375	6.4	3.4		
WISE	12 μm	(W3)	193	1.375	6.5	4.6	i	
WISE	22 μm	(W4)	193	1.375	12	5.6		
Spitzer	4.5 μm	(IRAC-2)	28	0.6	1.72	3		
Spitzer	5.8 μm	(IRAC-3)	17	0.6	1.88	3	j	
Spitzer	8.0 μm	(IRAC-4)	16	0.6	1.98	3		
Spitzer	24 μm	(MIPS-1)	25	2.45	6	5		k
Spitzer	70 μm	(MIPS-2)	18	4	18	10	l	
Spitzer	160 μm	(MIPS-3)	18	8	38	12		
Herschel	100 μm	(PACS-Green)	190	3	11	7	m	
Herschel	160 μm	(PACS-Red)	190	4	14	7		
Herschel	250 μm	(SPIRE-PSW)	193	6	18	5.5		n
Herschel	350 μm	(SPIRE-PMW)	193	8	25	5.5	o	
Herschel	500 μm	(SPIRE-PLW)	193	12	36	5.5		

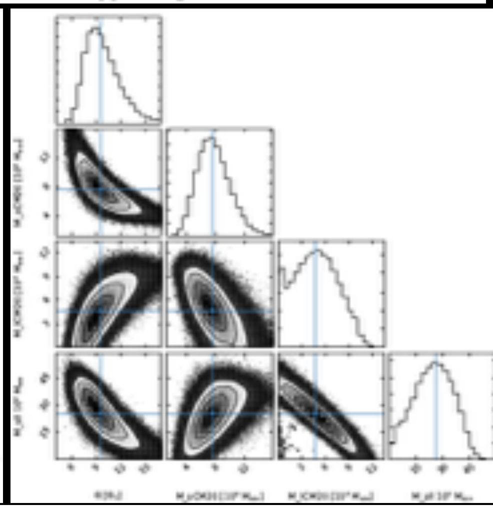
JCMT 450 μm
JCMT 850 μm

Spectral Energy Distributions of JINGLE galaxies



- ➢ **Star Formation Rates and Stellar Mass**





- ➢ **Dust parameters including Dust Temperature and Dust mass**

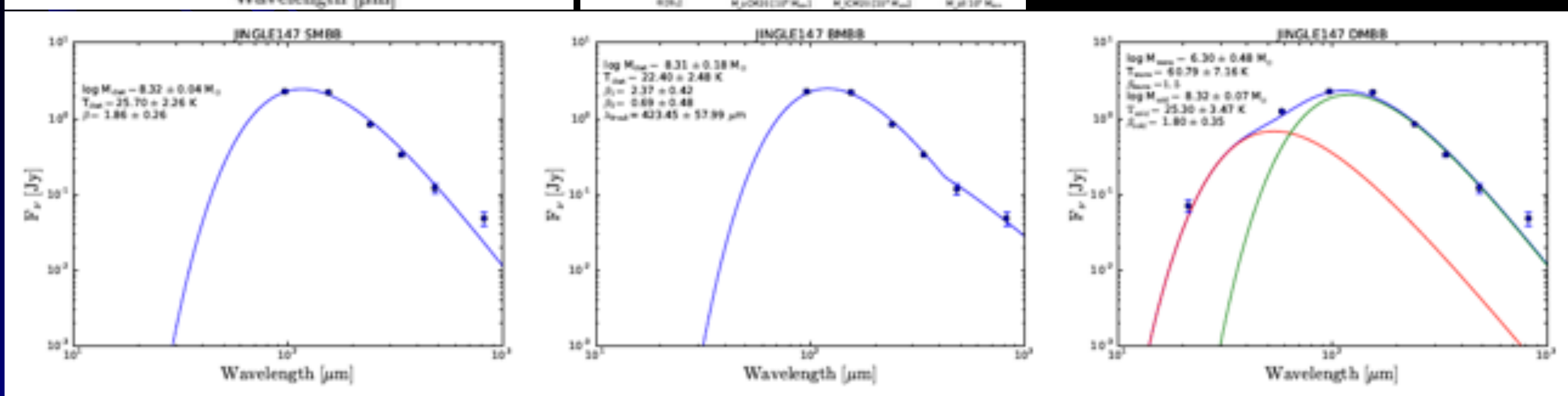
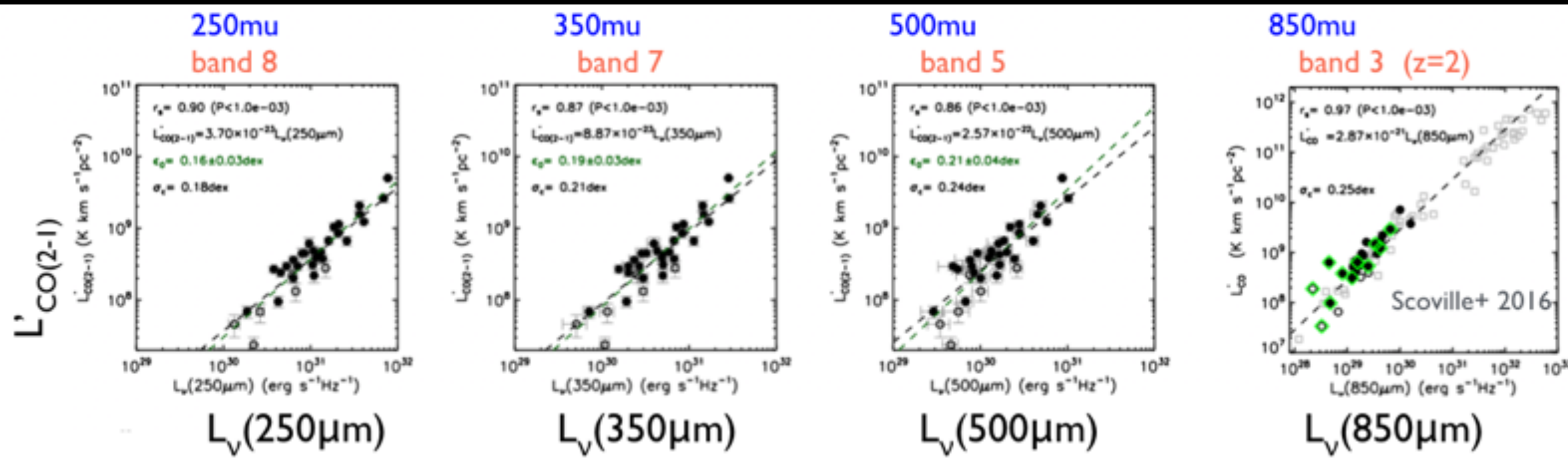


