A Summary of the NASA Astrophysics Senior Review of Operating Missions 2016

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Membership

- Mark Bautz (MIT)
- Megan Donahue (MSU; chair)
- Richard Green (U. Ariz.)
- Günther Hasinger (UH Manoa)
- Lisa Kaltenegger (Cornell)
- Henric Kawczynski (Wash. U. St Louis)
- Andrew MacFayden (NYU)
- Dan McCammon (U. Wis.)
- Rebecca Oppenheimer (AMNH)
- Paula Szkody (U. Wash.)
- Dennis Zaritsky (U. Ariz.)

Report delivered to Paul Hertz (Director NASA Astrophysics), Daniel Evans (Program Scientist), and Jeffrey Hayes (Program Executive)

Charge to the committee

- Individually assess missions over FY17-18 (+2 years), including an adjectival assessment for each criterion.
- Rank the projects.
- Provide specific findings (including Continuation/ Termination)
- Six missions under review: Fermi, K2, NuSTAR, Spitzer, Swift, XMM. Chandra and HST extended mission proposals were reviewed by two separate committees.

Basis of findings - Charge

- Panel assessment and rankings
- Overall mission portfolio strength and abilities,including context of near future missions
- Projected science returns vs. increased funding elsewhere in the NASA program
- Scientific tradeoffs and opportunity costs in extensions or termination compared to future Astrophysics missions

Criteria - Charge

A. Science Program (40%)

- Uniqueness/strength of science; Output and ROI
- Synergy with astro portfolio; quality of archive/data/use

B. Relevance and Responsiveness (30%)

- SMD/2010 decadal relevance; progress in PMOs from last review; performance on findings f/SR2014

C. Technical Capability and Cost Reasonableness (30%)

- Cost efficiency in meeting proposed goals
- Health of spacecraft and operations
- Operating Costs

Process

- Each mission submitted a proposal which all members read. Each mission provided a presentation with a short Q&A session.
- All missions were discussed in panel immediately; each mission was discussed again the next day.
- Each panelist gave a numerical grade for each mission for each criterion (3 grades per mission).
  (Table 2 in the report; see definitions of adjectives in Table 1)
- Each panelist gave a ranking 1-6 to each mission, incorporating programmatic balance and context considered.
  (Table 3 in the report.)

Operating Missions, ordered by criterion grades*

*Table 2

Name	Science	~Cost $M/yr
K2	Optical transients	10.4, 8.9
Swift	Gamma-ray, X-ray, opt/UV transients	6
XMM	X-ray imaging/ spectra	3
NuSTAR	Hard X-ray spectra	7
Spitzer	3.6 and 4.5 micron imaging	15, less for FY18
Fermi	Gamma-ray all-sky	17-18

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Table 2. Mean of panel rating matrix for the individual missions. Each row corresponds to a mission and each column corresponds to a criterion category.

Criteria	Science (A)	Relevance (B)	Cost (C)	Total
K2	E	E	E	E
Swift	E/VG	E	E	E
XMM	E/VG	E/VG	E	E/VG
NuSTAR	E/VG	E/VG	E	E/VG
Spitzer	E/VG	E/VG	VG	E/VG
Fermi	E/VG	E/VG	VG	E/VG

Scores: E=Excellent, E/VG = Excellent/Very Good, VG=Very Good

Mission	Rank
Swift	1
K2	2
NuSTAR	3
XMM	4
Fermi	5
Spitzer	6

- All mission proposals received extremely high grades for science (A) and relevance (B).
- The higher cost (C) of Spitzer and Fermi extended missions lowered their overall ranking compared to the other 4 extended missions.

