

National Aeronautics and Space Administration



Astrophysics

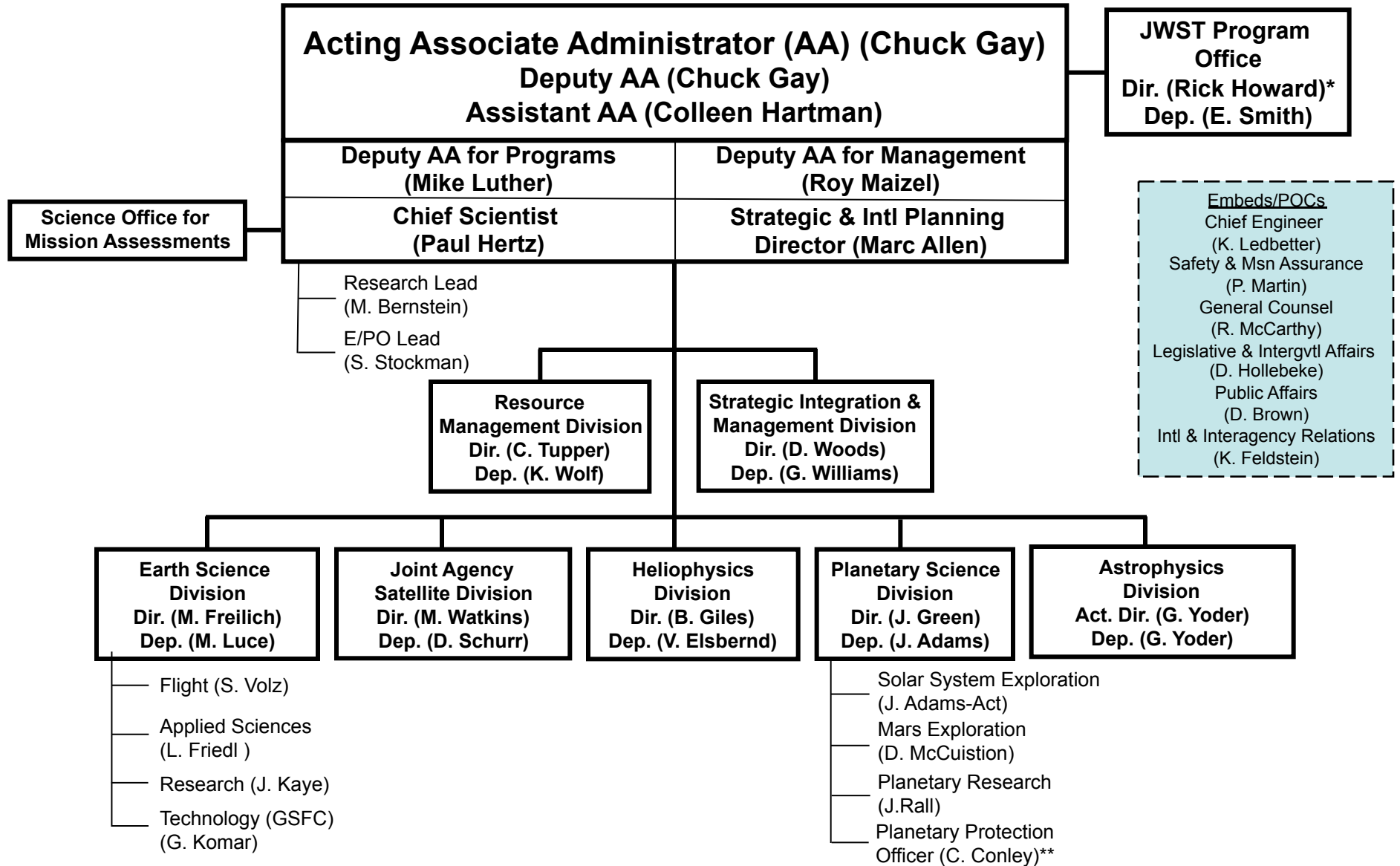
Geoff Yoder
AAAC

October 13-14, 2011

Agenda

- Organization Charts
- Missions and Significant Accomplishments
- Senior Review
- Explorers
- Special Topics
- ESA Cosmic Vision Status
- Technology Fellowship
- Theory and Computational Networks
- Awards
- Science Highlights

