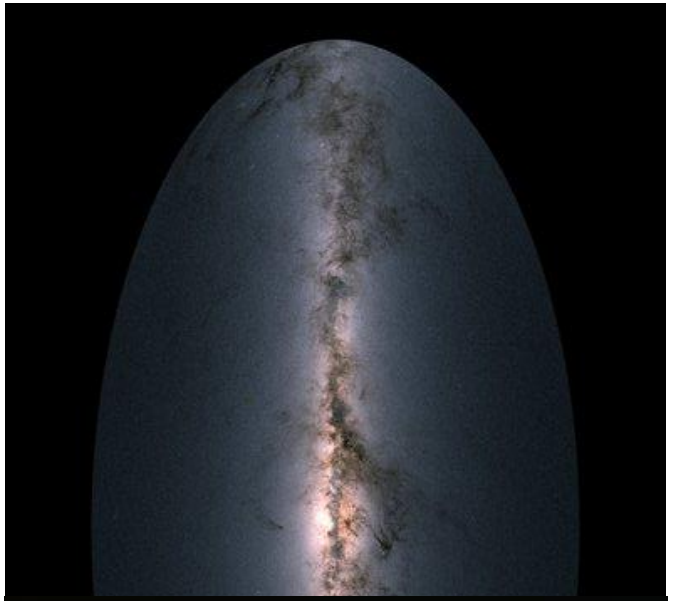
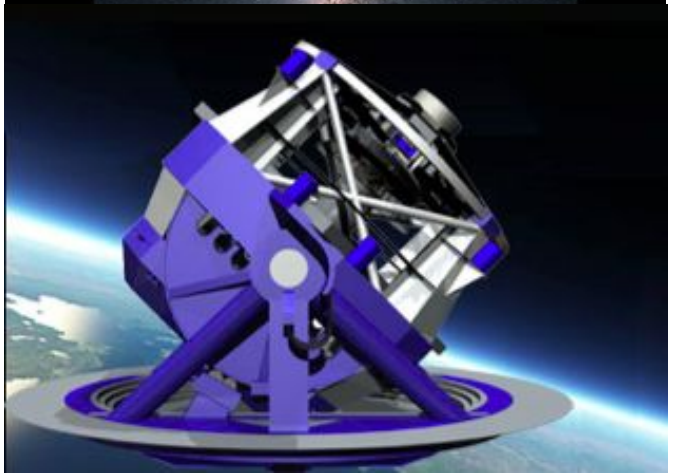
The LSST Stars, Milky Way and Local Volume (SMWLV) Science Collaboration





Will Clarkson
University of Michigan-Dearborn
For the SMWLV science collaboration

Stars, Milky way & Local Volume Science Collaboration

One-slide summary for the busy

SMWLV is a venue to help set the agenda for Stellar, Galactic and Local-Volume science for LSST.

Help prepare the Science community for LSST main operations (e.g. scientific/technical challenges; precursor data; complementary investigations; yield predictions);

Help determine the survey strategy (e.g. metrics and figures of merit for your science);

Input is welcome, either informally or as a collaboration member.

The LSST Stars, Milky Way and Local Volume (SMWLV) Science Collaboration

- SMWLV goals, example science
- SMWLV structure and activities
- Opportunities to contribute

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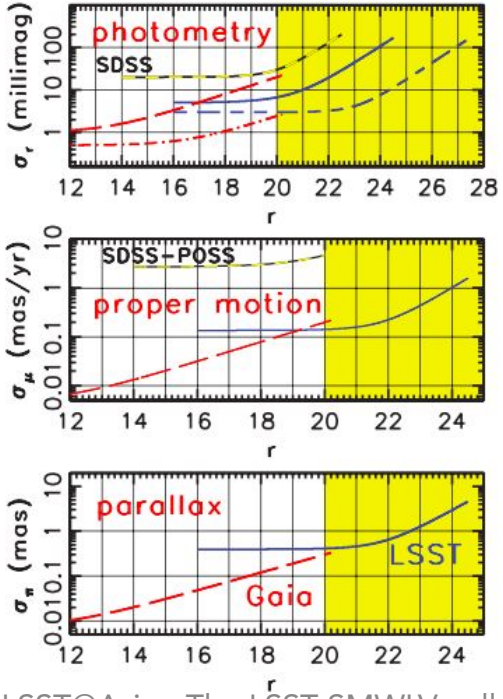
The LSST Stars, Milky Way and Local Volume Collaboration (SMWLV) has the overarching goals of understanding the accretion history and structure of the Milky Way and the Local Volume, and the fundamental properties of stars within 300 pc of the Sun.

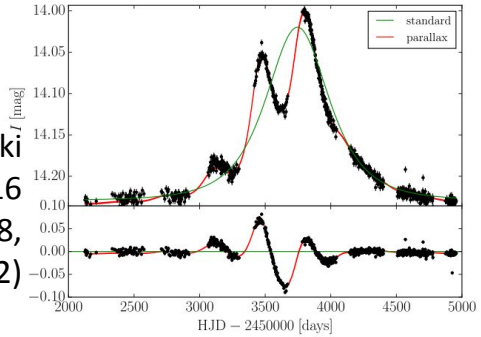
LSST will combine a number of highly desirable characteristics for SMWLV science:

High precision and sensitivity, complements existing and planned surveys



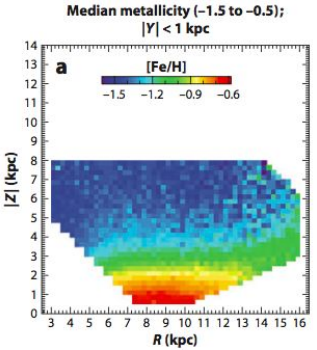
Ivezic et al. (2014 IAUS 298, 291)

10-year time baseline*

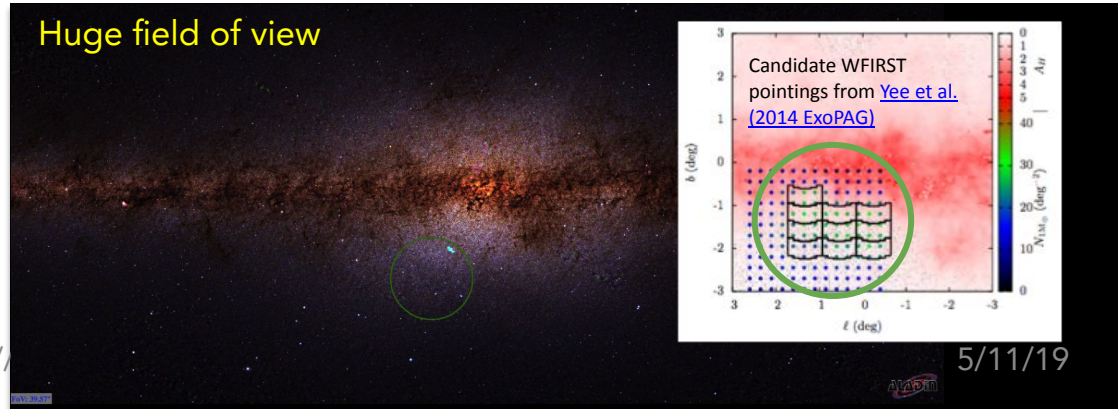


Wyrzykowski et al. (2016 MNRAS 458, 3012)

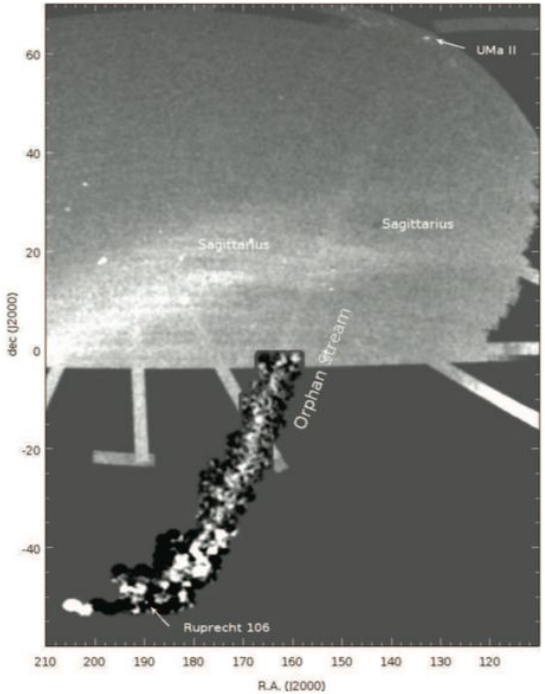
Very wide color stretch



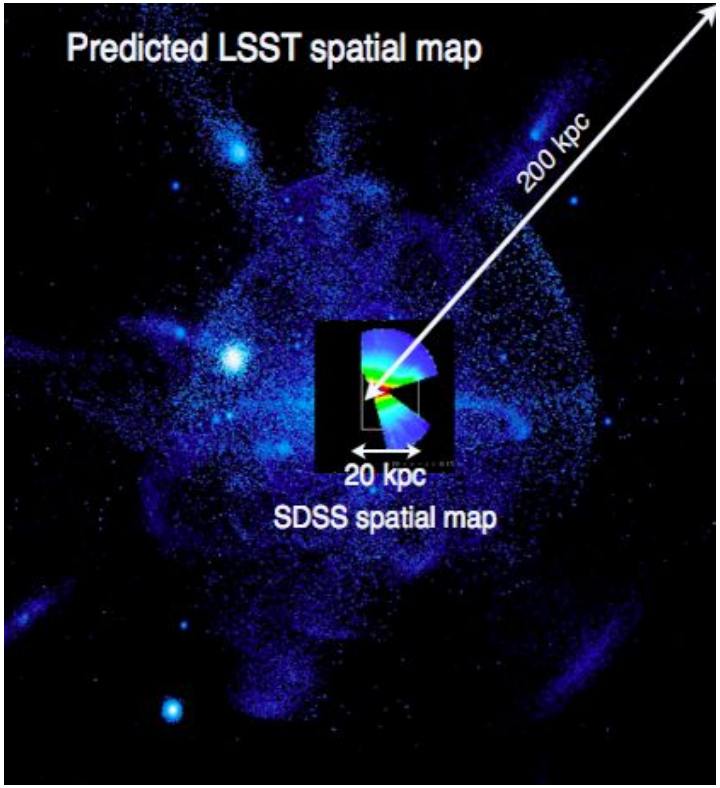
Ivezic, Beers & Juric (2012 ARAA 50, 251)