Figure 11. Example SED for JINGLE 147, fitted using the three models: SMBB (left panel), BMBB (middle panel) and DMBB(right panel). See text for a description of the three models and their parameters.

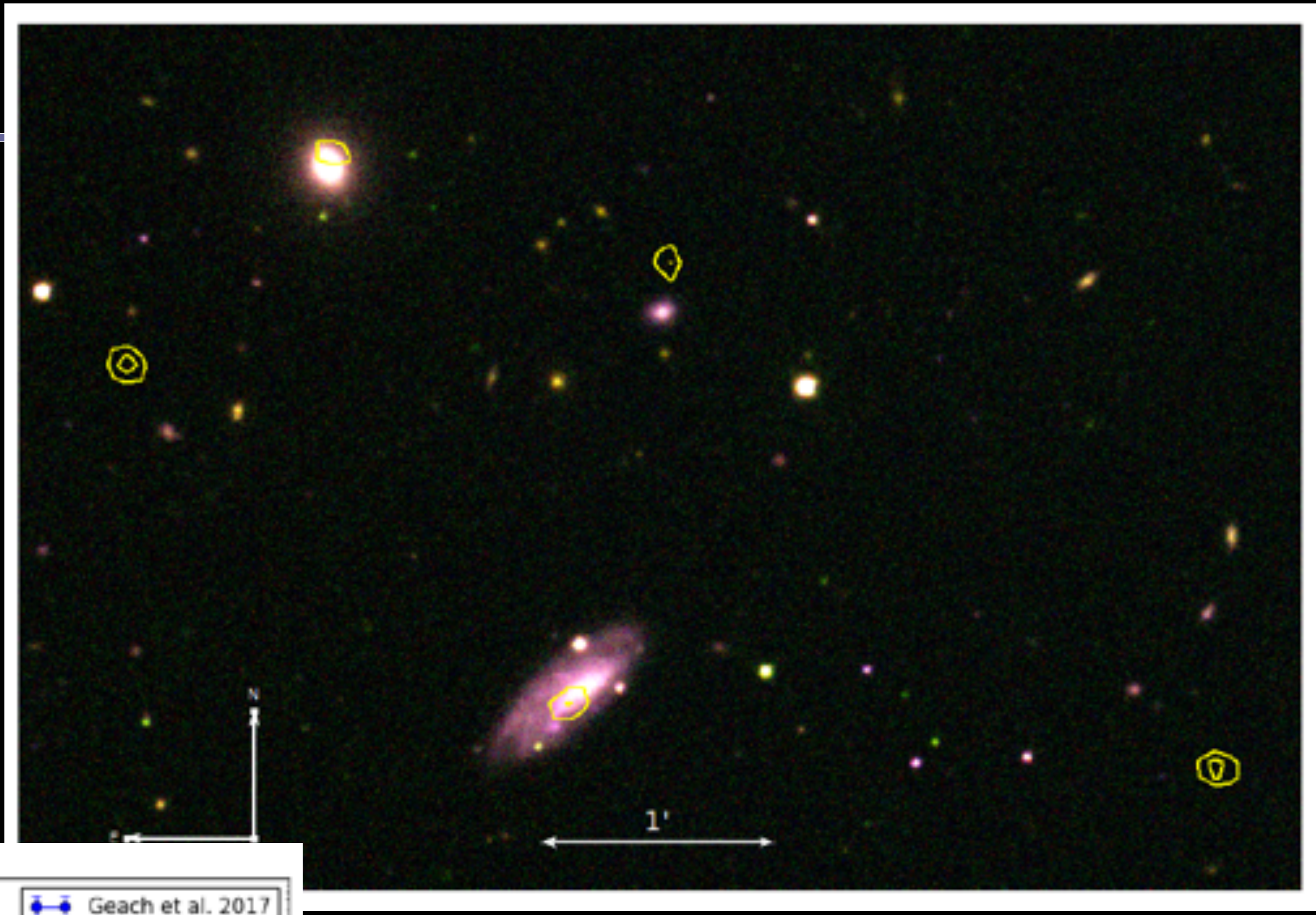
L_{CO}-L_{submm} Relations

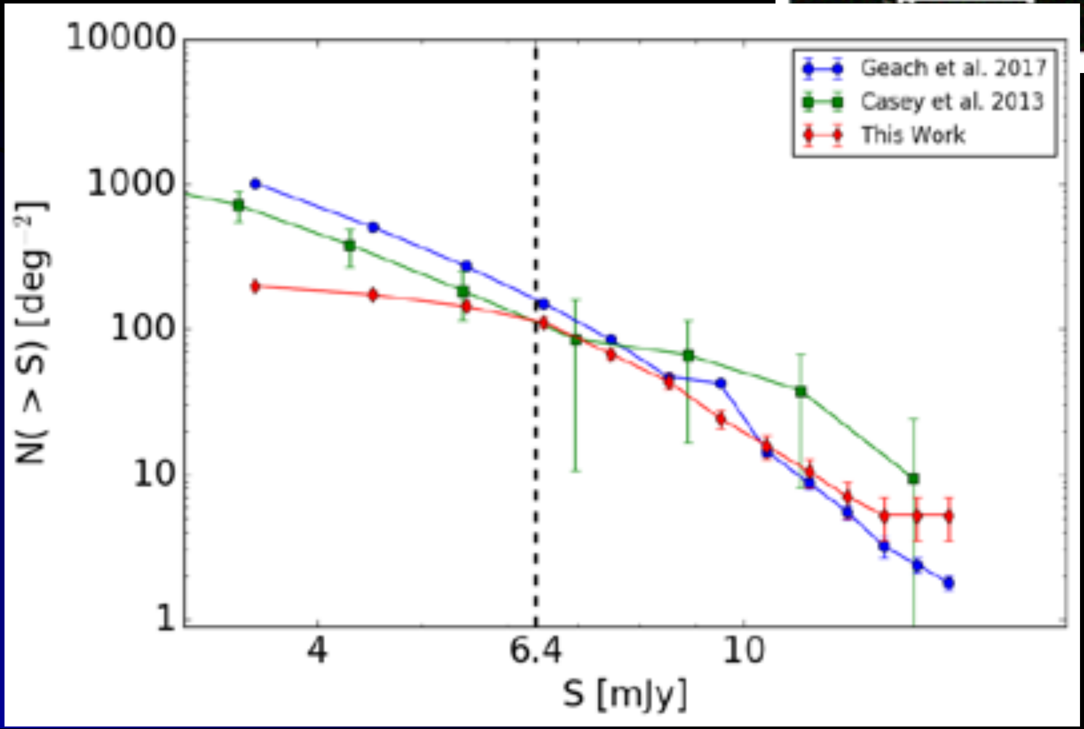
Bands:	3	4	5	6	7	8	9	10
Frequency (GHz)	84-116	125-163	163-211	211-275	275-373	385-500	602-720	787-950
Wavelength (mm)	3.57-2.59	2.40-1.84	1.84-1.42	1.42-1.09	1.09-0.80	0.78-0.60	0.50-0.42	0.38-0.32



