11 January, 2016

Dr. Larry Bradley
Space Telescope Science Institute
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Baltimore, MD 21218
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Brett Salmon
Dept. of Physics & Astronomy
Texas A&M University
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College Station, TX USA 77843-4242
bsalmon@physics.tamu.edu

Dear Dr. Larry Bradley

I would like to apply to the postdoctoral position at STScI as advertised on the AAS job register (JRID52940). I am finishing my PhD in the Department of Physics and Astronomy at Texas A&M University, under supervisor Prof. Casey Papovich.

My current research involves observational studies of distant galaxies, and how their physical properties evolve with time. In particular, I have experience in astro-statistics, nebular emission modeling, and galaxy spectral energy distribution (SED) modeling. As a junior scientist member of the CANDELS (Cosmic Assembly Near-infrared Deep Extragalactic Legacy Survey) team, I have contributed to several projects on high-redshift galaxy evolution. More recently, my research focuses on Bayesian approaches to infer the underlying dust absorption and scattering in infrared (IR)-selected galaxies at high redshift.

I am interested in working with you on better determinations of star formation rates (SFRs) at high redshift, new insights on the redshift evolution of dust properties and attenuation, and a greater understanding of the extragalactic contribution to reionization. These projects are specifically aimed at building the science case for future JWST proposals. I hope you find the projects well-suited for your position, as they will certainly benefit from your expertise studying lensed galaxies at high redshift.

My curriculum vitae and research statement are attached below, which provide more details on my research experience and project ideas.

Thank you for your time and consideration. I hope to hear from you soon.

Sincerely,

Brett Salmon

Curriculum Vitae
Brett Salmon

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Website: http://people.physics.tamu.edu/bsalmon

Address
Texas A&M University
Department of Physics and Astronomy
4242 TAMU
College Station, TX
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Phone
01-609-617-0510

Research Interests

Galaxy formation and evolution, high-redshift galaxies, star formation histories, SED fitting, Bayesian and other statistical techniques, Lyα/LyC emission, nebular emission, dust attenuation

Education

Ph.D., Physics **Aug. 2016**
Texas A&M University
Department of Physics and Astronomy
4242 TAMU
College Station, TX
77843-4242
Advisor: Casey Papovich
Dissertation: "Bayesian Approaches to Infer the Physical Properties of Star-forming Galaxies at Cosmic Dawn"

M.S., Physics **2015**
(see above)
Advisor: Casey Papovich

B.S., Astronomy Magna Cum Laude **2010**
Rutgers, The State University of New Jersey
57 US Highway 1
New Brunswick, NJ 0891-8554
Advisors: Charles Keeton, Andrew Baker
Senior Honors Thesis on Gravitational Lensing:
"Exploration of the Quintuple Quasar PMN J0134-0931"

Honors & Awards

APS TX Chapter Fall 2014 Presentation Award	2014
Richard J. Plano Summer Research Internship	2009
Harriet & Robert Druskin Scholar	2006-2010