Example: Local Volume accretion history and structure via a census of dwarf galaxies and streams



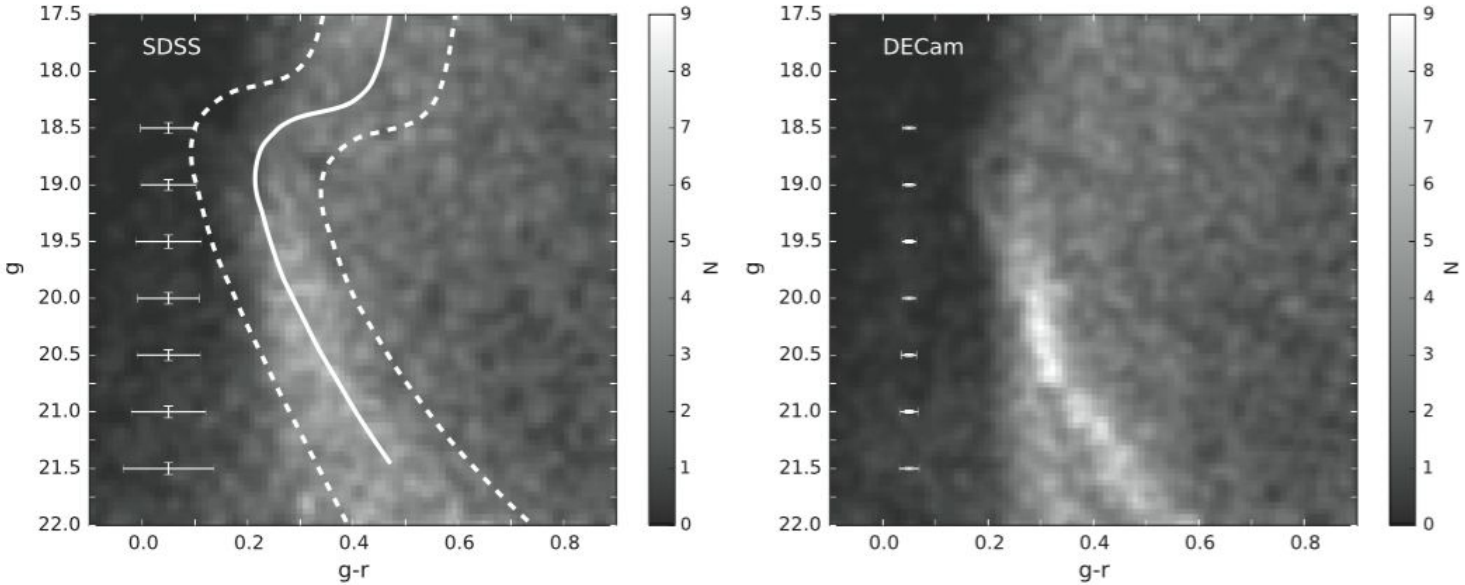
Grillmair et al. (2015 ApJL 812, 26)



Ivezic et al. (2008 arXiv:0805.2366v5)

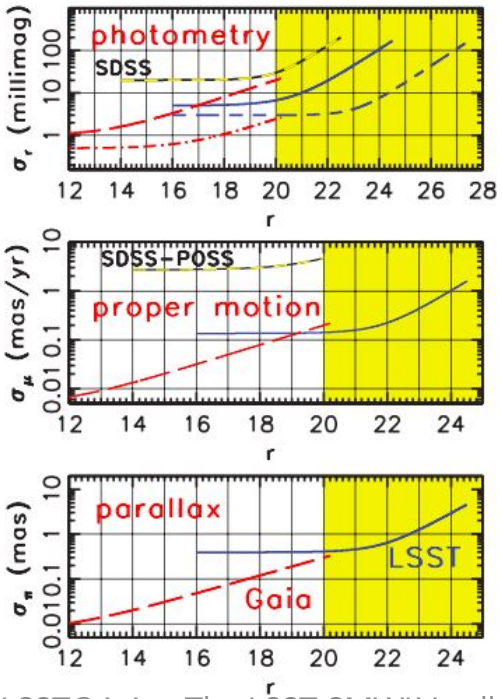
Example: MW accretion history via observations of tidally disrupting satellites

e.g. the Hydra I dwarf galaxy with DECam (right) compared to SDSS (left):

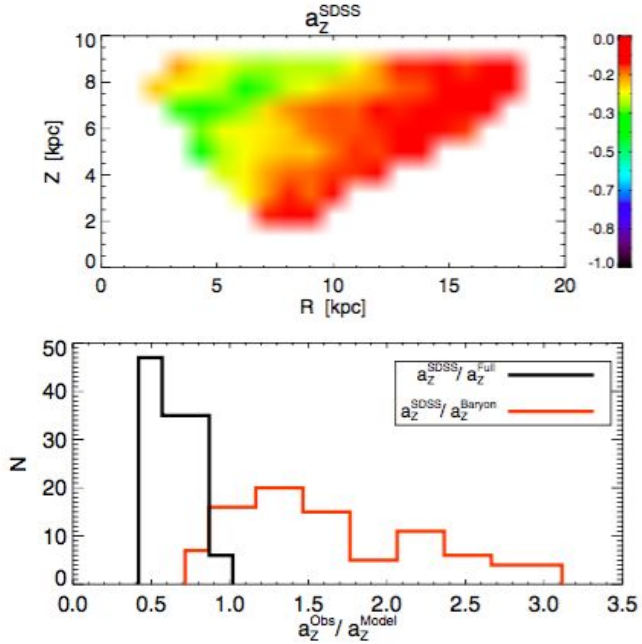


From Hargis et al. (2016 ApJ 818, 39)

Example: MW formation history via vertical acceleration diagnostics (DM halo shape)



Ivezic et al. (2014 IAUS 298, 291)

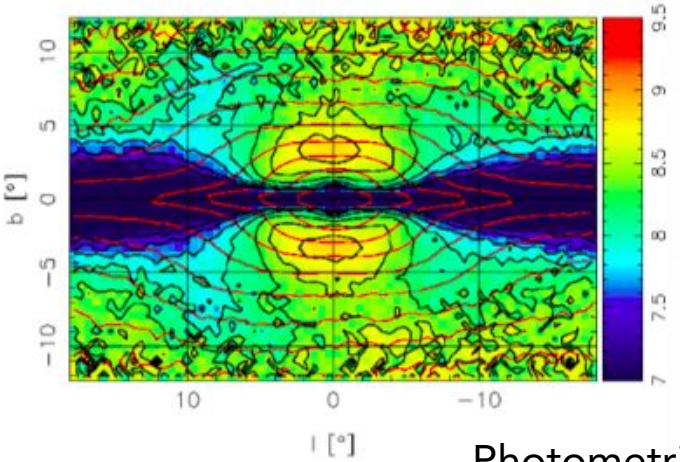


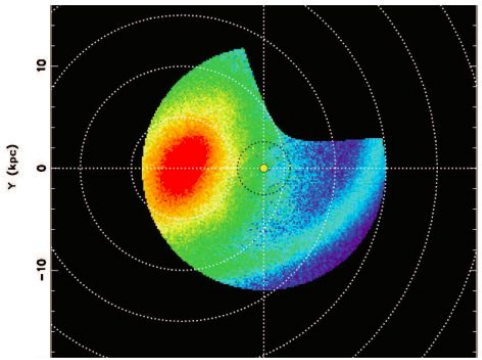
From Loebman et al. (2012 ApJL 758,23)

Example: MW structure and formation history via disentangling stellar populations in the Galactic bulge

Age distribution in a bar-driven model

Debattista et al. (2017 MNRAS 469, 1287)