SMD Organization Chart

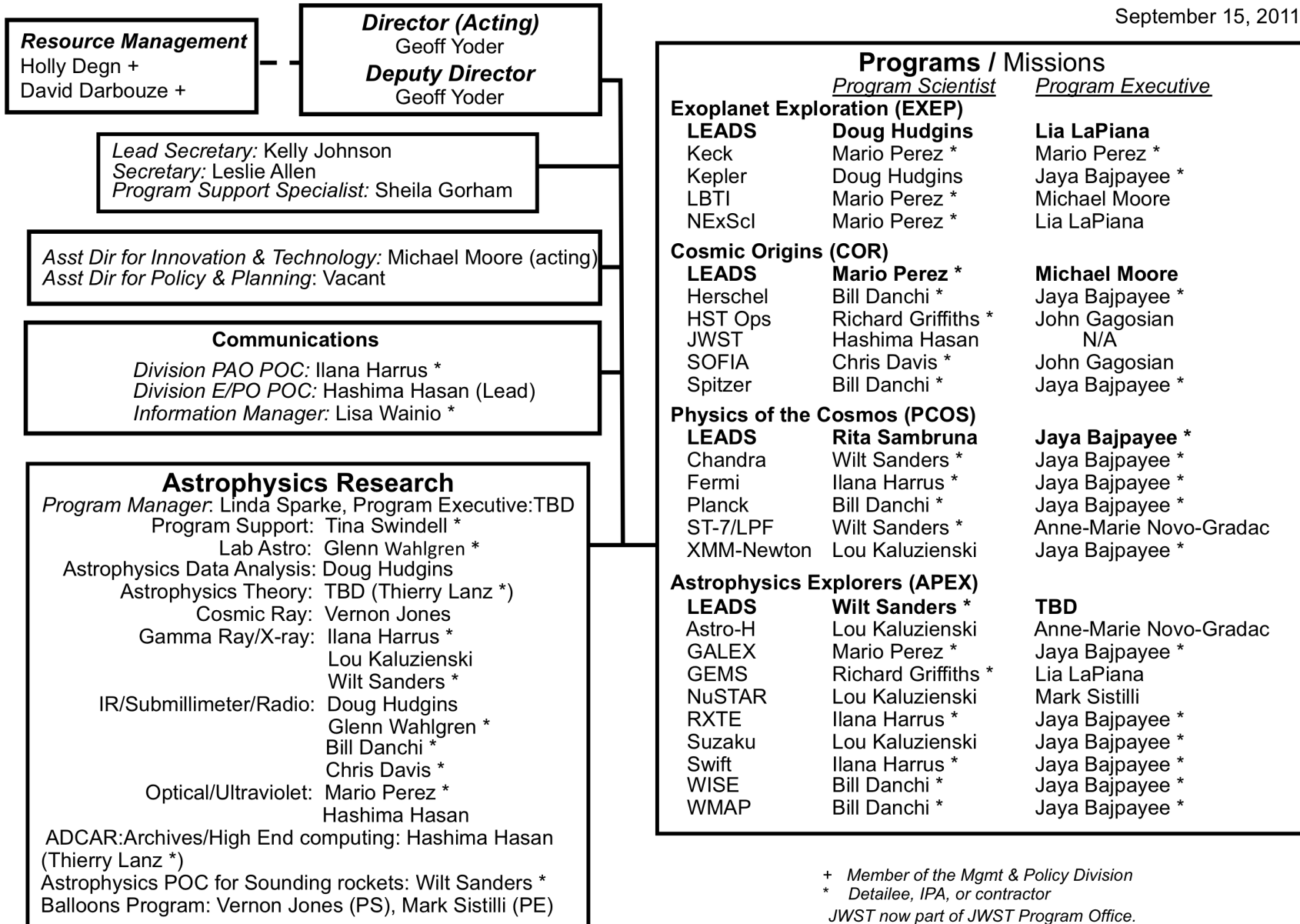


* Direct report to NASA Associate Administrator

** Co-located from the Front Office

Astrophysics Division Organization Chart

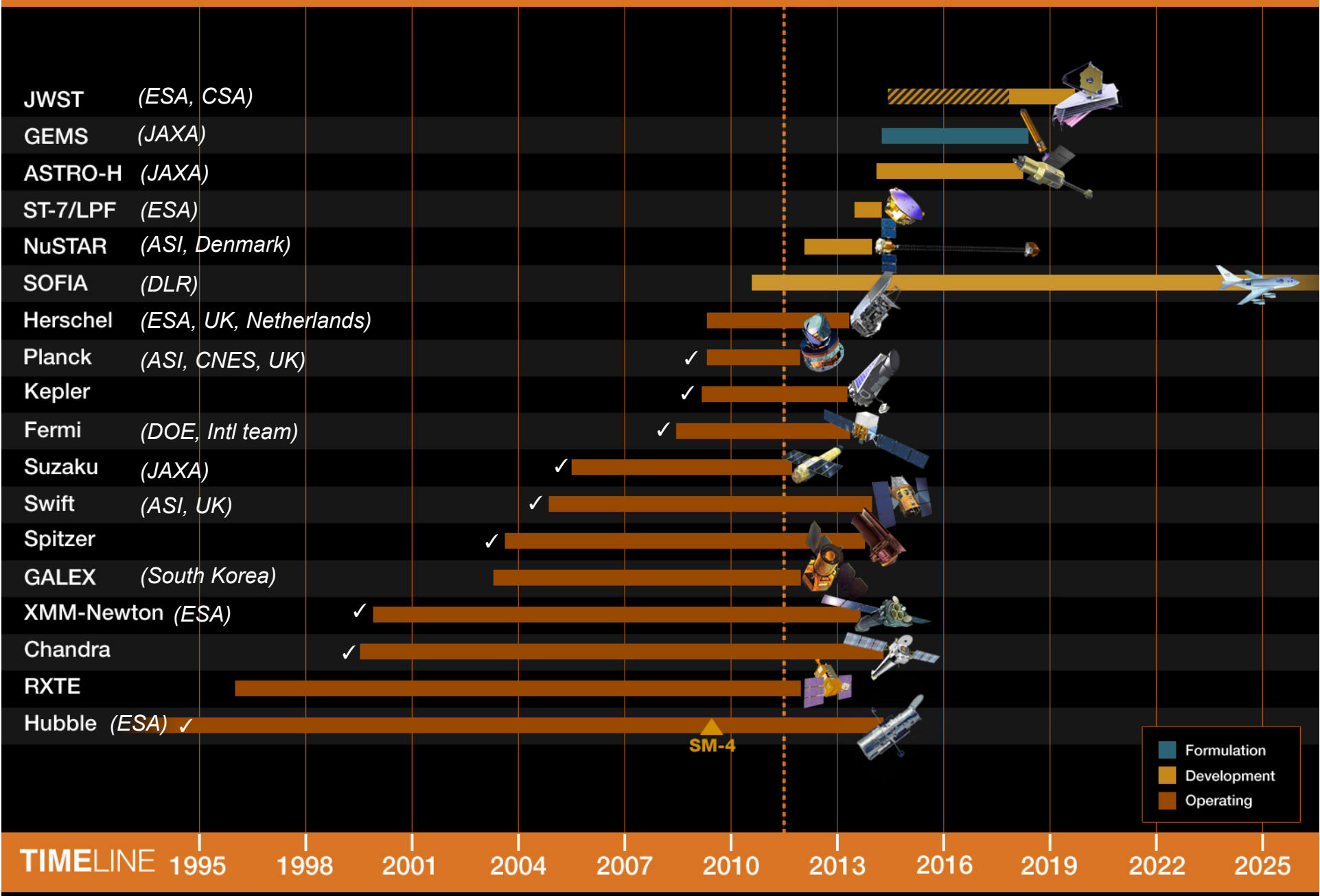
September 15, 2011



+ Member of the Mgmt & Policy Division
* Detailee, IPA, or contractor
JWST now part of JWST Program Office.

Astrophysics Missions timeline

✓ Next Senior Review in 2012





President's FY 2012 Budget Request

Budget authority, \$ in millions	Actual FY2010	Actual FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
Astrophysics	<u>\$647.3</u>	<u>\$605.2</u>	<u>\$682.7</u>	<u>\$758.1</u>	<u>\$775.5</u>	<u>\$779.8</u>	<u>\$810.9</u>
<u>Astrophysics Research</u>	<u>\$149.1</u>	<u>\$123.4</u>	<u>\$168.7</u>	<u>\$208.0</u>	<u>\$220.3</u>	<u>\$238.3</u>	<u>\$248.4</u>
Astrophysics Research and Analysis	\$59.6	\$59.6	\$67.6	\$86.4	\$87.8	\$89.3	\$92.7
Balloon Project	\$28.2	\$26.8	\$32.1	\$35.7	\$36.6	\$37.3	\$38.7
Other Missions and Data Analysis	\$61.3	\$37.0	\$69.1	\$86.0	\$95.9	\$111.7	\$117.0
<u>Cosmic Origins</u>	<u>\$225.3</u>	<u>\$227.1</u>	<u>\$239.7</u>	<u>\$244.5</u>	<u>\$233.3</u>	<u>\$216.1</u>	<u>\$206.3</u>
Hubble Space Telescope (HST)	\$100.8	\$91.6	\$98.3	\$98.0	\$98.0	\$94.0	\$90.0
Stratospheric Observatory for Infrared Astronomy (SOFIA)	\$73.6	\$79.8	\$84.2	\$85.5	\$88.0	\$88.0	\$86.0
Other Missions and Data Analysis	\$50.9	\$55.7	\$57.2	\$61.0	\$47.3	\$34.1	\$30.3
<u>Physics of the Cosmos</u>	<u>\$116.0</u>	<u>\$108.6</u>	<u>\$106.0</u>	<u>\$118.4</u>	<u>\$122.0</u>	<u>\$115.7</u>	<u>\$121.8</u>
Other Missions and Data Analysis	\$116.0	\$108.6	\$106.0	\$118.4	\$122.0	\$115.7	\$121.8
<u>Exoplanet Exploration</u>	<u>\$43.4</u>	<u>\$46.2</u>	<u>\$50.0</u>	<u>\$67.0</u>	<u>\$63.8</u>	<u>\$62.1</u>	<u>\$69.8</u>
Other Missions and Data Analysis	\$43.4	\$46.2	\$50.0	\$67.0	\$63.8	\$62.1	\$69.8
<u>Astrophysics Explorer</u>	<u>\$113.5</u>	<u>\$99.9</u>	<u>\$118.3</u>	<u>\$120.2</u>	<u>\$136.1</u>	<u>\$147.5</u>	<u>\$164.5</u>
Nuclear Spectroscopic Telescope Array (NuStar)	\$56.2	\$36.1	\$11.9	\$4.2	\$1.2	\$0.0	\$0.0
Gravity and Extreme Magnetism	\$3.1	\$23.0	\$74.1	\$44.5	\$23.1	\$2.0	\$0.0
Other Missions and Data Analysis	\$54.2	\$40.8	\$32.4	\$71.5	\$111.8	\$145.5	\$164.5

Astrophysics Mission Events


	CY2011	2012	2013	2014	2015																
Mission Launches etc.		▽ NET Feb 3 NuSTAR		▽ TBD 2014 LPF/ST-7 Astro-H	▽ Feb Astro-H	▽ NET Jul GEMS															
Suborbital Rocket Program.	▽ Jan FIRE	▽ Oct PICTURE 1	▽ Oct XQC 4	▽ Dec EXOS 2	▽ Dec IMAGER 1	▽ Jan SLICES 1	▽ Jan FORIS 1	▽ Feb ACCS 1	▽ Feb CIBER 1-3	▽ Feb Micro X	▽ Sep ACCES 2	▽ Dec XACT 1	▽ Dec DXL 1	▽ Feb ACCES 3	▽ Jun XACT 2	▽ Sep ACCES 4	▽ TBD FUSP 1	▽ TBD EXOS 4	▽ TBD KQCS 5	▽ TBD FORIS 2	▽ TBD EXOS 4
Balloon Campaigns	Antarctica D/J (CREAM VI, BLAST, SPB Test)	Sweden M/J (No astrophysics flights)	Ft. Sumner (spr) A/M	Palestine J/J	Ft. Sumner (fall) A/S (GRAPE, COFE, WASP)	Australia M/A (HERO)															
Opportunities	July 8 ▽ SOFIA Instr AO										Nov ▽ SMEX & MoO AO	Future AOs will depend upon availability of resources.									


Last Updated: October 12, 2011


Astrophysics - Missions in Formulation & Implementation

Project	Overall previous months				This Month					Comments
	-4	-3	-2	-1	O	T	C	S	P	
Physics of the Cosmos	G	G	G	G	G	G	G	G	G	
ST-7 (NET Apr 2014)	G	G	G	G	G	G	G	G	G	LPF Spacecraft level EMI/EMC testing completed in September.
Explorer Program										
NuSTAR (Feb 3, 2012)	Y	Y	Y	Y	Y	G	Y	Y	G	Observatory I&T underway.
Astro-H (~Feb 2014)	Y	Y	Y	Y	Y	Y	Y	Y	Y	EM SXT mirror shipped to Japan Oct 7. EM CSI post-vibe performance testing started.
GEMS (NET July 2014)	G	G	G	Y	Y	Y	G	Y	G	Polarimeter TRL to date has slipped, impacting PDR and CR dates.
Cosmic Origins										
SOFIA (ongoing)	G	G	G	G	G	G	G	G/Y	G	Completed first international deployment.
Exoplanet Exploration	G	G	G	G	G	G	G	G	G	
Balloons (ongoing)	G	G	G	G	G	Y	G	G	G	2011 Ft Sumner campaign underway. Antarctica campaign preparations initiated.

