



## HISTORY of Workshop on Impact of Blending on LSST Science (Tue-Thu)



- A bit of history: how did blending workshop end up at LSST2018?
  - As follow-up to blending discussions at LSST2017, Sarah Brough (Galaxies) was put in touch with Pat Burchat & David Kirkby (DESC Blending Task Force); Alexie Leauthaud and others @ UCSC also expressed interest.
  - We formed a multi-science-collaboration SOC and applied for LSSTC support:
    - granted \$25k; used for providing partial travel support for **14 grad students & postdocs** and **10 senior scientists** who needed support to attend.
  - Highest availability during LSST2018 so approached Beth Willman and Ranpal Gill.
- Did it work as a joint workshop? Yes!
  - Very relevant DM & Scarlet expertise was available when needed (e.g., Jim Bosch, Peter Melchior, Fred Moolekamp).
  - Broad range of SCs were represented.
  - Brought people to LSST2018 who would otherwise likely not have attended: *LSSTC support was extremely important for this!*

P&CW is a great space for cross-SC/DM engagement



# GOALS of Workshop on Impact of Blending on LSST Science



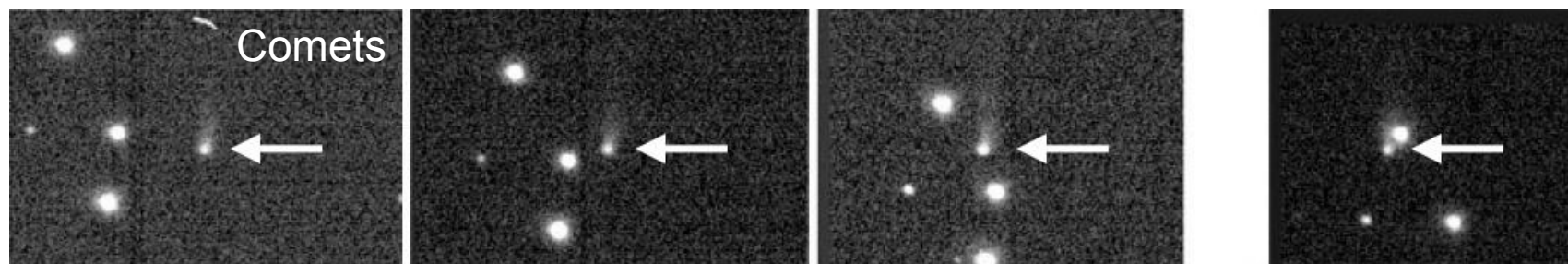
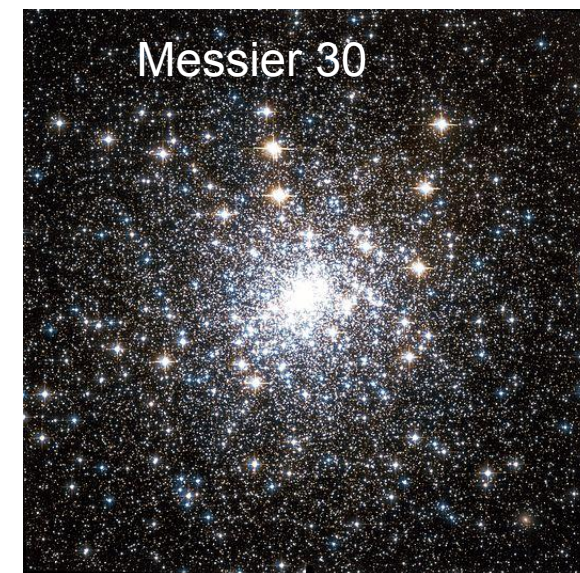
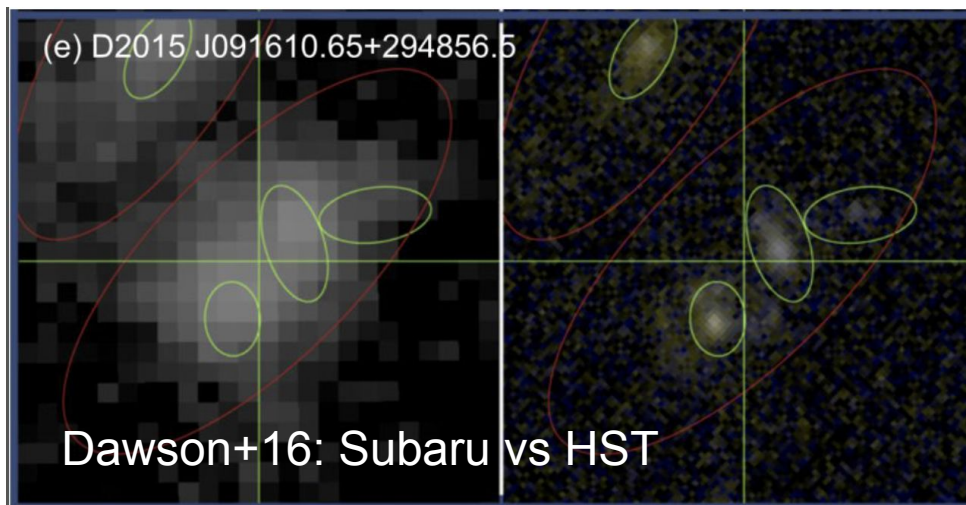
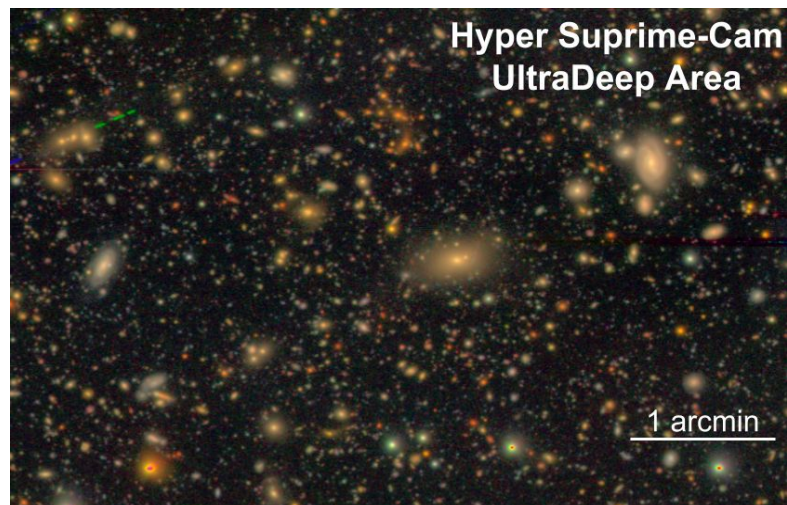
## From the Workshop page:

