National Aeronautics and Space Administration

EXPLORE SCIENCE

# Internal Scientist Funding Model Update

APAC Meeting | October 20, 2020

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ISFM Lead, Astrophysics Division

Science Mission Directorate

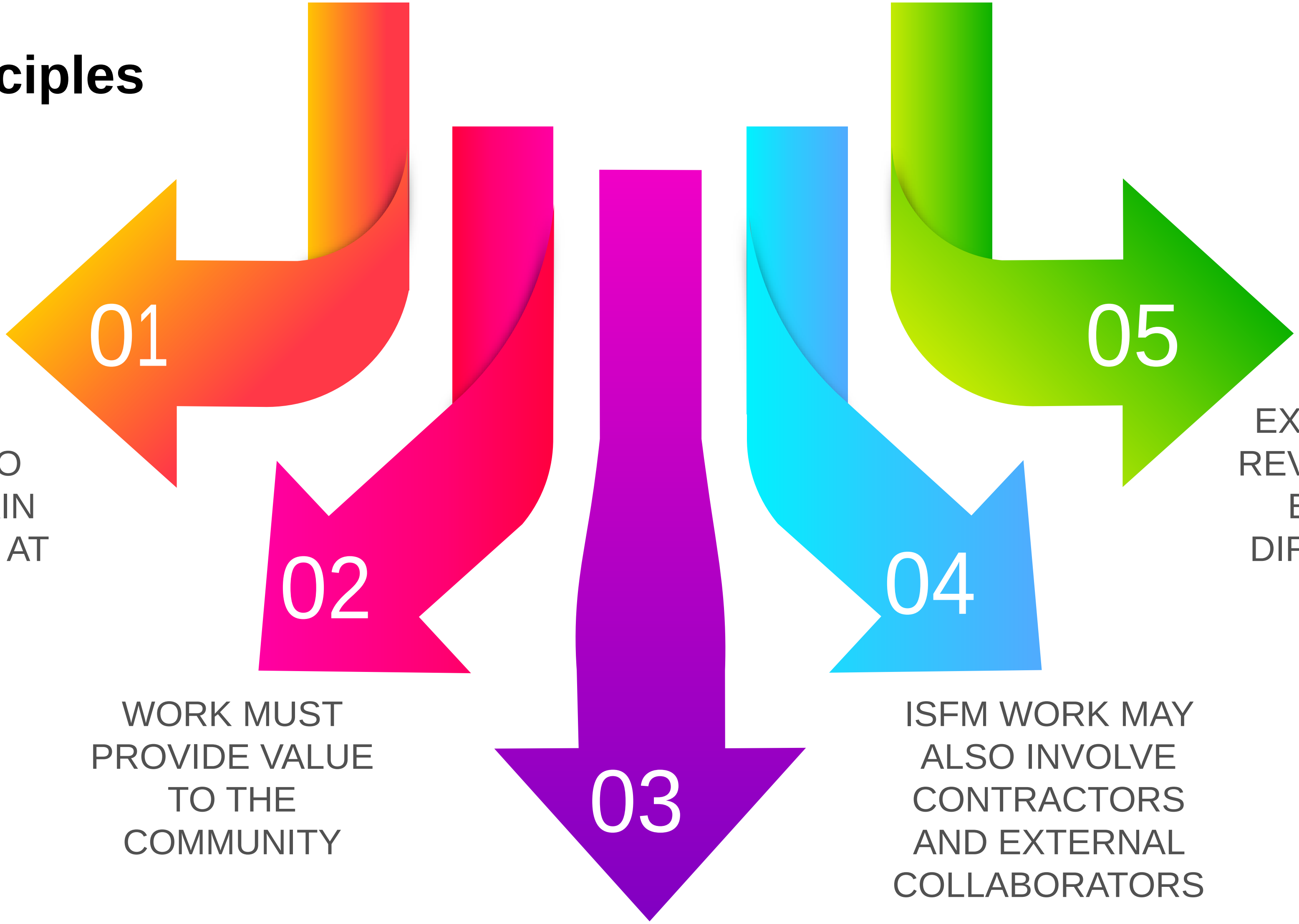
# ISFM Overview

# ISFM History

NASA's Internal Scientist Funding Model (ISFM) was created as a result of a 2015 internal study performed by the Agency Competition Team, created by then Associate Administrator, Mr. Robert Lightfoot. The NASA Mission Support Council found that:

- Approximately 350 of the 1000 Agency Civil Servant (CS) scientists are partially funded through competitively won Research and Analysis (R&A) grants (the total funding from R&A is ~150 FTE);
- Unlike Other Government Agencies (OGAs), internal (NASA CS) and external scientists (e.g., university researchers) compete for the same funding;
- NASA spends significant resources competing for already appropriated research funding dollars;
- Early Career scientists have a hard time competing with older, more established researchers, and face a system that doesn't nurture them;
- Scientists spend too much time writing proposals that only cover a small fraction (0.1 FTE) of their time, forcing them to write many proposals; and,
- There has previously been no strategic hiring of scientists. Hiring decisions have been made at Centers without HQ consultation and, therefore, without any NASA-wide planning.