➢ **Implications for ALMA observations of high-redshift galaxies.**

Background Sources





- ➢ **Galaxy Number Count!**
- ➢ **Drop out: High-z galaxies!**

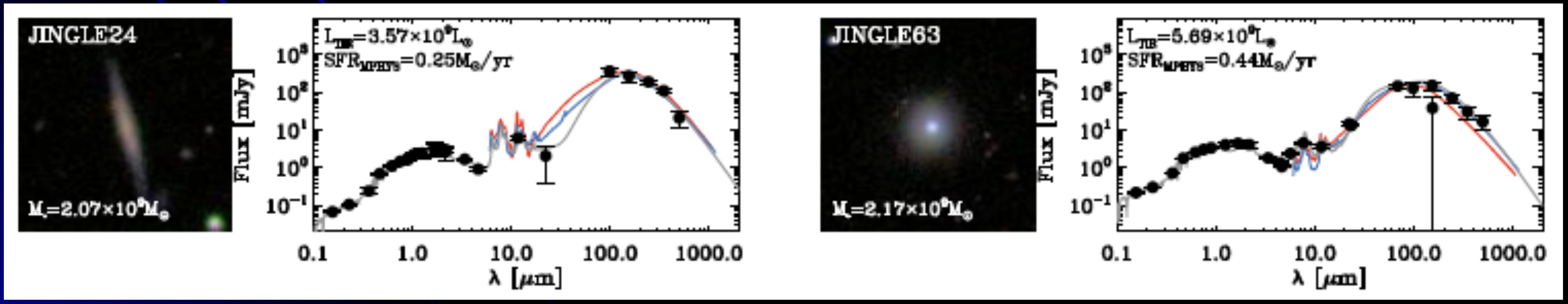
Data Release

- ➢ **Full data release (JINGLE I) in 2018+**
- ➢ **DR1**
  - ➢ **In Overview paper (Saintonge+17, MNRAS, submitted):**

  Derived products of all 193 galaxies regardless of their JCMT observations

Table 2. Properties of the JINGLE galaxies (the full table is available electronically)