The workshop will focus expertise across the LSST community on **assessing our current understanding of blending issues** and addressing the following questions:

- What are the **figures of merit** in quantifying the impacts of blending?
- What tools and data products **exist** to **evaluate these metrics** -- e.g., simulations, data sets, software frameworks?
- Which tools and data products are **missing**?
- What are the **requirements** on these metrics for different science cases?



# Why a Workshop on Impact of Blending on LSST Science?



Blending affects all science collaborations!

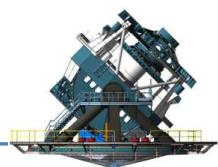




## OUTCOMES of Workshop on Impact of Blending on LSST Science



- [Scribe notes](#) for every one of 8 sessions => 17 pages to be synthesized!!
- Tutorial session:
  - Participants were given two Jupyter notebook tutorials, running in the LSST Science Platform Notebook Aspect (<https://nb.lsst.io/>).
    - How to use multi-band deblender Scarlet as a single package.
    - Walk-through of source detection, deblending with Scarlet, and running measurements in the LSST stack.
  - Tutorial will live on the Stack Club github page:  
<https://github.com/LSSTScienceCollaborations/StackClub>
  - Many thanks to Adam Thornton and SQuaRE for setting up the notebook environment and helping during the session!



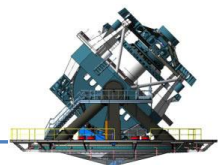
# OUTCOMES of Workshop on Impact of Blending on LSST Science



Session #8:  
Small group breakouts.



Type of Science	Impacted by blending?			Figures of merit for impacts		Most useful data sets (real, sims, object injection)
	detection	deblending	measurement	Identified?	Quantified?	
2-pt correlations	Yes!	Yes!	Yes!	Shapes: mostly yes Photo-z: not yet (difficult!)	Shapes: mostly yes Photo-z: not yet	All, especially galaxy injection in HSC data
Transients, comets, asteroids	Quality of difference imaging			Difference imaging.	Not yet	Same datasets as used to test difference imaging. Could inject comets.
Crowded fields	Yes	Yes	-	Completeness & accuracy	Not yet	BDBS, simulations on top of HSC. Object injection.
Galaxies & AGN	Yes!	Yes!	Yes!	luminosity-surface brightness; luminosity functions; etc	No yet	Source injection: Cutouts from hydro sims or HST. LSB galaxies & features (tidal streams, ICL).