Overview of Results

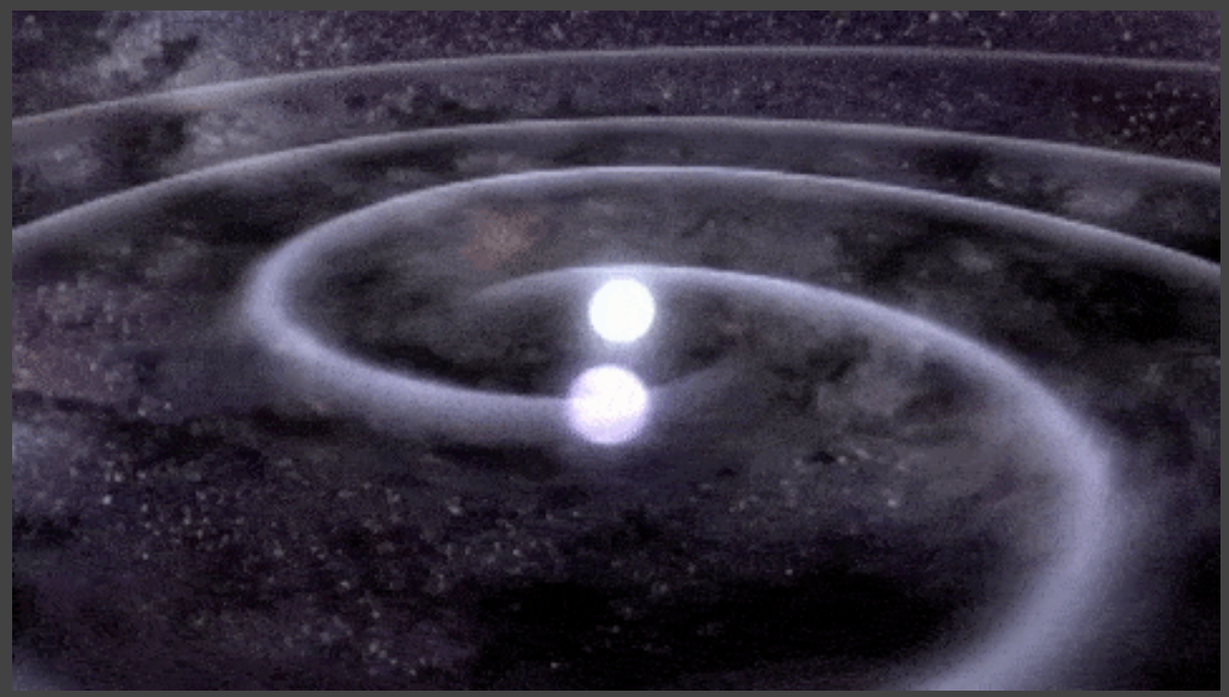
- The panel found no scientific reason to discontinue or significantly reduce funding for any of the six operating missions.
- The operating missions exhibit a high level of synergy. The current portfolio's scientific value is greater than the sum of its parts.
- Community science (GO/GI involvement) drives these missions at a very high scientific level of productivity, responsive to vital scientific needs.

Synergy Examples

- NuSTAR, Swift, and XMM simultaneous observations are answering long-standing questions about black hole binaries and accretion onto supermassive black holes.
- K2 monitoring campaigns have Swift coverage
- Spitzer follows up K2 campaign discoveries to characterize Earth-sized planets
- Spitzer IR coverage (e.g. high-z universe) makes discoveries for HST and JWST follow-up.
- Fermi+Swift monitor the transient gamma ray sky; potential gravitational wave science if transient is associated with LIGO GW source.