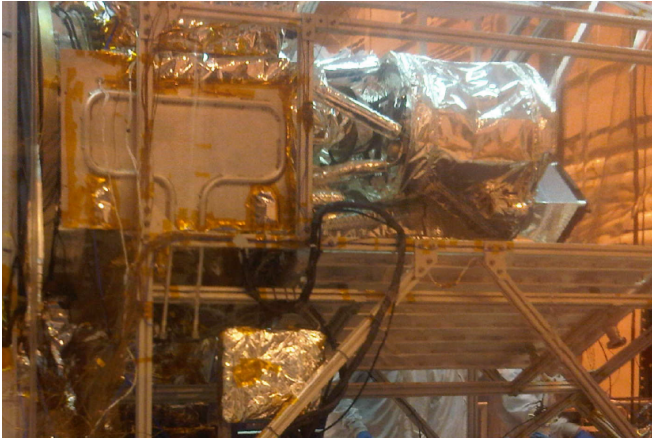
O: Overall, C: Cost, S: Schedule,
T: Technical, P: Programmatic

 On plan, adequate margin

 Problems, working to resolve within planned margin

 Problems, not enough margin to recover

Accomplishments & Significant Events



NuSTAR Observatory removal from TVAC chamber at OSC

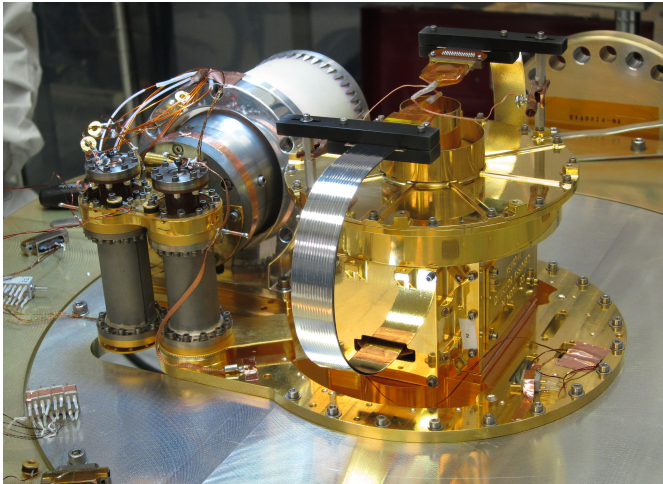


NuSTAR Observatory

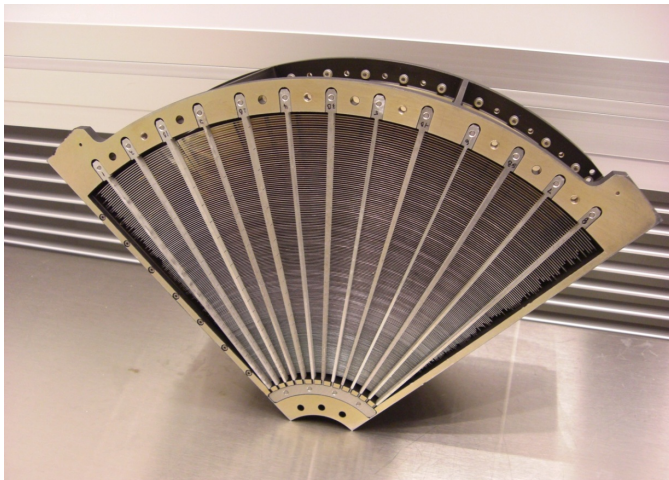
NuSTAR

- Thermal Vacuum Chamber testing successfully completed July 31 with no major issues.
- Solar Array attached to NuSTAR spacecraft, and successfully deployed on August 17, 2011.
- Vibration testing was underway when the east coast earthquake occurred. No damage. Vib test successfully completed September 8.
- Observatory acoustics test successfully completed September 14.
- Observatory shock test successfully completed September 19.
- NuSTAR launch scheduled for early 2012.

Accomplishments & Significant Events (cont.)



EM CSI: Detector assembly and ADR's #1 and 2 on right, ADR's #3 on left.



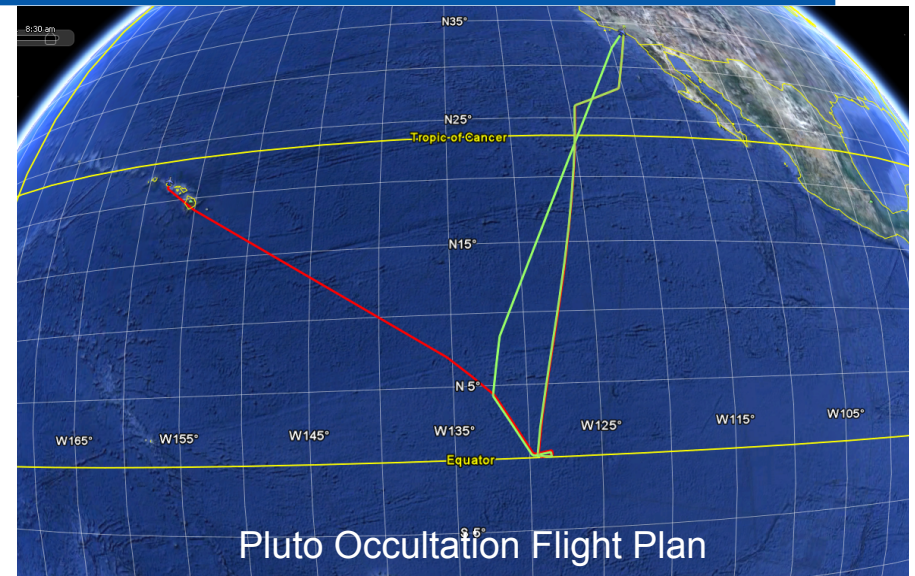
Astro-H EM Mirror quadrant.

Astro-H

- Engineering Model (EM) model Calorimeter Spectrometer Insert (CSI) has been completed. The CSI includes the detector and three Adiabatic Demagnetization Refrigerators (ADR's). The CSI is the primary NASA deliverable to JAXA for this mission.
 - Performance testing at cryogenic temperatures completed. Performance is nominal. The CSI cooled to operating temperature of 50 mK and X-rays were detected on all pixels.
 - Cold vibration testing completed in September. Post-vibe performance testing beginning week of October 10.
- The EM mirror quadrant for the soft X-ray telescope has been completed and was shipped to Japan October 7. The flight model (FM) mirror is in fabrication.
- The FM detector array is complete. The flight spare is in fabrication.

SOFIA

- Pluto Occultation successfully completed June 23, including 150-mile repositioning with in-flight replan.
- Released AO for second Generation Instruments on July 8. Proposals received Oct 7.
- Completed 9 (of 11 planned) Basic Science #2 flights with the GREAT instrument. Final two flight will be completed in early Nov.
- Completed mirror damage risk assessment and primary mirror repairs allowing completion of segment 2 flight schedule.
- First International Deployment to Germany (Sept 15-21) and Joint Base Andrews AFB stopover (Sept 22-23).



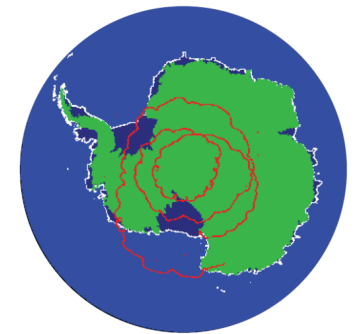
SOFIA Deployment to Germany September 2011



Balloon Program

Antarctica is center piece of the Balloon Program

- NASA-NSF/OPP Long-Duration Balloon (LDB) Program provides:
 - NASA's lowest cost access to space (\geq stratosphere)
 - Spacecraft-scale payloads (1000 - 2000 kg science instruments)
 - Exposures comparable to short-duration spacecraft
 - Recoverable / Re-usable payloads: Increase the exposure at low cost
- The Balloon Program has focused on expanding the highly successful LDB flights **around** Antarctica.
 - Flight durations of up to 4-6 weeks
 - Flight support to 3 payload flights every year



42-day CREAM flight
Dec - Jan 2004-05

Scientific Opportunities in the coming decade


- Frontier Astrophysics on Super-Pressure Balloons (SPB) launched **from** Antarctica enable Ultra-Long Duration Balloon (ULDB) flights.
- ULDB flights from Antarctica yield long exposure: 60 days now; 100 days soon.
 - Would like increased flight operations window in Antarctica
 - Work with NSF/OPP to enable flights to leave Antarctica and be recovered in South America, New Zealand, Australia, etc., thereby increasing science.





