

Mathematical and Physical Sciences Advisory Committee (MPSAC)

Jim Ulvestad
Acting Assistant Director
National Science Foundation
June 15-16, 2017



Agenda

Personnel Updates

Science Highlights

Facilities Updates

Program Updates

Agency Reorg & Reform



Agenda – Day 1

- State of the Directorate, Jim Ulvestad
- Budget, Michael Sieverts (Budget Division Director) and Jim Ulvestad
- Discussion of Workload Issues and Possibilities for Addressing Them, Deborah Lockhart (Deputy AD)
- Update on Transitions of Astronomy and DMR Facilities, Ed Ajhar (AST Acting Deputy Division Director), Linda Sapochak (DMR Division Director)
- Prep for Meeting with Director, Juan de Pablo



Agenda – Day 2

- NAS Surveys and Decadal Reports and the Role of AC Subcommittees (Part I), Jim Ulvestad and Juan de Pablo
- Communications with Congress and the Scientific Community, Amanda Greenwell (Head of OLPA)
- Science Hors D'oeuvre (LIGO), Denise Caldwell (PHY Division Director)
- Meet with Director and COO
- Cyberinfrastructure RFI Update, Bill Miller and Irene Qualters (Office of Advanced Cyberinfrastructure)
- NAS Surveys and Decadal Reports and the Role of AC Subcommittees (Part II), Jim Ulvestad and Juan de Pablo
- Future Role and Activities of the AC (Juan de Pablo)



MPS Advisory Committee Quarterly Meetings (2 at NSF, 0 – 2 Virtual)

Next Virtual Meeting
Sept 2017
if needed

Next Meeting at NSF
Nov/Dec 2017
Tentative !!



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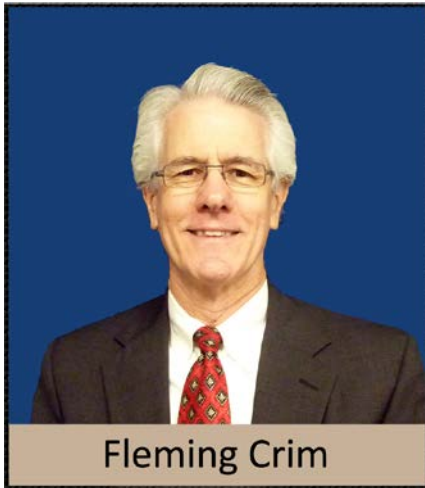
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Office of the Assistant Director

Farewell and Thanks



Fleming Crim

Fleming Crim
Retired(ish)/Returned
to U. of Wisconsin



Saul Gonzalez

Saul Gonzalez
Returned to PHY
from detail



Bogdan Mihaila

Bogdan Mihaila
Returned to PHY
from detail

Office of the Assistant Director

Welcome



Jim Ulvestad

Jim Ulvestad
Acting Assistant
Director



Kimberly Bryant

Kimberly Bryant
Directorate
Administrative
Coordinator (on detail)



Denise Zelaya

Denise Zelaya
Program Assistant
(Pathways Student)

Office of the Assistant Director

Welcome



Jessica Robin
Facilities Advisor
(on detail)



Vanessa Simon
Management and
Program Analyst

Mathematical and Physical Sciences (MPS)

Astronomical
Sciences
(AST)

Chemistry
(CHE)

Materials
Research
(DMR)

Mathematical
Sciences
(DMS)

Physics
(PHY)



**Ralph Gaume,
Acting DD**



**Angela
Wilson, DD**



**Linda
Sapochak, DD**



**Michael
Vogelius, DD**



**Denise
Caldwell, DD**

Mathematical and Physical Sciences (MPS)

Astronomical Sciences (AST)

Chemistry (CHE)

Materials Research (DMR)

Mathematical Sciences (DMS)

Physics (PHY)



Ed Ajhar
Acting DDD



Carol Bessel
DDD



Sean Jones
DDD



Tie Luo
DDD



Brad Keister
DDD



Mathematical and Physical Sciences (MPS)

Astronomical
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(DMR)

Mathematical
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Physics
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Search for AST Division Director Fall 2017

