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Data, code, algorithms, and astronomical knowledge production

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Data, Code, Algorithms, and Astronomical Knowledge Production

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<http://christineborgman.info>

@scitechprof

Galactic Center Group Workshop, UCLA

December 12, 2017



Christine Borgman



Peter Darch



Irene Pasquetto



Bernie Boscoe



Michael Scroggins



Milena Golshan



Jack Meadows, 1934-2016

The founder of the University of Leicester's astronomy department, who had a minor planet named in his honour, has died

August 18, 2016



By [Jack Grove](#)

Twitter: [@jgro_the](#)



Meadows, A. J.
(1974).
*Communication in
Science*. London:
Butterworths.



UCLA Center for Knowledge Infrastructures

[Christine L. Borgman](#), Distinguished Professor and Presidential Chair in Information Studies at UCLA, is the author of more than 250 [publications](#) in information studies, computer science, and communication. She directs the [Center for Knowledge Infrastructures](#) with research grants from the Alfred P. Sloan Foundation, the National Science Foundation, and other sources.

Bernie Boscoe (second from left), a third-year PhD student, brings her expertise in computer science and mathematics to our studies of data and software relationships in Astronomy.

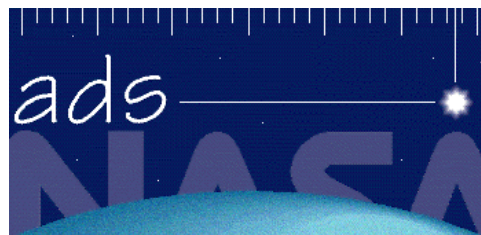


The [Center for Knowledge Infrastructures](#) conducts research on scientific data practices and policy, scholarly communication, and socio-technical systems. Their latest project, funded by the Alfred P. Sloan Foundation, is studying data practices, policy, and infrastructure of multiple distributed scientific collaborations, exploring methods of data collection and management, innovations in scaling and workflows, and multidisciplinary approaches to complex problems.

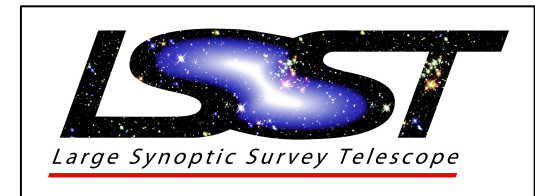
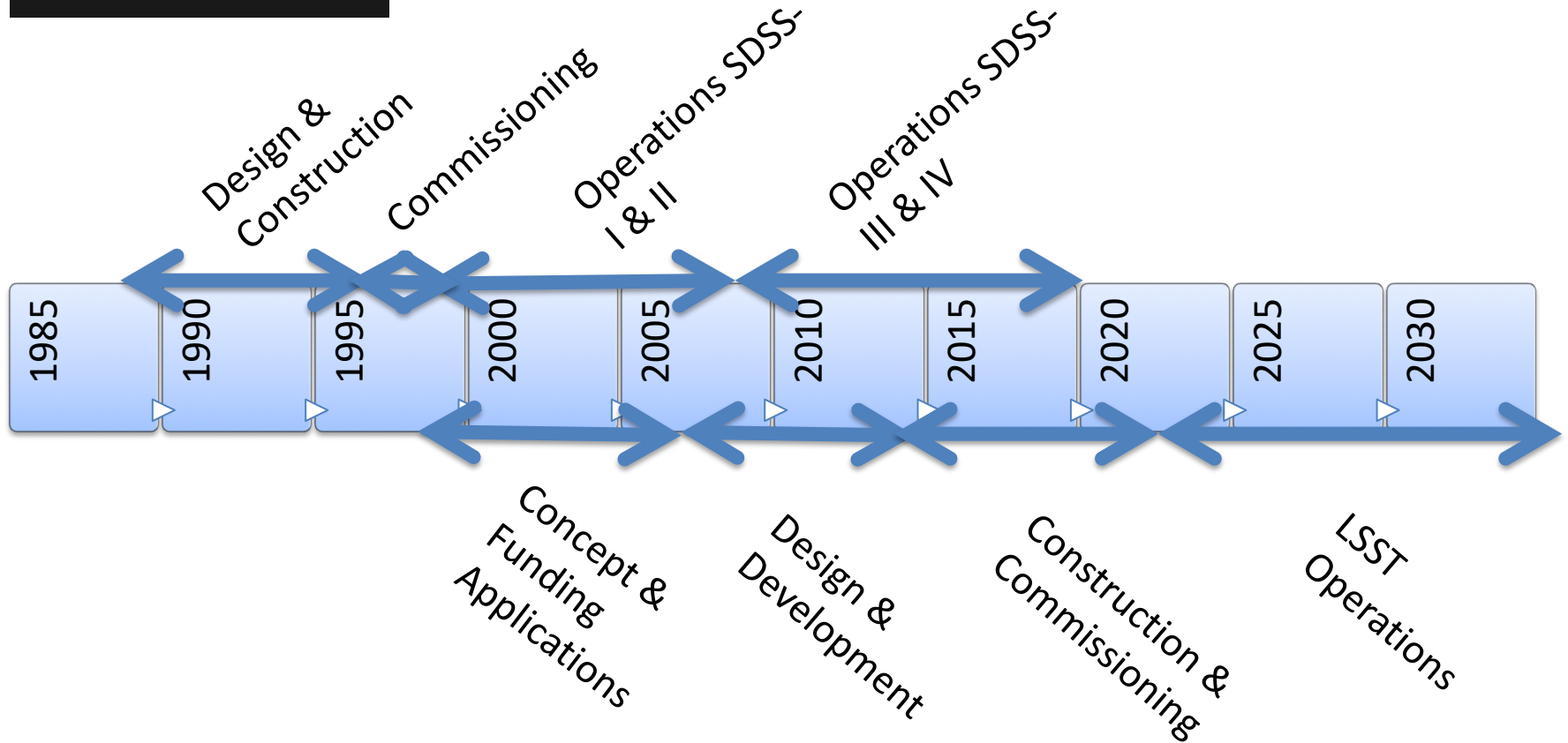