## OUTCOMES of Workshop on Impact of Blending on LSST Science



Strong desire for cross science collaboration communication & *sharing* of *already available resources*:

- **Web area** to document existence of tools, data sets,...
  - use LSSTC-sponsored SC pages (under redesign)?
- **Communication** options: new #lsst-blending slack channel? LSST Community?
- **Presentations** at DESC Blending Task Force meetings (with permission of presenters).
- **Tools** for generating pixel-level simulations of isolated or blended objects. Examples:
  - GalSim & WeakLensingDeblending open, well documented, widely used in DESC.
  - Blending Tool Kit (under development).
- Public data sets **with catalogs** (e.g., HST images).

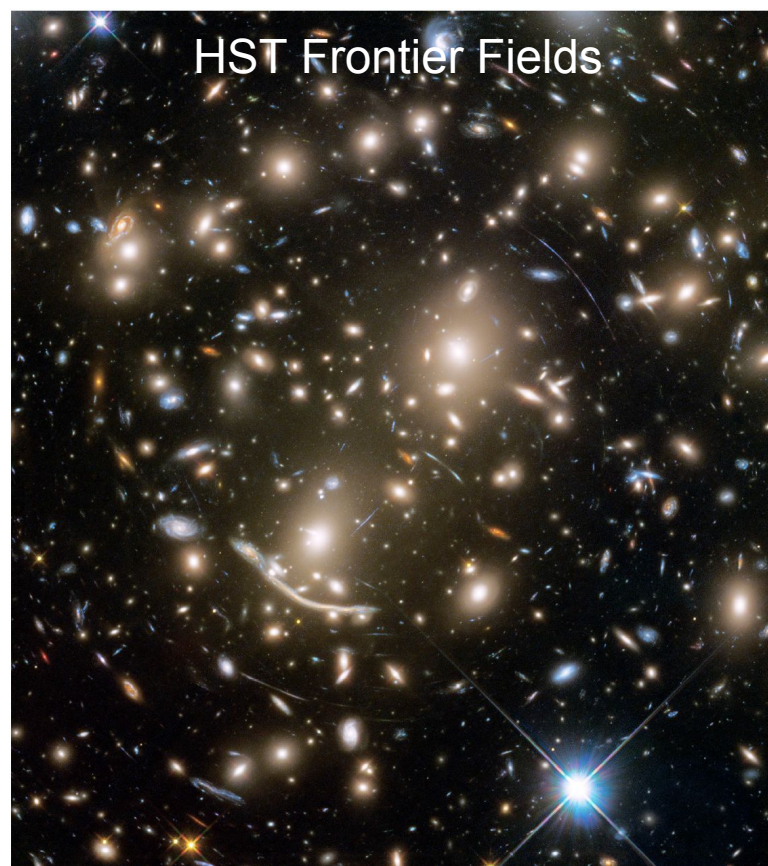
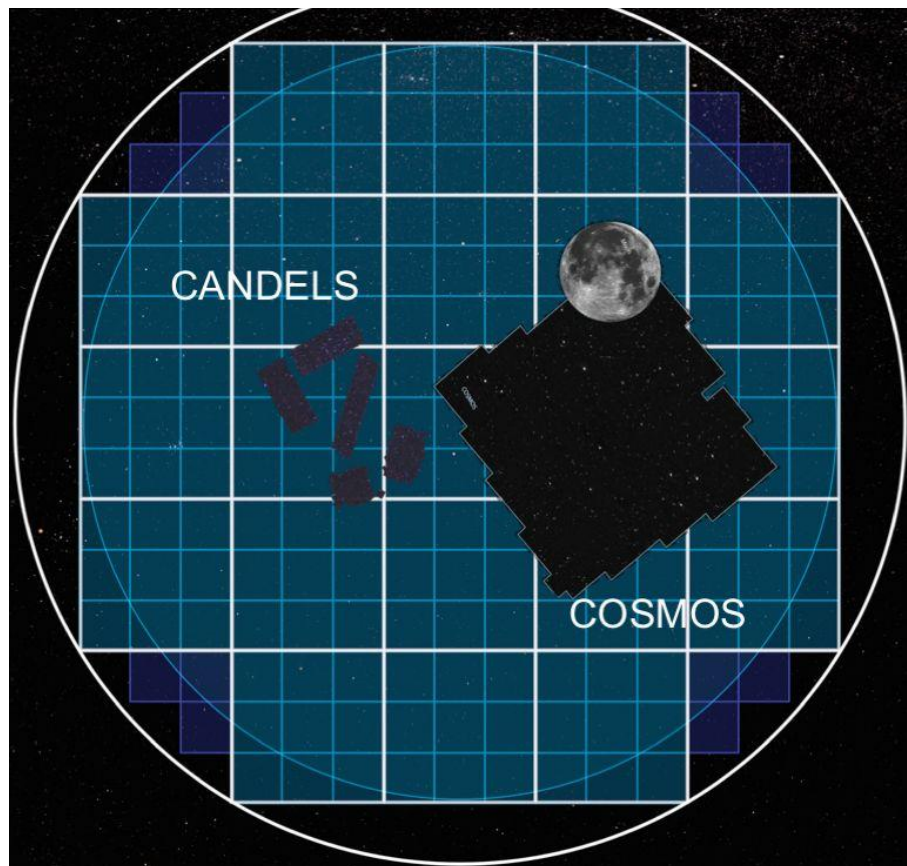
Lots of desire for  
working across science  
collaborations!