Recruitment Committee

Dr. Roger Blandford, Stanford
University

Dr. Joel Bregman, University of
Michigan

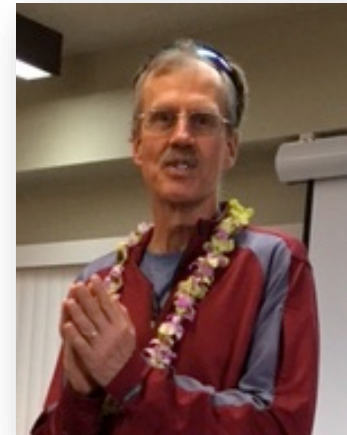
Dr. Debra Elmegreen, Vassar College

Dr. Lyman Page, Princeton University

Dr. Caty Pilachowski, Indiana
University



Jim Ulvestad



Mathematical and Physical Sciences (MPS)

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Physics
(PHY)



Michael Vogelius

Search for DMS Division Director Winter 2018

Recruitment Committee

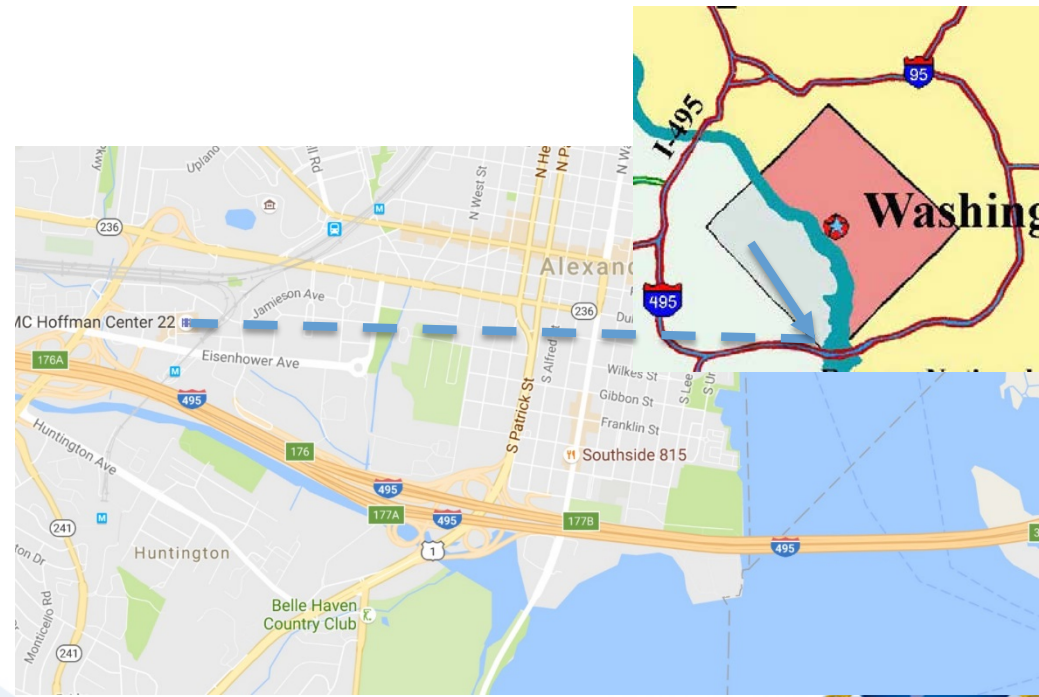
Dr. Robert Bryant, Duke U.
Dr. Russel Caflisch, UCLA/Courant
Dr. Marie Davidian, NC State
Dr. Bryna Kra, Northwestern U.
Dr. Francis Su, Harvey Mudd College

NSF is Moving!

- NSF will move from its current location in Arlington, Virginia to a location in Alexandria, Virginia in July-September 2017.
- The Directorate for Mathematical and Physical Sciences is scheduled to move over an extended Labor Day weekend in August/September.



