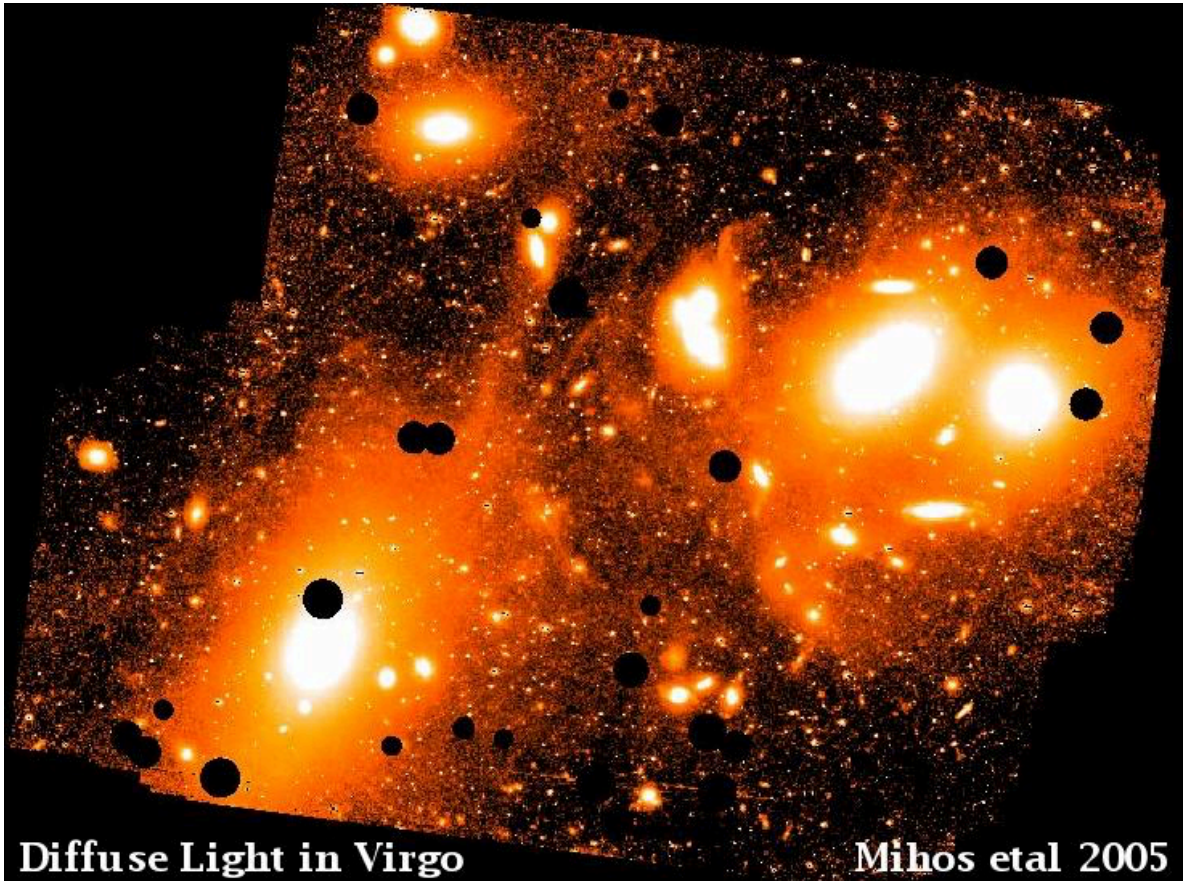
Workshop on impacts of blending on LSST science: Goals and Overview

Sarah Brough (UNSW) and Jim Bosch (Princeton)