Conferences and Presentations

Talk: *AstroLunch Talk*	University of Pittsburgh	Nov. 20, '15
Talk: *Informal Seminar*	Penn State University	Nov. 19, '15
Talk: *Large Scale Phenomena Seminar*	CfA/Harvard	Nov. 17, '15
Talk: *Seminar*	UMass Amherst	Nov. 16, '15
Talk: *Galaxy Journal Club*	STScI	Nov. 13, '15
Talk: *Astronomy Seminar*	Columbia University	Nov. 12, '15
Talk: *Informal Seminar*	New York University	Nov. 11, '15
Poster: *Bashfest Symposium*	University of Texas	Oct. 19–20, '15
Talk: *South by High Redshift*	University of Texas	Apr. 1–3, '15
Talk: *The SEDs of high redshift galaxies*	Sesto, Italy	Jan. 26–30, '15
Talk: *Rutgers University*	Rutgers University	Nov. 25, '14
Talk: *Galaxy Group Seminar*	University of Texas	Oct. 23, '14
Talk: *APS TX Chapter Meeting*	Texas A&M University	Oct. 18, '14
Talk: *Science in the ALMA Era: Mutli-Wavelength Studies of Galaxy Evolution*	Charlottsville, VA	Aug. 4–7, '14
Talk: *CANDELS Team Meeting*	STScI	Jul. 28–31 '14
Poster: *The Near-Field Deep-Field Connection*	UC Irvine	Feb. 11–14, '14
Poster: *Bashfest Symposium*	University of Texas	Oct. 6–8, '13
Talk: *CANDELS Team Meeting*	University of Kentucky	Aug. 26–30, '13
Poster: *GMT Science Meeting*	University of Chicago	Jun. 10–12, '13
Talk: *CANDELS Team Meeting*	University of Santa Cruz	Sept. 10–14, '12
Poster: *Bashfest Symposium*	University of Texas	Oct. 9–11, '11
Talk: *Texas A&M Astronomy Symposium*	Texas A&M University	Aug. '11–'15

Computational Expertise

– Proficient in IDL programming and plotting, and currently learning Python and R.
– Have a fully customizable SED-fitting procedure built in a Bayesian framework.
– Regularly submit bundles of single-node computations to The Brazos Cluster, a major computing cluster.
– Redshift fitting with EAZY, source identification with SExtractor.
– Far-IR SED fitting.
– Basic scripts using CLOUDY photoionization code

Observing Experience

McDonald Observatory [VIRUS-P]	PI: Emily Freeland	Jan 27–30, 2012
McDonald Observatory [VIRUS-P]	PI: Steven Boada	May 25–29, 2012
Gemini-S [GMOS]	PI: Vithal Tilvi Co-I: **B. Salmon**	Dec 17–18, 2012
Gemini-N [GMOS]	PI: Vithal Tilvi Co-I: **B. Salmon**	Feb 20–23, 2014

Teaching

(PDP) REU Introduction Lesson: Distance Measures in Astronomy	Summer 2015
Norton online lecture & assignment accuracy checking	2014–2015
TA: Astronomy 101 Basic Astronomy	Spring 2014
Lab: Astronomy 111 Overview of Modern Astronomy	Fall 2013
TA: Astronomy 101 Basic Astronomy	Spring 2013
Lab: Astronomy 111 Overview of Modern Astronomy	Fall 2012
TA: Astronomy 314 Survey of Astronomy	Spring 2012
Lab: Astronomy 111 Overview of Modern Astronomy	Fall 2011
TA: Astronomy 101 Basic Astronomy	Spring 2011
Lab: Astronomy 111 Overview of Modern Astronomy	Fall 2010

Mentoring

REU: Shaquann Seedorf	Summer 2015
DEEP Mentor: Kate Elston, Aldo Galvan, Koki Hara, Joshua Stenzel, Fu-Anne Wang	2014–15
DEEP Mentor: Kate Elston, Madeline Hansalik, Ana Perez, Cole Williams	2013–14

Outreach

CANDELS blog	2015–present
Mentoring Undergrad Researchers (training)	May 2013
Public Star Parties	Fall 2012–14
Prospective Grad Student Orientation	May 2012–13
Texas A&M Physics and Astronomy Festival	April 2011–15

Publications

First Author

★ 1. *"The Relation between Star Formation Rate and Stellar Mass for Galaxies at 3.5 < z < 6.5 in CANDELS"* 2015 ApJ, 799, 183
Salmon, Brett; Papovich, Casey; Finkelstein, Steven L.; Tilvi, Vithal; Finlator, Kristian; Behroozi, Peter; Dahlen, Tomas; Davé, Romeel; Dekel, Avishai; Dickinson, Mark; Ferguson, Henry C.; Giavalisco, Mauro; Long, James; Lu, Yu; Mobasher, Bahram; Reddy, Naveen; Somerville, Rachel S.; Wechsler, Risa H.