Record 54-day SPB
flight Dec - Feb
2008-09

Astrophysics – Operating Missions

Mission	Launch	End Date	Phase	-4	-3	-2	-1	This Month	Comments
Hubble	1990-04-24	2014-05-31	Prime	G	G	G	G	G	
RXTE	1995-12-30	2011-12-31	Ext	G	G	G	G	G	End of mission Dec 31, 2011.
Chandra	1999-07-23	2014-09-30	Ext	G	G	G	G	G	
XMM-Newton	1999-12-10	2012-09-30	Ext	G	G	G	G	G	
GALEX	2003-04-28	2011-12-31	Ext	G	G	G	G	G	End of mission Dec 31, 2011.
Spitzer	2003-08-25	2012-12-31	Ext	G	G	G	G	G	Decision made to swap to IRU-2 to continue high precision exoplanet science - done Aug 15-17th.
Swift	2004-11-20	2014-09-30	Ext	G	G	G	G	G	
Suzaku	2005-07-10	2011-09-30	Ext	G	G	G	G	G	
Fermi	2008-06-11	2013-08-18	Prime	G	G	G	G	G	Released updated gamma ray source catalog with 1873 sources, 589 are unidentified cosmic mysteries waiting to be solved.
Kepler	2009-03-07	2012-11-07	Prime	G	G	G	G	G	SOC8 was released late Sept.
Herschel	2009-05-14	2013-05-14	Prime	G	G	G	G	G	
Planck	2009-05-14	2012-02-14	Ext	G	G	G	G	G	

 On plan, adequate margin

 Problems, working to resolve within planned margin

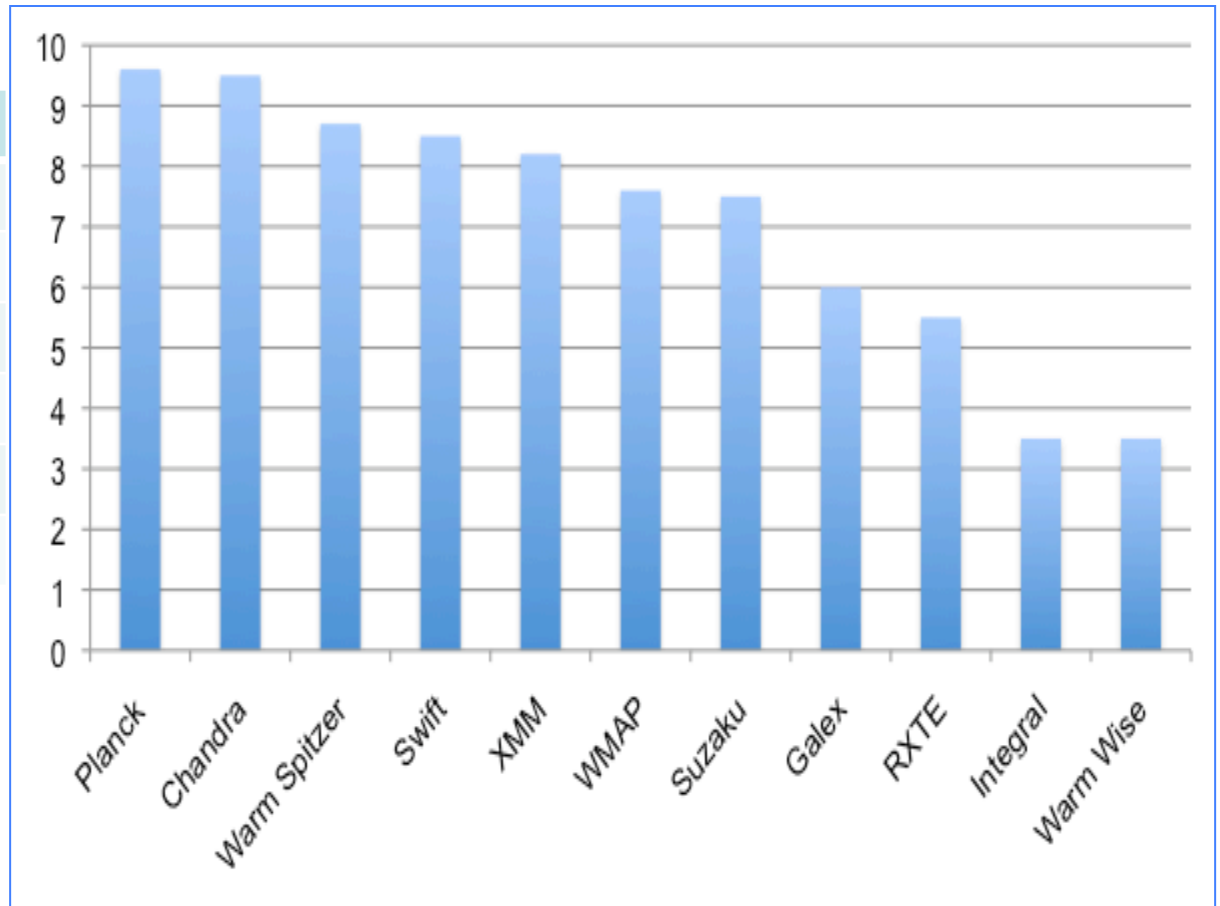
 Problems, not enough margin to recover

Senior Review of Operating Missions

- NASA uses the Senior Review process to maximize scientific productivity of operating missions which have completed prime operations. NASA uses the findings from the Senior Review to:
 - Prioritize the operating missions and projects.
 - Define an implementation approach to achieve astrophysics strategic objectives.
 - Provide programmatic direction to the missions and projects for two fiscal years following the Senior Review.
 - Issue initial funding guidelines for the 3rd and 4th fiscal years following the Senior Review.
- Held every two years, the Senior Review evaluates proposals for continued funding for its operating missions. It is the highest level of peer review within the Astrophysics program.
- Missions in this review include all operating missions in the Astrophysics portfolio that have completed their Level-1 requirements and completed prime operations.

Senior Review 2010 Rankings

Rank ordering	
1. Planck (9.6)	7. Suzaku (7.5)
2. Chandra (9.5)	8. GALEX (6)
3. Warm Spitzer (8.7)	9. RXTE (5.5)
4. Swift (8.5)	10. INTEGRAL (3.5)
5. XMM-Newton (8.2)	11. Warm WISE (3.5)
6. WMAP (7.6)	



2012 Senior Review of Operating Missions

Invited Missions	
Planck	Hubble
Chandra	Fermi
Warm Spitzer	Kepler
Swift	
XMM-Newton	
Suzaku	

2012 Senior Review Schedule	
Draft Call for proposals	Jul 1, 2011
Call for Proposals	Aug 10, 2011
EPO SR Proposals Due	Dec 15, 2011
SR Proposals Due	Jan 15, 2011
EPO Section Review	Jan 23 - 25, 2012
SRC Meets	Feb 28 - Mar 2, 2012
Final Report	Mar 30, 2012

Changes to the 2012 Senior Review

- Better defined process for inviting missions into the Senior Review.
- EPO review part of Senior Review 2012.
 - In 2010, the EPO review was performed separately, after the Senior Review.

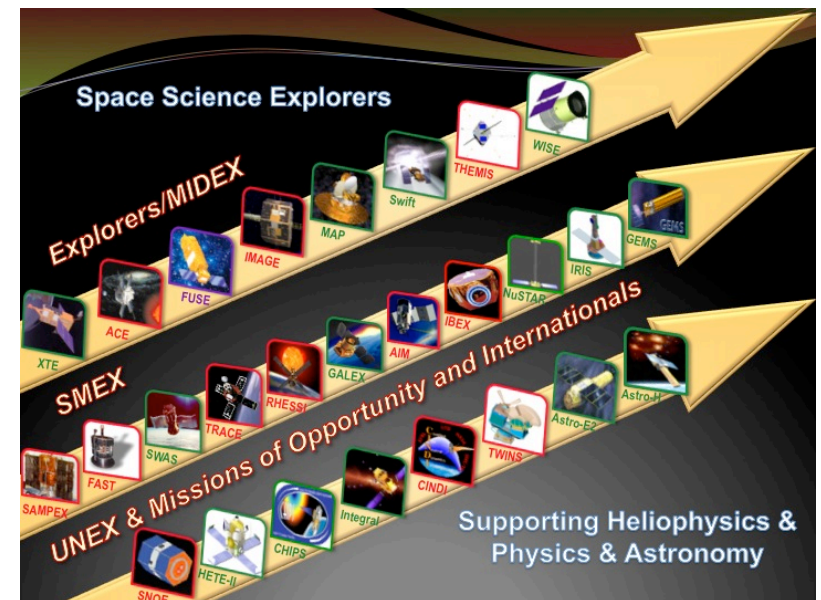
New Projects in the Senior Review

- Kepler and Fermi were invited to participate in the Senior Review - completed Level 1 requirements review.
- In 2009, the Astrophysics Subcommittee had recommended that Hubble be invited to the 2012 Senior Review.