Plenary Session, Tuesday morning, August 14, 2018

Workshop supported by LSSTC Enabling Science Program

My Science Driver



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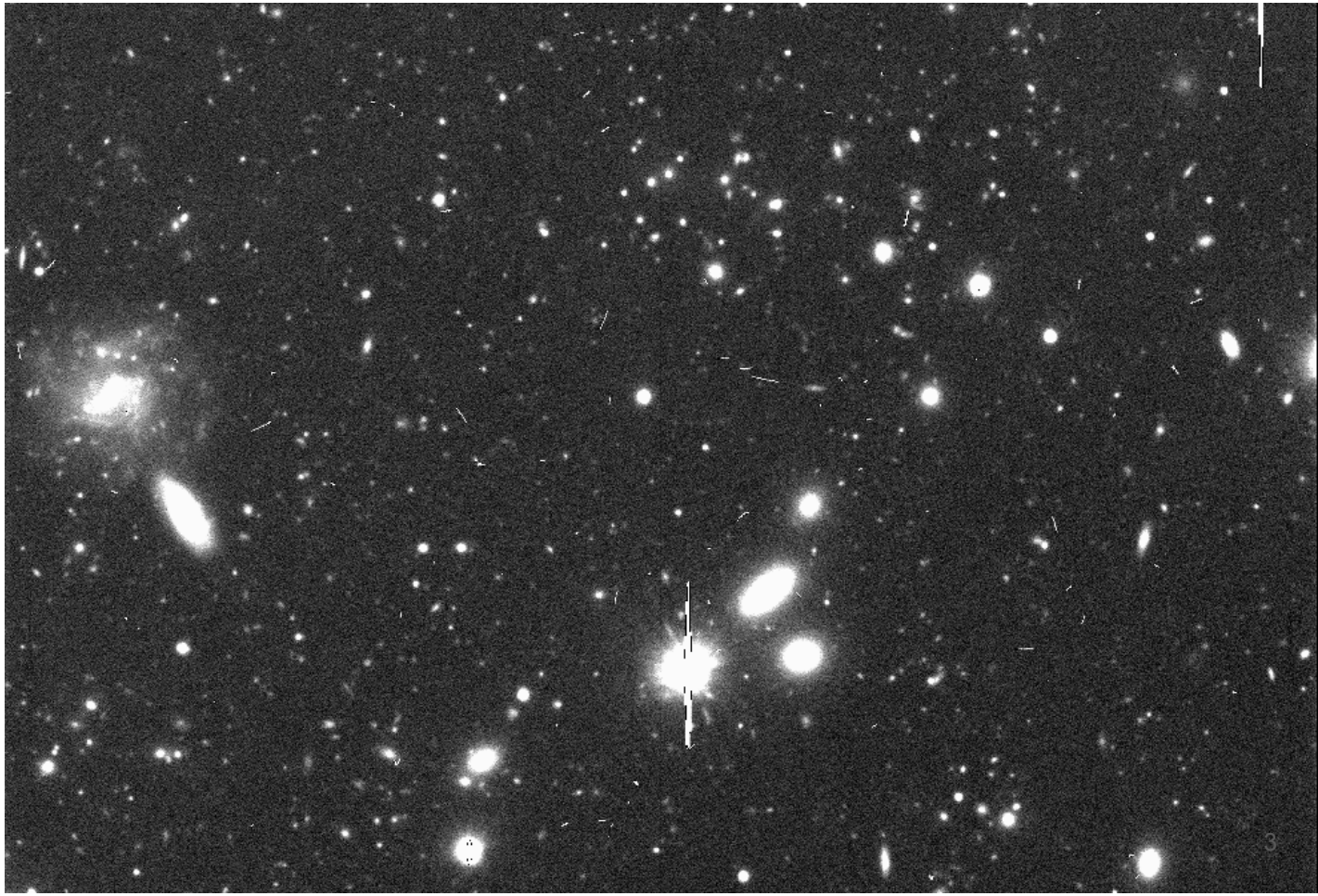