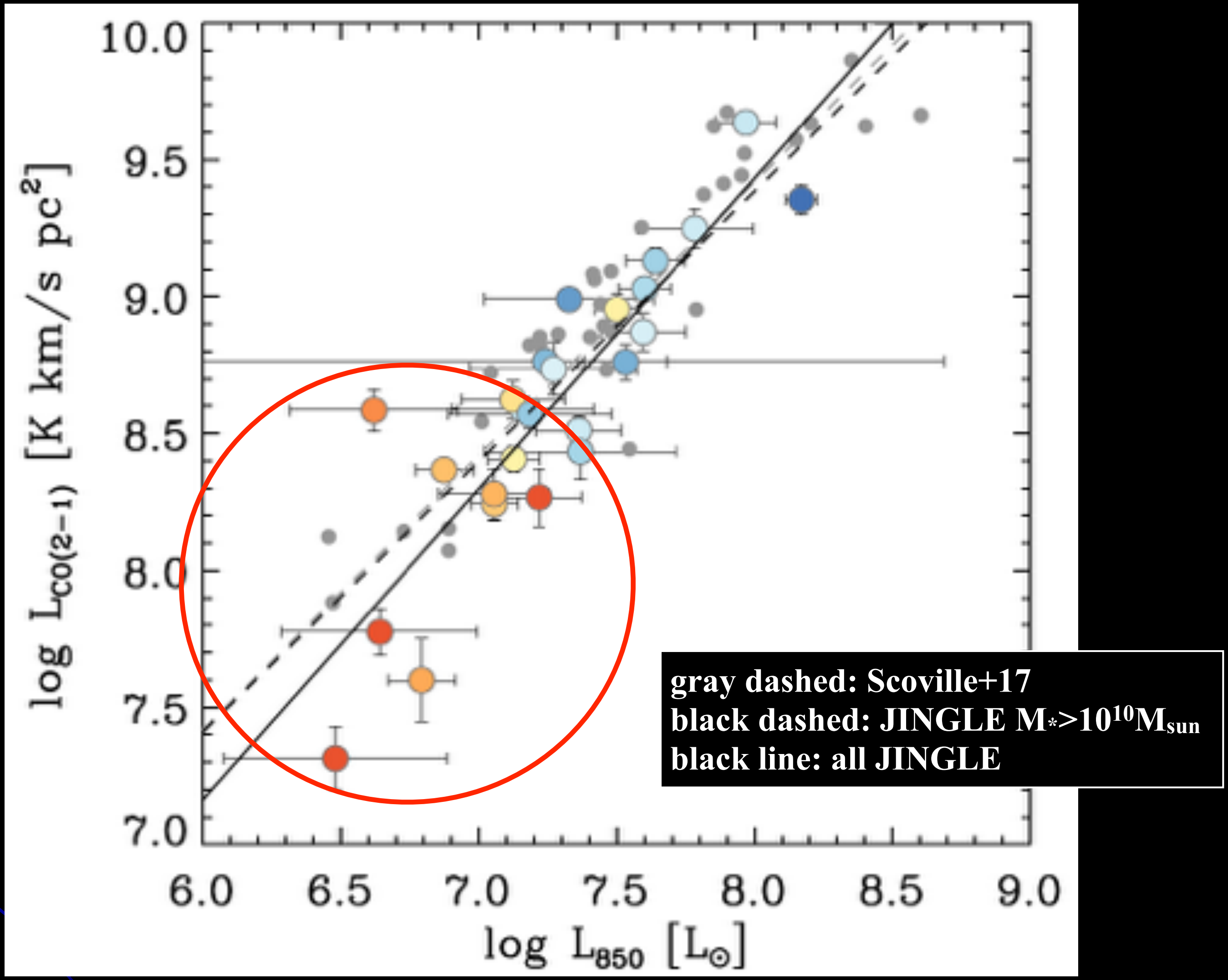
JINGLE ID	SDSS name	α_{J2000} [deg]	δ_{J2000} [deg]	z_{spec}	$\log M_*$ [$M_\odot$]	r_{50} [kpc]	$\log \mu_*$ [$M_\odot$kpc^{-2}]	C	M	logSFR [$M_\odot$yr^{-1}]	12+log(O/H)	BPT	Env
JINGLE0	J131616.82+252418.7	199.07012	25.40522	0.0129	10.31 ± 0.08	3.78	9.15	2.78	1	-0.92 ± 0.05	8.75	3	2
JINGLE1	J131453.43+270029.2	198.72264	27.00812	0.0154	9.95 ± 0.10	5.70	8.47	2.78	1	-0.66 ± 0.12	8.78	1	1
JINGLE2	J131526.03+330926.0	198.85848	33.15724	0.0162	9.12 ± 0.12	3.44	8.11	2.57	1	-0.75 ± 0.06	8.64	1	1
JINGLE3	J125606.09+274041.1	194.02541	27.67810	0.0165	9.00 ± 0.01	2.23	8.10	2.44	1	0.05 ± 0.02	8.56	1	3
JINGLE4	J132134.91+261816.8	200.39549	26.30467	0.0165	9.86 ± 0.05	2.73	8.95	2.63	1	-0.26 ± 0.02	8.82	1	1
JINGLE5	J091728.99-003714.1	139.37082	-0.62058	0.0166	9.97 ± 0.07	7.09	8.37	2.59	1	0.01 ± 0.02	8.76	1	3
JINGLE6	J132320.14+320349.0	200.83396	32.06361	0.0167	9.49 ± 0.08	6.00	7.85	2.25	1	-0.54 ± 0.04	8.68	1	3
JINGLE7	J132051.75+312159.8	200.21563	31.36661	0.0168	9.55 ± 0.04	5.13	8.03	2.44	1	-0.58 ± 0.05	8.68	1	3
JINGLE8	J091642.17+001220.0	139.17575	0.20556	0.0169	9.68 ± 0.07	3.29	8.90	2.69	1	-0.56 ± 0.05	8.65	2	1