Astronomy Knowledge Infrastructures

- Observations: continuity over millennia
- Astronomy became digital: 1970s-
- Array of stakeholders: international
- Private and public funding: renewal
- Consensus mechanisms: Decadal survey



Project Timelines





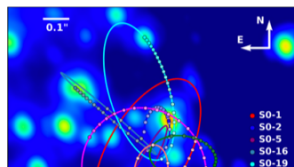
MEMBERS : A COLLABORATION

Members outside ULCA Royce Hall.

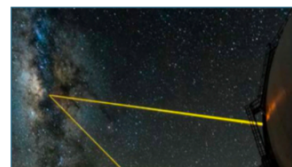
WELCOME TO THE GALACTIC CENTER GROUP AT UCLA

The Galactic Center Group (GCG) is dedicated to researching the innermost regions of the Milky Way at the highest angular resolution possible in order to understand the formation and evolution of galaxies and their central supermassive black holes.

SCIENCE



TECHNOLOGY



EDUCATION & OUTREACH



SCIENTIFIC RESEARCH - OVERVIEW

The advent of high resolution imaging, which enabled us to track rapid orbits of stars about an unseen gravitational force, has led to our discovery of the Supermassive Black Hole (SMBH) at the center of our galaxy. This has opened up a new way of studying the fundamental physics of black holes and the role that the black holes play in the formation and evolution of galaxies.

1995

data

data

data

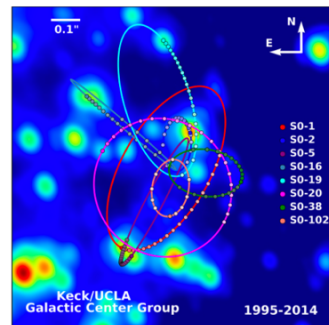
data

data

2017

data

BLACK HOLE & RELATIVITY



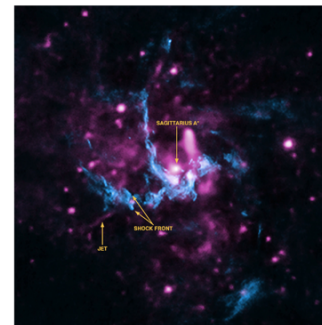
By studying the orbital motions of objects near the Galactic Center, we can extract information of the central Supermassive Black Hole (SMBH) and its properties. The SMBH has a mass of ≈ 4 million $M_{\odot}$ and objects moving close enough to the SMBH exhibit relativistic behaviors, which allows us to test General Relativity in areas never before explored. [Read more...](#)

