LSST Informatics and Statistics Science Collaboration (ISSC)

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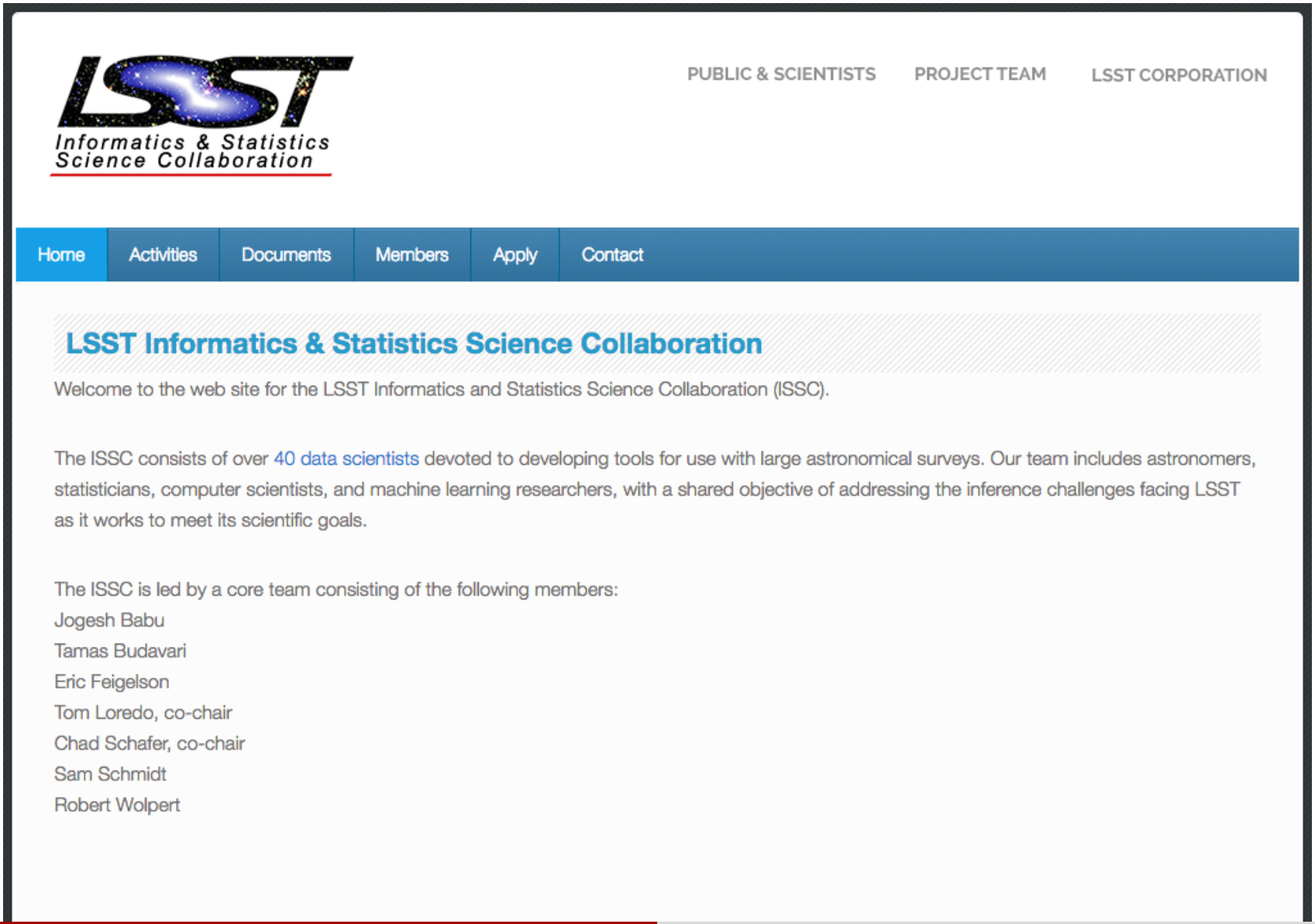
Mullard Space Science Laboratory (MSSL)
University College London (UCL)

Specialist Discussion Meeting on LSST, Royal Astronomical Society, May 2017

LSST Informatics and Statistics Science Collaboration (ISSC)

US (https://issc.science.lsst.org/)



