Towards an NOAO Expertise Center for LSST

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LSSTC Board Meeting
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Executive summary

• Establish a center of LSST expertise at NOAO to support the astronomy community
  – Enabling science now
  – Preparing community for scale of LSST
• Build on scientific and technical expertise of NOAO and its connection to community
  – Stellar populations and transient and variable science
  – DECam as a pre-LSST science platform
  – Community organization
• Current projects as prototypes for LSST activity
  – Transient event broker
  – Data Lab as platform for data experimentation
  – Guidance for cadence exploration
• Partner with SLAC to expand scope of user support
• Coordinate with LSSTPO to strengthen support for the community
Towards an LSST Expertise Center
Guiding concepts

• Goal
  – Create the LSST expertise center for the astronomy community
  – SLAC will support Dark Energy Science Collaboration (DESC)

• Method
  – Enable “big survey” research now
  – Build on DECam-based NOAO programs and Surveys
  – Extend to LSST

• Collaborate
  – LSST PO for various software tools
  – SLAC for common user support interests
  – NCSA for computing environment (eventually)
Towards an LSST Expertise Center

Topical areas

• Research area foci
  – Stellar populations in the Local Volume (SMWLV collaboration)
  – The time-variable Universe (Transients and Variables collaboration)

• Community organization
  – Organize workshops on topics general interest
  – Encourage visits to Expertise Center
  – Center scientific staff who are actively engaged in LSST community

• Big Data and the Community
  – Deploy collaborative spaces
  – Deploy tools for visualization and analysis

• Parsing the variable sky
  – Characterize alert streams
  – Identify the rarest of the rare

Build on existing scientific and technical expertise within NOAO science staff
Community organization
Current projects

• Staff participation in LSST Science Collaborations
  – LSST Transients and Variables
  – LSST Supernovae (NOAO Co-Chair)
  – LSST Stars, Milky Way, and Local Volume (NOAO subgroup leader)
  – Also LSST Galaxies and LSST AGN

• Workshops
  – Spectroscopy in Era of LSST (April 2013, completed, published report)
  – LSST Observing Cadences I. Science Metrics (August 2014)
  – Practical Big Data (working title, under development for 2015)
  – DECam Community Science and Lessons for LSST (working title, under development for 2015)

• Work with observatories and community groups on groundwork for LSST follow-up observations
  – Initial focus: Gemini South and SOAR
  – Have started dialogue with Gemini Director
Big Data and the Community
Challenges & approaches

• How do astronomers effectively share large imaging datasets and object catalogs with the broader community?
• How do large teams coordinate their data analysis activity of massive datasets?
• How do astronomers efficiently access, explore, and visualize datasets that are too big to fit on desktop computers?

• NOAO is developing a Data Lab concept to address these challenges; to be used as a tool by LSST SCs
• DECam-based NOAO programs and Surveys are natural starting point
  – A few existing NOAO Surveys may also help, e.g., NOAO Deep Wide
• Intermediate step is DES catalogs (coming in 2016+)
• As much as possible, adopt-adapt-deploy, not develop
NOAO Data Lab

Key objectives

- Centralized facility for data analysis, visualization, sharing, and publication amongst project teams using NOAO facilities
- Services to filter, explore, and access large catalogs and associated data generated from NOAO facilities
- Gateway to related catalogs, images, or spectra
  - Tools for sub-selecting or cross-matching catalogs and data
- Incorporate existing analysis tools and science workflows
- Add as test bed for new tools and workflows
NOAO Data Lab: Science Case

• Data Lab development focused on DECam community programs, in anticipation of DES data release in ~2017
• Two initial prototype programs
  – SMASH (Survey of the Magellanic Stellar History; PI Nidever)
  – A Synoptic DECam survey of the Galactic Bulge (PI Saha)
• Both programs have heavy NOAO staff involvement, providing efficient interface to development team
• Initial development will be focused on making Data Lab a useful resource to the teams themselves (audience of ~30 people); building on VO tools and services
• Both programs are also of strong interest to LSST Stars, Milky Way, and Local Volume Science Collaboration (audience of ~90 people); also Transients collaboration (~85 people)
• Applied stellar locus color-color cut to remove unresolved galaxies
• LMC well-detected at $R=14^\circ$ with main sequence stars
• Analysis of background galaxy-dominated field (using stellar locus cuts in ugriz) shows that our LMC population surface brightness limit is $\sim35.5$ mag/arcsec$^2$
SMASH data visualization
SMASH data visualization
Scene from One chip in Baade’s window