# ISFM Key Principles




01. NATIONAL INTEREST TO HOST CERTAIN CAPABILITIES AT CENTERS
02. WORK MUST PROVIDE VALUE TO THE COMMUNITY
03. WORK THAT COULD BE COMPETED SHOULD BE
04. ISFM WORK MAY ALSO INVOLVE CONTRACTORS AND EXTERNAL COLLABORATORS
05. EXTERNAL PEER REVIEW IS A CORE ELEMENT OF DIRECTED WORK

# Qualities of ISFM Work

| | |
|---|---|
| Strategic | • Utilizes unique NASA facilities, capabilities and/or skills or is of such duration or scope that the government benefits by NASA doing it in house.<br>• Requires or benefits from long-term stability. |
| Science enabling | • Provides a service or supports research being done by the scientific community<br>• Other researchers depend/rely on the results of this work. |
| Forward leaning | • Work is ambitious in nature.<br>• Substantial, not just individual investigator work. |
| Distinctive | • Does not create new capabilities at Centers in direct competition with capabilities already in existence in external organizations. |

# Astrophysics Approach to ISFM

# Astrophysics ISFM Work Packages Are…

- Strategically focused investments, which bring to bear the unique capabilities offered by a Center.
- Able to include the skills and labor offered by contractor support (i.e., they are not to solely fund Civil Servants). However, Civil Servants will provide the strategic leadership of each Work Package.
- Collaborative with / complementary to community efforts, and not competitive.
- Performed with service to the community and the Nation in mind.
- Aligned to the strategic goals of NASA, SMD, and the Astrophysics Division.

# Astrophysics ISFM Principles

1. The Astrophysics Division intentionally adopted a cautious approach to its ISFM Directed Work Packages.
2. Only work that is clearly in the national interest will be directed.
3. Rolling up existing ROSES awards into a larger work package will only be accepted if it is demonstrated that the combined package exceeds the sum of its parts.
4. Simply requesting that an existing research award be directed is unlikely to succeed unless there is a strong reason to do so.
5. The Astrophysics Division is unlikely to accept work packages with substantial cost growth unless there is a compelling reason to do so.
6. Astrophysics work packages must be proposed from Center Division leadership and negotiated with HQ Division leadership. This ensures appropriate coordination.
7. **Result: Astrophysics has directed relatively little work in terms of number of awards, meaning we expect only modest reductions in the number of proposals submitted.**

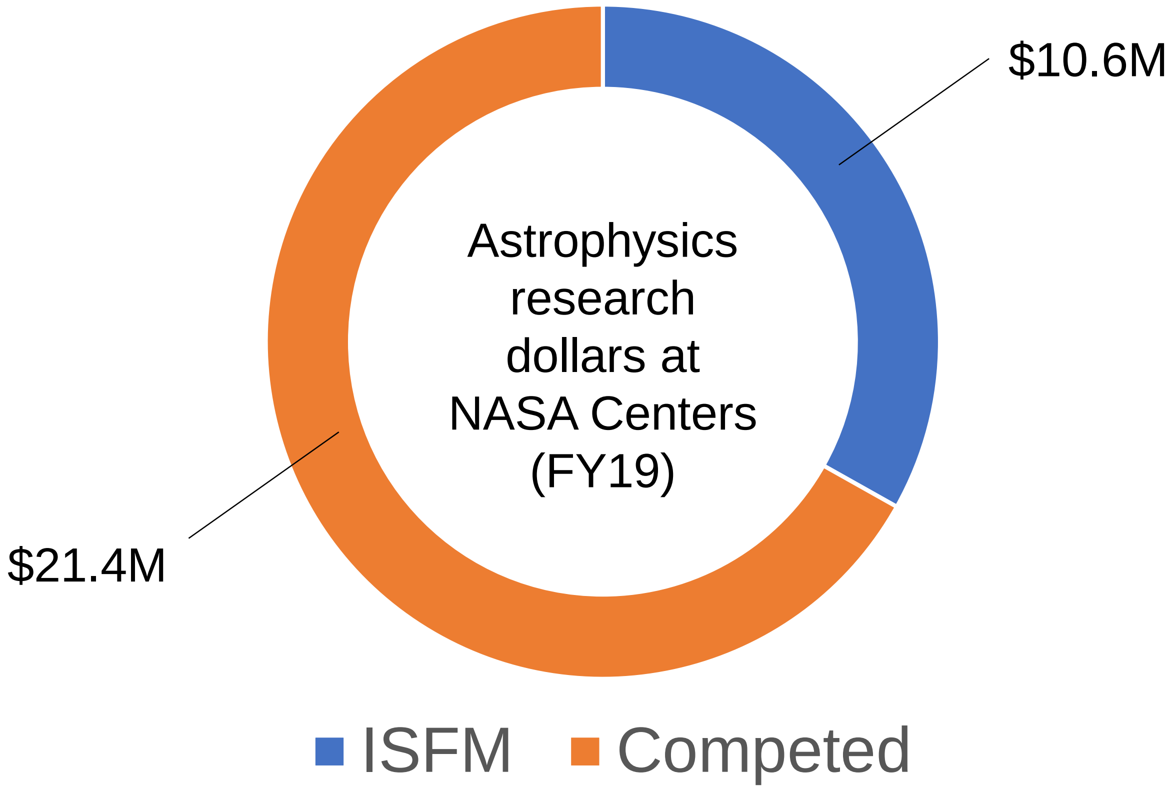
# Current Astrophysics ISFM Work Packages

# Current Astrophysics ISFM Work Packages in FY21

| Name of work package | Center | Average funding | Funding approved for |
|---|---|---|---|
| NASA Ames PAH IR Spectroscopic Database | ARC | $1.1M/yr | FY19-21 |
| Tech. Dev. For Exoplanet Imaging In Multi-Star Systems | ARC | $500k/yr | FY18-21 |
| Exoplanet Spectroscopy Technology | GSFC | $1.8M/yr | FY19-21 |
| Gravitational waves | GSFC | $300k/yr | FY18-21 |
| Microcalorimeters | GSFC | $900k/yr | FY18-21 |
| Next-generation X-ray optics | GSFC | $2.5M/yr | FY18-21 |
| Sellers Exoplanet Environments Collaboration | GSFC | $100k/yr (APD contribution only) | FY18-21 |
| Time-Domain Astronomy Coordination Hub (TACH) | GSFC | $600k/yr | FY19-21 |
| Precision Thermal Control | MSFC | $1.1M/yr | FY18-21 |
| Advanced X-ray mirrors | MSFC | $1.3M/yr | FY18-21 |

All ISFM awards are subject to regular reporting, as well as independent external mid-point peer reviews.