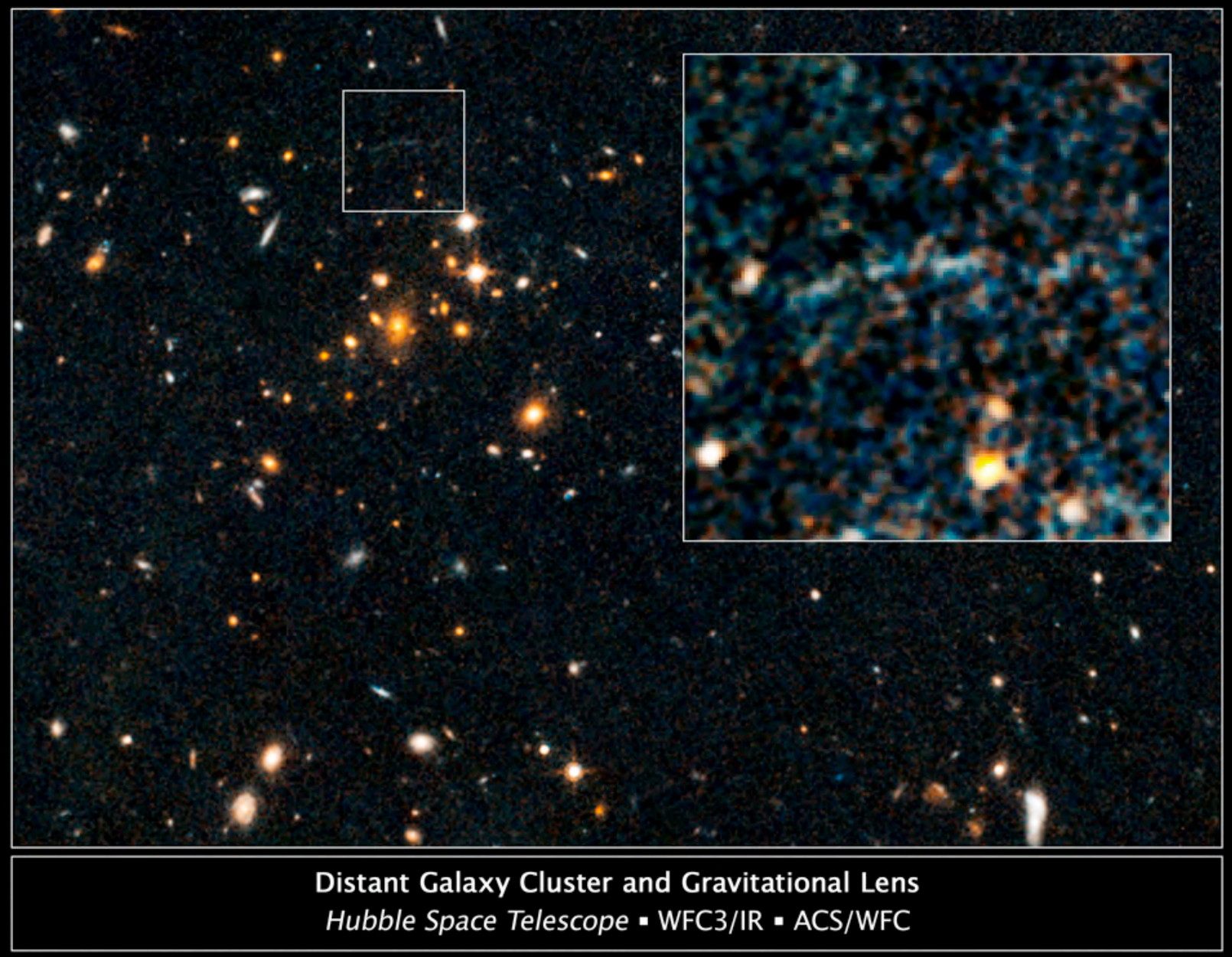
Fermi GBM may have the best chance of capturing the EM signature of a gravitational wave event

- NS and BH mergers may produce brief EM signals
- Large uncertainties in the source position
- The GBM sees a large fraction of the sky at one time.