BLACK HOLE ENVIRONMENT



The central region of our galaxy, less than few light years from the SMBH, has revealed a much larger diversity of stellar populations than what was first predicted. There are both very young (< 10 Myr) and old stars, as well as star clusters whose formation history remains mystery as tidal forces from the SMBH should have prevented them from forming. [Read more...](#)

BLACK HOLE ACCRETION



With the increased sensitivity provided by adaptive optics, the infrared emission from material accreting onto the Galactic Center has been detected. There has also been a recent discovery of an object that is plunging toward the SMBH, opening a new window to investigate the accretion flow physics. [Read more...](#)

QUICK LINKS

FOR SCIENTISTS
IMAGES - TECHNOLOGY
IMAGES - SCIENCE
ANIMATIONS
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HOME

LATEST NEWS

SCIENCE & ASTRONOMY
PUBLICATIONS
FOR THE PUBLIC

OUTSIDE LINKS

KECK OBSERVATORY
THIRTY METER TELESCOPE
UCLA PHYSICS AND ASTRONOMY
UCLA DIVISION OF ASTRONOMY
UCLA INFRARED LABORATORY
INSTITUTE FOR ASTRONOMY,

Astronomy Infrastructure Chronology

Astronomy Infra-structure	1960-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-
<i>NASA funded infrastructure</i> observatories missions centers archives & data tools	GSFC IPAC IRAS STScI	Hubble (HST) NED	ADS IRSA SATC	Chandra HEASARC 2MASS MAST NExScI Spitzer WIRE	SOFIA Spitzer Suzaku Swift	Fermi (FGST) Herschel Kepler Palomar (PTF) Planck WISE	NuSTAR
<i>Other infrastructure</i> observatories centers surveys data tools standards	SAO CfA CDS/ SIMBAD FITS		arXiv VizieR Keck	Aladin NVO IVOA SDSS Gemini Subaru		Dataverse GitHub LSST Pan- STARRS VAO WWT	ADSASS DDT Jupyter Note- book Zenodo DES TMT