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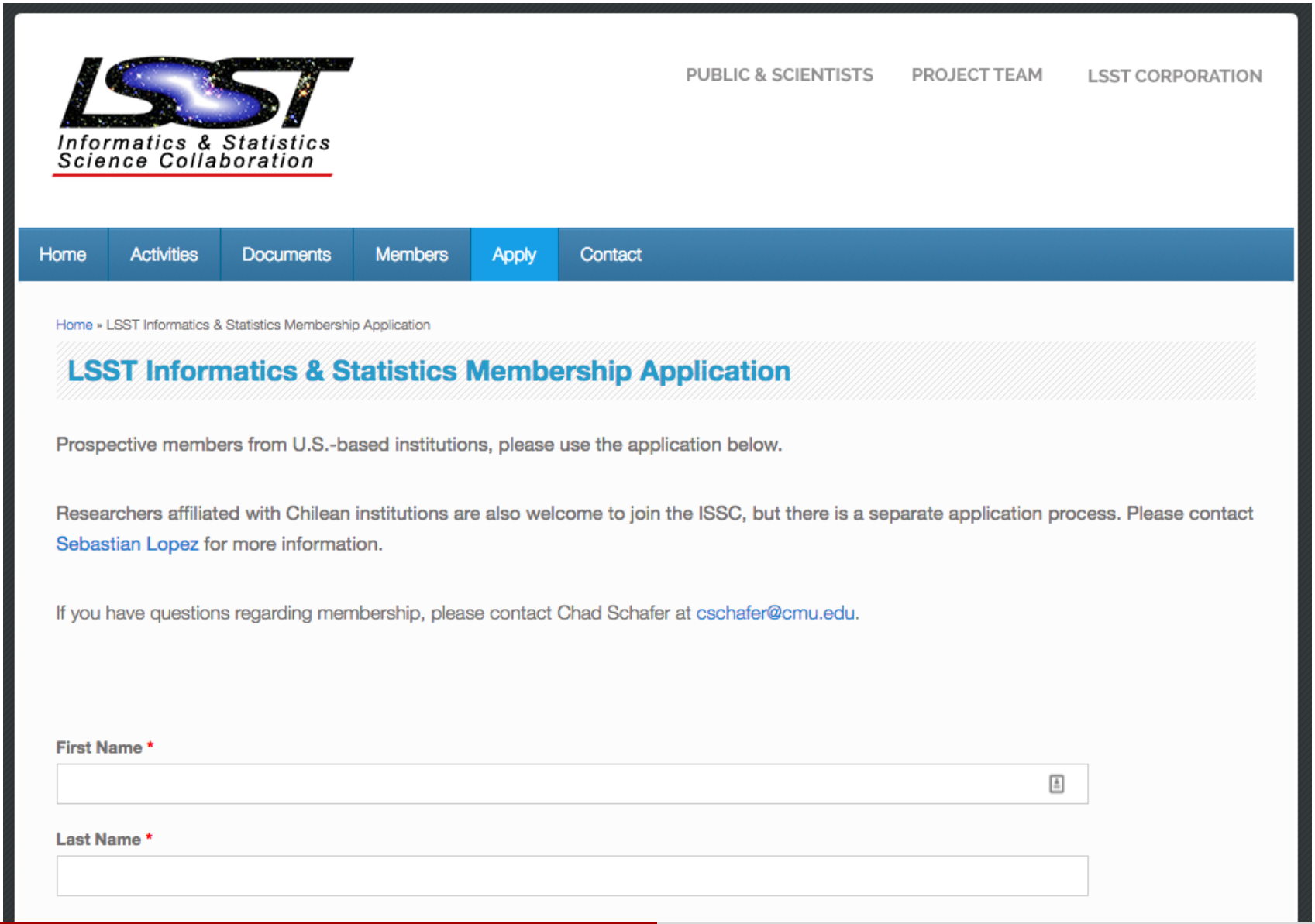
Joining (https://issc.science.lsst.org/apply)



LSST Informatics and Statistics Science Collaboration (ISSC)

LUSC-ISSC mailing list (LUSC-ISSC@jiscmail.ac.uk)

Subscribe by sending an email to listserv@jiscmail.ac.uk, with the following details:

Subject: <BLANK>
Message: SUBSCRIBE LUSC-ISSC <Firstname> <Lastname>

This mailing list will be used to keep everyone abreast of ISSC related activities.

All list members can post messages so feel free to make use of this list for general discussions of interest to members and don't hesitate if you have any questions about ISSC!

Although ISSC is a distinct science collaboration, there will be close interaction with the activities of DESC and other science collaborations to ensure informatics and statistics developments are closely related to the science goals of LSST.

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Conferences, meetings and visitor programmes

- Statistical Challenges in 21st Century Cosmology, Chania, 24-27 May 2016
  http://cosmo21.cosmostat.org/
- Statistical Challenges in Modern Astronomy, Carnegie Mellon University, 6-10 June 2016
  http://scma6.org/
- LSST@Europe 2, Belgrade, 20-24 June 2016
  https://project.lsst.org/meetings/lsst-europe-2016/
- SAMSI opening workshop on Statistical, Mathematical and Computational Methods for Astronomy, North Carolina, 22-26 August 2016
  https://www.samsi.info/programs-and-activities/research-workshops/2016-17-astro-opening-workshop-august-22-26-2016/
- SAMSI visitor programme, North Carolina
  https://www.samsi.info/programs-and-activities/year-long-research-programs/2016-17-program-on-statistical-mathematical-and-computational-methods-for-astronomy-astro/
- DESC collaboration meetings

...

Conferences, meetings and visitor programmes

- Biomedical and Astronomical Signal Processing (BASP) Frontiers workshop
  Villars, Switzerland, 29 January - 3 February 2017
  Dedicated LSST informatics and statistics session
  http://www.baspfrontiers.org/

BASP
Biomedical and Astronomical Signal Processing

IMPORTANT DATES

01.06.2016 Session proposal deadline
01.09.2016 Abstract submission opening
01.10.2016 Abstract submission deadline

About the workshop

The **International Biomedical and Astronomical Signal Processing (BASP) Frontiers workshop** was created to promote synergies between selected topics in astronomy and biomedical sciences, around common challenges for signal processing.

Building on the success of the first workshops (2011, 2013 and 2015), BASP Frontiers 2017 will gather around 100 participants and open its floor to many interesting hot topics in theoretical, astrophysical, and biomedical signal processing, with a particular focus on imaging.

Ski and full board philosophy: Following our tradition, BASP Frontiers 2017 will take

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  http://www.baspfrontiers.org/

Organiser: Tim Eifler

Session: Advanced Statistical Methods to extract Cosmological Information in the LSST Era

17:30 - 19:45 **Talks**

Joe Zuntz	*Sampling methods and pipeline design in modern cosmology*
Boris Leistedt	*Data-driven, interpretable photometric redshifts for deep galaxy surveys with unrepresentative training data*
Jean-Luc Starck	*Space variant deconvolution of galaxy survey images*
Elena Sellentin	*Estimated covariance matrices in large-scale structure observations*
Oleg Smirnov	*Challenges of Extreme Dynamic Range Imaging: The Cygnus Files*

19:45 - 20:30 **Posters and aperitif**

Boris Leistedt	*Spin-SILC: CMB polarisation component separation for next-generation experiments*
Matthieu Simeoni	*On Flexibeam for radio interferometry*
Nezihe Gürel	*On Denoising Crosstalk in Radio Interferometry*
Jean-François Robitaille	*A new perspective on turbulent Galactic magnetic fields*

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Organiser: Ben Wandelt

SESSION: ASTROSTATISTICS: FROM GALAXIES TO THE UNIVERSE

08:00 - 10:15 **Talks**

Andrew Connolly	*Compression, Sampling, and Classification: techniques for the analysis of a new generation of Petascale surveys*
Ethan Anderes	*CMB delensing for detecting primordial B-mode fluctuations*
Jens Jasche	*Bayesian data interpretation with large scale cosmological models*
Alan Heavens	*Bayesian Hierarchical Modelling of data*
Mike Hobson	*Bayesian compressed sensing*