# Key ISFM Statistics




- Approximately 33% of research (=R&A + ADAP + SAT) dollars NASA sends to Centers now come in form of ISFM

# Key ISFM Statistics

- ISFM has not reduced community funding.

25%

RATIO OF CENTER TO ALL OUTGOING RESEARCH DOLLARS BEFORE ISFM (FY15-17)

25%

RATIO OF CENTER TO ALL OUTGOING RESEARCH DOLLARS AFTER ISFM (FY19-20)

# ISFM and the Decadal Survey

# ISFM and the 2020 Astrophysics Decadal Survey

- The 2020 Astrophysics Decadal Survey will inform the broad strategy of NASA Astrophysics for the next decade
- Due to the strategic nature of ISFM investments, NASA will wait until the release of the Decadal Survey report before soliciting the next round of ISFM concepts
- Center options, given that APD does not want to appreciably grow ISFM:

**01**

Propose to extend an expiring ISFM package at approximately the same budget.

**02**

Propose to extend an expiring ISFM package with minor increases in scope.

**03**

Propose to not extend an expiring ISFM package and propose for something completely different in its stead.

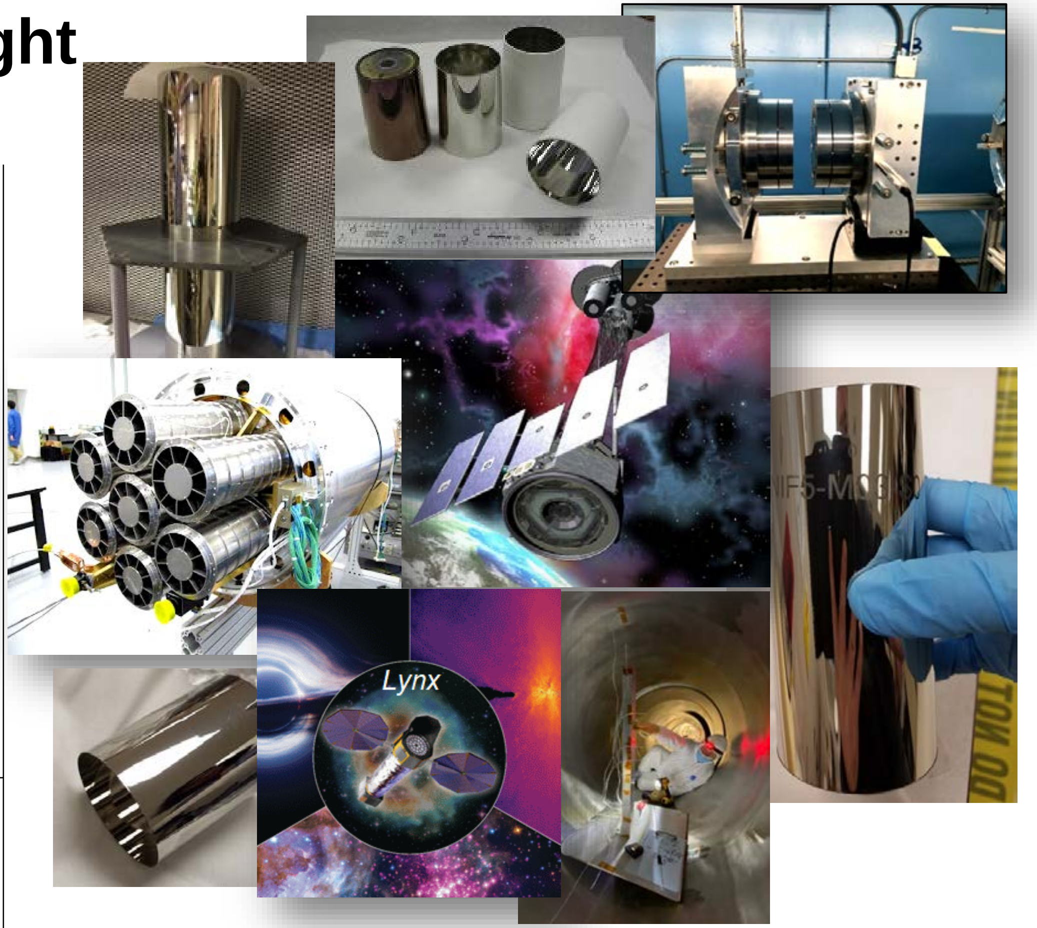
# Quad Charts

# MSFC Advanced X-ray Optics: Formulation to Flight

**Description of Package: end-to-end research and implementation designed to ultimately achieve light-weight sub-arcsecond full-shell X-ray optics and to enhance the performance of segmented optics for the Astronomy community.**

- MSFC's goal is to continue to supply the community with relatively low-cost, moderate-resolution flight mirrors and mirror assemblies and to develop the next generation of light-weight high angular-resolution mirrors and mirror assemblies for future missions.
- The value of APD, internal MSFC, and other competed investments, is that MSFC is able to continue to provide a comprehensive capability that involves innovation as well as the ability to ultimately design and deliver flight mirrors that meets multiple mission requirements.
- Essential and unique elements that build on decades of previous investments include (blue indicates current ISFM work):

- o Mirror and module design and STOP analysis
- o Metrology
- o Mandrel fabrication
- o Mirror shell replication
- o Mirror direct polishing
- o Low-stress or stress-compensating coatings
- o Post figure-correction(s) (Differential Deposition)
- o Mounting and alignment (for single mirror shells and assemblies)
- o X-ray test and calibration