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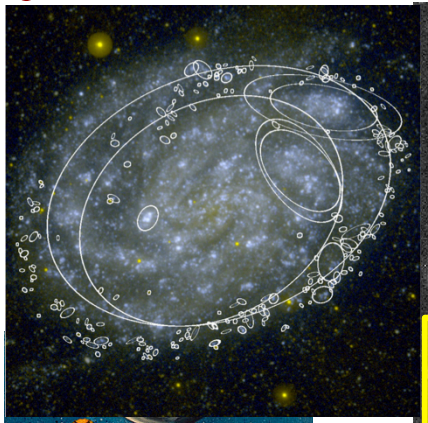
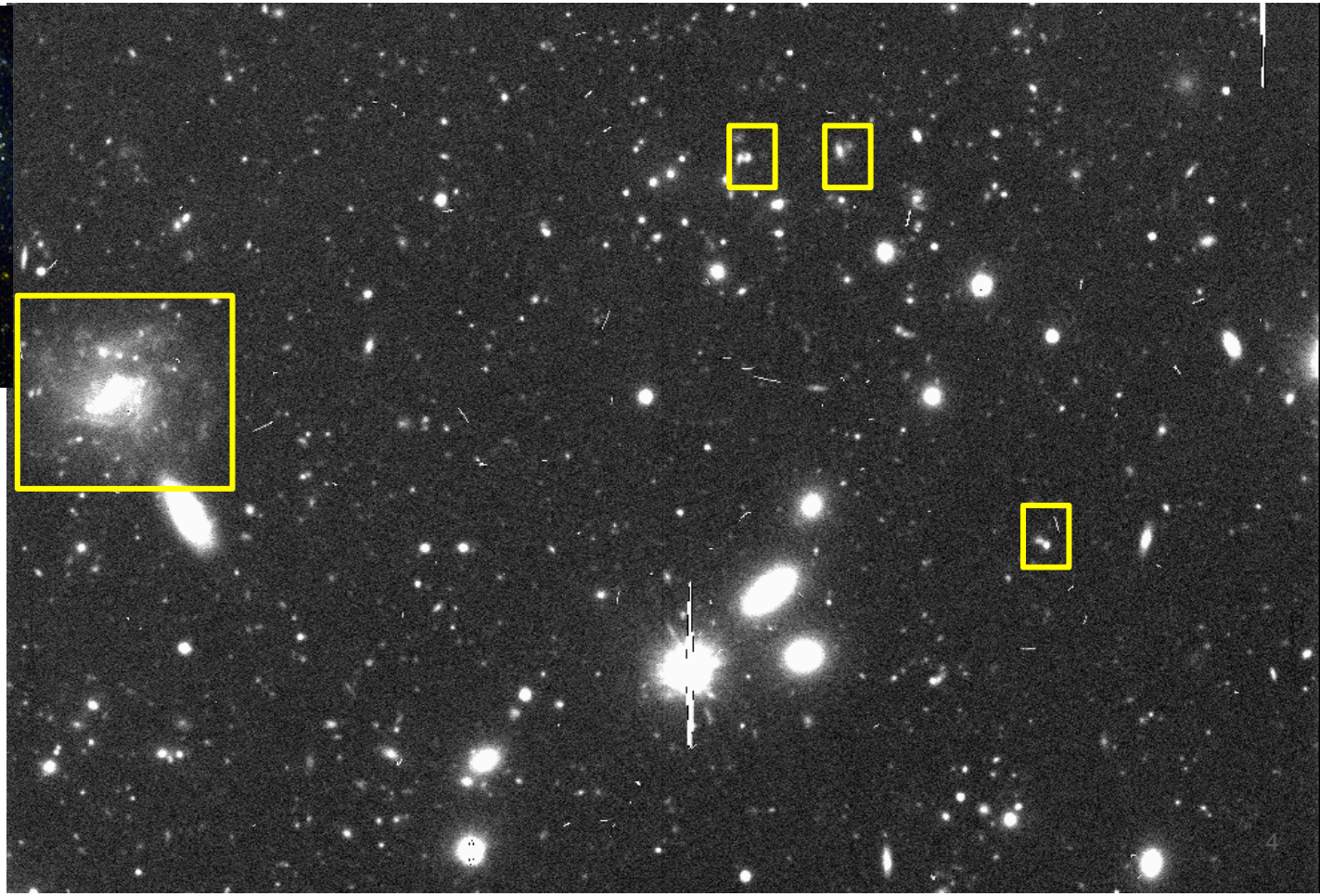