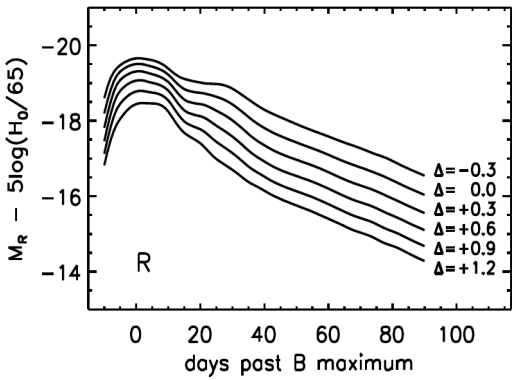
10:15 - 11:00 **Posters and coffee**

François Lanusse	*Deep Generative Models of Galaxy Images for the Calibration of the Next Generation of Cosmological Surveys*
Rémy Joseph	*Teaching computers to see colours in the Hubble Frontier Fields with Morphological Component Analysis-based method*
Edward Higson	*Statistical properties of nested sampling parameter estimation*

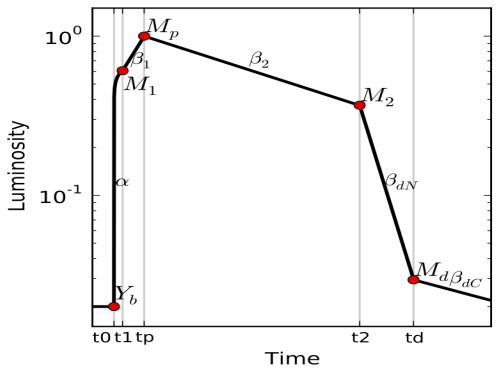
Photometric supernova classification

Machine learning

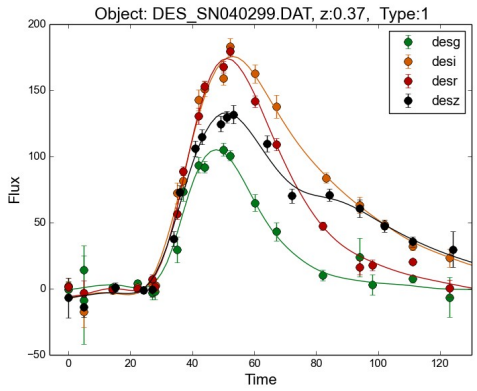
- Photometric supernova classification by machine learning
  (Lochner, McEwen, Peiris, Lahav & Winter 2016; arXiv:1603.00882)
- Go beyond single techniques to study classes.



(a) Templates



(b) Generic parameterisations



(c) Wavelets (non-parametric)

Figure: Feature selection classes (in order of increasing model independence)

- Integrate physics into machine learning (scale and dilation invariance).
- Understand physical requirements: representative training, redshift.

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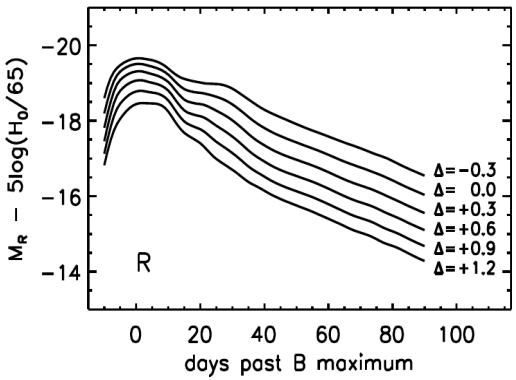

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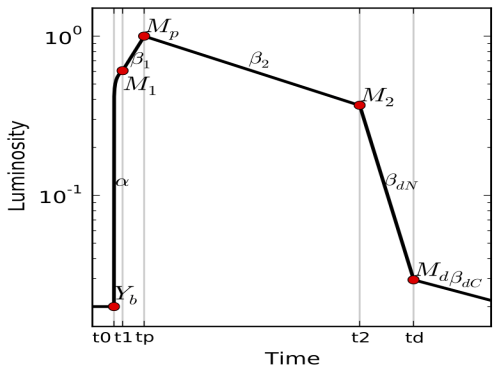

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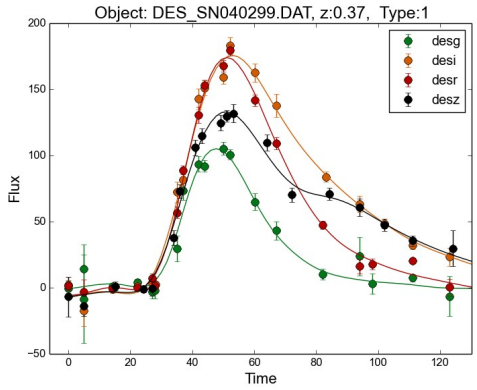

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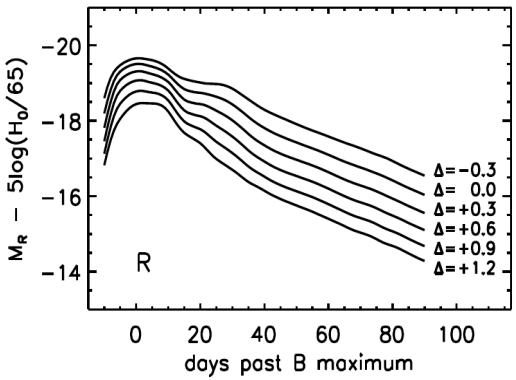

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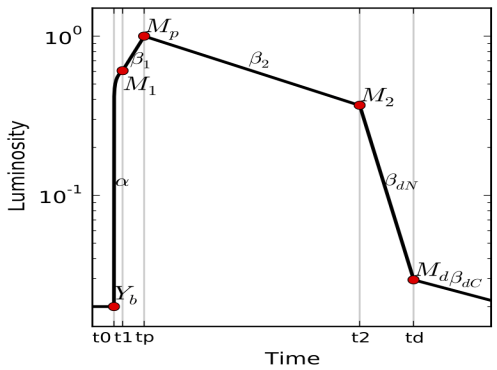