## Justification for ISFM Direction :

- MSFC has the ability to design and develop complete mirror assemblies with predictable flight performance for the community, for both suborbital and orbital payloads [we regularly fly full-shell mirror assemblies!]
- Support a larger NASA capability to design, manufacture, model, test, characterize, etc. grazing and normal incidence mirror systems for telescope.
- Technology developments are relevant to future X-ray missions that use either full-shell or segmented mirrors (e.g. Lynx)
- Provides X-ray mirror capabilities to other SMD divisions (Heliophysics) and other government agencies (NIF, NIST, etc.)
- Provides world-class x-ray test and calibration with combined Stray Light Test Facility and X-ray Cryogenic Facility capability for community testing of technologies and flight hardware

## Personnel counts:

- Average yearly number of FTEs supported by this package = 7.0
- Average yearly number of WYEs supported by this package = 2.0

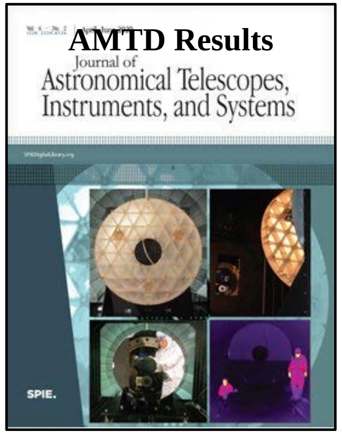
SRG ART-XC Mirror Assemblies

# Predictive Thermal Control (PTC) Technology to enable Thermally Stable Telescopes

PI: H. Philip Stahl / MSFC

**Description:**

- PTC develops active thermal control technology to keep mirrors at stable temperature independent of where the telescope points on the sky.
- PTC started as 4-yr SAT project in FY17 and was converted to IFSM in FY18.
- PTC leverages 2 previous AMTD SATs (FY12-17)






**Justification for ISFM direction:**

- Thermally stable telescopes enable ultra-high contrast observations of exoplanets.
- Zerodur mirror test data used for HabEx design.
- Maturing techniques to manufacture meter class cryogenic aluminum mirror segments for Far-IR.
- **MSFC's IFSMs support NASA's capability to design, manufacture and characterize normal and grazing-incidence telescope mirror systems.**

**Labor (FY12 to FY19):**

- Average FTE = 3.6
- Average WYE = 1.6

**Procurement (FY12 to FY19):**

- Range $0.1 to 1.0M/yr.
- Average = $0.3M

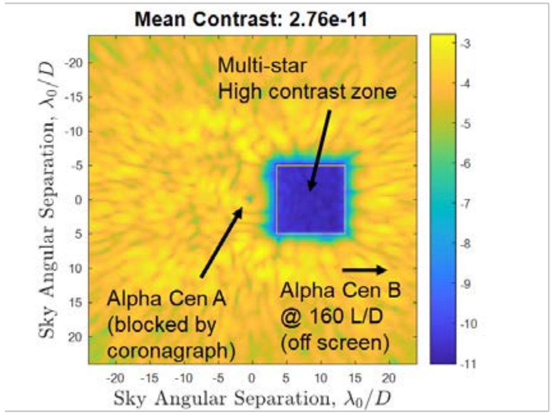
| | Total | Average | FY12 | FY13 | FY14 | FY15 | FY16 | FY17 | FY18 | FY19 |
|---|---|---|---|---|---|---|---|---|---|---|
| FTE | 29.0 | 3.6 | 2.4 | 3.2 | 2.6 | 4.1 | 3.9 | 3.5 | 3.6 | 5.8 |
| WYE | 13.1 | 1.6 | 0.8 | 2.1 | 1.6 | 1.7 | 0.5 | 0.8 | 3.0 | 2.5 |
| FTE ($M) | 5.0 | 0.6 | $0.5 | $0.6 | $0.5 | $0.7 | $0.7 | $0.6 | $0.6 | $0.8 |
| WYE ($M) | 2.7 | 0.3 | $0.2 | $0.4 | $0.3 | $0.3 | $0.1 | $0.2 | $0.6 | $0.5 |
| Procurement ($M) | 2.5 | 0.3 | $0.2 | $0.4 | $1.0 | $0.4 | $0.1 | $0.2 | $0.1 | $0.1 |
| Total People (FTE+WYE) | 42.1 | 5.3 | 3.2 | 5.3 | 4.1 | 5.8 | 4.4 | 4.3 | 6.6 | 8.3 |
| Total Funding ($M) | $10.1 | $1.3 | $0.8 | $1.4 | $1.8 | $1.5 | $0.9 | $0.9 | $1.3 | $1.4 |

# Development of a Method for Exoplanet Imaging in Multi-Star Systems (PI: Ruslan Belikov)

## Description of package:

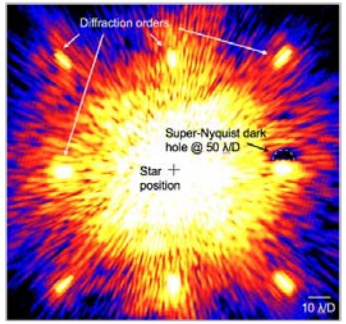
- Goal: Enable direct imaging of planets around binary star systems for future missions, including HabEx, LUVOIR, and Roman ST
- Motivation: Most Sun-like stars belong to binary star systems, including Alpha Centauri, the nearest system to the Sun
- Technology: Design, simulations, and lab demo of a new wavefront control algorithm called multi-star wavefront control (MSWC) that can be applied to any existing coronagraph instrument with minimal hardware modifications.