Directorate for Mathematical and Physical Sciences



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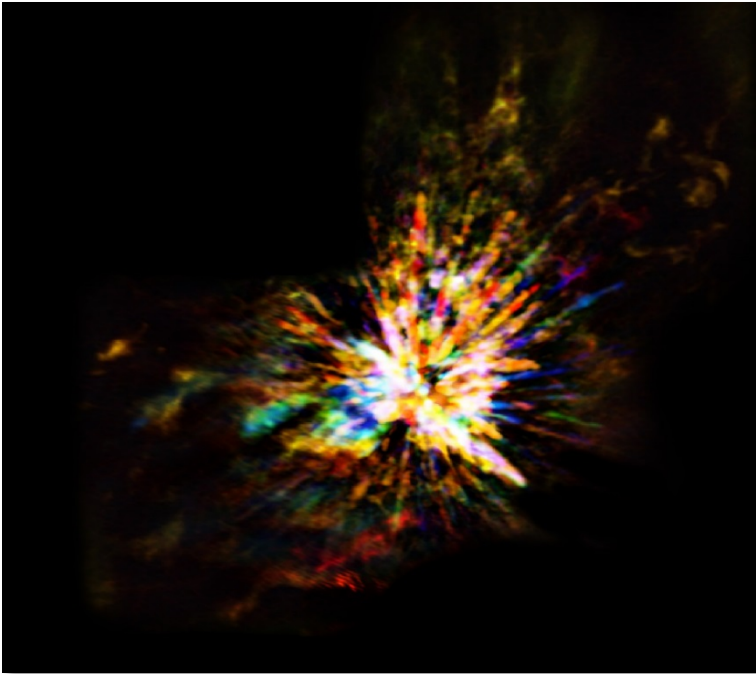
Facilities Updates

Program Updates

Agency Reorg & Reform

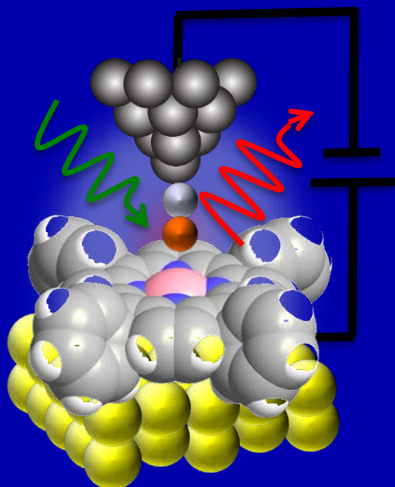


Explosive Star Formation Seen with ALMA



Credit: ALMA (ESO/NAOJ/NRAO), J. Bally; B. Saxton (NRAO/AUI/NSF); Gemini Observatory/AURA
NRAO press release at:
<https://public.nrao.edu/news/image-release-alma-captures-explosive-star-birth/>

- Bally (U. Colorado) and collaborators imaged the densely-packed star-forming region “Orion Molecular Cloud 1” with ALMA.
- Image shows molecular CO gas color-coded by the expansion velocity, ranging up to ± 150 km/s.
- Explosive event believed to have been triggered by the merger or near-collision of two forming stars which released gravitational potential energy, ejecting stars and gas.
- Streamers point towards high proper motion, shock-excited Fe and H₂ gas seen in earlier near-infrared images with Gemini.



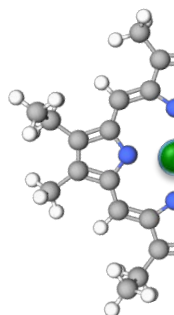
CaSTL researchers are developing 'chemiscopes' – microscopes that operate at a 10th of a nanometer and femtosecond timescale to observe the atomic position and bond vibration in real-space

Imaging Molecules in Real-Space and Real-Time

CHE-1414466, V. Ara Apkarian, UC Irvine

Chemists need tools to characterize new molecular and nanoscale structures. Until now, existing tools could not characterize both the dynamics of chemical bonding and nanoscopic structure simultaneously.

CaSTL combines scan probe microscopy and ultrafast vibrational spectroscopy to reach joint space-time resolution at Å-fs limit, and records moving pictures of elementary steps in chemical reactions. Seeing is the first step toward manipulating individual atoms and molecules to build and understand larger and more complex structures



CaSTL partners with industry (Newport Corporation and Molecular Vista Inc) to disseminate their novel optical and molecular instruments and computational technologies.