nasa.tumblr.com

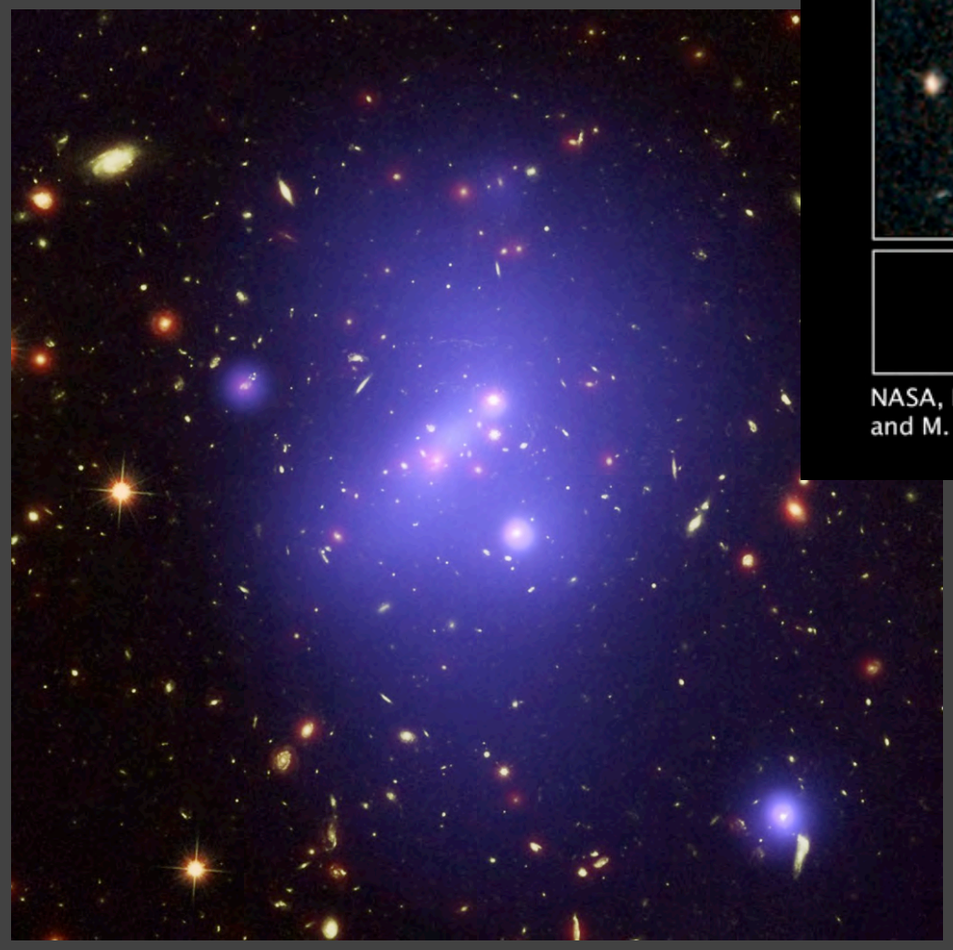
Spitzer efficiently finding and characterizing high redshift clusters of galaxies (th cluster at z=1.75 was found with Spitzer, characterized with HST and Chandra)



Distant Galaxy Cluster and Gravitational Lens
Hubble Space Telescope ▪ WFC3/IR ▪ ACS/WFC