JINGLE9	J131547.11+315047.1	198.94630	31.84642	0.0170	9.86 ± 0.18	5.87	8.07	2.36	1	0.41 ± 0.23	8.68	1	2
JINGLE10	J091750.80-001642.5	139.46168	-0.27848	0.0175	10.45 ± 0.05	7.98	8.78	2.41	1	0.01 ± 0.01	8.72	1	2
JINGLE11	J131020.14+322859.4	197.58392	32.48319	0.0176	9.75 ± 0.06	9.16	7.94	2.42	1	-0.25 ± 0.02	8.65	-1	1
JINGLE12	J132251.07+314934.3	200.71281	31.82622	0.0178	9.38 ± 0.05	6.49	7.68	2.15	1	-0.32 ± 0.02	8.62	1	1
JINGLE13	J114253.92+000942.7	175.72470	0.16187	0.0185	8.97 ± 0.01	3.02	8.11	2.25	1	0.16 ± 0.29	8.49	1	3



Data Release

- Full data release (JINGLE I) in 2018+
- DR1
  - In Overview paper (Saintonge+17, MNRAS, submitted): Derived products of all 193 galaxies regardless of their JCMT observations
  - In SCUBA-2 technical paper (Smith+, in prep.): 850µm maps + photometric catalog
  - In RxA3m technical paper (Xiao+, in prep.): integrated line fluxes and luminosities, molecular gas masses, CO-based redshifts and line-widths

However,



- ➢ Not many galaxies with high and low sSFRs!
- ➢ They will key to fully calibrate the scaling relation for subsequent application at high redshift.
- ➢ Extension of JINGLE proposal!