<http://science.nasa.gov/astrophysics/2012-senior-review/>

Explorers Summary

- **NWNH Recommendation:**
The committee therefore recommends, as its second priority in the large category of space-based projects, that NASA should support the selection of two new astrophysics MIDEX missions, two new astrophysics SMEX missions, and at least four astrophysics MoOs over the coming decade. AOs should be released on a predictable basis as close to annually as possible, to facilitate Missions of Opportunity. Further, the committee encourages inclusion of suborbital payload selections, if they offer compelling scientific returns.
- A Future Astrophysics Explorer missions budget was created to increase the flight rate to achieve the recommended four missions and four missions of opportunity selected by the end of the decade.
- **Notional Mission Selection Dates:**
 - ✓ September 2011 Step 1 Explorer and MoO selection (current AO)
 - February 2013 Step 2 Explorer selection and MoO (current AO)
 - September 2013 Step 1 Explorer and MoO selection (next AO)
 - February 2015 Step 2 Explorer selection and MoO (next AO)



The September 2011 selection had:

- 15 Astrophysics EX mission proposals - \$200M plus launch costs
- 11 Astrophysics SALMON/Missions of Opportunity proposals - \$55M includes both Partner MOs and Small Complete Missions

Explorer Selections

September 2011

Step 1 Explorer Selections

Fast INfrared Exoplanet Spectroscopy Survey Explorer (FINESSE) Mark Swain, PI, JPL
This proposal would use a space telescope to survey more than 200 planets around other stars. This would be the first mission dedicated to finding out what comprises exoplanet atmospheres, what conditions or processes are responsible for their composition, and how our solar system fits into the larger family of planets.

Transiting Exoplanet Survey Satellite (TESS) George Ricker, PI, MIT
Using an array of telescopes, TESS would perform an all-sky survey to discover transiting exoplanets, ranging from Earth-sized to gas giants, in orbit around the nearest and brightest stars in the sky. The mission's primary goal would be to identify terrestrial planets in the habitable zones of nearby stars.

MoO Selections

Gal/Xgal U/LDB Spectroscopic/Stratospheric THz Observatory (GUSSTO) Christopher Walker, PI, University of Arizona, Tucson -- This mission would launch a high altitude balloon with a one-meter telescope to provide a comprehensive understanding of the inner workings of our Milky Way galaxy and one of our galaxy's companion galaxies, the Large Magellanic Cloud.

Neutron star Interior Composition ExploreR (NICER) Keith Gendreau, PI, Goddard -- This mission would place an X-ray timing instrument on the International Space Station (ISS) to explore the exotic states of matter within neutron stars and reveal their interior and surface compositions.

Programmatic Special Topics

Astrophysics Division

- **Improving Communications**

- New Astrophysics Division Communication Plan created.
 - Concise, accurate, and timely communication to internal and external stakeholders is critical.
 - Improve communication with the scientific community and the public.
 - SMD Astrophysics website will evolve to provide additional info.
- New Quarterly Program Office meeting will:
 - Improve communication between the Program Offices.
 - Use the Program expertise.
 - Build outreach.
- Astrophysics Division Website:
 - *<http://science.nasa.gov/astrophysics/>*

Objective

- Develop alternative plans to address high priority IXO and LISA scientific objectives described in the 2010 Astrophysics Decadal Survey, “*New Worlds, New Horizons*” (NWNH).
- Identify mission concepts in the \$300M- \$2B to satisfy part or all of X-Ray and Gravitational Wave science goals recommended by NWNH.
- Provide guidance for technology investments for X-ray and gravitational wave sciences.

Key Products

- A Study Report summarizing achievable science goals within certain cost bins.
 - Mission design details and cost information for those missions refined through one of NASA’s mission design labs.
 - Summary of all responses received through the RFI.
- Presentation to the CAA.



X-Ray & Gravitational Wave Concept Studies

Approach

- Gather information from community through Request for Information (RFI).
 - RFI Solicits concepts for missions, instruments and enabling technology for future X-ray and gravity wave missions.
- Assemble a Community Science Team (CST) through solicitation via Dear Colleague Letters to provide scientific guidance.
- Narrow down concepts in community workshop.
- Further refine concept through NASA's mission design labs.
- Present concepts to NRC Committee of Astronomy & Astrophysics (CAA).
- Develop strategic mission concept based on CAA recommendations.
- PCOS Program Office is focal point for coordinating studies.
- PCOS Program Office and CST work as a team in conducting these studies.

Important Dates

X-Ray Concept Study	
RFI Release	Sept 13, 2011
Responses Due	Oct 28, 2011
CST solicitation release (thru Dear Colleague Ltr)	Oct 3, 2011
CST responses due	Oct 19, 2011
Community Workshop	Dec 2011
Mission Design Activity	Feb-Apr 2011
Draft Report Release	Early June, 2012
Final Report Release	Late June 2012
CAA Presentation	TBD

GW Concept Study	
RFI Release	Sep 27, 2011
Responses Due	Oct 28, 2011
CST solicitation release (thru Dear Colleague Ltr)	Oct 7, 2011
CST responses due	Oct 25, 2011
Community Workshop	Dec 2011
Mission Design Activity	Feb-Apr 2012
Draft Report Release	Early June 2012
Final Report Release	Late June 2012
CAA Presentation	TBD

- Concept Study activity will conclude with presentations to the CAA.
- The study team, including the CST, will then be disbanded.

<http://pcos.gsfc.nasa.gov/studies/>

ESA Cosmic Vision Status

Astrophysics

M-Class Missions (M1 and M2)

- ✓ September 19, 2011, the Astrophysics Working Group (AWG) sent its recommendations to the Space Science Advisory Committee (SSAC).
- ✓ AWG recommended that Solar Orbiter and Euclid be selected as M1 and M2, respectively, and proposed that PLATO continue in the competitive process for the M3 mission.
- ✓ October 4, 2011, the SSAC accepted the recommendations of the AWG.
- November 2011, the Science Programme Committee (SPC) meets to consider the SSAC decision on two missions for the invitation to Tender release.
- July 2012, following 'consolidation' of partners, Science Programme Committee will consider adoption of missions (Cost-at-Completion and Payload Formal Agreement).
- September 2012, M2 mission enters Implementation Phase.

M-Class Mission M3

- ✓ EChO, LOFT, MarcoPolo-R and STE-QUEST selected for Assessment Phase and further downselect for launch in 2022. (PLATO may be included if the mission re-proposes per AWG recommendation)

Timeline for selection of M-Class missions from: <http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=42370>

ESA Cosmic Vision Status Astrophysics

L-Class Missions (L1 & L2)

- ✓ October 2007: EJSM-Laplace, IXO & LISA selected for study, with NASA in a key role in all three.
- ✓ February 2011: Assessment phase completed, but NWNH and NASA budget preclude proceeding
- ✓ April 2011: ESA defined new approach – European-led teams to define affordable European-led missions with limited international participation for launch in early 2020s
 - ✓ Athena (replacing IXO), LISA, and EJSM-Laplace studies are underway
 - Technical studies to be completed in November 2011
 - Review by ESA advisory bodies in December 2011 – January 2012
- February 2012: Recommendation to SPC for one or two missions to enter phase A/B1
- L1 target launch date 2020.

Euclid

- On Sept 19, 2011, ESA sent its recommendations to the Science Programme Committee (SPC).
 - ESA recommended that Solar Orbiter and Euclid be selected as M1 and M2, respectively, and will propose that PLATO continue in the competitive process for the M3 mission.
 - ESA has asked for a longer definition phase for Euclid than previously planned and ESA will propose that the SPC adopt the mission in July 2012 instead of February 2012. The launch would be in Q4 2019.
- On Oct 4, 2011, the Working group/SSAC recommendation for adoption of two missions was completed.
 - Same as ESA's recommendation above.
- Nov 2011, SPC decision on two missions for ITT release.
- July 2012, SPC adoption of missions (Cost-at-Completion and Payload Formal Agreement).
- September 2012, Missions enter Implementation Phase.

WFIRST

- Science Definition Team (SDT) has delivered its interim report in July 2011.
 - Copy of the report can be found at: http://wfirst.gsfc.nasa.gov/science/WFIRST_IDRM_Report_Final_signed_Rev2.pdf
 - The Interim Design Reference Mission (IDRM) is a proof of concept that a mission can be constructed that is compliant with the NWNH recommendation for groundbreaking observations in Dark Energy, Exoplanet and NIR sky surveys.
- Final SDT report to be delivered NLT December 2012.



New Technology Fellowship

Nancy Grace Roman Technology Fellowship in Astrophysics

- The Roman Fellowship is structured into three components with specific gates for entering the next phase.
 - A one-year Concept Study to generate the detailed plans and commitments for developing the proposed astrophysics technology. A final report is due nine-months after the start of the award, which will be peer reviewed.
 - A subset of the Technology Fellows will be selected to continue the fellowship and implement the plans conceived during the Concept Study. This Development Effort is for an additional four-years.
 - Fellows in the four-year Development Effort may apply for start-up funds when they obtain a tenure-track, permanent civil service, or equivalent position.
- The Roman Fellowship will:
 - Provide early career researchers the opportunity to develop the skills necessary to lead astrophysics flight instruments/projects and become principal investigators of future astrophysics missions.
 - Develop innovative technologies that have the potential to enable major scientific breakthroughs.
 - Foster new talent by putting early-career instrument builders on a trajectory towards long-term positions.