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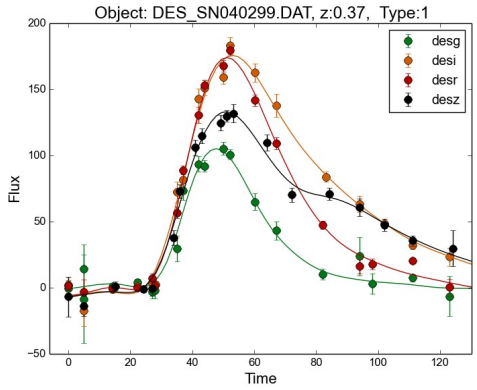

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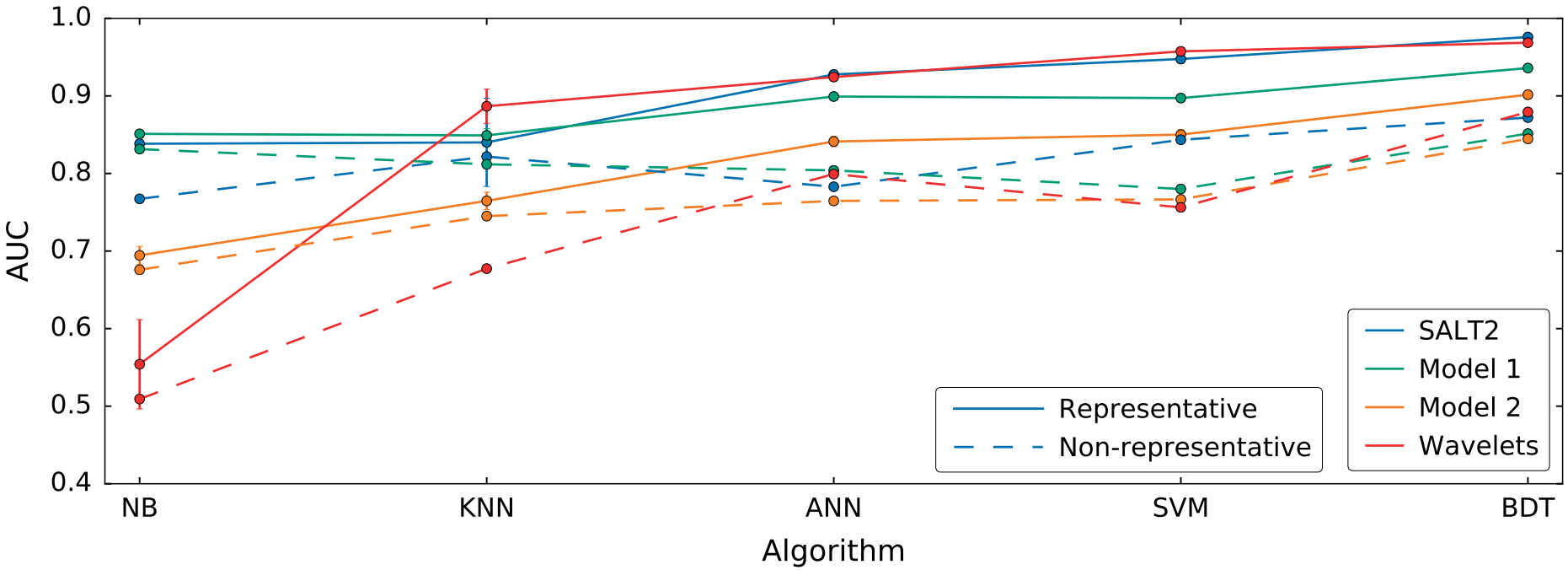
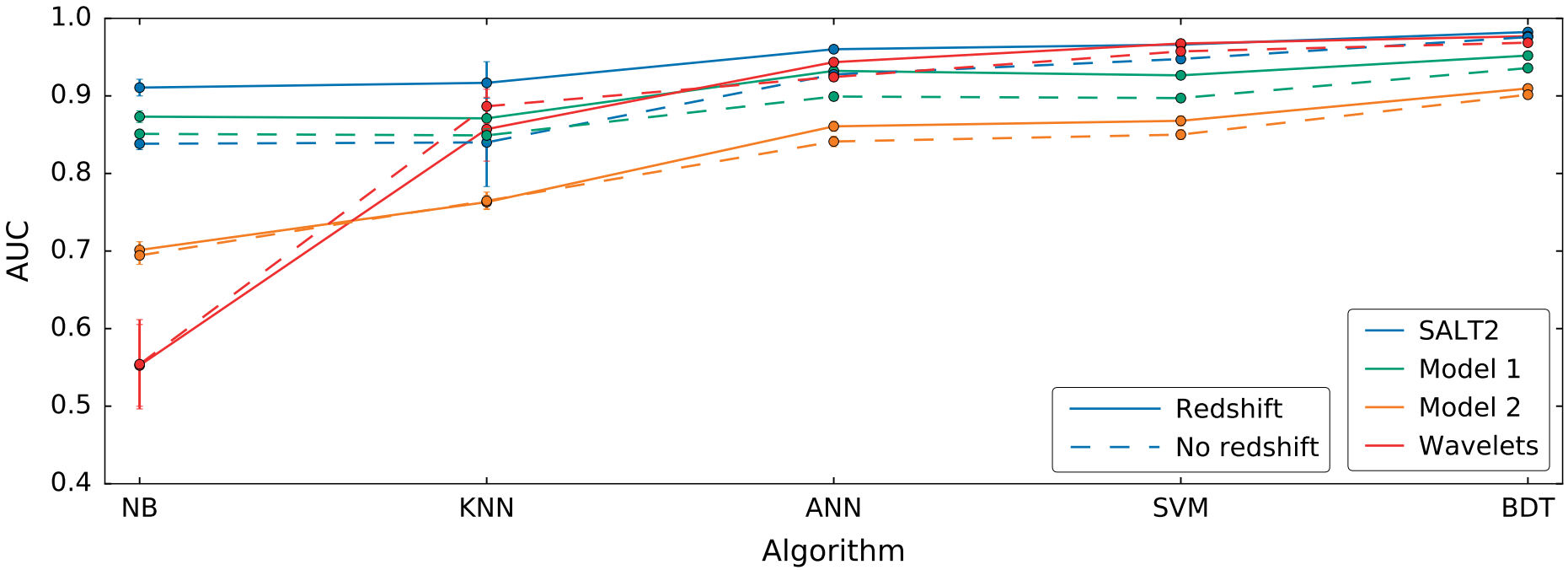
Photometric supernova classification