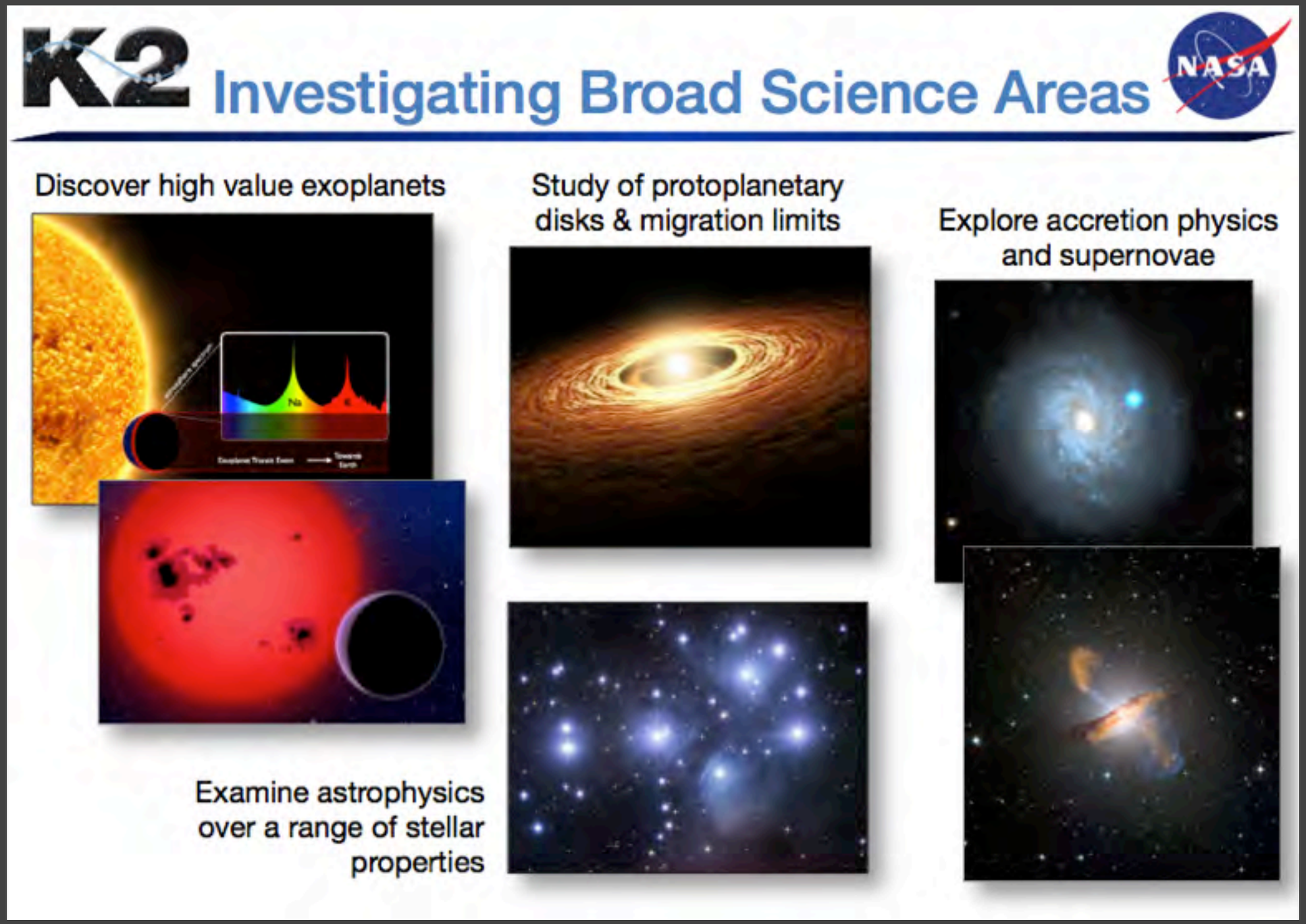
NASA, ESA, and A. Gonzalez (University of Florida), A. Stanford (University of California), and M. Brodwin (University of Missouri)