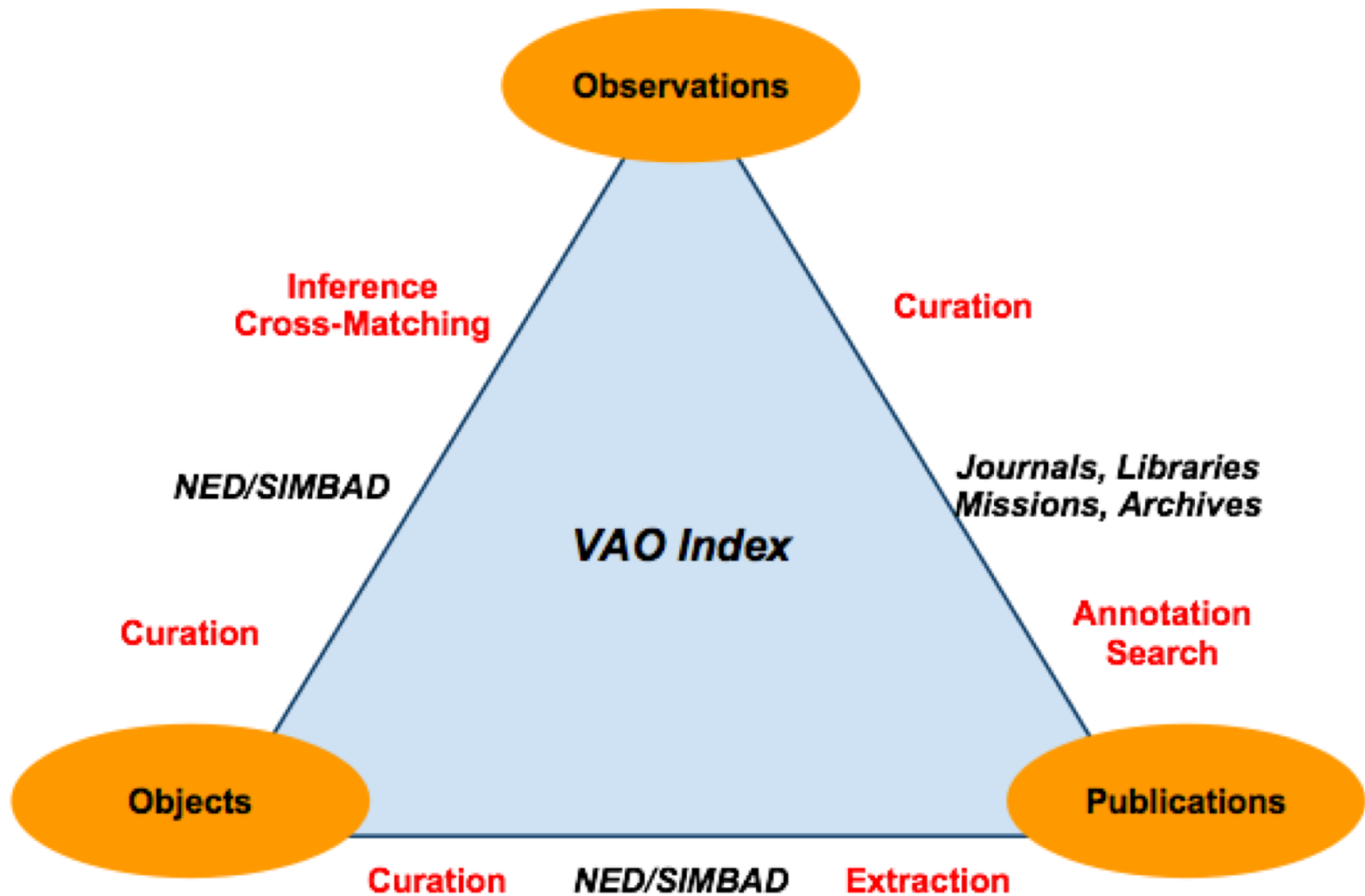


Figure 1. Relationships between Publications, Objects, Observations and the corresponding major actors in the curating process and their activities (in red).



The **HSC v2.1** release (2017 January 26) includes additional spectroscopic matches, median magnitudes, and more. [Close x](#)

Welcome to the Hubble Legacy Archive



The Hubble Legacy Archive (HLA) is designed to optimize science from the Hubble Space Telescope by providing online, enhanced Hubble products and advanced browsing capabilities. The HLA is a joint project of the Space Telescope Science Institute (STScI), the Space Telescope European Coordinating Facility (ST-ECF), and the Canadian Astronomy Data Centre (CADCC).

[Enter Site here.](#)



DR9.1 Release (2016 September 29)

NEW DATA PRODUCTS

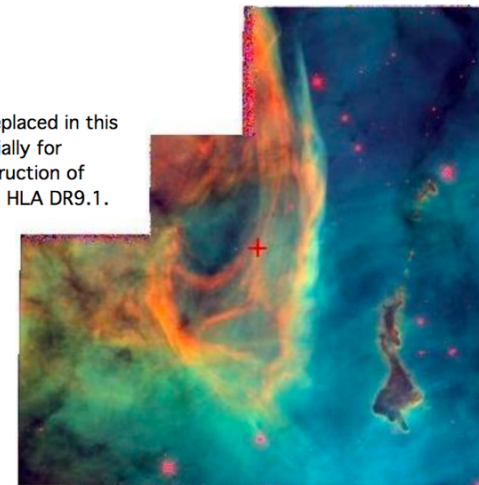
- Newly processed ACS and WFC3 source lists. Almost all old source lists have been replaced in this catalog. The new source lists have higher quality astrometry and photometry, especially for SExtractor catalogs in crowded fields. These new source lists were used in the construction of version 2 of the [Hubble Source Catalog](#), which is being released simultaneously with HLA DR9.1.

USER INTERFACE ENHANCEMENTS

- The interactive display's advanced HSC controls can be used to show either the current HSCv2 catalog or the previous HSCv1 catalog.
- The [Gaia DR1](#) catalog is available for overlay in the display.
- New controls can change the catalog overlay region to load sources from only a small part of the image. This greatly improves performance in large images and crowded regions.