Graphene encapsulated growth of 2D gallium nitride

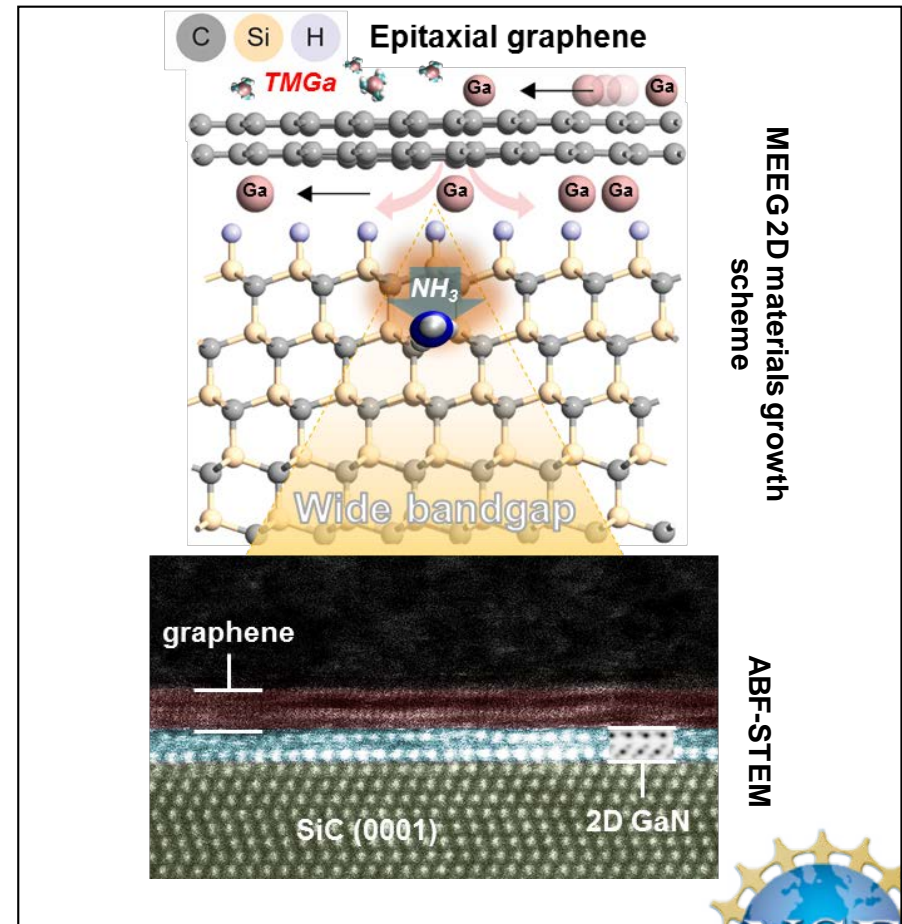
Joan Redwing (Penn State University)

- Process called “**migration enhanced epitaxial growth**” (MEEG) developed to synthesize two dimensional (2D) sheets of gallium nitride.
- **Ga atoms** are deposited on epitaxial graphene formed on SiC, **intercalate beneath the graphene** via defects and wrinkles and diffuse along the graphene/SiC interface forming a stable bilayer of Ga atoms. **The Ga atoms are converted to gallium nitride via exposure to ammonia (NH₃).**
- **2D gallium nitride formed** by MEEG is a direct gap semiconductor with a bandgap energy of ~4.8-4.9 eV and may enable new types of electronic and optoelectronic devices.
- **MEEG may also be used to synthesize other 2D semiconductors that don't exist as layered materials or are unstable and air sensitive.**

Funded by:

Electronics and Photonic Materials
(EPM) Program

DMR -1410765, 2016



Reference: Z.Y. Al Balushi, et al. Nature Materials (2016) doi:10.1038/nmat4742



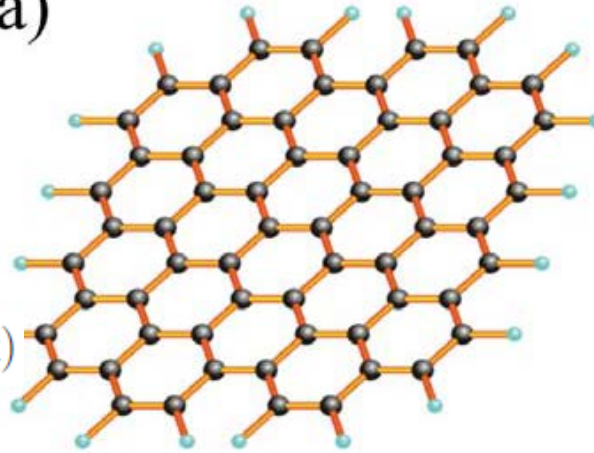
Energy on the Edge: A Mathematical Study