STScI-PRC12-19a



Massive, $5x10^{14}$ solar mass cluster IDCS J1426+3508
Brodwin, M. + 2016, ApJ

K2 campaigns apply near-Kepler photometric precision to new science areas



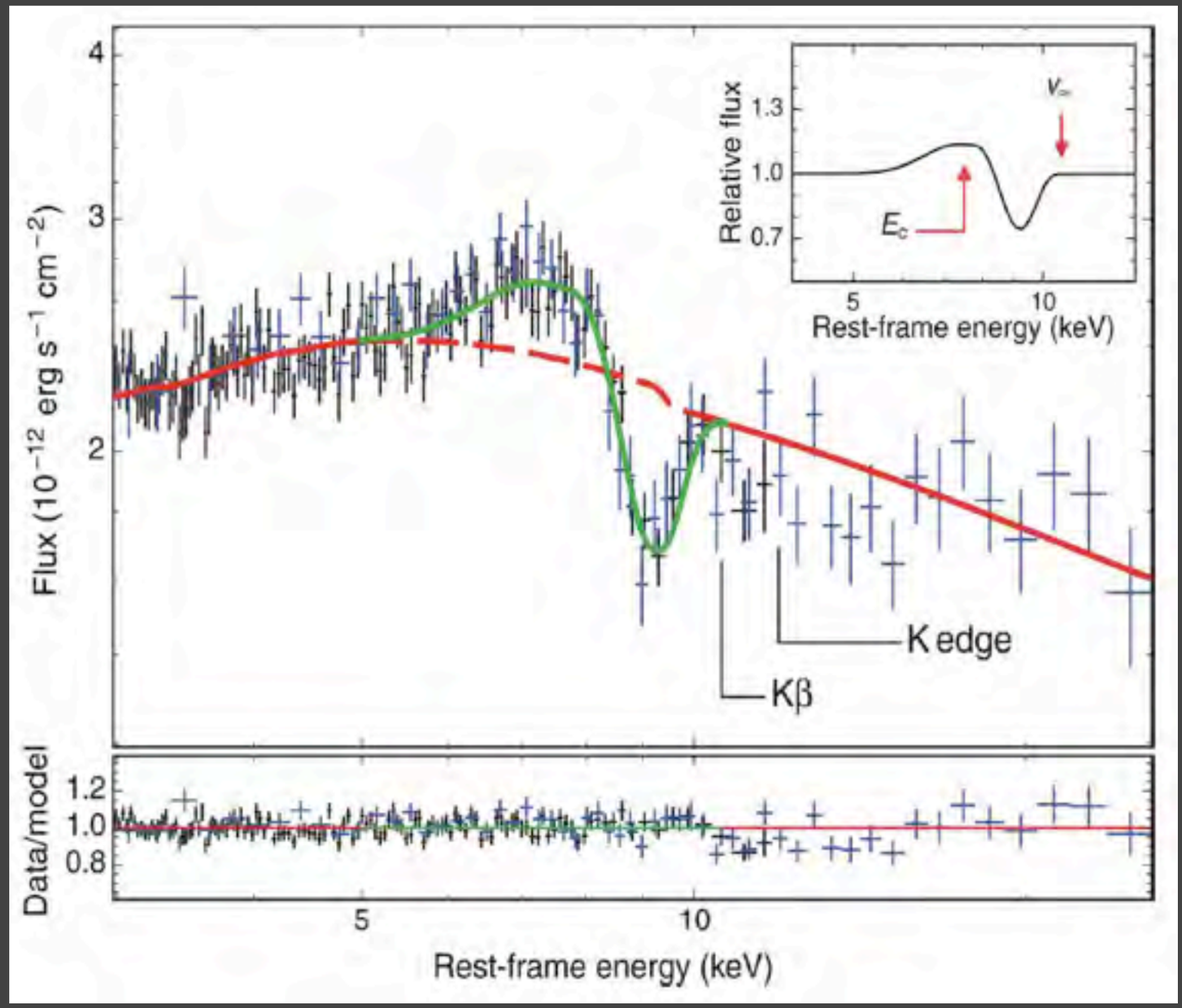
Portfolio: Swift monitoring, Spitzer longer-term planet observations