JINGLE 2

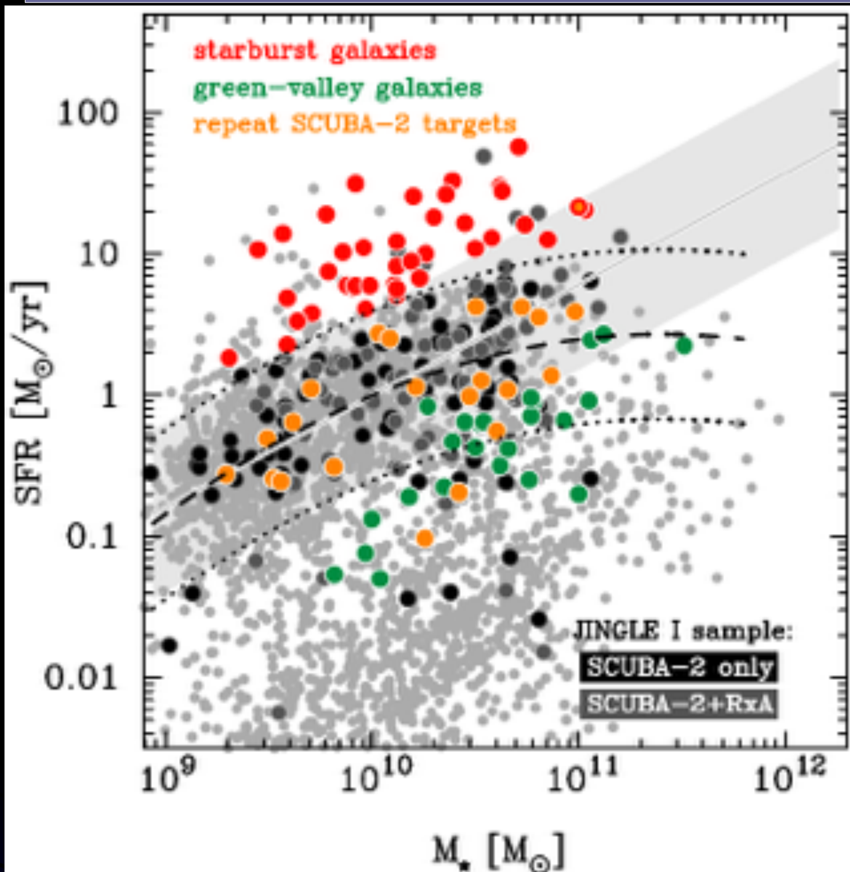
JINGLE at the edge: the ISM of starbursts and green valley galaxies

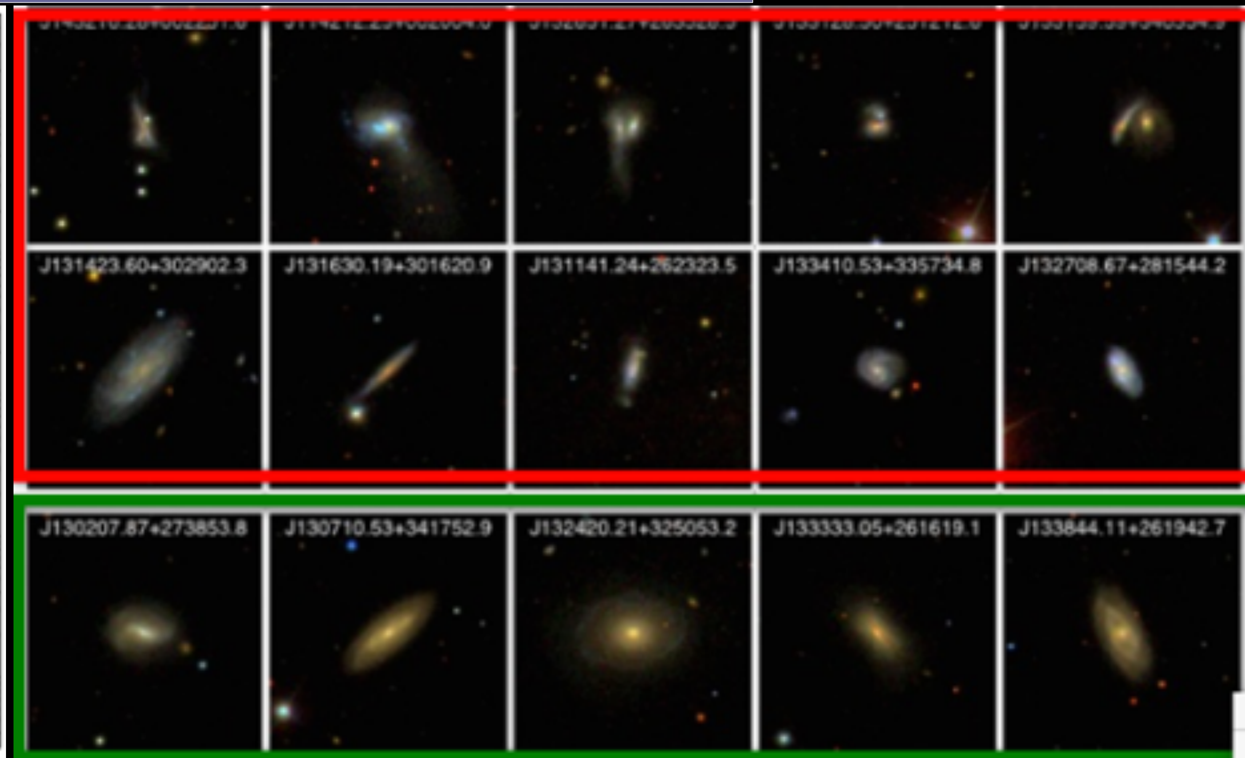
Extending the *JCMT dust and gas In Nearby Galaxies Legacy Exploration* (JINGLE) to galaxies above and below the galaxy main sequence