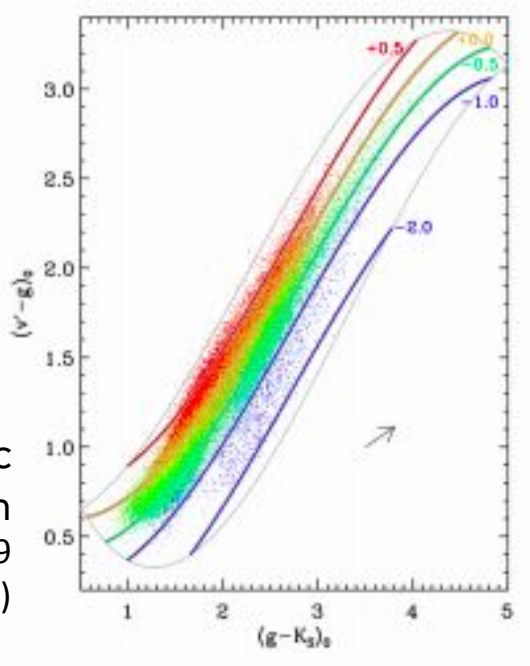


Metallicity mapping

Ivezic, Beers & Juric (2012 ARAA 50, 251)

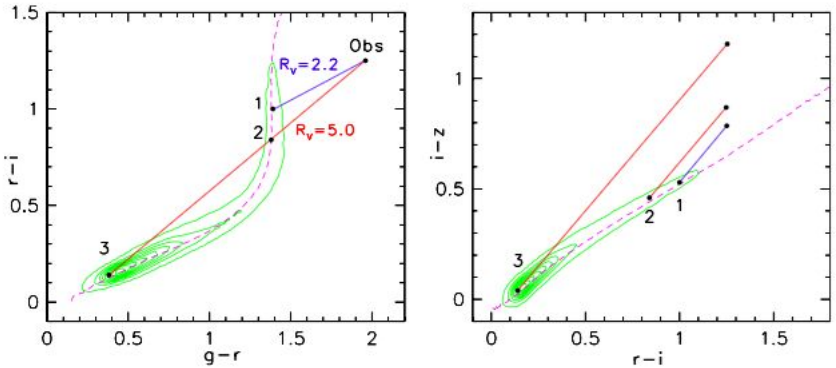
Photometric metallicity dissection

Casagrande et al. (2019 MNRAS 487, 2770)



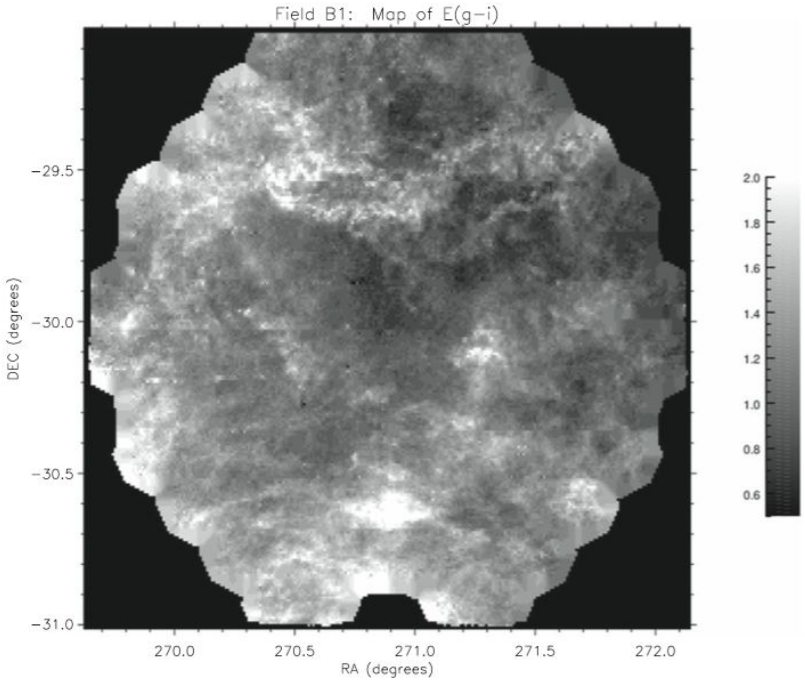
See e.g. Rich 2017 https://arxiv.org/abs/1712.02885

Example: better determination of MW structure via extinction determination



Extinction via {riz} photometry

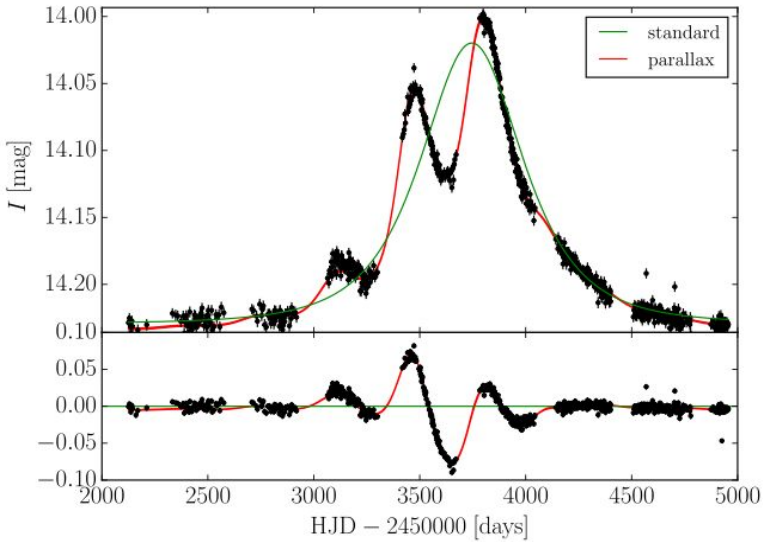
Berry et al. 2012 ApJ 757, 166



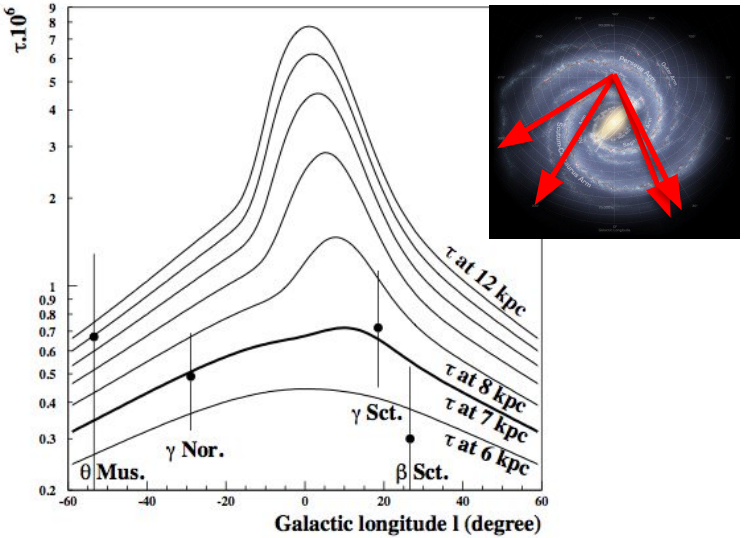
Exctinction map from RR Lyrae

Saha et al. 2019 ApJ 874, 30

Example: MW structure and evolution via astrophysically important but rare tracers

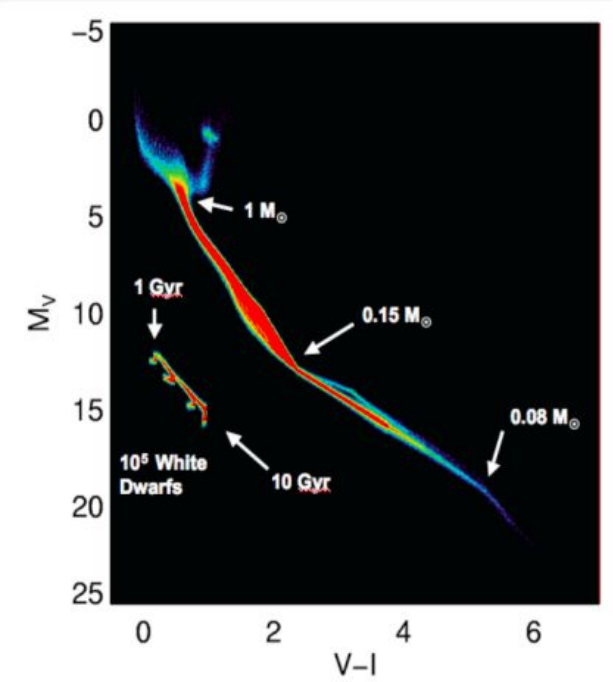


Microlensing parallax from long-duration events: e.g. local compact object N(M)
Wyrzykowski et al. 2016 MNRAS 458, 3012)