Importance of representative training data



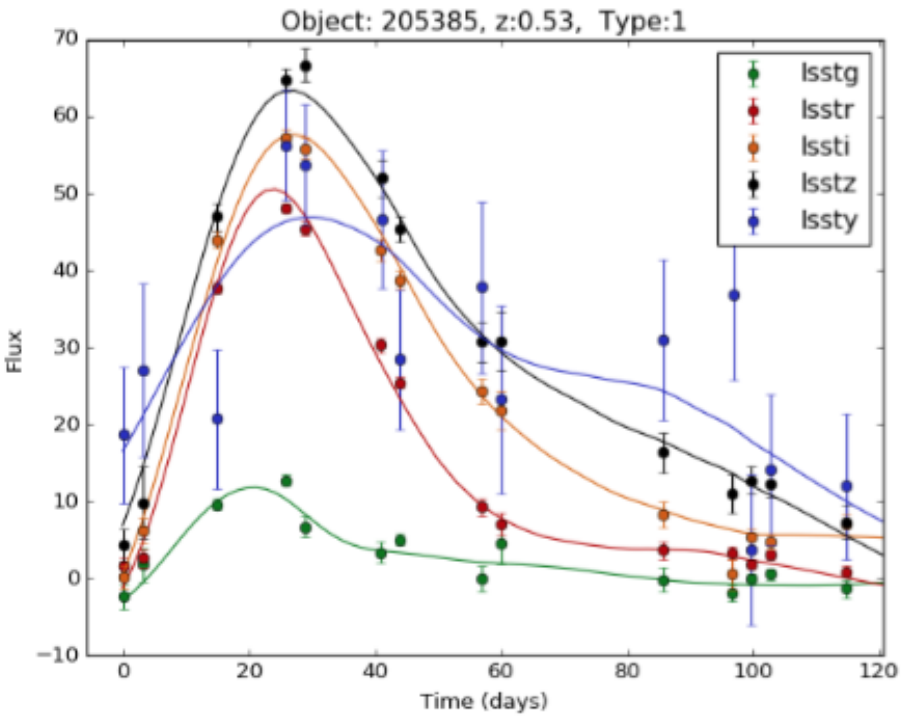
Photometric supernova classification

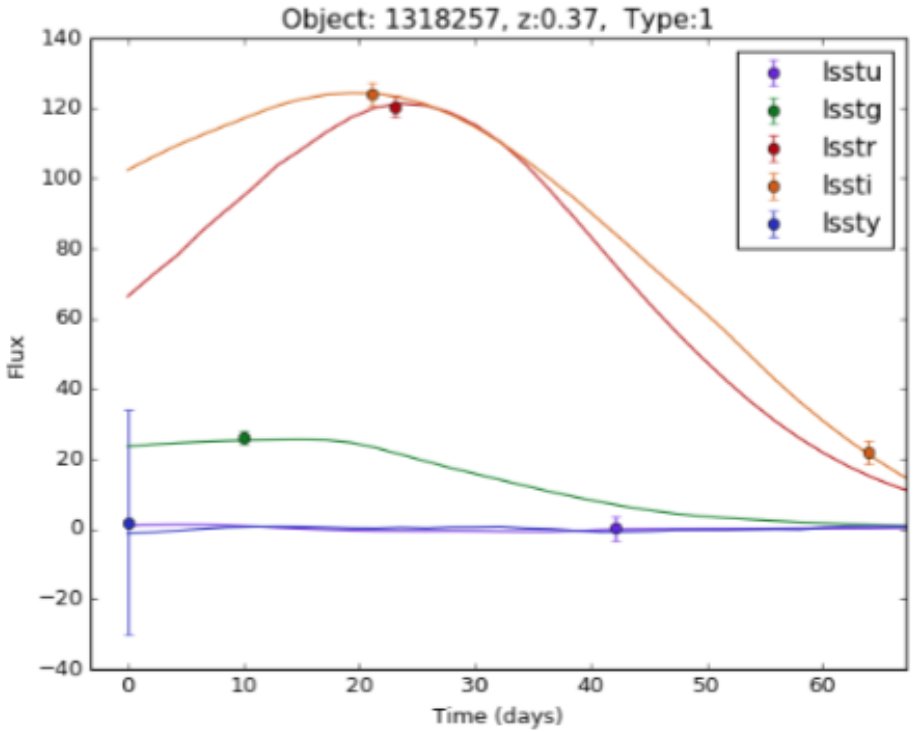
Importance of redshift



Photometric supernova classification

Applying to LSST cadence simulations





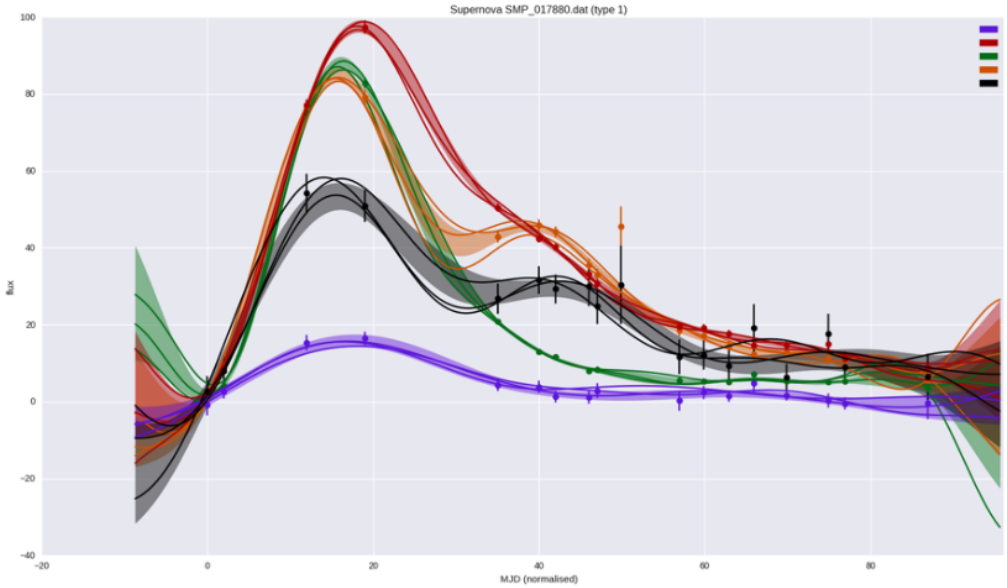
Wavelets, Deep Drilling Fields