- 100s exposure in $r'$
- Note patchy dust
- Some stars saturated
- DoPHOT finds 200,000 objects
Prototyping the Data Lab
Using Galactic Bulge Variable project

- DoPHOT-based photometric pipeline
- >5×10^6 objects measured in Baade’s Window field
- Developed variable identification technique on M5 calibration cluster
Prototyping the Data Lab
Using Galactic Bulge Variable project

328188 (18.0)  Baade's window  74694 (15:18:20.19 02:02:50.5)  M5

phw/c_mean = 24.56
refmag_g = 24.9752

phw/c_mean = 22.78
refmag_r = 23.0530

phw/c_mean = 29.14
refmag_u = 29.7558

phw/c_mean = 20.78
refmag_g = 21.1244

phw/c_mean = 20.42
refmag_i = 20.5702

phw/c_mean = 20.39
refmag_r = 20.6050

phw/c_mean = 23.70
refmag_u = 24.0876

phw/c_mean = 20.71
refmag_z = 20.8793

LSSTC Board, DC, Apr 2014 (KO2)
From LSE-163, a DIASource is a source detected from a difference image with S/N>5. For each detected DIASource, an alert is transmitted within 60 seconds.

- The system is scaled to issue ~$10^7$ alerts per night.
- Over time, most alerts will come from objects known previously to vary.
- Will still need to filter full alert stream to find objects of interest.
Questions:
• How many alerts per night should we expect from prior experience?
• How many alerts from new objects per night?
• How to design a broker to serve broad filtering needs?

Approaches:
• Use an empirical data set (Kepler variability) to establish numbers
• Look at individual object classes to establish new object alert rate
• Collaboration with U.A. CS Dept. to design LSST-scale broker
 Parsing the variable sky
A simulation

- Empirical study of statistics of stellar variability based on Kepler Quarter 13 data
- Statistics for stars mapped to whole sky through match of Kepler variability rate to Besançon Galaxy model
- Predicts alert rate as function of location for LSST and for GAIA
- Analysis includes treatment of variable AGN and moving objects
- While number of alerts on new objects for LSST and GAIA will be very large at first, drops by orders of magnitude after 2-3 years
- Critical to handle moving objects, as they dwarf other types of new alerts at start of survey
- Paper (Ridgway et al. 2014) submitted, presented at Hotwired III
- Next step: basis for alert stream simulator

LSSTC Board, DC, Apr 2014 (KO2)
Funded 3-year initial project
Collaboration with U.A. Computer Science Department
NOAO Co-Is: T Matheson, Abi Saha
Prototype focused on finding “rarest of the rare”
Will test core flow of system
Open source/open access
No alerts will be lost
Future versions can expand to accommodate multiple filtering paths to address many goals
• Prototype being built around the alert streams of existing projects as well as simulated streams
  – Stripe 82, PanSTARRS, CRTSS

• By end of current project, scale to larger streams
  – e.g. DECam/DES

• Ultimate goal: deploy LSST-scale version for LSST Commissioning
  – Possible collaboration with NCSA
SLAC/NOAO collaboration
Areas of common interest

- SLAC and NOAO together provide a larger pool of expertise
- In area of LSST software and simulation tools, NOAO (OpSim) and SLAC (PhoSim, DM development) have complementary expertise
- SLAC has expertise in large-scale computing and Dark Energy science, NOAO has broad astronomical experience and connection to astronomy community
  - Discussing analyzing precursor data at scale, OpSim on large-scale computing platform
- Joint meetings and reciprocal visits to strengthen ties
- Organize workshops on LSST topics (Cadence workshop first example)
- Work together to lead “First Byte” pre-LSST dry run, driven by SC members in DESC and e.g. SMWLV, Transients and Variables
- Collaborate on commissioning activity
Summary

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