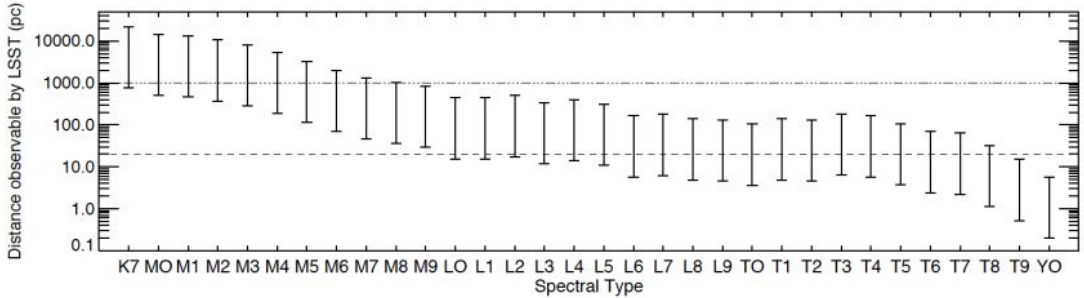


Microlensing optical depth constraints at high Galactic latitude
Rahal et al. 2009 A&A 500, 1027)

Example: a complete census of stars within 300 pc of the Sun via selection on parallax



(V, V-I) CMD for stars detectable within 200pc by LSST (Bochanski et al. 2012 AAS 219)



Distance limits for L,T,Y dwarfs in a single z-band LSST exposure

Bochanski et al. (2012 AAS 219)

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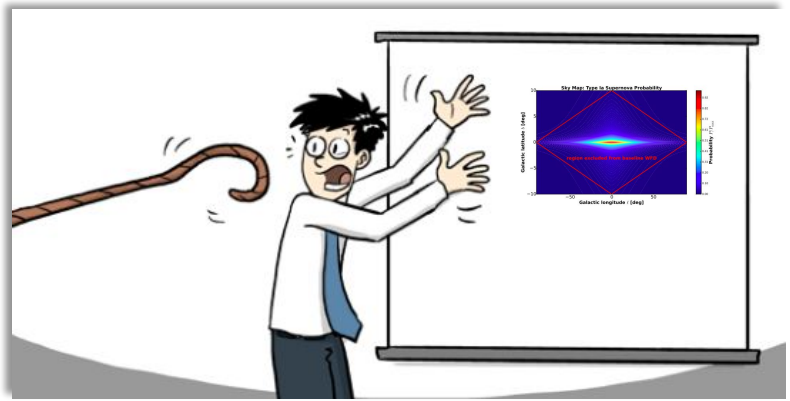

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SMWLV structure and activities are organized to help the Stars, Milky Way & Local Volume science community prepare for LSST main operations, and to advise the Project on the best observing strategies to enable as wide a range as possible of Stellar, Galactic and Local-Volume science.

SMWLV organization (2019 May 11)

Co-chairs: John Bochanski, John Gizis, Nitya Kallivayalil

Arranged into seven working groups by science area

The Solar Neighborhood(s): Ben Burningham & Sebastien Lepine

Star Clusters: Kevin Covey & Jay Strader

Variable Stars: David Ciardi

Galactic Structure and the ISM: Peregrine McGehee

The Galactic Bulge: Will Clarkson & Victor Debattista

The Magellanic Clouds: Knut Olsen

Near-field Cosmology: Marla Geha & Carl Grillmair

SMWLV organization (2019 May 11)

Co-chairs: John Bochanski, John Gizis, Nitya Kallivayalil

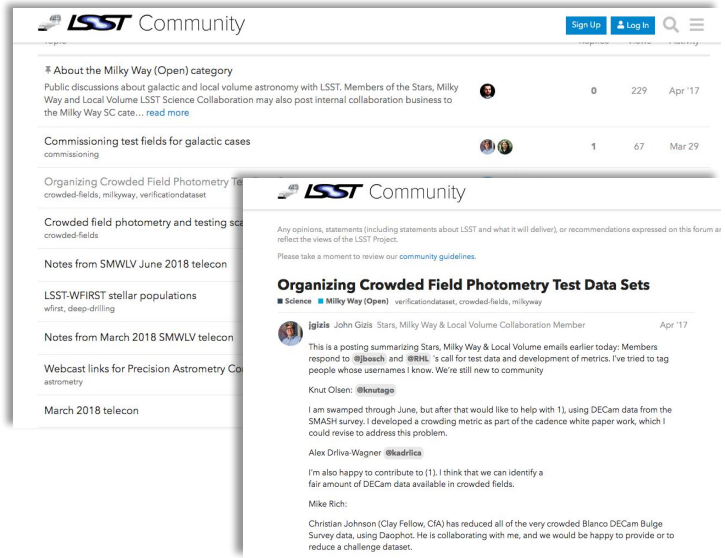
Arranged into seven working groups by science area

Volunteer effort: investigators are encouraged to contribute expertise and effort (e.g. already-funded investigations that are relevant for Stellar/Galactic/Local Volume science).

Helping the community prepare for LSST main operations

Helping the community prepare for LSST main operations

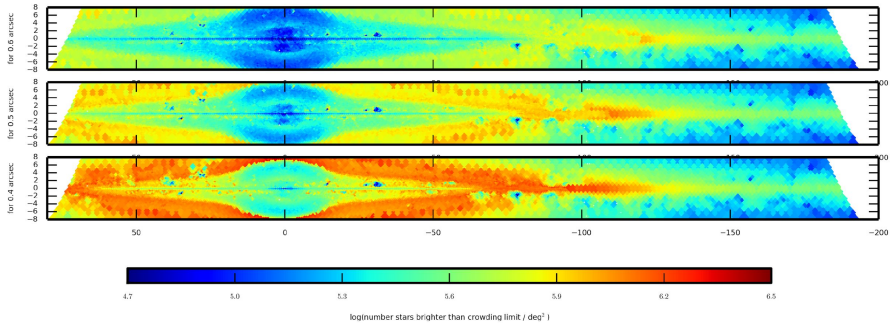
- 2013-2015: science roadmaps by each subgroup
- Regular communication with the LSST project leadership
- Regular communication with other SC's (particularly Transients & Variable Stars: TVS)
- Advocacy for SMWLV science at project and community workshops
- Helping the science community self-organize for science preparation*
- Informing the science community about LSST-related proposal opportunities*



*online venue: LSST-provided http://community.lsst.org

Identifying the main scientific and technical challenges for SMWLV science

- Star/Galaxy separation
- Crowded field photometry & astrometry
- Stellar variability classification
- Stellar tracer classification
- Precursor science
- Synergy with other surveys
- Quantitative predictions for astrophysical yield with LSST
- Handling very bright objects



Predicted star counts above the crowding limit vs apparent magnitude (Leo Girardi: from https://community.lsst.org/t/lsst-crowded-field-static-science-discussion/3579/9)

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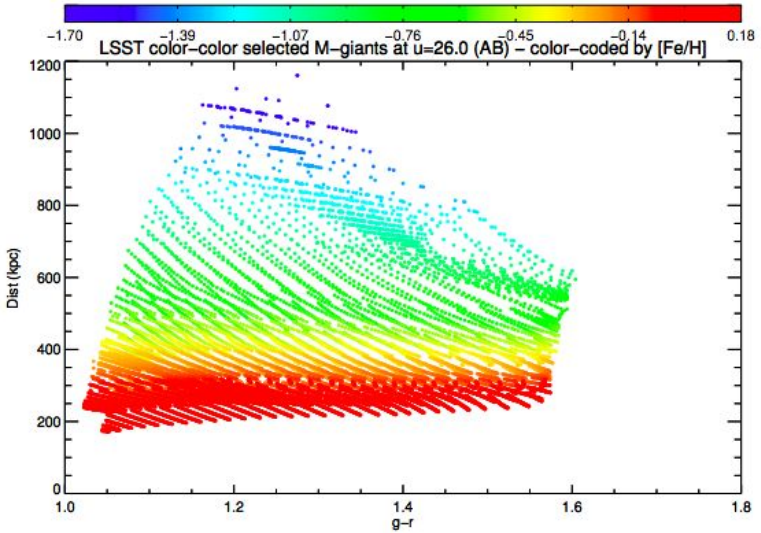

Distance at which M-giants can be identified in the halo assuming limiting magnitude u=26.0 (Kathy Vivas)

Identifying the main scientific and technical challenges for SMWLV science

- Star/Galaxy separation
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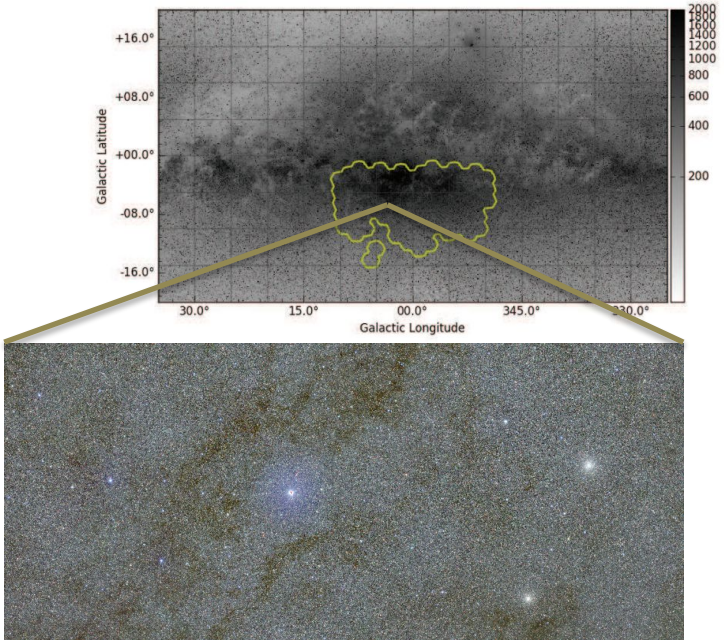

e.g. the Blanco DECam Bulge Survey (PI R. Michael Rich; catalog produced by Christian I Johnson)