PIs: M. Sargent (UK), L.-H. Lin (EAO/Taiwan), T. Xiao (EAO/China), C. Wilson (Canada), H. S. Hwang (EAO/Korea), T. Tosaki (EAO/Japan)

The JCMT Large Project JINGLE is in the process of obtaining gas and dust mass measurements of 200 local galaxies which predominantly reside on the main sequence of star-forming galaxies. In combination with H-ATLAS and MaNGA this rich data base is currently being used to derive scaling relations between dust, gas, and global galaxy properties (including star formation), and will provide critical benchmarks for high-redshift studies with JCMT and ALMA. Here we propose to extend the JINGLE legacy data set with 63 starburst and green valley galaxies (i.e. galaxies with clearly elevated and suppressed star formation activity compared to the galaxy main sequence). With these new data we will be able to (a) address the debated existence of a bimodal star-formation law for starbursts and disk galaxies, and (b) test galaxy quenching scenarios. We also propose to improve the depth of the SCUBA-2 maps for 22 galaxies from the original JINGLE sample. This project requires a total of 454 hours of Rx3Am and 170 hours of SCUBA-2 observing time, respectively, for a total time request of 624 hours. The majority of these observations can be scheduled in weather bands 4 & 5. Timely data reduction and data release to the public will be ensured by a team involving scientists from all JCMT partner organizations and which already has experience with all aspects of the data reduction and analysis.

JINGLE 2 (led by Mark Sargent)