Scientific Organizing Committee

Sarah Brough (**Galaxies SC**)
Patricia Burchat (**DESC**)
David Kirkby (**DESC**)
Alexie Leauthaud (**DESC**)

Active Galactic Nuclei SC: *Niel Brandt*
Galaxies SC: Mike Cooper, *Harry Ferguson, Brant Robertson*, Graham Smith, *Sugata Kaviraj*
Solar Science SC: Wes Fraser, *Henry Hsieh*
Stars, Milky Way, LV SC: *John Gizis*
LSST DESC + DM: *Peter Melchior, Fred Moolekamp*
Transients/Variable Stars SC: Rachel Street
Strong Lensing SC: Aprajita Verma

(*Italics* indicate those present)

Workshop Sessions (Presidio III/IV)

Tuesday

- 11am-12:30pm - #1 Challenges, Current Status and Future Plans for Addressing Blending in LSST Data Release Pipelines
- 1:30-3pm - **#2 Overview of Blending Challenges for LSST Science**
- 3:30-5pm - #3 Hands-on Deblending: Simulations and Pipeline Tutorial

Wednesday

- 11am-12:30pm - #4 New Concepts for Object Detection and Deblending
- 1:30-3pm - #5 Tools and Data Sets for Developing and Evaluating Algorithms for Blended Objects
- 3:30-5pm - ??UNCONFERENCE??

Thursday

- 11am-12:30pm - #6 Clues About Blending in the LSST Object Catalog
- 1:30-3pm - #7 Solar System Objects, Crowded Fields, and Other Specialized Blending Challenges
- 3:30-5pm - **#8 Workshop Closeout**

Workshop Session #2

We will start with 5-min presentations (+2 min for questions) from the Science Collaborations (SCs):

1. Galaxies SC (Brant Robertson)
2. AGN SC (Niel Brandt)
3. Strong Lensing SC (Phil Marshall)
4. Dark Energy SC (David Kirkby / Pat Burchat)
5. Transient/variable stars SC (Federica Bianca)
6. Solar System SC (Henry Hsieh)
7. Stars, Milky Way and Local Volume SC (John Gizis)

Expected outcomes of this session:

- An inventory of challenges.
- Identified overlaps or common challenges between SCs.
- Identified ideas for unconference sessions.

DESC Blending Task Force Presentations

link

DATE	PRESENTER	TItle	Slides	VIDEO
10/02/2017	Jim Bosch	LSST Data Release Pipelines; Big Questions for Blending	animated google presentation, pdf	Zoom
10/16/2017	Peter Melchior, Fred Moolekamp	Multi-band deblending for LSST (also see 05/07/2018 presentation on Scarlet) [arXiv:1708.09066)]	Peter (pdf), Fred (pdf)	Zoom
10/23/2017	Gary Bernstein	Shear estimation with Bayesian Fourier Domain (BFD) method; thoughts on blending at LSST depths	pdf	Zoom
10/30/2017	Simon Samuroff	Im3shape and blending in DES	pdf	Zoom
11/06/2017	Erin Sheldon	The MOF deblender used in DES + discussion of interplay with metacalibration	pdf	Zoom
11/20/2017	Robert Lupton	Failure modes due to blended objects, at LSST depth (e.g., HSC), in detection, photometry, shape measurements, etc.	pdf	Zoom
11/27/2017	Rachel Mandelbaum	Shear estimation and blending in HSC	pdf	N/A
12/04/2017	Ian Dell'Antonio, Shenming Fu, Binyang Liu	Effects of blending on cluster shear profiles	google presentation (updated Aug 2018)	N/A
12/18/2017	Laurence Perreault Levasseur	Convolutional neural networks and independent component analysis of multi-filter imaging data (continued on Jan 29) [arXiv:1708.08842]	pdf	N/A
01/22/2018	David Kirkby	Image simulations for blended objects	pdf	Zoom
01/29/2018	Laurence Perreault Levasseur	Convolutional neural networks and independent component analysis of multi-filter imaging data (continued	pdf	N/A