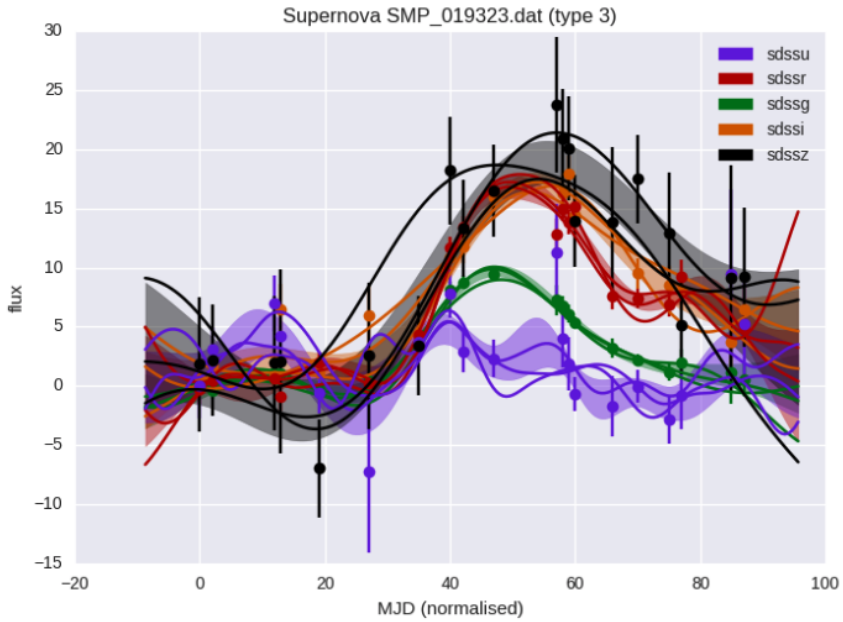
Wavelets, Wide-Fast-Deep

Photometric supernova classification

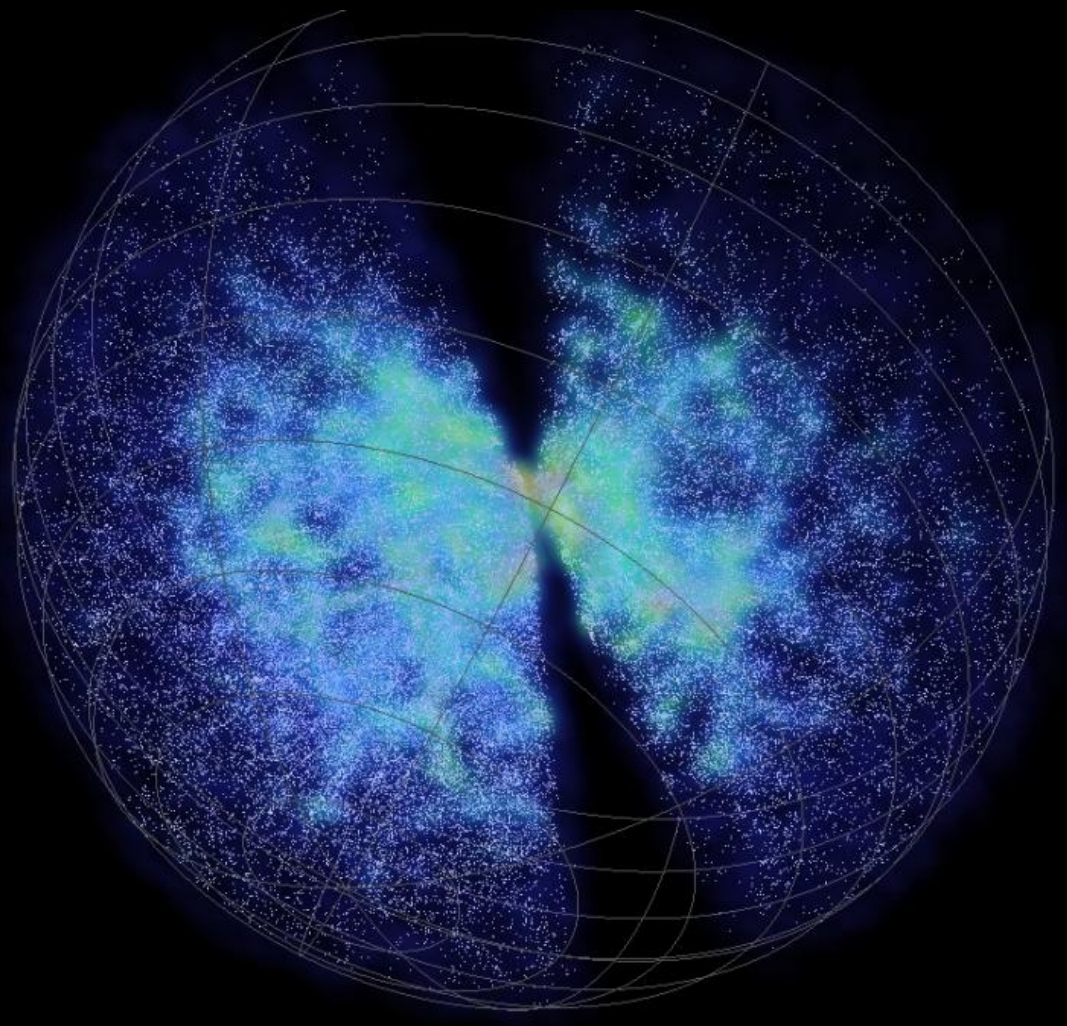
Representative training

- Accurate Core Collapse SNe templates (CoCo)
  (Firth, Prajs, Sullivan, in prep.)
- Augment training data using Gaussian processes
  (Schuhmann *et al.*)