2. *"Breaking the Curve with CANDELS: A Bayesian Approach to Reveal the Non-Universality of the High-Redshift Dust-Attenuation Law"* ApJ submitted, ArXiv 1512.05396
Salmon, Brett; Papovich, Casey; Long, James; Wilner, Steven; Finkelstein, Steven L.; Ferguson, Henry C.; Faber, Sandra; Newman, Jeffrey; Dickinson, Mark; Duncan, Kenneth; Pacifici, Camilla; Pérez-González, Pablo; Koekemoer, Anton; Kurczynski, Peter; Pforr, Janine

3. *"The Non-Universality of the Dust-Attenuation Law Since the First Billion Years"* **(in prep.)**
Salmon, Brett; Papovich, Casey; Long, James; Finkelstein, Steven L.; Ferguson, Henry C.; Faber, Sandra; Dickinson, Mark; Duncan, Kenneth; Pacifici, Camilla;

Co-Author

1. *"An Increasing Stellar Baryon Fraction in Bright Galaxies at High Redshift"* 2015 ApJ 814, 95
Finkelstein, S. L.; Song, M.; Behroozi, P.; & 12 coauthors including **Salmon, B.**
2. *"The SFR-M* Relation and Empirical Star-Formation Histories from ZFOURGE at 0.5 $< z <$ 4"* 2015 ApJ (accepted) arXiv:1510.06072
Tomczak, Adam R.; Quadri, Ryan F.; Tran, Kim-Vy H.; Labbe, Ivo; & 18 coauthors including **Salmon, B.**
3. *"Probing the Physical Properties of Z = 4.5 Lyman Alpha Emitters with Spitzer"* 2015 ApJ 813, 78
Finkelstein, K. D.; Finkelstein S. L.; Tilvi, V.; Malhotra, Sangeeta; & 9 other coauthors including **Salmon, B.**
4. *"The Evolution of the Galaxy Rest-Frame Ultraviolet Luminosity Function Over the First Two Billion Years"* 2015 ApJ, 810, 71
Finkelstein, S. L.; Ryan, R E., Jr.; Papovich, C.; Dickinson, M.; Song, M.; Somerville, R.; Ferguson, H. C.; **Salmon, B.**; & 21 coauthors
5. *"The Evolution of the Galaxy Stellar Mass Function at z= 4-8: A Steepening Low-mass-end Slope with Increasing Redshift"* 2015 ApJ (resubmitted) arXiv:1507.05636
Song, M.; Finkelstein, S. L.; Ashby, M. L. N.; Grazian, A.; Lu, Y.; Papovich, C.; **Salmon, B.**; & 12 coauthors
6. *ZFOURGE/CANDELS: On the Evolution of M* Galaxy Progenitors from z = 3 to 0.5"* 2015 ApJ, 803, 26
Papovich, C.; Labbé, I.; Quadri, R.; Tilvi, V.; Behroozi, P.; Bell, E. F.; Glazebrook, K.; Spitler, L.; Straatman, C. M. S.; & 32 coauthors including **Salmon, B.**
7. *"The galaxy stellar mass function at 3.5 $< z <$ 7.5 in the CANDELS/UDS, GOODS-South, and HUDF fields"* 2015 A& A, 575, 96
Grazian, A.; Fontana, A.; Santini, P.; & 38 coauthors including **Salmon, B.**
8. *"The Distribution of Satellites around Massive Galaxies at 1 $< z <$ 3 in ZFOURGE/ CANDELS: Dependence on Star Formation Activity"* 2014 ApJ, 792, 103
Kawinwanichakij, L.; Papovich, C.; & 24 coauthors including **Salmon, B.**
9. *"The HETDEX Pilot Survey. V. The Physical Origin of Ly? Emitters Probed by Near-infrared Spectroscopy"* 2014 ApJ, 791, 3
Song, M.; Finkelstein, S. L.; Gebhardt, K.; & 18 coauthors including **Salmon, B.**
10. *"Discovery of Lyman Break Galaxies at $z \sim 7$ from the zFourGE Survey"* 2013 ApJ, 768, 56
Tilvi, V.; Papovich, C.; Tran, K.-V. H.; & 22 coauthors including **Salmon, B.**