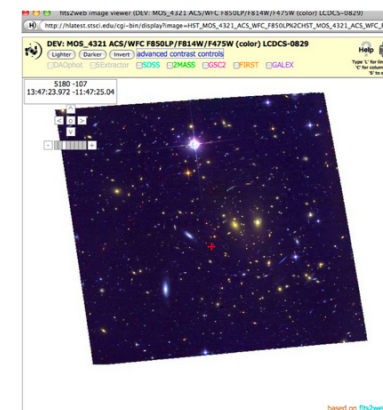
- See the [display help](#) for more information on the new display features.

See the [release notes](#) for more details on this and past releases.



HLA ESSENTIALS

- The HLA interface runs in [Firefox](#), [Safari](#), [Chrome](#), [Internet Explorer](#) (versions 8* and 9), and similar compatible browsers. *IE8 limitations - the scatterplot and plotting tools do not work on IE8 as it does not support HTML5.
- To fully realize all of the HLA's functionality, one must have [cookies](#) and [pupups](#) enabled.
- The HLA includes enhanced data products (ACS, WFPC2, & NICMOS images, ACS & WFPC2 source lists, ACS & NICMOS extracted grism spectra, prototype ACS mosaics) and also provides access to the standard HST data products when HLA enhanced products have not yet been created.
- [Footprints](#), which graphically display the sky coverage on a background image from the Digitized Sky Survey, are available for both standard and enhanced HST data products, including extracted grism spectra and community-contributed high-level science products.
- Here is a matrix describing what is and is not in the HLA:



Instrument/Product	Source	HLA Enhanced Products ¹	Download Format	Interactive Display?
ACS/combined images	STScI	93% ²	FITS	✓
ACS/source lists	STScI	87% ³	Ascii	✓
ACS/grism extractions	ST-ECF	70% ⁴	FITS	
ACS/mosaic images	STScI	143 images for 67 pointings	FITS	✓

W. M. KECK OBSERVATORY

UCO acts a managing partner
of the Keck Observatory on Mauna Kea, Hawaii.

[Learn More](#)

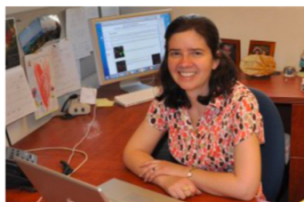
The University of California Observatories (UCO) is a multi-campus research unit. We operate the Lick Observatory, the technical labs at UC Santa Cruz and UCLA, and we are a managing partner of the Keck Observatory in Hawaii. We are the center for the UC participation in the Thirty-Meter Telescope (TMT) project.

[Learn More](#)

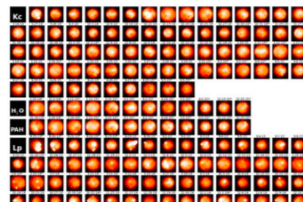
Information for Observers:

[Call for Proposals](#)

Featured News



Gillian Wilson
appointed Interim
Deputy Director

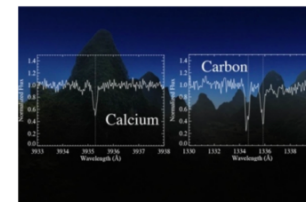


Tracking volcanos on
Jupiter's moon Io

OCTOBER 24, 2016



Follow-Up Of Kepler
Data Yields More Than
100 Confirmed



Planet-Devouring Star
Reveals Possible
Limestone Crumbs



KOA STATUS

Archive is running normally.

KOA LINKS

[User Interface](#)

[FAQ](#)

[Filename translator](#)

[Reducing Keck Data](#)

[HIRES News](#)

[HIRES Data Description](#)

[HIRES Keywords](#)

[HIRES Page](#)

[KCWI Keywords](#)

[NIRC2 News](#)

[NIRC2 Data Description](#)

[NIRC2 Keywords](#)

[NIRC2 Page](#)

[NIRSPEC News](#)

[NIRSPEC Data Description](#)

[NIRSPEC Keywords](#)

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[LRIS Keywords](#)

[MOSFIRE Keywords](#)

[DEIMOS Keywords](#)

[ESI Keywords](#)

[OSIRIS Keywords](#)

[NIRC Keywords](#)

[LWS Keywords](#)

[Help Desk](#)