LSST 3D data compression (3DDC) taskforce



Credit: SDSS

LSST 3D data compression (3DDC) taskforce

3DDC taskforce wiki page:
https://confluence.slac.stanford.edu/pages/viewpage.action?pageId=195857648

3DDC taskforce Slack team:
https://lsst3ddc.slack.com

Contributors: Franz Elsner, Jean-Eric Campagne, Benjamin Joachimi, Thomas Kitching, Francois Lanusse, Boris Leistedt, Jason McEwen, Hiranya Peiris, Layne Price, Anze Slosar, Edo van Uitert, . . .

- Why 3D?
  - Extract more information
  - Filter non-linear scales
  - Deal with covariances
- Challenges
  - Fast transforms for data and theory
  - 3D pixelisations
  - Mask, selection effects, covariances, systematics

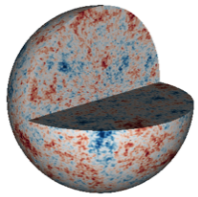
LSST 3D data compression (3DDC) taskforce

Identified existing codes for 2D/3D transforms

Add yours!	**CosmicPy**	C++, Py	Theory Fourier-Bessel
	MRS3D	C++	Fourier-Bessel + wavelets
	3DEX	F90 (!)	Fourier-Bessel transform
	HEALPIX	C, F90, Py, IDL	2D Spherical harmonics
	SSHT	C, Matlab	2D Spherical harmonics
	FLAG(LET)	C, Py, Matlab	3D Fourier-Laguerre + wavelets
	LagSHT	C++	3D Fourier-Laguerre + Bessel
	3DFast	C	Flat-sky Fourier-Bessel

Plan to start **Uber 3D code** TM

Get in touch if you'd like to contribute!



LSST 3D data compression (3DDC) taskforce

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[ 96%] Linking CXX shared library libuber3d.so
[ 96%] Built target uber3d
[ 98%] Building CXX object src/dsbt/CMakeFiles/dsbt.dir/fastDSBT.cpp.o
[100%] Linking CXX shared library libdsbt.so
[100%] Built target dsbt
[francois@Procyon build]$
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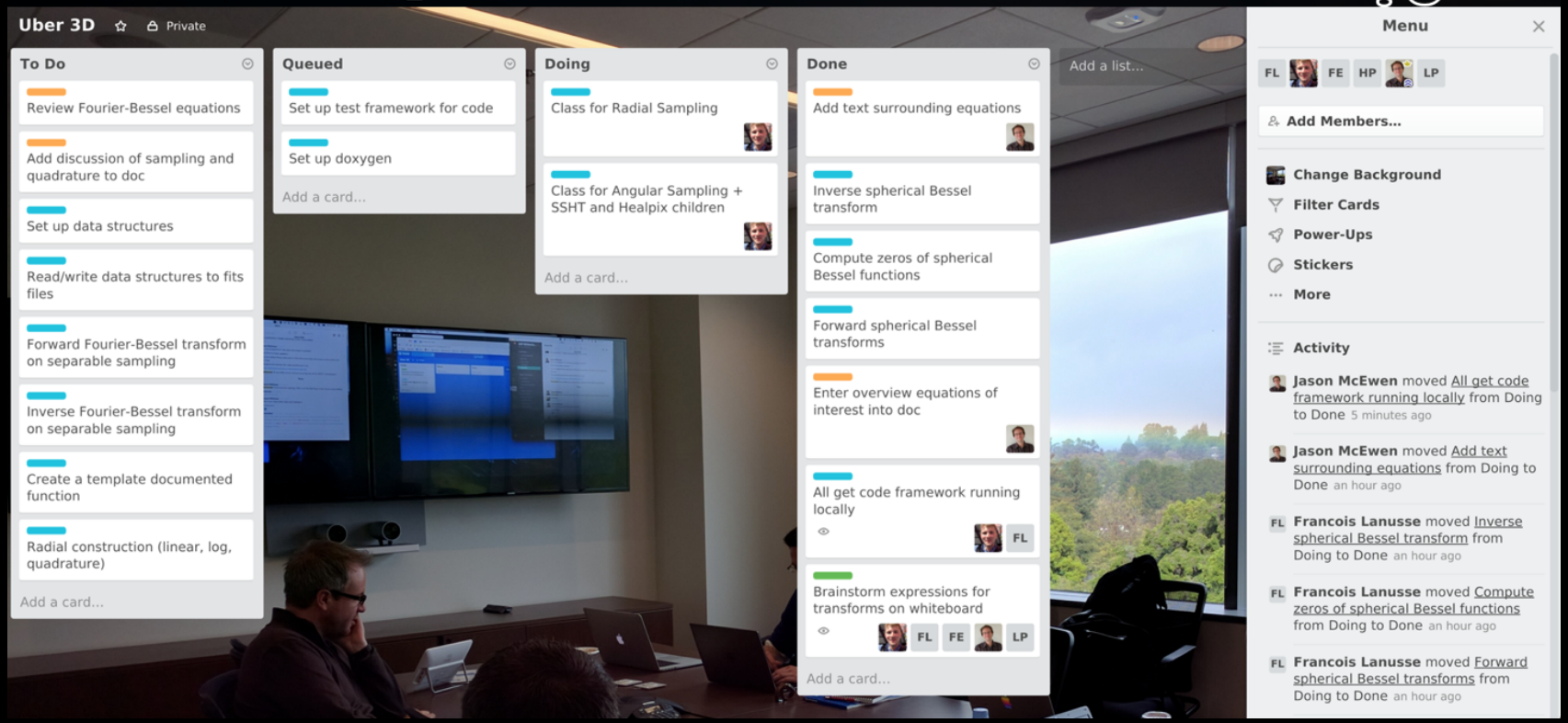
Uber3D Trello Board after hack day,
March DESC Collaboration Meeting @SLAC