11. *"CANDELS: The Evolution of Galaxy Rest-frame Ultraviolet Colors from $z = 8$ to 4"* 2012 ApJ, 756, 164
Finkelstein, S. L.; Papovich, C.; **Salmon, B.**; Finlator, K.; Dickinson, M.; & 16 coauthors

12. *"Extreme Emission-line Galaxies in CANDELS: Broadband-selected, Starbursting Dwarf Galaxies at $z > 1$"* 2011 ApJ, 742, 111
van der Wel, A.; Straughn, A. N.; Rix, H.-W.; & 29 coauthors including **Salmon, B.**

References

Dr. Casey Papovich	Dr. Steven Finkelstein	Dr. Henry Ferguson
Dept. of Physics & Astronomy	Dept. of Astronomy	Space Telescope
Texas A&M University	University of Texas	Science Institute
01-979-862-2704	01-512-471-1483	01-410-338-5098
papovich@tamu.edu	stevenf@astro.as.utexas.edu	ferguson@stsci.edu

Brett Salmon - Statement of Research

My research involves observational studies of distant galaxies, and how their physical properties evolve with time. Specifically, I am interested in how galaxies accrue stellar mass through star-formation, and both the processes that reveal and impede that understanding. I have worked with rest-frame ultra-violet through far-infrared data, as well as several nebular emission lines. In addition, my research identifies how absorption and scattering by dust and limitations involved with the modeling of spectral energy distributions (SEDs) affect our interpretation of galaxy properties.

The Star-formation Rate and Stellar Mass Relation: The relation between star-formation rate (SFR) and stellar mass is a measure of the current and past star-formation activity of galaxies. The scatter between the relation alludes to the stochasticity of galaxy SFRs and gas accretion histories. I have led a comprehensive study on this relation among high-redshift ($z > 4$) galaxies which has become one of the key results of CANDELS (Cosmic Assembly Near-infrared Deep Extragalactic Legacy Survey). This study required facilitating communication between faculty and postdoctoral researchers from theory, observation, and statistics disciplines. Figure 1 shows the primary result, revealing little evolution in slope or scatter in the relation out to $z \sim 6$.