Identifying the main scientific and technical challenges for SMWLV science

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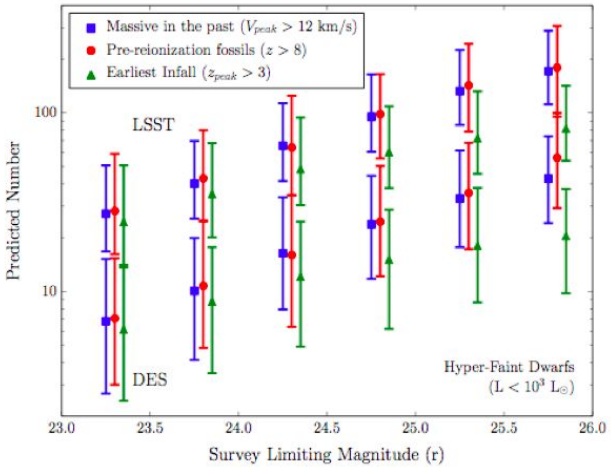


Hargis, Willman & Peter (2014 ApJL 795, 13)

Prediction for faint dwarf satellite galaxy counts by LSST (top) and DES (bottom)

Much of SMWLV's current effort focuses on LSST's observational strategy for SMWLV science.

Much of SMWLV's current effort focuses on LSST's observational strategy for SMWLV science.

Are your targets in the Wide-Fast-Deep (WFD) survey footprint?

Does your science need a "Deep Drilling field?"

What regions of the sky do you need?

What is your depth limit in the presence of crowding?

What typical repeat-visit interval do you need / can you use?

How many exposures total?

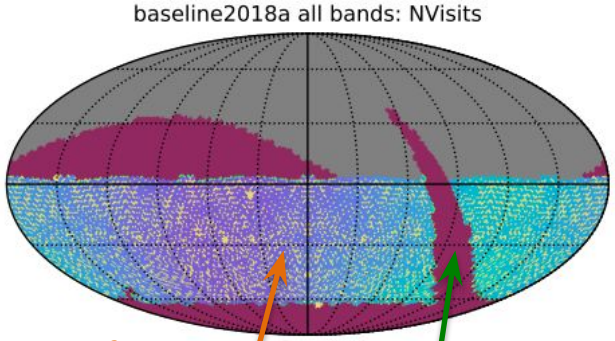
What total time baseline?

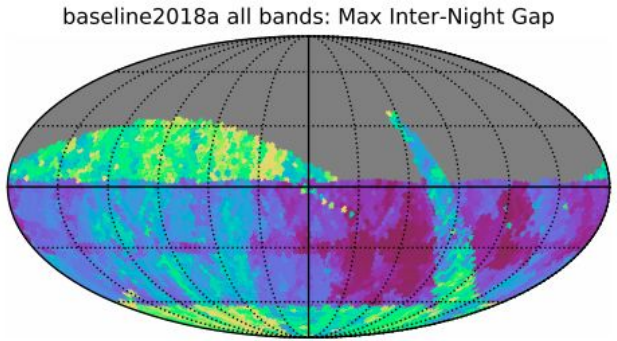
What exposure spacing?

What filters?

Much of SMWLV's current effort focuses on LSST's observational strategy for SMWLV science.

Example: coverage in the current LSST baseline cadence





WFD: 892 visits per field

6. For the 2,293 (overlapping) fields from the WFD area, the median number of visits in the *ugrizy* bands is (61, 85, 194, 193, 180, 179), respectively. These medians exceed the

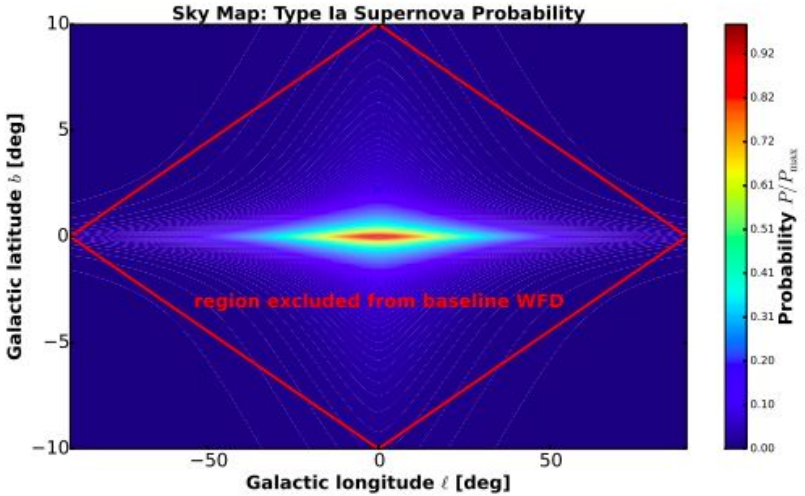
over *griz* bands. These fields are placed along the northern part of the Ecliptic. The Galactic Plane proposal (1.6%) obtained (27, 27, 27, 27, 29, 30) visits in *ugrizy*, respectively, per field across the region extending in Galactic latitude 10 degrees from the Galactic center, with the

GP: 167 visits per field

Jones, L et al. 2018 LSST document 28453 - *A new baseline operations simulation*
https://github.com/lsst-pst/survey_strategy/raw/master/baseline2018a-doc/baseline-doc/baseline.pdf

Much of SMWLV's current effort focuses on LSST's observational strategy for SMWLV science.

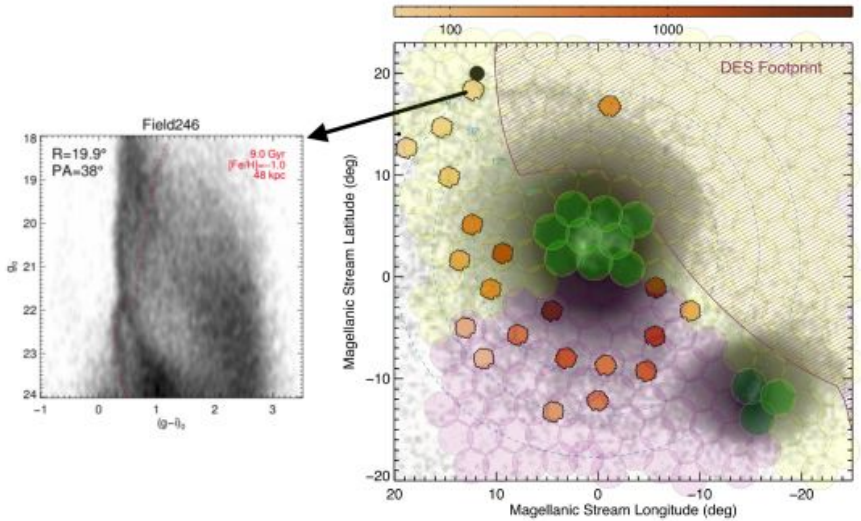
E.g. what is the scientific impact of reduced time on the inner Plane? Should WFD be extended to cover the inner plane? What would be the impact on LSST's main science operations?



From Strader et al.
https://arxiv.org/abs/1811.12433

Much of SMWLV's current effort focuses on LSST's observational strategy for SMWLV science.

E.g. what is the best way to use LSST to fully map the Magellanic Clouds (MC's) and their periphery? What is the best way to properly cover the MC's without compromising the main survey?



From Olsen et al.
https://arxiv.org/abs/1812.03139

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What is your depth limit in the presence of crowding?

What typical repeat-visit interval do you need / can you use?

How many exposures total?

What total time baseline?

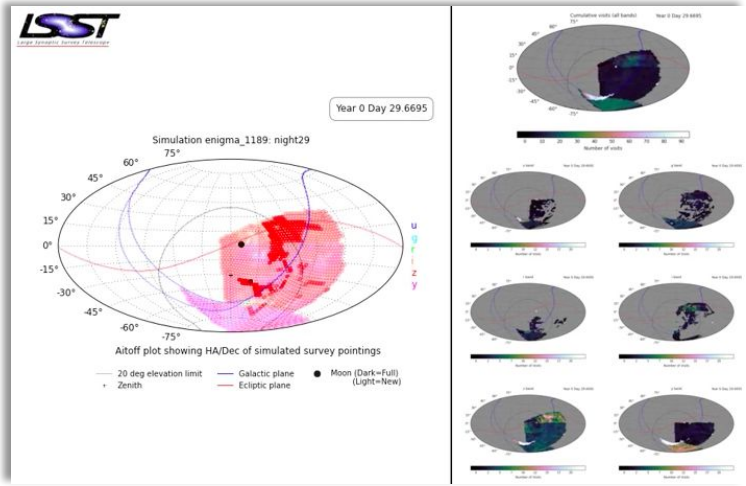
What exposure spacing?

What filters?

How does your desired strategy impact other science areas for LSST? (i.e. would it be reasonable for LSST data to enable your science?)