Spherical mass mapping

Planar approximations not applicable to forthcoming observations

- Cosmic shear ${}_2\gamma$ related to convergence ${}_0\kappa$ (integrated mass) by:

$$ {}_2\gamma = 2\eth^2 \left(\eth\bar{\eth} + \bar{\eth}\eth \right)^{-1} {}_0\kappa $$

Differential form

$$ {}_2\gamma(\boldsymbol{n}) = \int_{\mathbb{S}^2} \mathrm{d}\Omega(\boldsymbol{n}') \, {}_0\kappa(\boldsymbol{n}') ({}_{\mathcal{R}\boldsymbol{n}}\,{}_2\mathcal{K})(\boldsymbol{n}') $$

Integral form

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Integral form

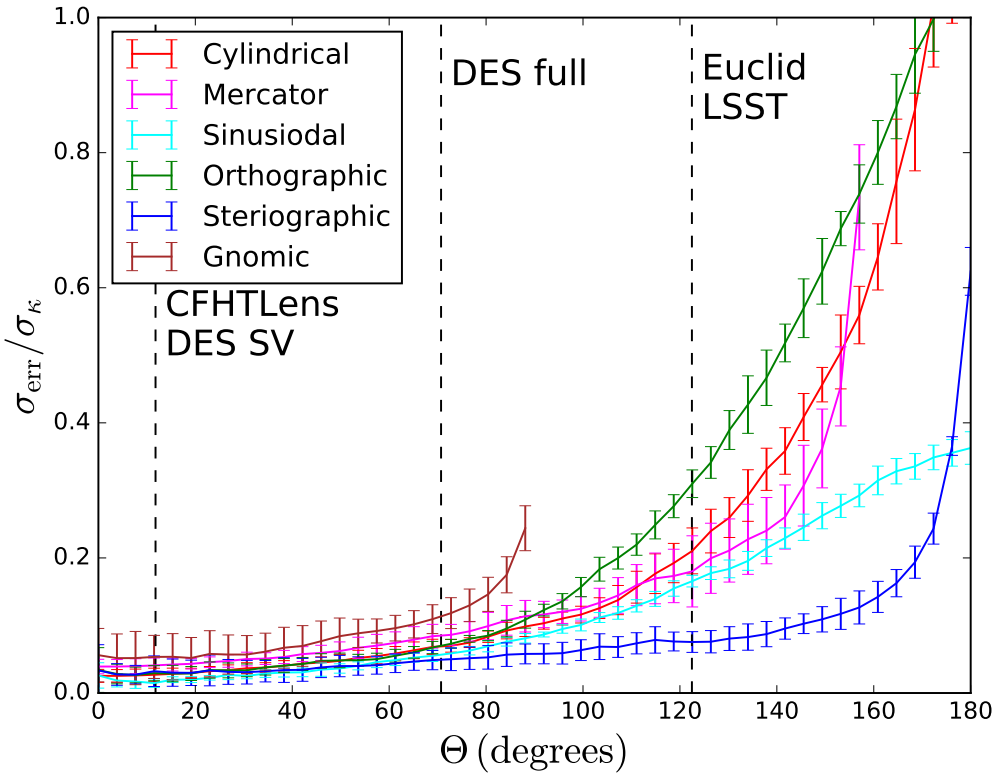
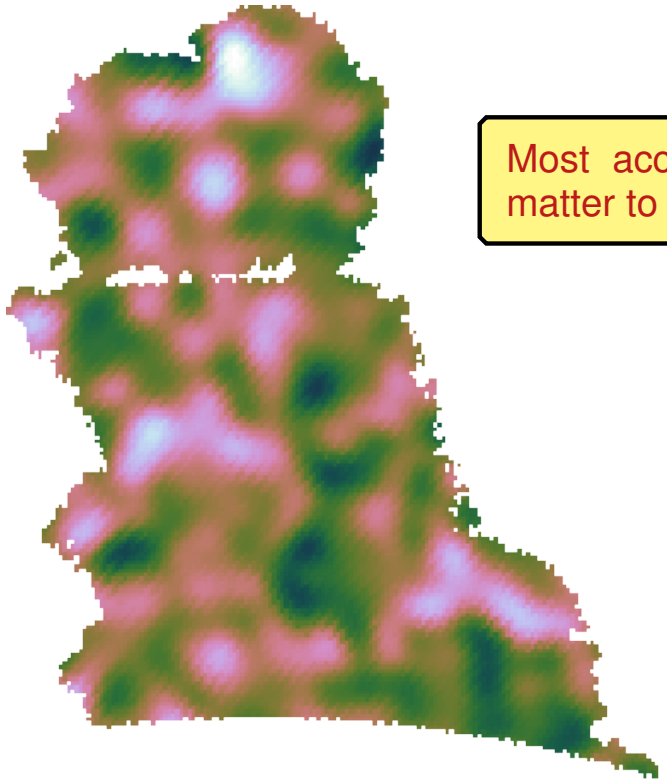


Figure: Error introduced by planar approximations in mass mapping (Wallis, McEwen, Kitching, Leistedt & Plouviez 2017; arXiv:1703.09233).

Spherical mass mapping

DES-SV observations

- Solve mass mapping problem in spherical setting, avoiding planar approximations (Wallis, McEwen, Kitching, Leistedt & Plouviez 2017; arXiv:1703.09233).



Most accurate public map of dark matter to date.

Figure: Recovered spherical convergence map ${}_0\kappa$ from DES-SV observations.

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