*Simulation of Habex in Binary Star Imaging Mode enabled by Multi-Star Wavefront Control*




(Sirbu et al. 2019)

*In-progress vacuum demonstration at JPL/HCIT/DST of MSWC technology at 4e-7 contrast level (and improving) in broadband light*




(Decadal Survey Testbed, operated by Garreth Ruane, 2020)

## Justification for ISFM direction:

- MSWC is directly aligned with NASA strategic exoplanet goals. It increases the number, diversity, and completeness of targets for LUVOIR, HabEx, and (potentially) Roman ST, and enables what is arguably the best target, Alpha Centauri
- Project is unique – no other team is pursuing this technology, or (to our knowledge) any other technology that enables targeting most binary star systems
- Strong value to community, by enabling new science (directly imaged exoplanets around binary star systems), improving the science yield, and instrument performance on almost any future direct imaging mission
- Team has a demonstrated track record of winning proposals (2 ROSES and several internal ones) advancing this technology from its inception

## Personnel counts:

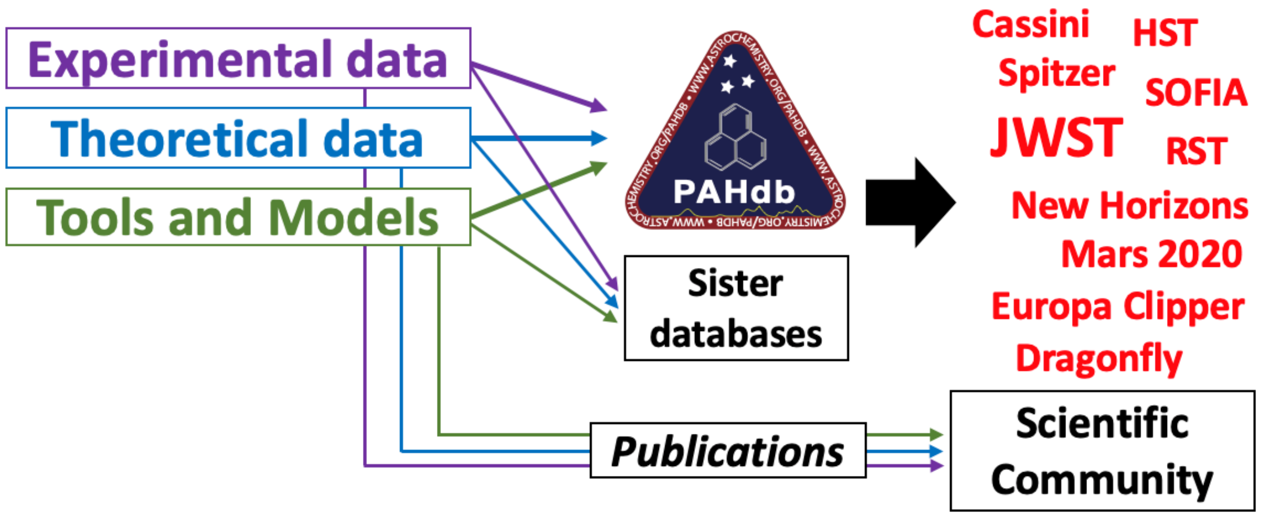
- Average yearly number of FTEs supported by this package = 0.8
- Average yearly number of WYEs supported by this package = 2.4 (Includes JPL Co-Is)

# NASA Ames PAH IR Spectroscopic Database

Ella Sciamma-O'Brien (POC), Lou Allamandola, Salma Bejaoui, Christiaan Boersma, Jesse Bregman,
Gustavo Cruz Diaz, Lisseth Gavilan, Andy Mattioda, Emmett Quigley, Alessandra Ricca, Joe Roser, Farid Salama

## Description of package:

- **Provide spectroscopic data (experiment + theory) and data analysis tools** to interpret observations, enhancing the science return from many NASA missions (*cf. figure*)
- **Coordinate inter-laboratory research efforts** (5 sub-groups)
- **Expand the content and impact** of the publicly-available NASA Ames Polycyclic Aromatic Hydrocarbons infrared (IR) spectroscopic database (PAHdb)
- **Develop sister databases (**Raman, UV, Optical constants)




## Justification for ISFM direction:

- Synergistic effort that leverages Ames' **unique laboratory facilities + computational resources** + **scientific expertise**
- **PAHdb**'s unrivaled and continuously expanding spectroscopic content, software analysis tools and dedicated website **allow the scientific community to interpret astronomical PAH IR spectra. It will play a major role in *JWST* data analysis.**
- New Raman, UV spectroscopy, and optical constants sister databases will **support a wider range of NASA missions**

## Personnel counts:

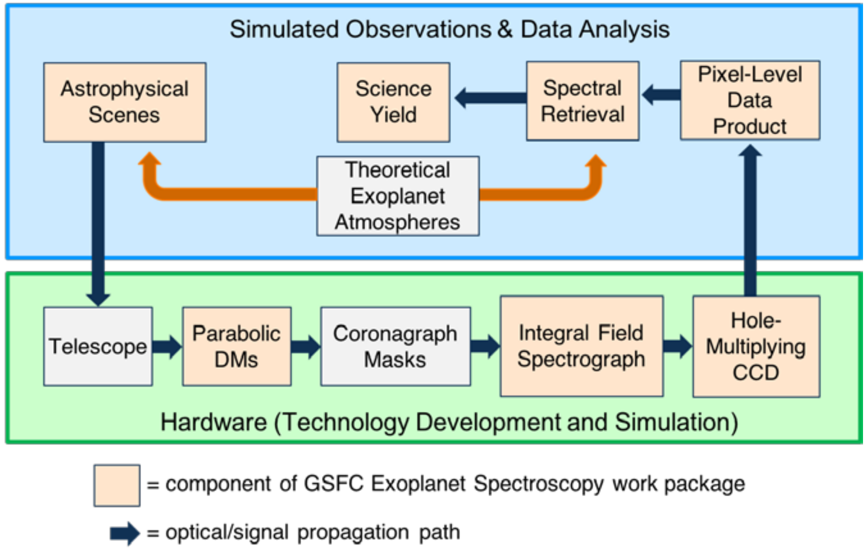
- Average yearly number of FTEs supported: *1.0*
- Average yearly number of WYEs supported: *4.9*

# Exoplanet Spectroscopy Technologies
## Michael McElwain (PI/GSFC)

## Description of package:
- Develop exoplanet spectroscopy technologies, high fidelity end-to-end integrated modeling tools, and spectral retrieval algorithms to define ***science-driven systems level mission requirements***.