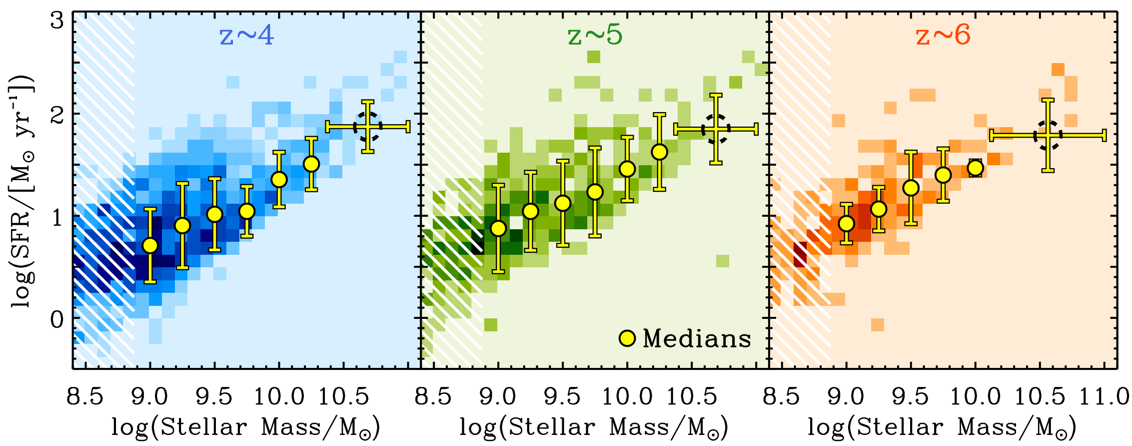

Figure 1: The relation between star formation rate (SFR) and stellar mass for star-forming galaxies in GOODS-S. The darker shaded regions indicate a higher number of galaxies in bins of stellar mass and SFR. Yellow circles and error bars represent the median and σ_{NMAD} scatter of SFR in bins of stellar mass, and the dashed black circle for a wider, high-mass bin. The white hatched regions mark the completeness limits. The slope or scatter of the relation evolves little from $z \sim 6$ to 4.

Part of my thesis work involved constructing an SED-fitting procedure in a Bayesian framework, to improve constraints on SFRs and stellar masses. One of the strengths of Salmon et al. 2015 was the recovery of galaxy physical parameters from mock catalogs produced by semi-analytic models (Somerville et al. 2012 MNRAS 423 1992) of galaxies with complex star-formation histories. This proved fruitful on two counts: showcasing the improved SED-fitting methodology and enriching comparisons to cosmological models.

Nebular Emission at High-z: Another aspect of my thesis involved the incorporation of nebular line emission to SED models of stellar populations. My public nebular emission procedure has already been used successfully in several studies (e.g., van der Wel et al. 2011 ApJ 742, 111; Tilvi et al. 2013 ApJ 768, 56; Finkelstein et al. 2012 ApJ 756, 164). Ionized gas near star-forming regions will produce strong nebular emission, which can significantly boost the broadband rest-optical flux of high-z galaxies (Schaerer & de Barros 2009), causing the SED to mimic an older, more massive stellar population.