Much of SMWLV's current effort focuses on LSST's observational strategy for SMWLV science.

The LSST project has put great effort into survey strategy development & assessment via its opsim and sims_maf frameworks, and its ongoing engagement with the SCs.



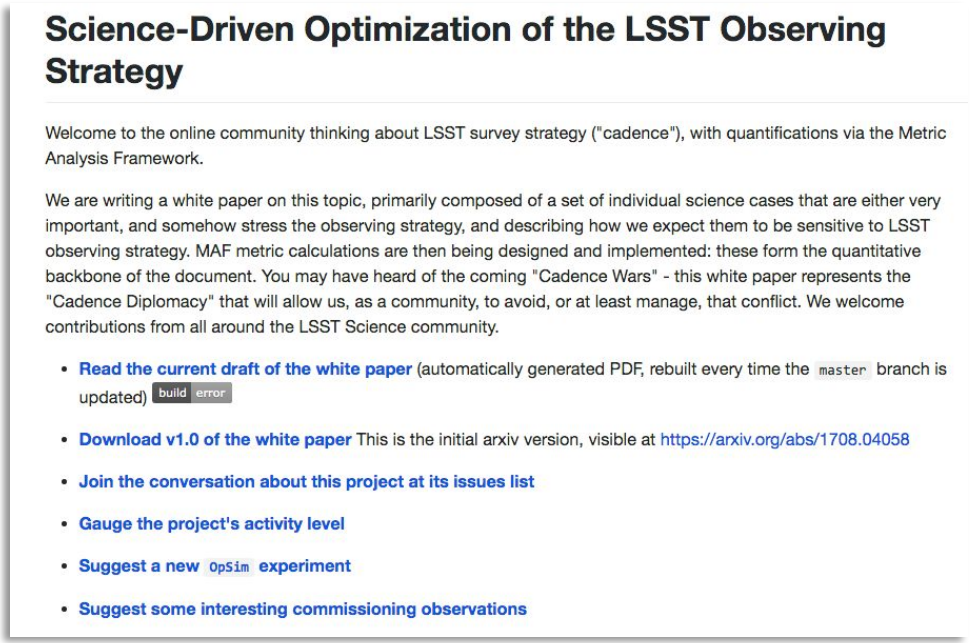
Contributions to the observing strategy via the Community Observing Strategy Evaluation Paper (COSEP)

Cadence whitepaper to assess LSST observing strategies for community science cases

Co-ordinators: Zeljko Ivezic, Beth Willman

Editor-in-chief: Phil Marshall

Developed in the open, 104 authors



Science-Driven Optimization of the LSST Observing Strategy

Welcome to the online community thinking about LSST survey strategy ("cadence"), with quantifications via the Metric Analysis Framework.

We are writing a white paper on this topic, primarily composed of a set of individual science cases that are either very important, and somehow stress the observing strategy, and describing how we expect them to be sensitive to LSST observing strategy. MAF metric calculations are then being designed and implemented: these form the quantitative backbone of the document. You may have heard of the coming "Cadence Wars" - this white paper represents the "Cadence Diplomacy" that will allow us, as a community, to avoid, or at least manage, that conflict. We welcome contributions from all around the LSST Science community.

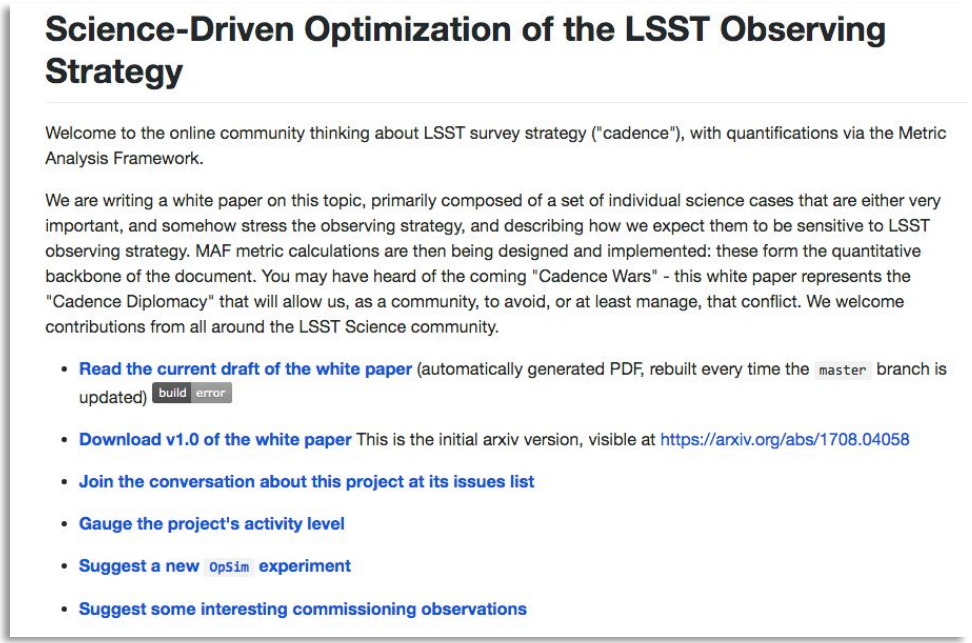
- **Read the current draft of the white paper** (automatically generated PDF, rebuilt every time the `master` branch is updated) build error
- **Download v1.0 of the white paper** This is the initial arxiv version, visible at https://arxiv.org/abs/1708.04058
- **Join the conversation about this project at its issues list**
- **Gauge the project's activity level**
- **Suggest a new `OpSim` experiment**
- **Suggest some interesting commissioning observations**

https://github.com/LSSTScienceCollaborations/ObservingStrategy

Contributions to the observing strategy via the Community Observing Strategy Evaluation Paper (COSEP)

SMWLV-relevant chapters:

Chapter 4: The Milky Way
Chapter 5: Variable Stars
Chapter 7: The Magellanic Clouds
Chapter 10: Special Surveys



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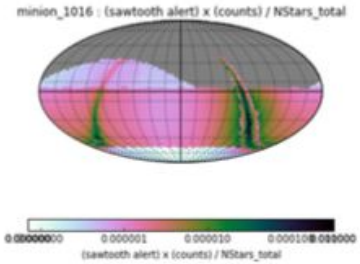
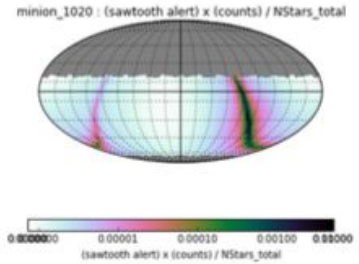
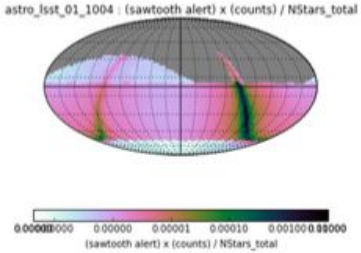
https://github.com/LSSTScienceCollaborations/ObservingStrategy

Effort is needed to develop and implement science metrics (per-field) and Figures of Merit (single-number per science case) for your SMWLV science.

Example (COSEP Chapter 4): the next Galactic supernova





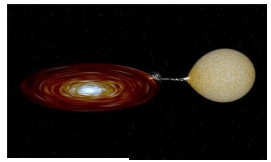


New metrics & figures of merit are needed.

These need updating!

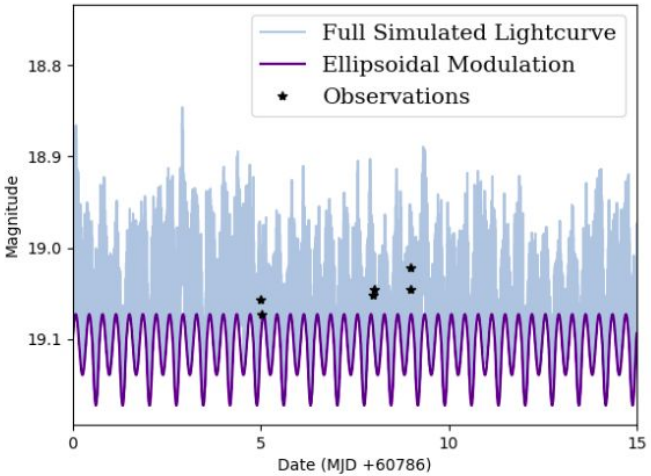
FoM	Brief description	minion_1016	minion_1020	astro_lsst_01_1004	future run 2	Notes
1.1	LMXB ellipsoidal variations	-	-	-	-	-
1.2	Uncertainty in DNe duty cycle	-	-	-	-	LSST as initial trigger
2.1	Fraction of Novae detected	-	-	-	-	-
2.2	Fraction of Nova alerts	-	-	-	-	-
3.1	Galactic Supernova pre-variability	0.13	**0.83**	0.73	-	Fraction of SN2010mc-like outbursts that LSST would detect; $FoM_{preSN} = f_{var} \times N_*$
4.1	Fraction of LSST-triggered microlens candidates	-	-	-	-	-
4.2	Uncertainty in derived planetary mass function	-	-	-	-	LSST as initial microlens trigger