Season 1

02/26/2018	Benne Holwerda	What do we know about occulting galaxy pairs? [arXiv:1605.02420]	pdf	Zoom
03/05/2018	Joachim Harnois-Deraps	Testing the blend-exclusion bias on cosmic shear with mocks lensing data [arxiv:1805.04511]	pdf	Zoom
03/19/2018	Erin Sheldon	Single object co-adds: implementations and testing	pdf	Zoom
04/16/2018	Alexie Leauthaud	Study of photometric performance of HSC pipeline by superimposing GalSim images on HSC images (SynPipe)	arXiv:1705.01599, SynPipe github	
04/30/2018	Raphael Shirley	Using the Bayesian Evidence for Source Extraction, Model Comparison and Deblending	pdf	N/A
05/07/2018	Peter Melchior, Fred Moolekamp	Improvements to SCARLET deblender, update on integration into the LSST stack, and future directions in deblending (including multi-survey) [arXiv:1802.10157]	Fred (pdf), Peter (pdf)	Zoom
05/21/2018	Sowmya Kamath	Quantifying effects of blending using simulated galaxy pairs + Hybrid use of the LSST science pipelines & Scarlet	pdf	Zoom
06/18/2018	Jim Bosch	Co-addition algorithms and impacts of blending	animated google presentation	Zoom
07/02/2018	Cyrille Doux	Deblending galaxies with deep, convolutional, probabilistic neural networks	pdf	1st half of Zoom
07/02/2018	Sowmya Kamath	Addressing blending challenges with neural networks – A case study: Mask R-CNN	animated google presentation, pdf	2nd half of Zoom
07/24/2018	Francois Lanusse	CMU DeepLens: Deep Learning For Automatic Image-based Galaxy-Galaxy Strong Lens Finding		N/A