## Why a Workshop on Impact of Blending on LSST Science ?



- Space-based “truth” is limited.  
=> Curate and share catalogs across science collaborations.



Data useful to  
many Science  
Collaborations





## OUTCOMES of Workshop on Impact of Blending on LSST Science



### Shared training & test data sets: “Wish List” examples

- Simulated postage stamps with truth (including seg maps for each object) with or without noise, for training (e.g., ML) and testing algorithms
- Simulated objects “injected” into HSC images and run through DM processing?
- DESC Data Challenge 3 (being specified during next ~year) - bigger volume, improved realism, specific science questions?

### Shared near term goals across different science collaborations?

- Can make sure they are consistent with DM schedule for Scarlet development, object injection, etc.

Lots of desire for working across science collaborations!





## OUTCOMES of Workshop on Impact of Blending on LSST Science



### Injecting targets:

Balrog: The injection simulation package in the Dark Energy Survey (Eric Huff et al.)  
Similar tool developed for HSC (SynPipe). DM plans to implement in next ~6 months.





## OUTCOMES of Workshop on Impact of Blending on LSST Science



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Anticipate this object injection tool will be very useful!



## OUTCOMES of Workshop on Impact of Blending on LSST Science



### Ideas for future workshops:

- Machine learning focus for detection, classification, deblending, generative models\*\*, ... (all SC's?)
- Morphometrics workshop (Galaxies SC).
- Hack/Sprint with specific data sets / goals.

When/Where? Append to another meeting? Examples:

- LSST DESC meeting, Feb 25 - Mar 1, 2019 at SLAC (or Bay Area)
- [LSST@Asia](#), May 20-23, 2019, in Sydney

\*\* See [Blending Session #5](#).





## OUTCOMES of Workshop on Impact of Blending on LSST Science



Is it a star? Or is it a galaxy?

Generate “look alike”?

Generative adversarial networks (GAN),  
variational autoencoders (VAE),  
VAEGANs, and all that...



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Example:

[arXiv/1807.00734](https://arxiv.org/abs/1807.00734)







Scenario	Absolute probability (Standard GAN)	Relative probability (Relativistic average Standard GAN)
Real image looks real <b>and</b> fake images look fake		 $\begin{aligned} C(x_r) &= 8 \\ P(x_r \text{ is bread}) &= 1 \end{aligned}$ $\begin{aligned} \overline{C(x_f)} &= -5 \\ P(x_r \text{ is bread}   \overline{C(x_f)}) &= 1 \end{aligned}$
Real image looks real <b>but</b> fake images look similarly real on average		 $\begin{aligned} C(x_r) &= 8 \\ P(x_r \text{ is bread}) &= 1 \end{aligned}$ $\begin{aligned} \overline{C(x_f)} &= 7 \\ P(x_r \text{ is bread}   \overline{C(x_f)}) &= .73 \end{aligned}$
Real image looks fake <b>but</b> fake images look more fake on average		 $\begin{aligned} C(x_r) &= -3 \\ P(x_r \text{ is bread}) &= .05 \end{aligned}$ $\begin{aligned} \overline{C(x_f)} &= -5 \\ P(x_r \text{ is bread}   \overline{C(x_f)}) &= .88 \end{aligned}$



# OUTCOMES of Workshop on Impact of Blending on LSST Science



1 ADULT corgi ~ 46 litres

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