<u>Exoplanet Spectroscopy Technology Development</u>

1. High Contrast Integral Field Spectroscopy
2. Photon-Counting Radiation Hard p-channel CCDs
3. Parabolic Deformable Mirrors




## Community-enabling aspects:
- Science-driven systems level mission requirements to support the formulation and execution of a large space telescope with the goal of reflected light spectroscopy of ExoEarths.
- Cross-divisional coordination and leverage of the Sellers Exoplanets Environments Collaboration (SEEC) work package led by the Planetary Sciences Division.

## Personnel counts:
- Average yearly number of FTEs supported by this package = 6
- Average yearly number of WYEs supported by this package = 5
- Diverse set of early career researchers developed by this package = 12

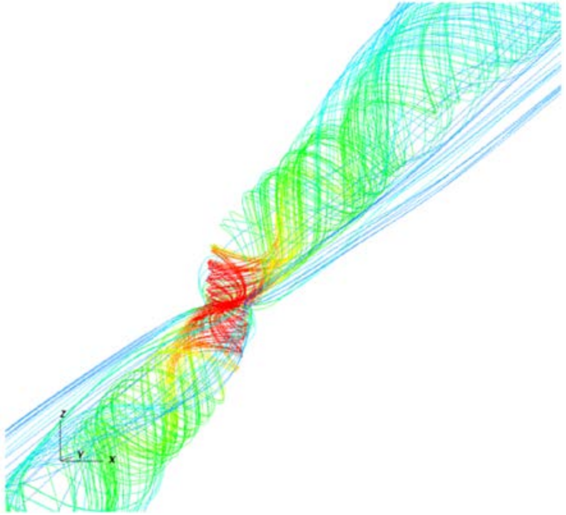
**Sub-Leads: Zimmerman . Rauscher . Groff . Mandell . Marley**

# Multi-messenger Source Modeling

**John Baker (PI/GSFC)**

**Description of package:**

- Advance black hole merger EM signal GRMHD+Radiation modeling
- Study merger/emission physics
- Develop community codes
- Prepare for EM+LISA observing



Magnetic jet structure developing near a black hole with misaligned external magnetic from a GRMHD simulation modeling the immediate post-merger state of an MBH merger (Kelly+ 2020).

**Justification for ISFM direction:**

- Prepare for future NASA missions
- Jump-start for theory foundations
- Stimulate community research
- Provide bridge for broader community participation in LISA

**Personnel counts:**

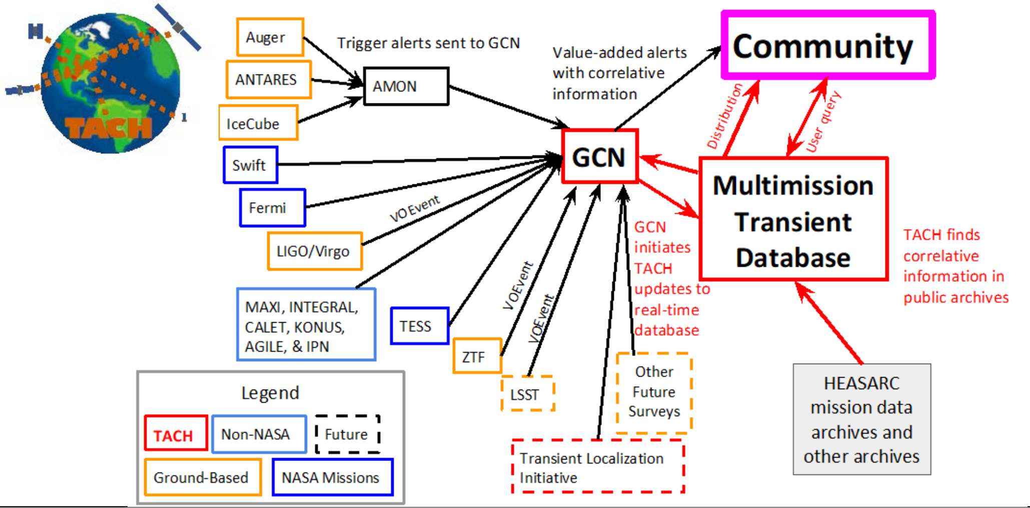
- Average yearly number of FTEs supported by this package = 0
- Average yearly number of WYEs supported by this package = 2
- Total count of early career researchers involved = 4

# Time Domain Astronomy Coordination Hub (TACH)

**Judy Racusin, Scott Barthelmy, Alan Smale (GSFC)**

## Description of package:

Building upon existing NASA resources (GCN + HEASARC) with new tools to enable rapid alerts from space and ground-based observatories, and follow-up observations in multi-messenger astrophysics.




## Justification for ISFM direction:

- Enable community coordination in response to astronomical transients.
- Modernizing tools in preparation for new facilities added to network.
- Adding functionality for coordination between NASA and non-NASA projects.