Both quantum state of graphene, a honeycomb lattice of carbon atoms (a), and the light diffraction through 'photonic graphene,' a honeycomb wave array (b), obey the Schrödinger equation [z plays the role of t in (b)].

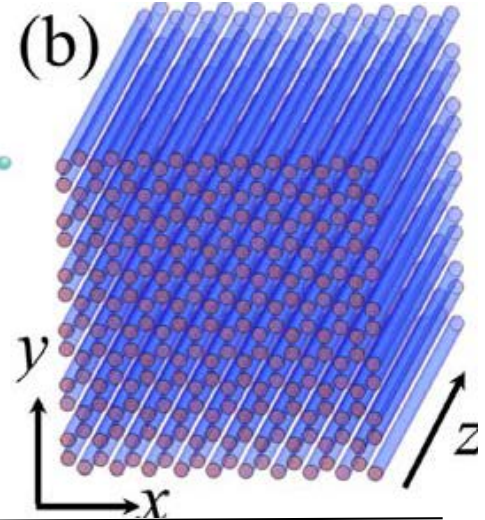
$$\frac{i\hbar}{2} \frac{\partial}{\partial t} \psi = H_V \psi, \quad H_V \equiv -\Delta + V(\mathbf{x})$$

V is a 'honeycomb lattice potential'

(a)

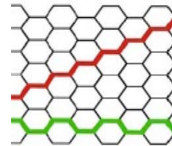


(b)

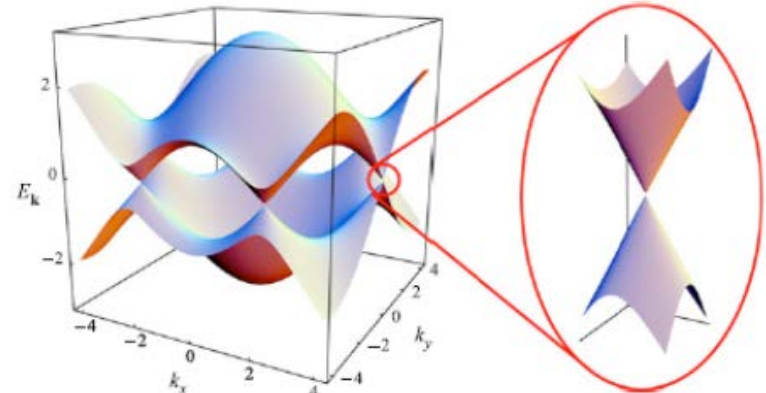


Mathematical Highlights:

The Dirac cone degeneracy of the spectrum is structurally stable with respect to the perturbations of the potential. Topologically protected edge states, which are stable against strong local distortions of the edge, and are therefore potential vehicles for robust energy transfer in the presence of defects and random imperfections.

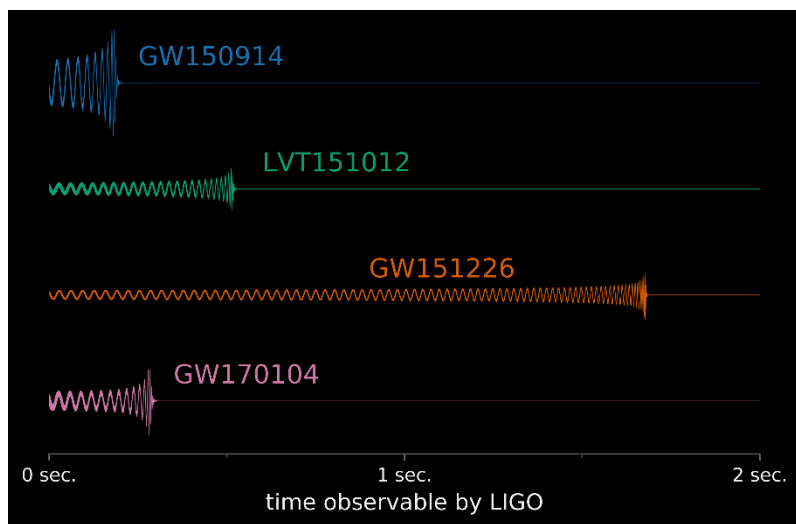


Dirac cones for two lower energy levels:

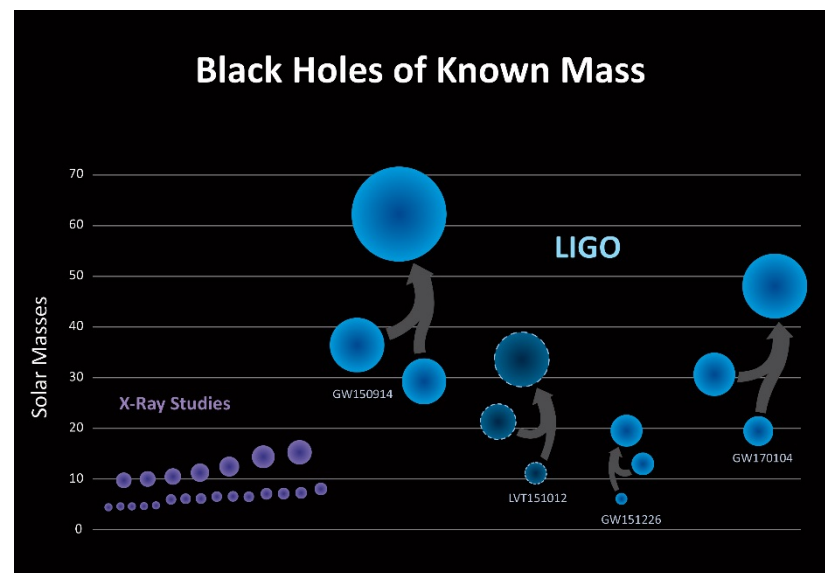


Third Confirmed LIGO Detection GW170104

The newfound black hole, formed by the merger, has a mass about 49 times that of our sun. This fills in a gap between the masses of the two merged black holes detected previously by LIGO, with solar masses of 62 (first detection) and 21 (second detection).



Images: LIGO.org



Original Black Holes Masses: 19 and 31 M_{\odot} .
Final Black Hole Mass: 49 M_{\odot} .
Distance: 880 Mpc ($z = 0.18$). The farthest detection so far.

Unlike the previous two detections, it is likely that in this merger the BH spins were initially counter aligned with the orbital angular momentum

No evidence of departure from GR.



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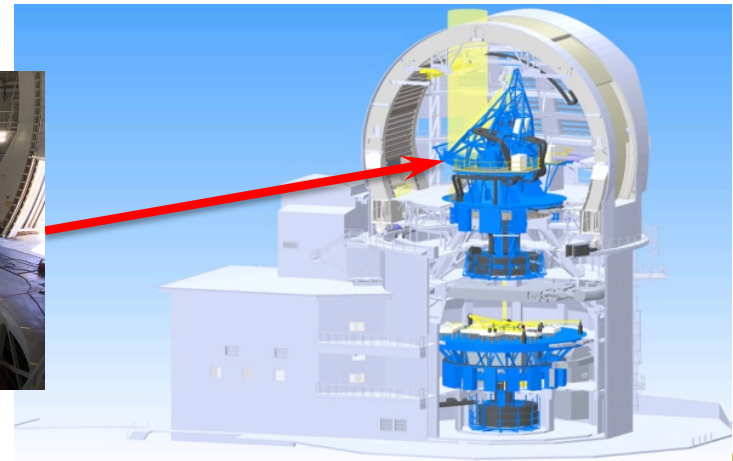
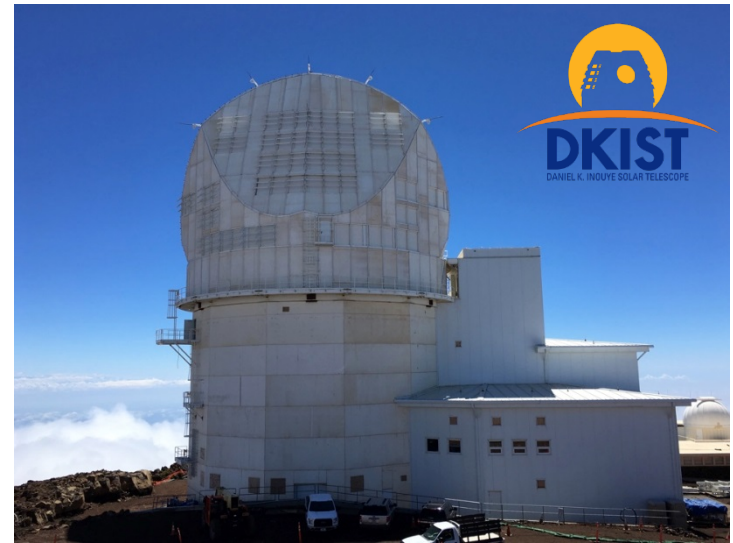
Agency Reorg & Reform