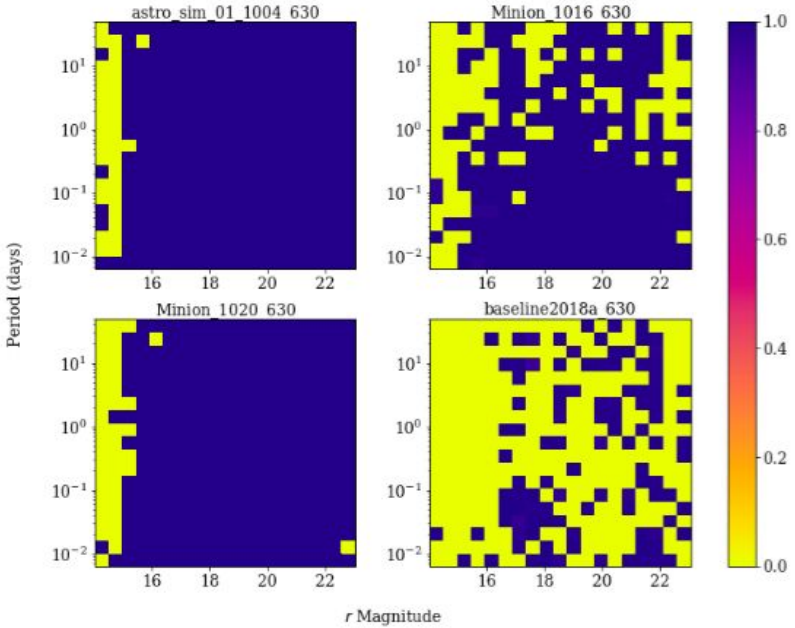
Effort is needed to develop and implement science metrics (per-field) and Figures of Merit (single-number per science case) for your SMWLV science.



Example: discovering faint low-mass X-ray binaries with LSST

Johnson et al. (2019 MNRAS 484, 19)



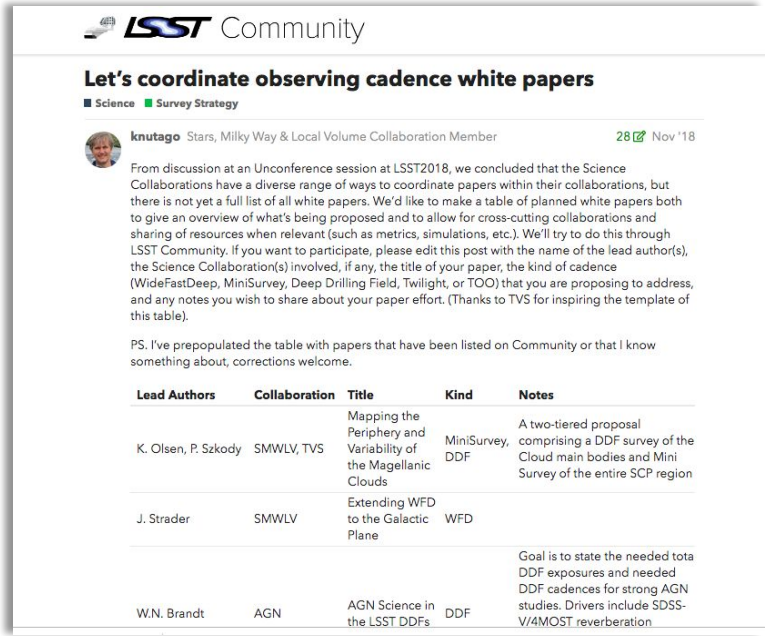


Effort is needed to develop and implement science metrics (per-field) and Figures of Merit (single-number per science case) for your SMWLV science.

[Your science case goes here]

SMWLV is also active in co-ordinating community efforts to provide formal input on survey strategy

E.g. responses to the LSST project's 2018 Call for Cadence Whitepapers



LSST Community

Let's coordinate observing cadence white papers

Science · Survey Strategy

knutago Stars, Milky Way & Local Volume Collaboration Member — 28 · Nov '18

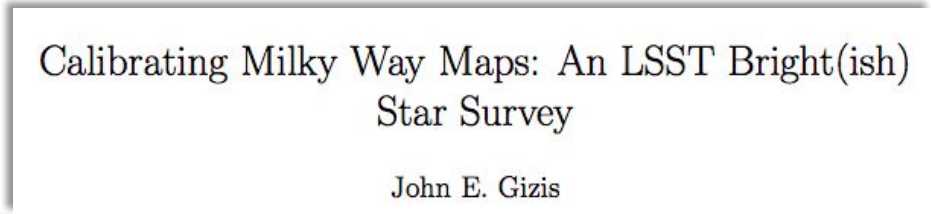
From discussion at an Unconference session at LSST2018, we concluded that the Science Collaborations have a diverse range of ways to coordinate papers within their collaborations, but there is not yet a full list of all white papers. We'd like to make a table of planned white papers both to give an overview of what's being proposed and to allow for cross-cutting collaborations and sharing of resources when relevant (such as metrics, simulations, etc.). We'll try to do this through LSST Community. If you want to participate, please edit this post with the name of the lead author(s), the Science Collaboration(s) involved, if any, the title of your paper, the kind of cadence (WideFastDeep, MiniSurvey, Deep Drilling Field, Twilight, or TOO) that you are proposing to address, and any notes you wish to share about your paper effort. (Thanks to TVS for inspiring the template of this table).

PS. I've prepopulated the table with papers that have been listed on Community or that I know something about, corrections welcome.

Lead Authors	Collaboration	Title	Kind	Notes
K. Olsen, P. Szkody	SMWLV, TVS	Mapping the Periphery and Variability of the Magellanic Clouds	MiniSurvey, DDF	A two-tiered proposal comprising a DDF survey of the Cloud main bodies and Mini Survey of the entire SCP region
J. Strader	SMWLV	Extending WFD to the Galactic Plane	WFD	
W.N. Brandt	AGN	AGN Science in the LSST DDFs	DDF	Goal is to state the needed tota DDF exposures and needed DDF cadences for strong AGN studies. Drivers include SDSS-V/4MOST reverberation

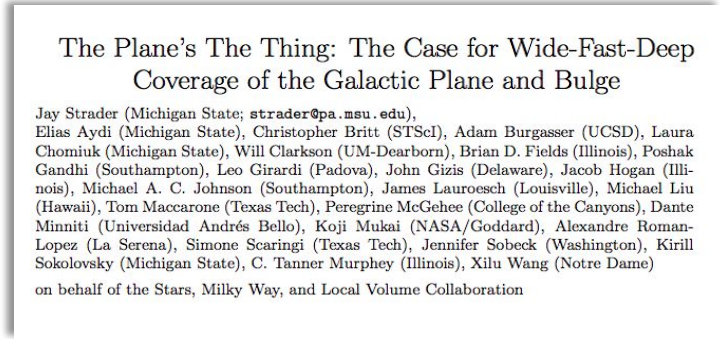
All 46 submitted Cadence whitepapers (across all Science Collaborations) can be found at https://www.lsst.org/submitted-whitepaper-2018

SMWLV is also active in co-ordinating community efforts to provide formal input on survey strategy



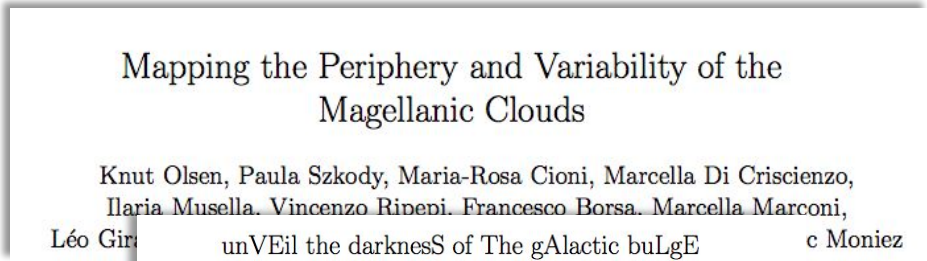
Calibrating Milky Way Maps: An LSST Bright(ish) Star Survey

John E. Gizis



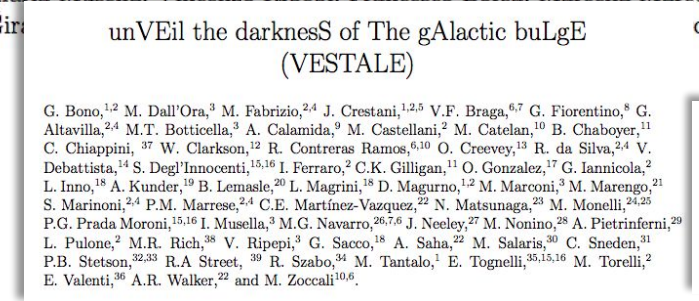
The Plane's The Thing: The Case for Wide-Fast-Deep Coverage of the Galactic Plane and Bulge