<https://science.nasa.gov/researchers/sara/student-programs/nancy-grace-roman-technology-fellowships-astrophysics-early-career-researchers/>

Theory and Computational Networks

- Astro2010 recommended a new competed theory program with coordinated interagency support to enable the large-scale theoretical investigations identified as science priorities by Astro2010.
- NASA and NSF have discussed the possible creation of such a joint program that should
 1. Advance both theoretical and computational astrophysics;
 2. Be explicitly multi-disciplinary; and
 3. Address workforce development in new research techniques.
- NSF and NASA plan to request the assistance of the AAAC in organizing and convening a workshop to collect input from the theoretical and computational astrophysics communities to better define the scope of such a program. (Discussion on agenda, at 2:25pm)
- Based on the report of the community workshop to be held in early 2012, the Agencies will consider the opportunity to issue a joint solicitation (no earlier than late 2012, with the first network selections in 2013).

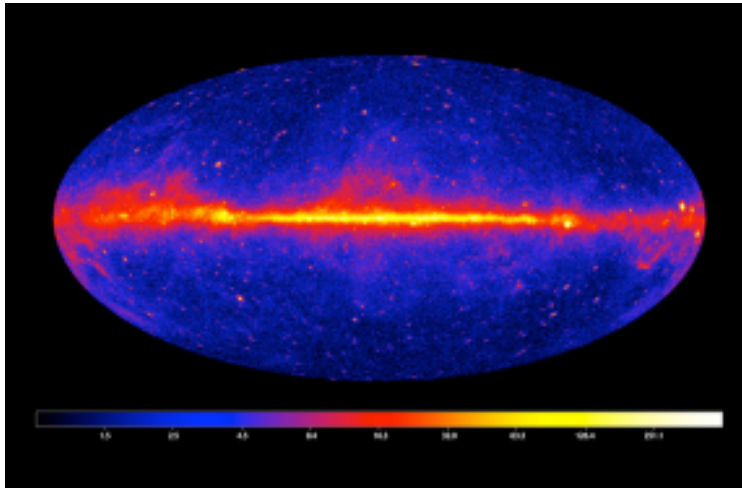
Awards

- **Saul Perlmutter, Brian P. Schmidt, and Adam G. Riess** received the 2011 Nobel Prize in Physics for the “discovery of the accelerating expansion of the Universe through observations of distant supernovae.”
- **W. Vernon Jones**, senior scientist, Astrophysics Division, NASA HQ received the:
 - 2011 AIAA Otto Winzen Lifetime Achievement Award, which honors outstanding contributions and achievements in the advancement of free-flight balloon systems or related technologies. Jones is being honored for applying the vision of long-duration balloons to a better understanding of cosmology and the fundamental origins of our universe.
 - 2011 Yodh Prize for his outstanding contributions to balloon-borne cosmic ray and particle astrophysics experiments
- **William Atwood** (UC Santa Cruz) received the American Physical Society’s 2012 W.K.H. Panofsky Prize in Experimental Particle Physics for his leading work on the design, construction, and use of the Large Area Telescope on the Fermi Gamma-ray Satellite, enabling numerous new results in gamma-ray astrophysics and fundamental physics.
- **Gerald Fishman** (MSFC) and **Enrico Costa** (Institute of Space Astrophysics and Cosmic Physics) shared the 2011 Shaw Prize in Astronomy for their leadership of space missions that enabled the demonstration of the cosmological origin of gamma ray bursts, the brightest sources known in the universe. Fishman was the principal investigator of the BATSE experiment aboard the Compton Gamma Ray Observatory, while Costa led the development of the Dutch-Italian satellite BeppoSAX.
- **Benjamin A. Mazin**, University of California, Santa Barbara, received the 2010 PECASE award. He was recognized for outstanding contributions to the development of ultra-sensitive, low-temperature detector arrays that provide energy resolution and arrival timing for photons from X-rays to the near infrared.

Top 10+1 Science Highlights of the Year

- **Fermi** Discovers Giant Structure in Our Galaxy (November 9, 2010)
- **Chandra** Finds Youngest Nearby Black Hole (November 15, 2010)
- **Kepler** Mission Discovers Its First Rocky Planet (January 10, 2011)
- **Fermi** Catches Thunderstorms Hurling Antimatter into Space (January 10, 2011)
- **Gravity Probe B** Confirms Two Einstein Space-Time Theories (May 4, 2011)
- **GALEX** Helps Confirm Nature of Dark Energy (May 19, 2011)
- **Hubble/Spitzer** Telescopes Discover Surprisingly Young Galaxy (April 12, 2011)
- **Herschel** Helps Solve Mystery of Cosmic Dust Origins (July 7, 2011)
- **WISE** Earth's First Trojan Asteroid Discovered – Neo-WISE Planetary (July 27, 2011)
- **Swift** Spots Black Hole Devouring a Star (August 24, 2011)
- **Kepler** Discovers First Planet Orbiting Two Stars (September 15, 2011)

FY11 Science Highlights



This **Fermi Gamma-ray Space Telescope** all-sky image is the deepest and best-resolved portrait of the gamma-ray sky. The colors map the number of gamma rays above 1 GeV per 0.01 square degree. It clearly shows that the entire sky is filled with gamma-rays with the brightest along the plane of our galaxy (bright yellow “bar” in the middle). Discrete gamma-ray sources include pulsars and supernovae remnants within our galaxy, as well as distant galaxies powered by supermassive black holes.

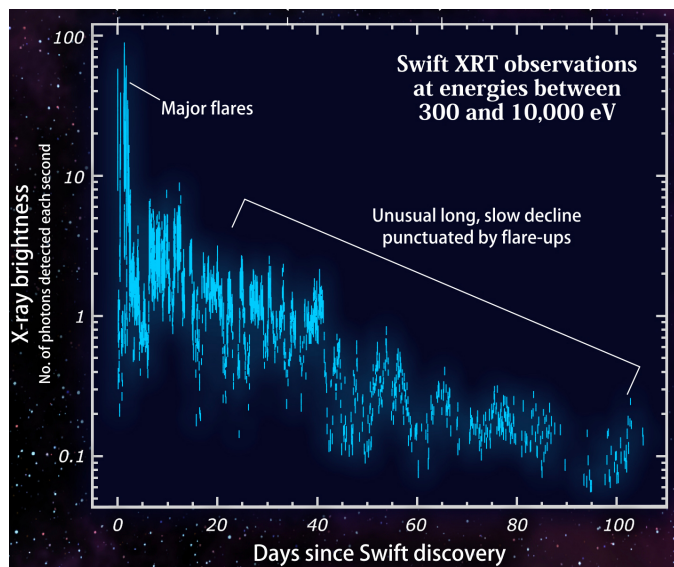


Scientists using data from NASA's **Wide-field Infrared Survey Explorer (WISE)** have discovered the coldest class of star-like bodies, with temperatures as cool as the human body. Astronomers hunted these dark orbs, termed Y dwarfs, for more than a decade without success. When viewed with a visible-light telescope, they are nearly impossible to see. WISE's infrared vision allowed the telescope to finally spot the faint glow of six Y dwarfs relatively close to our Sun, within a distance of about 40 light-years.

FY11 Science Highlights

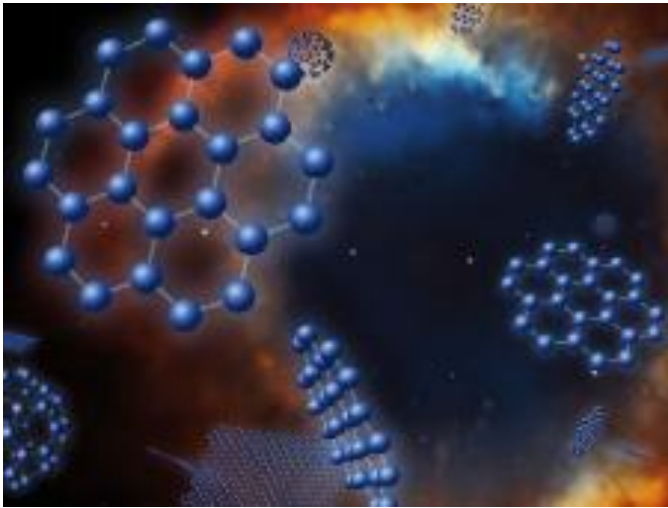


VV 340, also known as Arp 302, provides a textbook example of colliding galaxies seen in the early stages of their interaction. Data from NASA's **Chandra X-ray Observatory** (purple) are shown here along with optical data from the **Hubble Space Telescope** (red, green, blue). The edge-on galaxy near the top of the image is VV 340 North and the face-on galaxy at the bottom of the image is VV 340 South. Millions of years later these two spirals will merge - much like the Milky Way and Andromeda will likely do billions of years from now. VV 340 is located about 450 million light years from Earth.