NEW! First Release of KODIAQ Data, and Public Release of LWS Data Now Available: [Data Access](#)

Funded by [NASA](#), the *Keck Observatory Archive (KOA)* is a joint development between the [W. M. Keck Observatory](#) (WMKO) located in Waimea, Hawaii and the [NASA Exoplanet Science Institute \(NExSci\)](#) located in Pasadena, California. Currently, KOA archives data taken with [HIRES](#), [NIRSPEC](#), [NIRC2](#), [LRIS](#), [KI \(Keck Interferometer\)](#), [MOSFIRE](#), [DEIMOS](#), [ESI](#), [OSIRIS](#), [NIRC](#), and [LWS](#).

The process by which data are archived is as follows:

- Locate all FITS files taken in the previous 24 hour period
 - Determine the validity and data integrity of each file
 - Add [meta-keywords](#) to the FITS header
 - Archive the metadata ([native](#) + [meta-keywords](#)) for each FITS header
 - Archive the data for each FITS file
 - Archive ancillary data associated with each night's data
- Ancillary data include Keck nightly plots of weather and image quality trends and, when available, all-sky images and photometric data

The physical location of the archive is at [NExSci](#). Both metadata and raw FITS files are transferred via the Internet from WMKO to NExSci, and are available through a [User Interface](#) within hours of the end of observations. Both the data files and the metadata are subject to a [proprietary period policy](#). During the proprietary period, program PIs will be able to access their data via a [user login/password protected site](#). The data are released to the public upon expiration of the proprietary period.

KOA NEWS

May 30, 2017

KOA has released browse-quality spectra extracted with a new, automated pipeline from 18,821 nights of NIRSPEC high-dispersion data. The freely available pipeline is written in Python. A quick-look reduction mode is available to observers at the telescope. Version 2 of the Moving Object Search Service is also released.

September 28, 2015

Public release of LWS data (1998-2005).

July 06, 2015

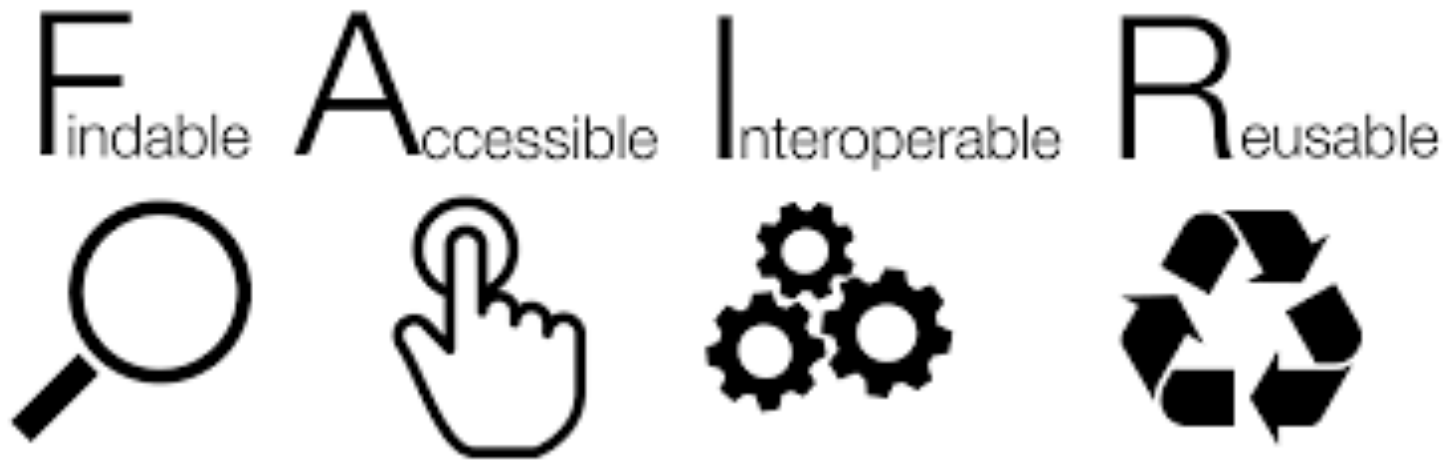
Public release of NIRC data (1995-2010).

May 15, 2015

First release of...