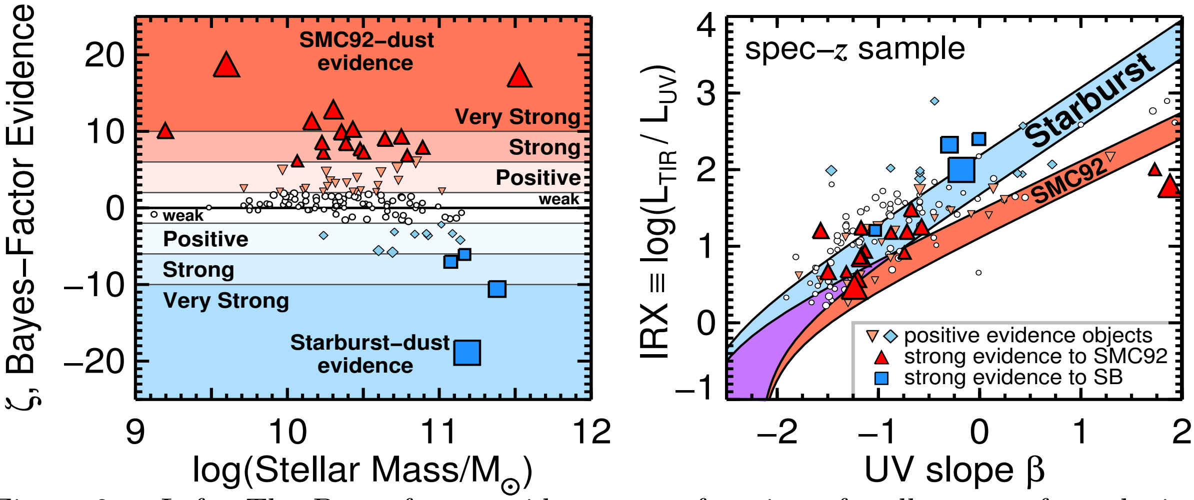

Figure 2: Left: The Bayes-factor evidence as a function of stellar mass for galaxies with spectroscopic redshifts $1.5 \leq z \leq 2.5$ and 24 μm detections. Darker regions indicate increasing levels of Bayes-factor evidence (Kass & Raftery '95) and are used to select galaxies with strong preference between SMC (Pei et al. 1992 ApJ 395, 130, red triangles) or Starburst (Calzetti et al. 2000, blue squares) dust laws. Right: UV slope vs. IR excess. Curves show predicted locations of galaxies from stellar population models. Galaxies selected by the strength of their Bayes-factor evidence tend to follow the $IRX-\beta$ relation of their predicted dust law. This shows that although galaxies of a given β exhibit a range of attenuations, a Bayesian modeling of the rest-frame UV-to-near-IR SED can predict the appropriate shape and scale of their underlying dust law.

Bayesian Approach to High-z Dust: Salmon et al. 2015b showcased the power of Bayesian statistics in studying dust in distant galaxies. Dust attenuation affects many aspects of galaxy evolution, including our interpretation of distant galaxy SFRs, and is parameterized by a wavelength-dependent dust-attenuation curve, or dust law. This dust law is usually assumed *a priori* when deriving physical properties of galaxies (Papovich et al. 2001 ApJ 559, 620).

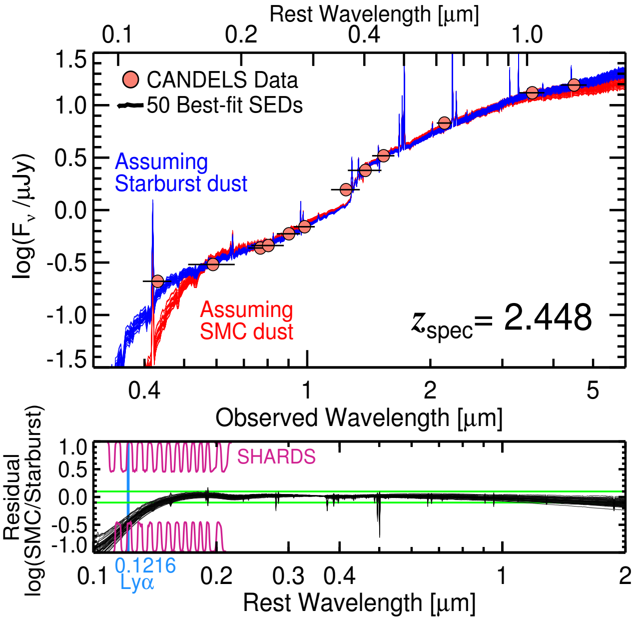

Figure 3: Example of fitting stellar populations to a galaxy SED under two assumptions of the dust law. For reddened galaxies, the color of the two bands in the rest-UV can help constrain the dust law. Bottom: residuals of the SEDs show that SHARDS medium bands can better sample the rest-UV at $z{\sim}3$.

With a sample of CANDELS galaxies at $z_{\rm spec}{\sim}2$, Salmon et al. 2015b demonstrates that we can distinguish between dust laws in individual galaxies using only broadband rest-frame UV-to-near-IR photometry, confirmed independently from IR measurements. The results are summarized in Figure 2. Galaxies with more attenuation (high IRX) have a flatter, grayer wavelength dependence to their dust law, and galaxies with low attenuation have steeper, SMC-like dust laws. This result has implications for dust corrections to high-redshift SFRs and potentially hints to radiative transfer predictions of dust production and grain size evolution (Gordon et al. 2001 ApJ 551, 269).

Future Work - The High-z Dust Law: Figure 3 shows a galaxy from Salmon et al. 2015b with rest-UV colors indicative of a starburst (ie., Calzetti et al. 2000) dust law. When the UV-to-near-IR SED suggests heavy reddening, the UV colors constrain the wavelength-dependence of attenuation. Salmon et al. 2015b used this method to constrain the dust law with *HST* data, but the GTC/SHARDS medium bands provide an even finer sampling of the rest-UV. This data can better constrain the shape of the dust law and even produce evidence for the enigmatic 2175Å dust absorption feature, who's presence is poorly constrained in distant galaxies. The Bayesian methods required for this project have already been developed in Salmon et al. 2015b and the SHARDS data is provided through collaboration with CANDELS team members.