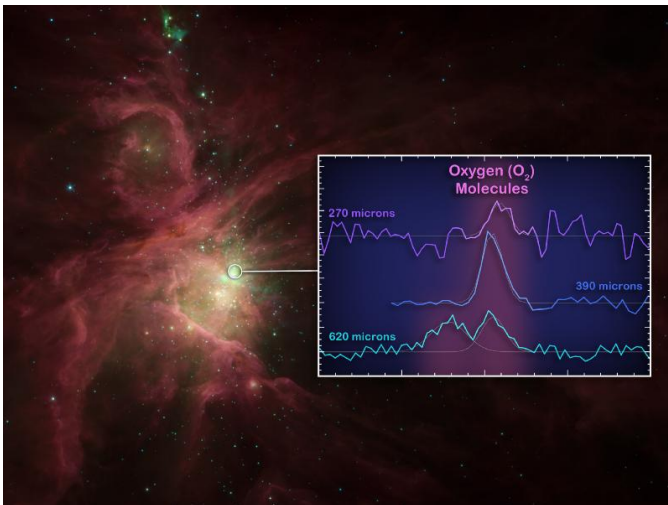


The **Swift X-ray Telescope** continues to record high-energy flares from Swift J1644+57 more than three months after the source's first appearance. Astronomers believe that this behavior represents the slow depletion of gas in an accretion disk around a supermassive black hole. The first flares from the source likely coincided with the disk's creation, thought to have occurred when a star wandering too close to the black hole was torn apart.

FY11 Science Highlights



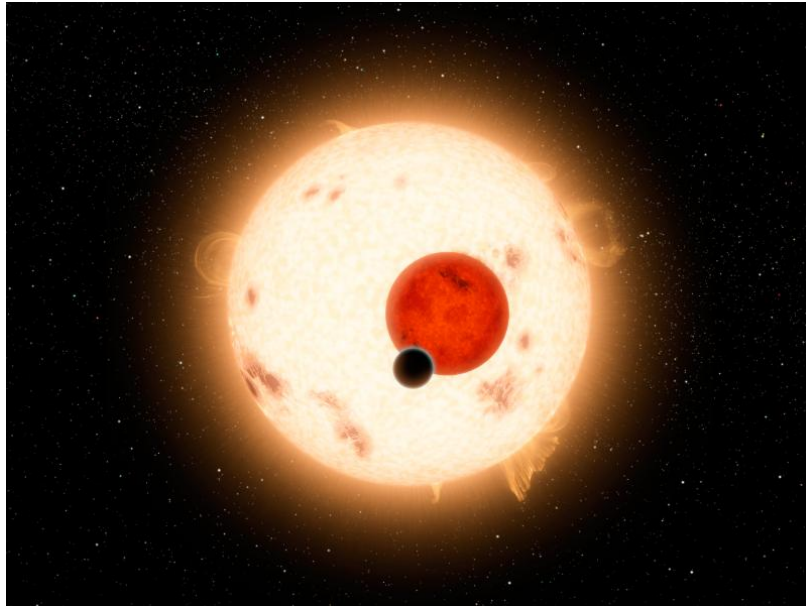
NASA's **Spitzer Space Telescope** has spotted the signature of graphene in space. If confirmed, this would be the first-ever cosmic detection of the material -- which is arranged like chicken wire in flat sheets that are one atom thick. Graphene was first synthesized in a lab in 2004, and subsequent research on its unique properties garnered the Nobel Prize in 2010. It is as strong as it is thin, and conducts electricity as well as copper. Some think it is the "material of the future," with applications in computers, screens on electrical devices, solar panels and more.



The **Herschel Space Observatory**, an ESA mission with important NASA contributions, definitely confirmed oxygen molecules in space near the star-forming core of the Orion nebula. The molecules, whose presence had been hinted at in space before, were detected by Herschel. The heterodyne instrument for the far infrared was used to split light from a specific region of the Orion nebula into its different submillimeter wavelengths. Astronomers recognized three distinct fingerprints of oxygen molecules. The three lines show different ranges of wavelengths, with the signatures of oxygen molecules highlighted in pink.

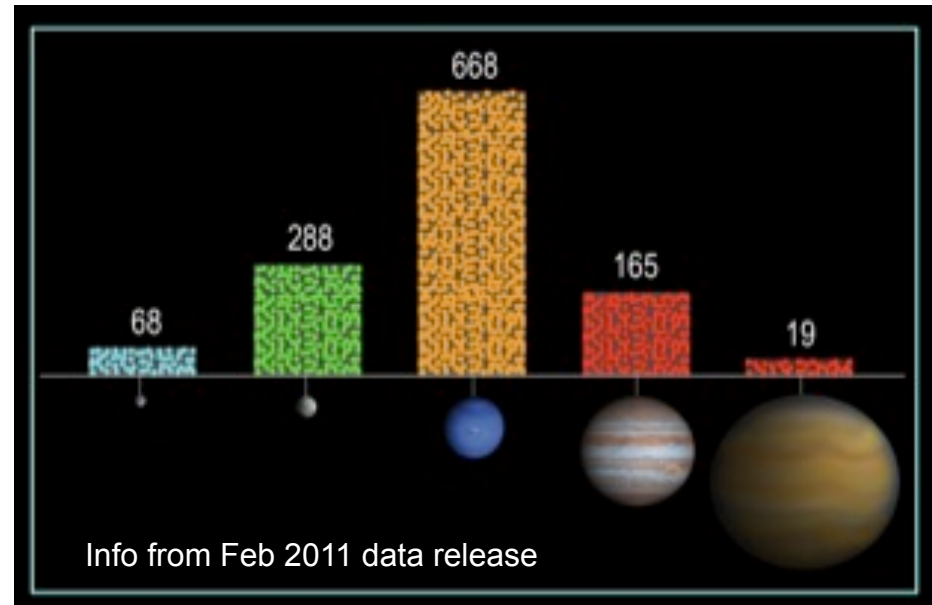
Kepler Mission

The First Circumbinary Planet



- The Kepler mission has made the first unambiguous detection of a circumbinary planet -- a planet orbiting two stars -- 200 light-years from Earth.
- The planet, called Kepler-16b, is a cold world, with a gaseous surface, and not thought to harbor life.
- Kepler-16b orbits around both stars every 229 days, similar to Venus' 225-day orbit.
- The parent stars are smaller than our sun. One is 69 percent the mass of the sun and the other only 20 percent.
- Kepler-16b lies outside the system's habitable zone, where liquid water could exist on the surface, because the stars are cooler than our sun.

Additional Data Released to Public Sept. 27



- The planetary candidates include: 68 of Earth-size, 288 of super-Earth-size, 662 of Neptune-size, 165 of Jupiter-size, and 19 larger than Jupiter as of January 2011.
- Kepler has released data on 155,453 stars and on the 1,235 planetary candidates that it has discovered in the first 4 months of science operations.
- 54 planetary candidates are in the habitable zone of their host stars, a region where liquid water could exist on a planet's surface. The 5 smallest of these range in size from 0.9 to twice the size of the Earth.
- 170 stars show evidence of multiple planetary candidates.
- Confirmed 20 exoplanets. Remaining planet candidates still require follow-up observations to verify they are actual planets.

On September 12, 2011, at the Extreme Solar System Conference, it was reported that Kepler has now identified: 1781 candidates, 121 in habitable zone, 123 are less than 1.25 as wide as the Earth, and 27 confirmed exoplanets.

Backup Slides

Response to AAAC 2011 Report

- *The new NRC Astro2010 decadal survey report: New Worlds, New Horizons (NWNH), is a culmination of unprecedented community effort. The report represents the nationwide consensus of the most critical and promising future directions in astrophysics and astronomy. For the first time independent assessment of cost and technical maturity of all proposed projects was included in the decision making process.*

Agreed. No response required.

- *The many ongoing NASA, NSF and DOE science breakthroughs and successes in astrophysics and astronomy are the result of successful agency stewardship of previous decadal surveys. That is, the decadal process really works, and it is important to maintain the priorities and balance given in NWNH.*

Agreed. No response required.

Response to AAAC 2011 Report (cont.)

- *Budgetary constraints may severely delay the implementation of many of the NWNH recommended projects. Continued budgetary constraints have the potential to damage current U.S. worldwide leadership in astronomy and astrophysics.*

No response required. See previous slides.

- *We highly commend the initial response of the agencies to NWNH, given the budgetary constraints. Especially welcome are NASA's plans for the midscale Explorer program, NSF's plan for midscale innovation projects, the NASA Tech Fellows program, and NASA's Wide-Field Infrared Survey Telescope (WFIRST) plans.*

No response needed.