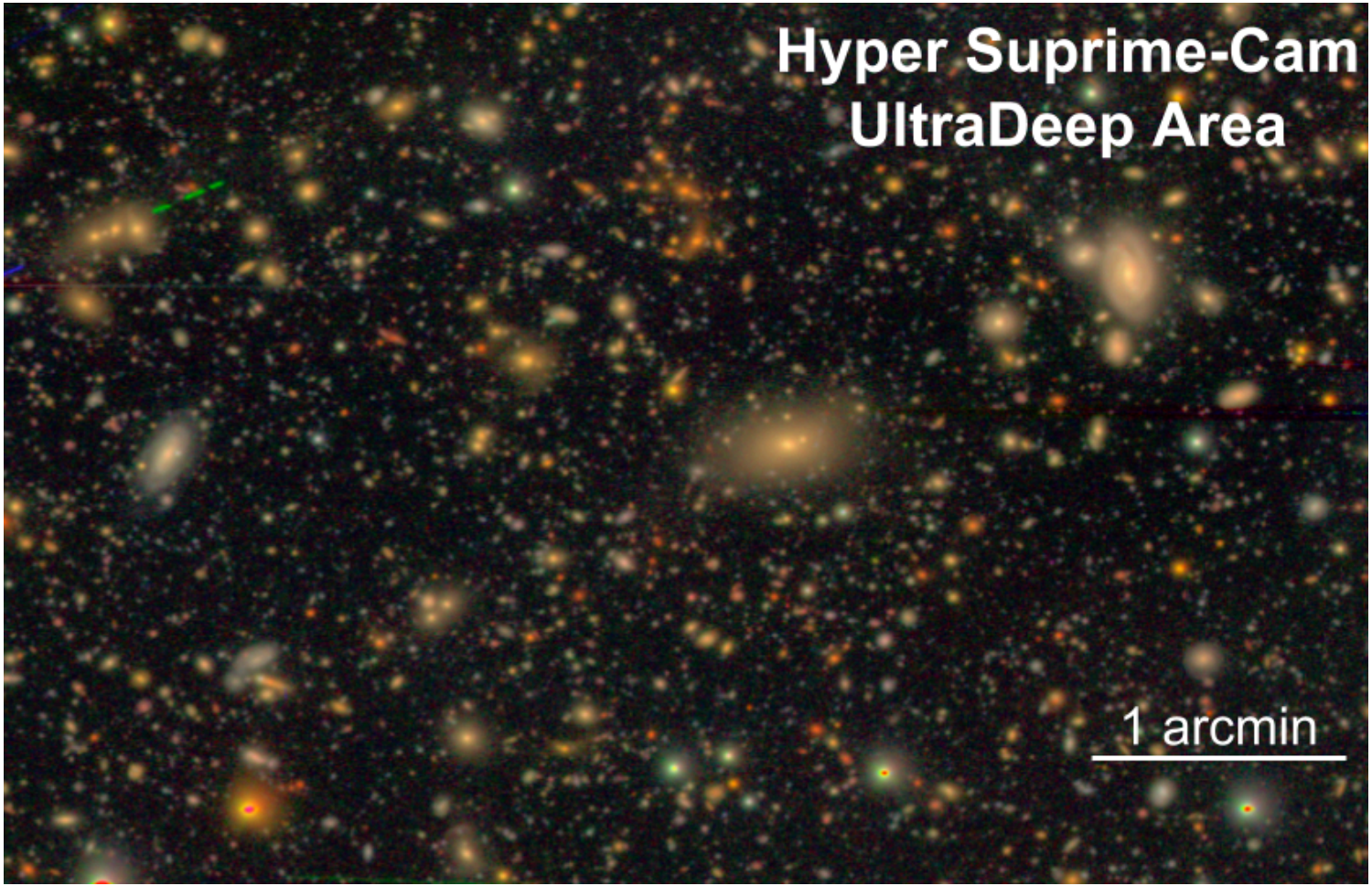
Season 2

Workshop Session #3

Specific Instructions for Hands-on Deblending Tutorial:

- Basically: Go to **https://identity.lsst.org/join/4VYAMGK2E3** and hit the button for “Register a new user and join”

(Link in the slack channel #mtg-lsst2018 with instructions for obtaining an NCSA account to access the demo server (which contains the tutorials) or instructions are at: https://community.lsst.org/t/lsst-science-platform-demos-at-lsst2018/3116)


Hyper Suprime-Cam
UltraDeep Area
1 arcmin

Some Terminology

blended: two or more objects are close enough that you can't accurately measure them independently.

detection: given images of a patch of sky, return above-threshold regions and the rough positions of objects within them.

deblending (1): given images and the rough positions of blended objects, construct images or models that separate their flux so they can be measured separately.

deblending (2): both detection and deblending (1)

DM and Community Roles in Blending

Most deblending happens in pipelines DM runs, in code DM nominally writes.

But deblending is *intrinsically impossible*, so:

- it's one of our most difficult algorithms to develop and test, and there's a broad range of classes of algorithm to consider;
- we don't have any simple ways to know when we've done a good job - subtle problems can probably only be caught by trying to do high-level science;
- our outputs may involve several mutually-exclusive interpretations of the true scene, and it'll be up to the community to determine which is best for any particular science analysis.

"Most deblending happens in pipelines DM runs"

But there will be some classes of blend we don't handle well. Those probably include:

- strong gravitational lenses
- supernova light echos
- galactic cirrus
- messy galaxy mergers

Our goals are to handle common classes of blend well, and do well enough on the rare cases to allow them to be found and handled by custom user processing.

"in code DM nominally writes"

...but if the community writes a better one, we'll absolutely use it.

The current deblender *was* written by DM.

- Derived from SDSS deblender (where the algorithm worked pretty well).
- Used in all HSC data releases to date (described in Bosch et al 2018).
- It's known not to be good enough at LSST depths.

The deblender we're integrating and evaluating for the future was *partially* written by DM: *Scarlet* (Melchior & Moolekamp 2018).

We're also considering at least one other deblender written completely outside DM.

DM's Goals for the Blending Workshop

- Help the community predict what blending and DM deblending will do to the astronomical objects they care about.
- Encourage and enable the community to help in evaluating Scarlet (and potentially other algorithms).
- Make sure DM deblending plans stay consistent with the community's needs and priorities.
- Make sure community algorithm/simulation/testing development proceed in ways that can feed back into DM.