NuSTAR + XMM-Newton

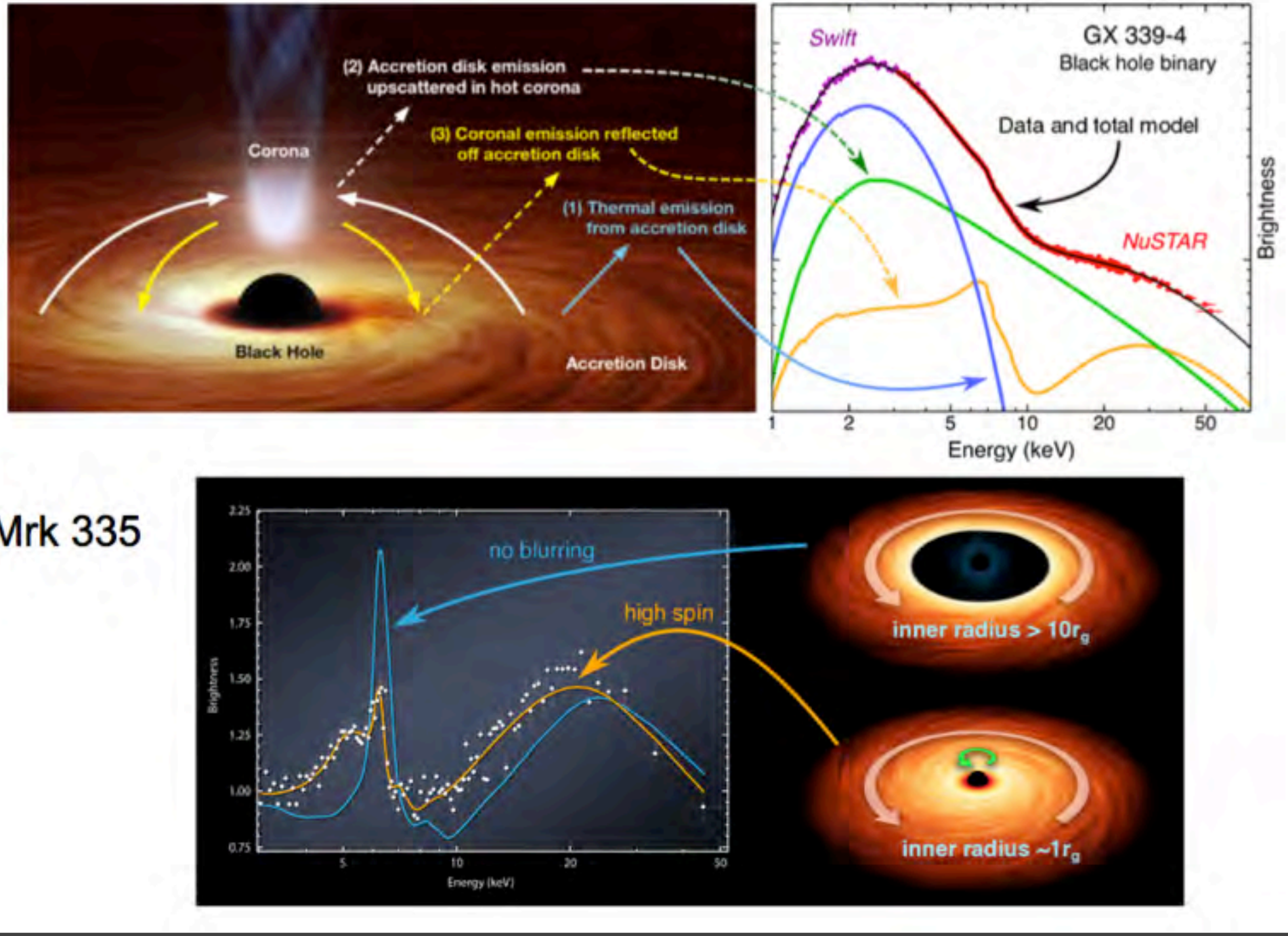
Possible AGN feedback mechanism:

P-Cygni profile of a wide, fast wind in a quasar.

Nardini+2015, Science, 347, 860



NuSTAR + X-ray



Maximally spinning black hole GX 339-4 (Parker +2016, ApJ Letter)

Maximally spinning supermassive black hole (NuSTAR + Suzaku, Swift, XMM; Parker+2014, MNRAS)

Uncertain budget

- The Senior Review was asked for scientific judgement and was not asked to solve NASA's budget problems, real or predicted.
- The overall Astrophysics budget uncertainty was at a level of the same order of magnitude as the SR2016 wedge.
- The SR identified a few areas of potential cost-savings and relative priorities in individual budgets.
- The SR2016 report identifies scientific synergies and strengths that should be taken into consideration under budget pressure.

Recommendations

1. Cut overguides in reverse order of priority.
2. Reduce Fermi/Spitzer costs (<$3.5-4 M)
3. Further cut Spitzer (no shutdown)
4. Further cut Fermi, priority GBM over LAT (no shutdown)

Some areas of cost savings and priorities for specific missions were identified in the SR2016 report; we recommended NASA scrutinize budgets and operations for efficiencies.

Summary of NASA decisions

- Chandra X-ray Observatory: continued operation confirmed.
- Fermi Gamma-ray Space telescope: extension approved.
- Hubble Space Telescope: continued operation confirmed.
- K2 mission: extension approved through end of mission.
- Nuclear Spectroscopic Telescope Array (NuSTAR): extension approved.
- Spitzer Space Telescope: extension approved through end of mission.
- Swift Gamma-ray Burst Explorer: extension approved.
- X-ray Multi-Mirror Mission-Newton (XMM-Newton) (ESA mission): extension approved.

These decisions are contingent on the Astrophysics Division receiving the funding requested in the FY 2017 President's Budget Request. Additionally, some adjustments will need to be made within the Astrophysics Division budget to accommodate all operating missions.

Link to NASA Response

- http://science.nasa.gov/media/medialibrary/2016/06/28/NASA_Response_SR2016_Final-2_tagged.pdf