Response to AAAC 2011 Report (cont.)

- *We commend the interagency actions by the NSF and DOE with respect to the Large Synoptic Survey Telescope (LSST), which we find to be consistent with the recommendations of NWNH.*

No response required.

- *"Rising Above the Gathering Storm" warns that the Nation must do a better job in training the next generation of scientists and engineers in order to remain competitive. Astronomy has a role to play in this regard, because it is a mind-opening field, a gateway, in which exciting discoveries can attract young people to STEM (science, technology, engineering, and mathematics) careers.*

See E/PO slide in Division Update.

Response to AAAC 2011 Report (cont.)

- *As noted in the AAAC letter of October 22, 2010, the Committee remains concerned about the potential impacts of the anticipated James Webb Space Telescope (JWST) cost increases and schedule delays on the NWNH recommended major space activities for the decade.*

No response required.

- *NWNH called for the formulation of a Decadal Survey Implementation Advisory Committee (DSIAC) to provide strategic advice on decadal report-related issues and to monitor the progress on achieving the recommendations. While the AAAC has a role as shepherd over the decadal results, its charge is primarily to be a tactical committee, whose role is to advise on issues related to project development, particularly projects that cut across more than one agency. AAAC is available to work with a newly formed DSIAC as needed.*

NASA will use the National Research Council to set up advisory councils on an as needs basis.

Response to AAAC 2011 Report (cont.)

- *The Committee finds that interagency cooperation plays a key role in the astronomy research program and will continue to do so through the next decade. The agencies have identified opportunities for joint activities from the priorities recommended in the NWNH program, but the Committee notes that in many cases activities may be limited by the tight fiscal environment.*

NASA will continue to seek collaborative opportunities with NSF and DOE and work towards maximizing the scientific output from its missions and research programs in astronomy.

Astro2010 Decadal Survey Agency Response

- Astro2010/NWNH Science Objectives:
 - ✓ Astrophysics programmatic structure is well-aligned with the three scientific thrusts.
- Astro2010/NWNH Small-Scale:
 - ✓ Augmented investments in core research and technology programs as recommended:
 - Astrophysics Theory Program
 - Definition of a future UV-optical space capability
 - Intermediate technology development
 - Laboratory Astrophysics
 - Suborbital Program
 - ✓ Initiated discussions with NSF on a joint program for Theory and Computation Networks (discussing with AAAC).
 - ✓ Maintaining discussions with JAXA and ESA on SPICA concept development.
- Astro2010/NWNH Medium-Scale:
 - ✓ Augmented Exoplanet technology development support that feed into candidate architectures for a future direct-detection mission.
 - ✓ Initiated technology development support for cosmic inflation probe concepts.
- Astro2010/NWNH Large-Scale:
 - ✓ An Astrophysics Explorer Future Missions budget has been created to increase the flight rate to achieve the recommended four missions and four missions of opportunity selected by the end of the decade.
 - ✓ Support for mission concept planning and technology development relevant to the survey's Large space missions: WFIRST, LISA, IXO. NASA is also exploring potential collaborations on ESA's proposed Medium and Large Cosmic Vision missions.

Astrophysics Education and Public Outreach Portfolio

- **Flight Missions:** Every mission is required to have an E/PO plan.
- **Competitive opportunities for community participation:**
 - Education and Public Outreach for Earth and Space Science (EPOESS) is an annual solicitation through ROSES.
 - ROSES Education and Public Outreach supplements for any funded NASA research investigation.
 - NASA Earth and Space Science Fellows solicitation for graduate students.
 - SOFIA Airborne Astronomy Ambassadors.
- **Program Offices:**

Develop thematic initiatives reflecting the science and technology of the individual missions and the overall thematic elements of the program.

 - PCOS and COR Program Offices are developing coordinated approach to PCOS and COR science E/PO.
 - Exoplanet Exploration Program Office has an established E/PO program which has been updated to reflect the current program.
- **Science Education and Public Outreach Forums:** NASA's Forums can help you share your science with educators, students, or the public (see <http://smdepo.org/node/305>).
 - The Astrophysics Forum is creating an education and outreach resource partner network where you will be able to share ideas and connect with NASA programs.
 - Contact address: AstroForum@stsci.edu

Press releases since May

60 press releases linked to science in the APD portfolio

May 2011

- May 4: Gravity Probe B Confirms Two Einstein Space-Time Theories
- May 9: Herschel: Raging Storms Sweep Away Galactic Gas
- May 11: NASA: Fermi Spots 'Superflares' in the Crab Nebula
- May 12: Hubble: Galaxy NGC 4214 - A Star Formation Laboratory
- May 12: Chandra: The Crab Nebula in Action & the Dog That Did Not Bark
- May 13: Kepler: SETI Survey Focuses on Kepler's Top Earth-Like Planets
- May 19: GALEX Helps Confirm Nature of Dark Energy
- May 23: Kepler's Astounding Haul of Multiple-Planet Systems
- May 23: Hubble Views Star that Changed the Universe
- May 24: Chandra: Nearby Supernova Factory Ramps Up
- May 25: The Spitzer Photo Atlas of Galactic 'Train Wrecks'
- May 25: Swift: New Candidate for Most Distant Object in Universe
- May 25: NASA's WISE Mission Offers Taste of Galaxies to Come
- May 25: Hubble Finds 'Blue Stragglers' in Milky Way's Hub
- May 26: Spitzer Sees Crystal 'Rain' in Outer Clouds of Infant Star
- May 27: Astro-H Satellite Will Gather Elusive X-ray Data

June 2011

- June 8: Chandra: New Supernova Remnant Lights Up
- June 10: Chandra/Swift: Nearby Galaxy Boasts Two Monster Black Holes
- June 15: Chandra: X-ray Telescope Finds Voracious Black Holes in Early Universe
- June 15: Chandra/Hubble: Astronomers Discover Earliest Black Holes
- June 15: Hubble: Spectacular Hubble View of Centaurus A
- June 15: Chandra: Black Holes Were Common in Early Universe
- June 16: Gamma-Ray Flash from Star Being Eaten by Black Hole
- June 22: Hubble/Chandra/VLT/Subaru: Pandora's Cluster - Clash of the Titans
- June 24: SOFIA Observes Challenging Pluto Occultation
- June 28: XMM-Newton: Neutron Star Bites Off More Than It Can Chew
- June 29: Fermi: Odd Couple' Binary Makes Dual Gamma-Ray Flares
- June 30: Integral Challenges Physics Beyond Einstein
- June 30: Spitzer Finds Distant Galaxies Grazed on Gas

Press Releases (cont.)

July 2011:

- July 5: Hubble Makes Millionth Science Observation
- July 7: Herschel Helps Solve Mystery of Cosmic Dust Origins
- July 13: XMM-Newton/VLT: What Activates a Supermassive Black Hole?
- July 19: Herschel: Twisted Tale of Our Galaxy's Ring
- July 20: Hubble: Hubble Discovers Another Moon Around Pluto
- July 21: Hubble: Four Unusual Views of the Andromeda Galaxy
- July 27: WISE: Earth's First Trojan Asteroid Discovered
- July 27: Chandra Observatory Images Gas Flowing Toward Black Hole
- July 28: Webb Telescope Technologies Already Helping Human Eyes

August 2011

- August 1: Herschel Telescope Detects Oxygen Molecules in Space
- August 11: Hubble Offers a Dazzling View of the 'Necklace' Nebula
- August 18: Webb Telescope Instrument Completes Cryogenic Testing
- August 23: WISE Mission Discovers Coolest Class of Stars
- August 24: Swift Spots Black Hole Devouring a Star
- August 25: Hubble: Missing Fuel for Galactic Star Formation Identified
- August 30: NASA: Astrophysics Fellowship Named for Iconic Woman Astronomer
- August 31: Hubble Movies Show Supersonic Jets from Young Stars
- August 31: Chandra Finds Nearest Pair of Supermassive Black Holes

Press Releases (cont.)

September 2011:

- September 7: HEAD: Prize for Top High-Energy Astrophysics Dissertation Awarded
- September 8: HEAD: Dennis Overbye Wins Schramm Science Journalism Award
- September 8: Kepler: Invisible World Discovered
- September 9: Fermi: Latest Gamma-ray Census Highlights Cosmic Mysteries
- September 13: Herschel Paints New Story of Galaxy Evolution
- September 13: Webb Telescope Completes Mirror Coating Milestone
- September 13: Chandra: Star Blasts Planet with X-rays
- September 15: Hubble: Small Distant Galaxies Host Supermassive Black Holes
- September 15: Kepler Discovers First Planet Orbiting Two Stars
- September 16: Kepler: The Turbulent Lives of Stars
- September 19: WISE Raises Doubt About 'Dino Killer' Asteroid Family
- September 20: WISE Captures Black Hole's Wildly Flaring Jet
- September 22: Kepler: Web Users May Have Found New Planets