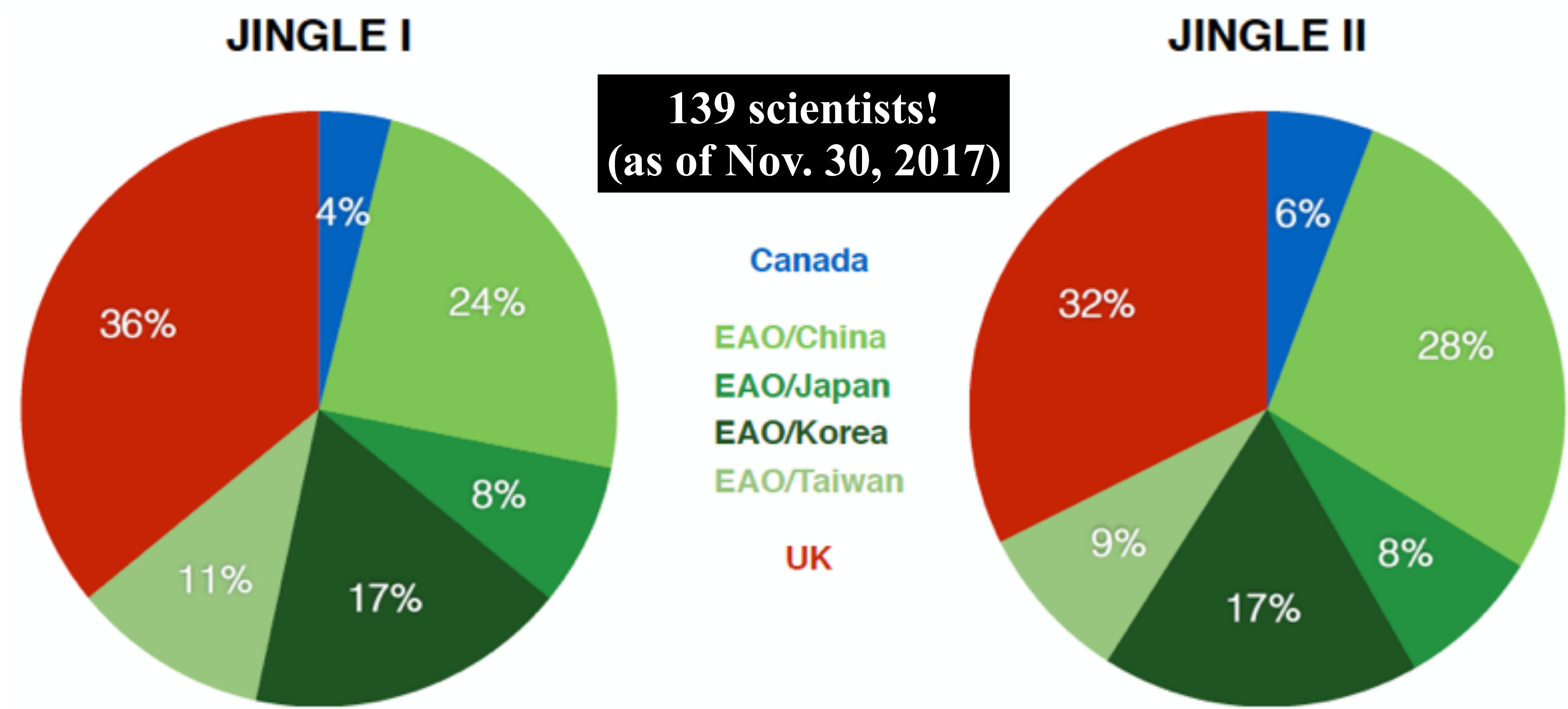




- Targets
  - 39 starburst galaxies
  - 24 green-valley galaxies: 9 in MaNGA
- Requested Observations
  - 454 hours of RxA3m observations
  - 170 hours of SCUBA-2 observations

- Received only RxA3m time (2017.8 - 2020.1)
  - Band 4: 285.0 hours
  - Band 5: 169.0 hours

Team Structure



Regional Coordinators:

Canada: Chris Wilson (McMaster University), *wilson@physics.mcmaster.ca*
China: Ting Xiao (Shanghai Astronomical Observatory), *xiaoting@shao.ac.cn*
Japan: Tomoka Tosaki (Joetsu University of Education), *tosaki@juen.ac.jp*
Korea: Ho Seong Hwang (Korea Institute for Advanced Study), *hhwang@kias.re.kr*
Taiwan: Lihwai Lin (ASIAA), *lihwailin@asiaa.sinica.edu.tw*
UK: Amelie Saintonge (University College London), *a.saintonge@ucl.ac.uk* and Mark Sargent (University of Sussex), *Mark.Sargent@sussex.ac.uk*

JINGLE Publication Plans

HoSeongHwang | Settings | Logout

JINGLE: WelcomePage

ProposalsAndReports » Publications » UpcomingTeamMeetings » ShanghaiPresentations » WelcomePage

RecentChanges | FindPage | HelpContents | WelcomePage

Edit (Text) | Edit (GUI) | Info | Subscribe | Add Link | Attachments | More Actions:

Welcome to JINGLE!

JINGLE public web page: http://www.star.ucl.ac.uk/JINGLE/

Team-only web pages:

- Team Members
- Observing Status
- Data Evaluation
- Publications and Science Ideas
- Previous and Upcoming Team Meetings
- Proposals And Reports

HoSeongHwang | Settings | Logout

JINGLE: Publications

ProposalsAndReports » ShanghaiPresentations » WelcomePage » UpcomingTeamMeetings » Publications

RecentChanges | FindPage | HelpContents | Publications

Edit (Text) | Edit (GUI) | Info | Subscribe | Add Link | Attachments | More Actions:

JINGLE Publication Plans

Early-science core papers

(1) Survey overview

contacts: A. Saintonge & C. Wilson version submitted to MNRAS: JINGLE_Paper1_submitted.pdf

(2) RxA technical overview + first CO results

contacts: T. Xiao & M. Sargent

(3) SCUBA-2 technical overview + first 850um results

contact: M. Smith

(4) SED modeling + first dust scaling relations

contact: I. De Looze

Additional early-science papers ideas

(1) The impact of environment of dust and gas properties

contact: A. Mok & C. Wilson

(2) High-redshift / lensed background sources

contact: J. Greenslade & D. Clements

(3) Kennicutt-Schmidt relation in dust and gas

contact: T. Williams & W. Gear

(4) Starbust galaxies

contact: M. Sargent

(5) Dust in early type galaxies

(6) The gas-to-dust ratio across the local galaxy population

(7) The dependence of resolved star formation rate and stellar mass relation on the gas content

contact: Hsi-An Pan & Lihwai Lin

(8) Variation in the Dust Mass Absorption Coefficient

contact: C. Clark

+ MaNGA projects!!

(9) The interrelationship between stellar mass, metallicity, star formation rate and gas mass

contact: Y. Peng

Summary

- ➢ JINGLE is going well.
- ➢ Any questions or comments!