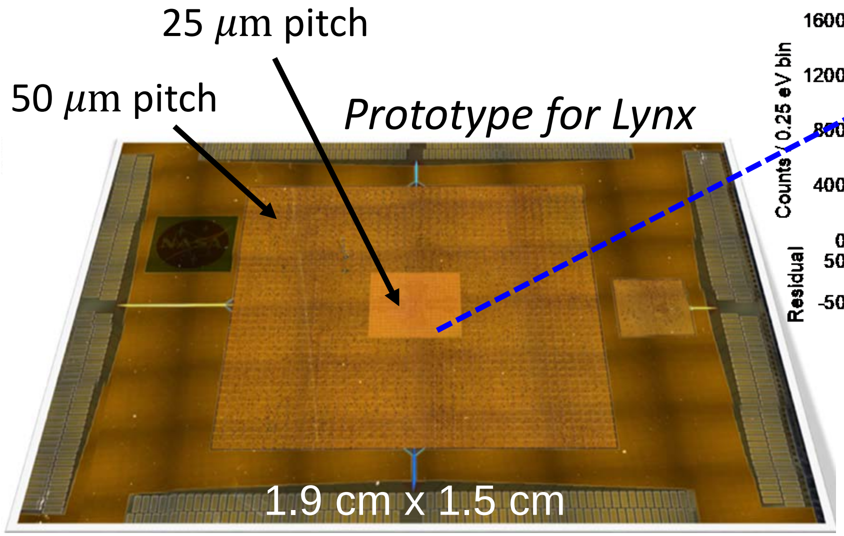
## Personnel counts:

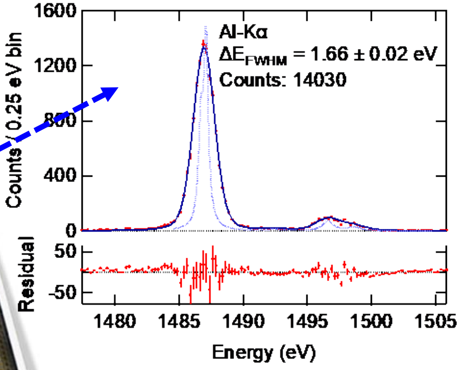
- Average yearly number of FTEs supported by this package = 1.7
- Average yearly number of WYEs supported by this package = 0.9
- Number of early career scientists involved = 5

# Advanced X-ray Microcalorimeters – SR Bandler, FS Porter, CA Kilbourne

## Description of package:

- Imaging high-resolution X-ray spectroscopy
  - Innovations enabling 100,000 pixels (25 per superconducting or magnetic ther-mometer, distinguished by pulse shape)
- Instruments for lab spectroscopy relevant to space atomic physics




Spectrum from 25-pixel calorimeter element

## Justification for ISFM direction:

- GSFC invented X-ray micro-calorimeters 36 years ago; is a leader in advancing the capabilities.
- Lab spectroscopy supports data-base community uses to interpret high-res astrophysical X-ray spectra.

## Personnel counts:

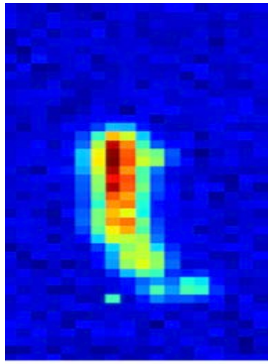
- Average yearly number of FTEs supported by this package = 1.1
- Average yearly number of WYEs supported by this package = 2.7
- Early-career individuals = 3 PhD, 1 masters, 2 minority PhD students

# Next Generation X-ray Optics – William W. Zhang

**Develop an X-ray telescope fabrication technology with following characteristics, compared to that used for making Chandra's:**

- Comparable PSF in 5 years.
- 3X better PSF in 10 years.
- 30X lighter per unit effective area.
- 30X lower in cost.

Mirror module containing one pair of parabolic-hyperbolic mirror segments 50X thinner than Chandra's.



0.82-arcsec PSF image obtained with 4.5 keV X-rays

**Community-enabling aspects**

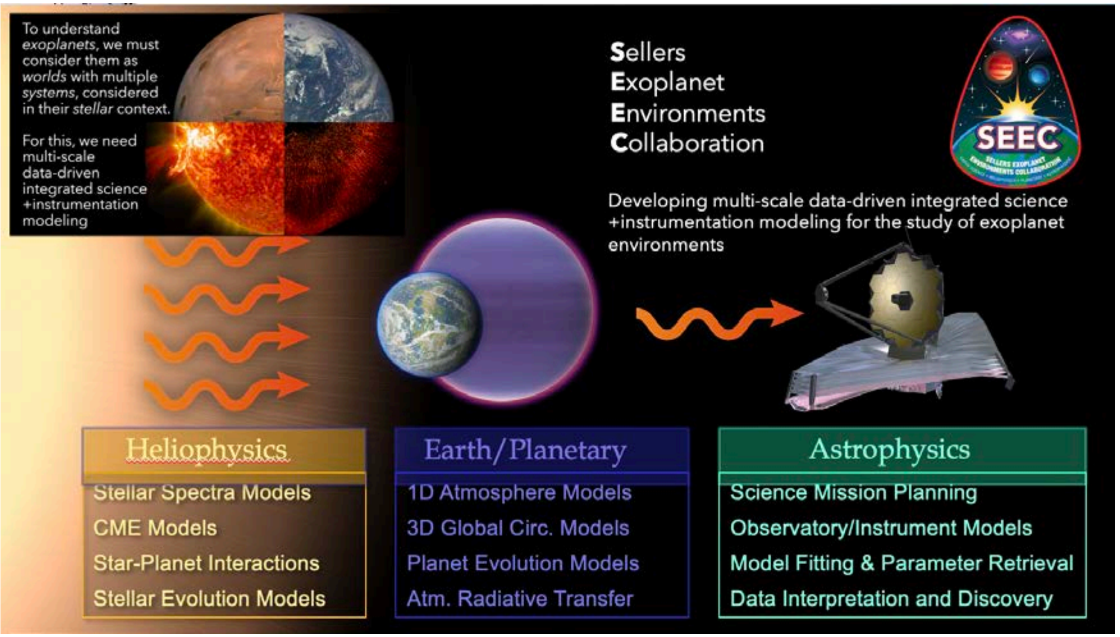
- Enables major missions like Lynx, and those led by university scientists: OGRE (Penn State), PiSOX (MIT), and HEX-P (Caltech).
- Enables X-ray optics technology development work at universities: MIT, SAO, Northwestern, & Penn State.
- Enables technology development at MSFC.