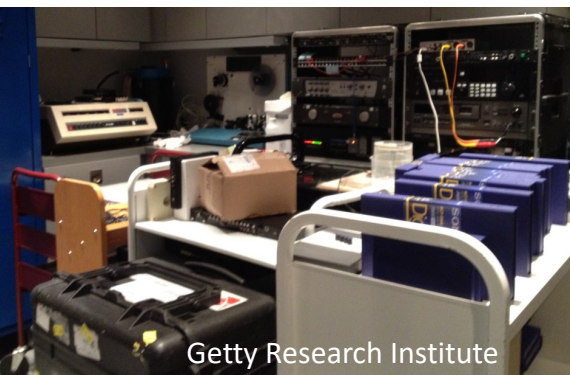
[more news...](#)

Data Stewardship: The Ideal



Wilkinson, et al. (2016). The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data*, 3, <http://dx.doi.org/10.1038/sdata.2016.18>

Data Stewardship: the Reality



We just need to migrate the data from these systems to fit into that hole over there.



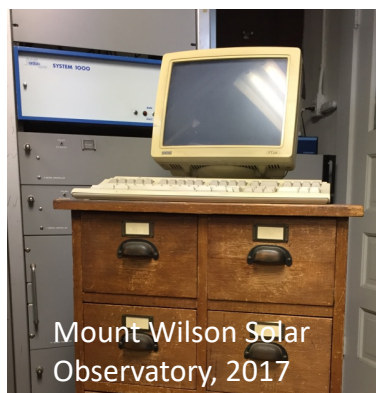
<http://www.datamartist.com/data-migration-part-1-introduction-to-the-data-migration-delema>



Graduate students



Post-doctoral fellows



Astronomy Infrastructure: Durability

- Collaboration and openness
- International coordination
- Long term value of data
- Agreed standards
 - Units of measurement
 - Coordinate systems
 - Data structures
- Shared resources
 - Missions, instruments
 - Data Archives
 - Tools and technologies



[The Library of Congress](#)

Operating a hand drill at Vultee-Nashville, woman is working on a "Vengeance" dive bomber, Tennessee (LOC) Palmer, Alfred T., photographer. 1943 Feb. Title from FSA or OWI agency caption. Transfer from U.S. Office of War Information, 1944.

Astronomy Infrastructure: Fragility

- Investment in data stewardship
 - Varies by mission
 - Varies by type of research
 - Space-based vs ground based
 - Large missions vs observing proposals
 - Shared instruments vs custom instruments
- Access to data varies
 - Public archives
 - Local data collections
 - Derived data



Mount Wilson Solar
Observatory, 2017

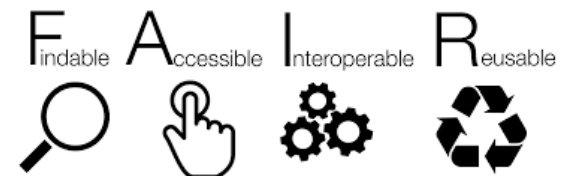
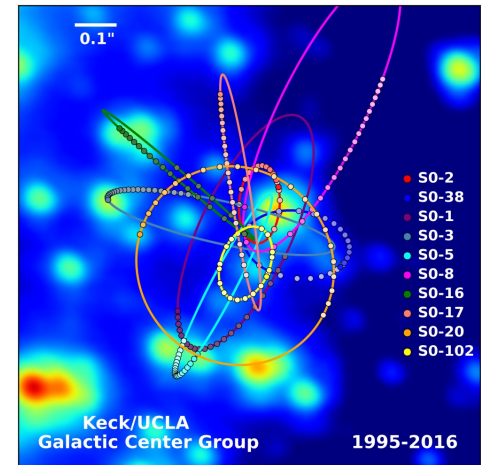
Astronomy Infrastructure: Fragility

- Curation of tools and technologies
 - Shared investments
 - Open source
 - Proprietary tools
 - Local tools, scripts
- International coordination
 - Investment in new instruments, mission
 - Investment in archives, infrastructure



Conclusions

- Infrastructures are fragile
- Durability is an accomplishment
- Visible infrastructure
 - Instruments
 - Institutions
- Invisible infrastructure
 - Data, metadata, provenance...
 - Information work



**STAYING
ALIVE**