Jay Strader (Michigan State; strader@pa.msu.edu),
Elias Aydi (Michigan State), Christopher Britt (STScI), Adam Burgasser (UCSD), Laura Chomiuk (Michigan State), Will Clarkson (UM-Dearborn), Brian D. Fields (Illinois), Poshak Gandhi (Southampton), Leo Girardi (Padova), John Gizis (Delaware), Jacob Hogan (Illinois), Michael A. C. Johnson (Southampton), James Lauroesch (Louisville), Michael Liu (Hawaii), Tom Maccarone (Texas Tech), Peregrine McGehee (College of the Canyons), Dante Minniti (Universidad Andrés Bello), Koji Mukai (NASA/Goddard), Alexandre Roman-Lopez (La Serena), Simone Scaringi (Texas Tech), Jennifer Sobeck (Washington), Kirill Sokolovsky (Michigan State), C. Tanner Murphey (Illinois), Xilu Wang (Notre Dame)
on behalf of the Stars, Milky Way, and Local Volume Collaboration



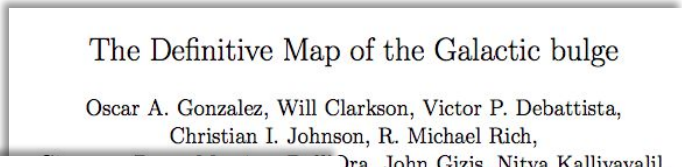
Mapping the Periphery and Variability of the Magellanic Clouds

Knut Olsen, Paula Szkody, Maria-Rosa Cioni, Marcella Di Criscienzo,
Ilaria Musella, Vincenzo Ripepi, Francesco Borsa, Marcella Marconi,
Léo Gir… c Moniez



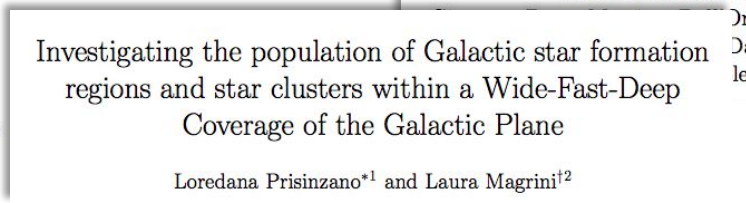
unVEil the darknesS of The gAlactic buLgE (VESTALE)

G. Bono,[1,2] M. Dall'Ora,[3] M. Fabrizio,[2,4] J. Crestani,[1,2,5] V.F. Braga,[6,7] G. Fiorentino,[8] G. Altavilla,[2,4] M.T. Botticella,[3] A. Calamida,[9] M. Castellani,[2] M. Catelan,[10] B. Chaboyer,[11] C. Chiappini, [37] W. Clarkson,[12] R. Contreras Ramos,[6,10] O. Creevey,[13] R. da Silva,[2,4] V. Debattista,[14] S. Degl'Innocenti,[15,16] I. Ferraro,[2] C.K. Gilligan,[11] O. Gonzalez,[17] G. Iannicola,[2] L. Inno,[18] A. Kunder,[19] B. Lemasle,[20] L. Magrini,[18] D. Magurno,[1,2] M. Marconi,[3] M. Marengo,[21] S. Marinoni,[2,4] P.M. Marrese,[2,4] C.E. Martínez-Vazquez,[22] N. Matsunaga,[23] M. Monelli,[24,25] P.G. Prada Moroni,[15,16] I. Musella,[3] M.G. Navarro,[26,7,6] J. Neeley,[27] M. Nonino,[28] A. Pietrinferni,[29] L. Pulone,[2] M.R. Rich,[38] V. Ripepi,[3] G. Sacco,[18] A. Saha,[22] M. Salaris,[30] C. Sneden,[31] P.B. Stetson,[32,33] R.A Street, [39] R. Szabo,[34] M. Tantalo,[1] E. Tognelli,[35,15,16] M. Torelli,[2] E. Valenti,[36] A.R. Walker,[22] and M. Zoccali[10,6].



The Definitive Map of the Galactic bulge

Oscar A. Gonzalez, Will Clarkson, Victor P. Debattista,
Christian I. Johnson, R. Michael Rich,
…Ora, John Gizis, Nitya Kallivayalil,
…Dante Minniti, Ricardo Schiavon,
…lena Valenti, & Manuela Zoccali



Investigating the population of Galactic star formation regions and star clusters within a Wide-Fast-Deep Coverage of the Galactic Plane

Loredana Prisinzano*[1] and Laura Magrini†[2]

All 46 submitted Cadence whitepapers (across all Science Collaborations) can be found at https://www.lsst.org/submitted-whitepaper-2018

The LSST Stars, Milky Way and Local Volume (SMWLV) Science Collaboration

- SMWLV goals, example science
- SMWLV structure and activities
- Opportunities to contribute

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Effort is needed on all SMWLV-related investigations, and we welcome all input (particularly on developing metrics for the Survey Strategy).

Effort is needed on all SMWLV-related investigations, and we welcome all input (particularly on developing metrics for the Survey Strategy). Example questions:

What do precursor data have to say about LSST's performance for your science?

What single Figure of Merit would you use to quantify the utility of a particular observing strategy for your science?

What observing strategies should we be advocating?

How will LSST data complement your investigations with other facilities?

Effort is needed on all SMWLV-related investigations, and we welcome all input (particularly on developing metrics for the Survey Strategy).

Informally (e.g. contribution of expertise via community.lsst.org)

Formally (contribution of effort as a Collaboration Member)

Full members: commit ~5% of their time for LSST-related work (~7h/month); funded work that is also LSST precursor work counts.

Associate members: graduate students working under the supervision of a full member, or more senior personnel who do not expect to commit 5% of their time.

For more information on membership criteria:
https://milkyway.science.lsst.org/?q=application

SMWLV organization (2019 May 11)

Co-chairs: John Bochanski, John Gizis, Nitya Kallivayalil

Arranged into seven working groups by science area

The Solar Neighborhood(s): Ben Burningham & Sebastien Lepine

Star Clusters: Kevin Covey & Jay Strader

Variable Stars: David Ciardi

Galactic Structure and the ISM: Peregrine McGehee

The Galactic Bulge: Will Clarkson & Victor Debattista

The Magellanic Clouds: Knut Olsen

Near-field Cosmology: Marla Geha & Carl Grillmair

Stars, Milky way & Local Volume Science Collaboration

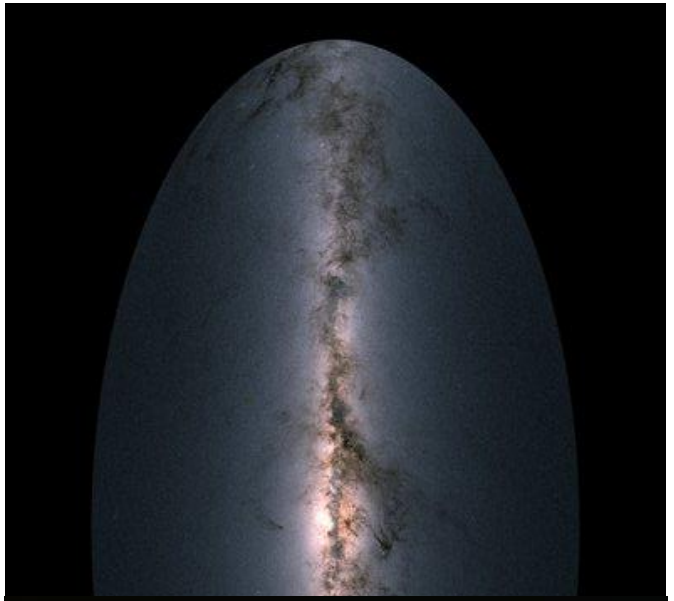
SMWLV is a venue to help set the agenda for Stellar, Galactic and Local-Volume science for LSST.

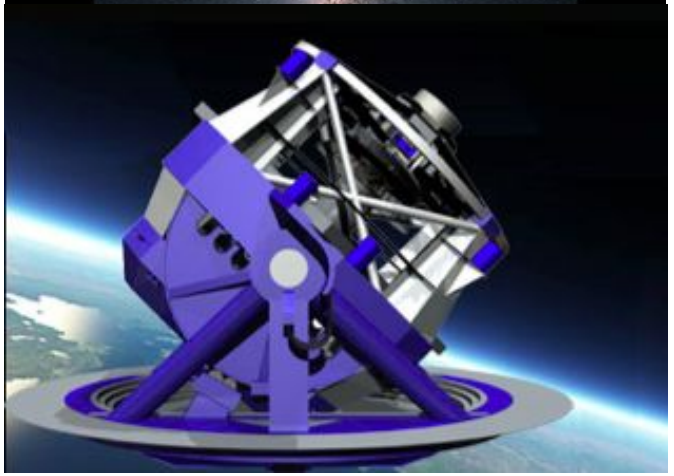
Help prepare the Science community for LSST main operations (e.g. scientific/technical challenges; precursor data; complementary investigations; yield predictions);

Help determine the survey strategy (e.g. metrics and figures of merit for your science);

Input is welcome, either informally or as a collaboration member.

The LSST Stars, Milky Way and Local Volume (SMWLV) Science Collaboration





Will Clarkson
University of Michigan-Dearborn
For the SMWLV science collaboration

SPARE SLIDES

SMWLV science has substantial overlap with other SC's, particularly the Transients & Variable Stars (TVS) science collaboration