Future Work - The Prevalence of Dust at High z: Mounting observational evidence of sub-mm galaxies suggest the presence of obscured starbursts even out to $z>5$ (Capak et al. 2011 Nature 470, 233, Riechers et al. 2013b Nature 496, 392, Casey et al. 2014 ApJ 796, 95). While these galaxies are likely extreme cases, they cause us to question our assumptions of dust prevalence at high z. The 'dust budget crisis' (Morgan & Edmonds 2003 MNRAS 343, 427) is the recognition that low-intermediate mass stars are incapable of producing the large dust masses observed so early in the universe (Rowlands et al. 2014 MNRAS 441, 1040). If rapid dust formation mechanisms exist at high redshift (eg. from AGB stars or SNe), then this has implications for our interpretation of reionization because dust readily absorbs and scatters UV ionizing radiation.

I can lead a search to confirm or deny the prevalence of massive, dust-obscured galaxies at $z>5$. This will require observations from *ALMA* and *Herschel* to measure the dust continua of high-z galaxies, but also *HST* multi-wavelength data to select the most massive, red galaxies. Figure 2 shows an example of such a selection, and their predicted dust continuum measurements at 850 μm. Continuum detections of these galaxies would broaden our understanding of dust in the distant universe, while non-detections would introduce new SED shapes that are extremely red yet with low dust.

I thank the committee for their consideration, and look forward to hearing back soon.

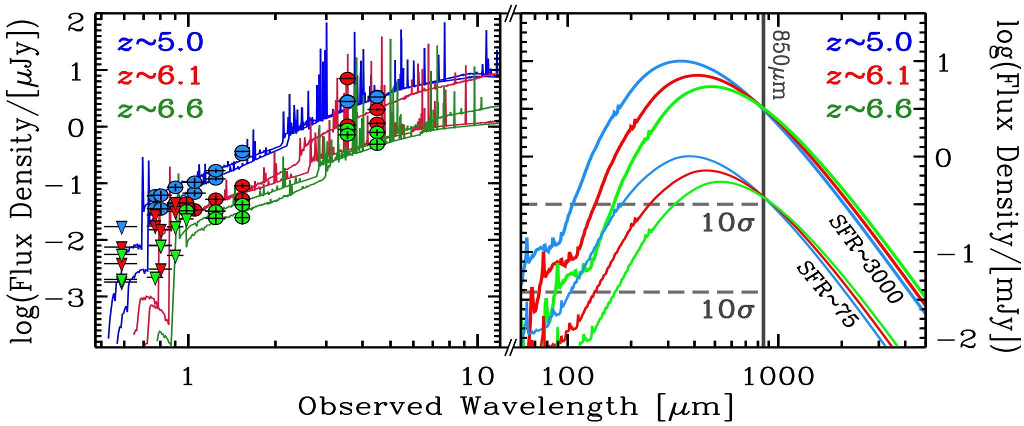

Figure 4: *Left:* Example best-fit SEDs of six red galaxies at $z\sim5$–7. Circles represent *HST* and *Spitzer* data, with triangles denoting upper limits. *Right:* The predicted far-IR SEDs (Rieke et al. 2009) assuming two SFR scenarios: the SED-derived SFRs of $\sim$3000 $M_\odot$/yr or the conservative 5%-tile of the SFR probability, $\sim$75 $M_\odot$/yr. Horizontal lines show the 10-σ detection limits for each scenario. ALMA can quickly confirm or deny the bright dust continua of these dust-obscured star-forming galaxies at high redshift.

Other References: Calzetti et al. 2000 ApJ 533, 682; Salmon et al. 2015a ApJ 799, 183; Salmon et al. 2015b ApJ submitted, ArXiv 1512.05396; Schaerer & de Barros 2009 A&A 502, 423