NSF's Daniel K. Inouye Solar Telescope (DKIST)

- Science Driver: Determining the nature of solar magnetism and how these magnetic fields drive the phenomena collectively known as space weather.
- Location: Haleakala, Maui, Hawai'i
- Hawaii Supreme Court affirmed construction permit (October 2016)
- Planned Completion: Early 2020

DKIST will be the world's flagship facility for ground-based solar astronomy.



Large Synoptic Survey Telescope

- Science Driver: Ten year survey of 10s of billions of objects in space and time. Data base will change the way astronomy is done.
- Location: Cerro Pachon, Chile
- 3.2 Gpixel camera, 2 sec readout, ~15 TB per night
- Main survey = 18,000 sq degree (full moon = 0.2 sq degree)
- ~10 million transient event alerts per night, 60 sec latency
- Construction progressing well, late 2022 start date for survey.

Construction in May 2017 after 16 inches of snow ...



... compared to artist's impression



Images credit LSST Project/NSF/AURA



Upcoming NSB Actions

- Following dates are tentative, and the earliest possible! Dates are contingent on satisfactory outcome of reviews
- August 2017: NHMFL renewal
- February 2018: National Center for Optical and Infrared Astronomy concept approval
- May 2018: LSST operations proposal
- May 2018: LIGO renewal
- May 2018: HL-LHC advancement to final design stage



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A Sampling of Activities and Issues

- Bio Math Institutes (with Simons Foundation)
- TRIPODS
- Upcoming COVs
 - PHY in FY 2018
 - AST and DMR in FY 2019
- Coalition for National Science Funding Capitol Hill Reception—May 16, 2017
- Astronomy on the Mall—June 2, 2017
- One-on-one meetings on FY 2018 budget request with Representatives, Senators, and staffers
- DMR decadal survey ongoing



American Innovation and Competitiveness Act (AICA)

- New Authorization Act for NSF (and NIST), passed by Congress in early January.
- No specific funding targets incorporated.
- Supports NSF principles of merit review.
- Language relating to NSF awards being in the national interest.
- Language about facility oversight.
- NSF group tasked with developing responses to all specific requirements.



FY 2017 Appropriation

- FY 2017 appropriation passed by Congress in early May (with <5 months left in FY 2017).
 - Essentially flat with respect to FY 2016.
- NSF FY 2017 spending plan to be submitted to Congress via OMB.
- Processing of awards handicapped by late budget and early financial closeout (related to the NSF move to new location).



NSF INCLUDES

- New INCLUDES video from the Director



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Agency Reorganization & Reform

- Initial hiring freeze, January-April 2017
- OMB memo M-17-22 (April 12)
 - Comprehensive Plan for Reforming the Federal Government and Reducing the Federal Civilian Workforce
- Agency Steering Committee
- Agency town halls for staff input
- Preliminary Agency Reform Plan due June 30
- More detailed plan due September 30
 - Incorporate into FY 19 budget request



AD Retreat, June 20-21

- FY 19 budget request
- Big Ideas
- Preliminary Agency Reform Plan



Questions & Discussion