**Personnel counts:**

- Average yearly number of FTEs supported by this package = 5, of whom one is a Pathway graduate student.
- Average yearly number of WYEs supported by this package = 9, of which two are University of Maryland research scientists.

# Astro Support of Sellers Exoplanet Environments Collaboration
# Padi Boyd (PI/GSFC) Subpackage; SEEC PI Avi Mandell (GSFC/PSD)

SEEC is a community-facing modeling center that develops, integrates, coordinates, and applies a wide variety of exoplanet models to comprehensively address interdisciplinary/cross-divisional exoplanet questions related to data interpretation and future mission design.




**Justification for ISFM direction:**

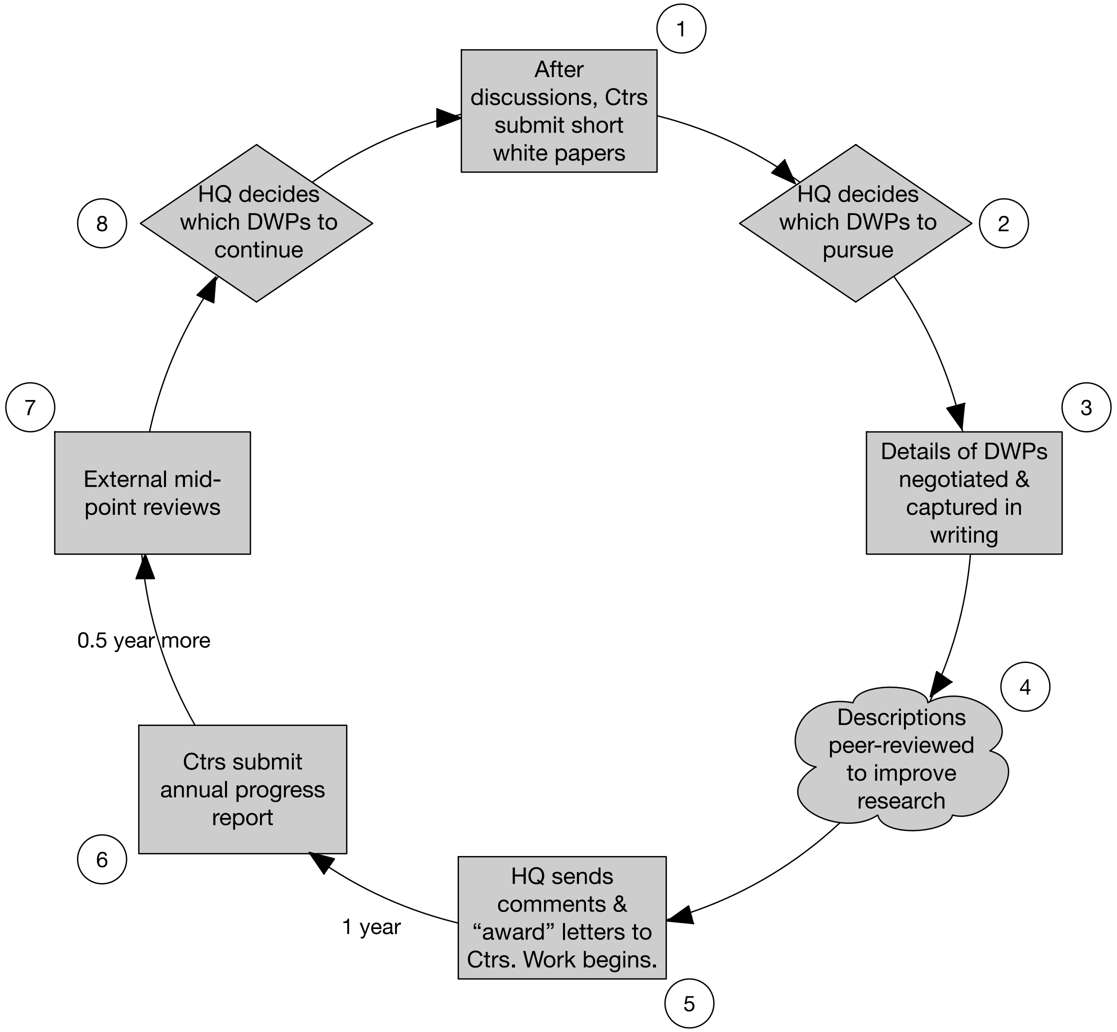
- Funding was converted from existing, successful ADAPs, XRPs and NN-EXPLORE grants in direct support of SEEC goals.
- ASD scientists develop and inform models related to radiative transfer, microlensing, transit spectroscopy and dynamical evolution.
- Provides observ. data to compare with models.

**Personnel counts:**

- Average yearly number of FTEs supported by this package = 0.47
- Average yearly number of WYEs supported by this package = 0.16
- Typically one undergraduate summer intern and a portion of a graduate student supported.

# Backup

# Major Steps in the ISFM DWP Life Cycle



| FISCAL YEAR | QUARTERS | CALENDAR YEAR | QUARTERS | MONTH | ISFM Event (for 1 generation of DWPs) |
|---|---|---|---|---|---|
| FY (N-1) | FY Q1 | CY (N-2) | CY Q4 | OCT | |
| | | | | NOV | |
| | | | | DEC | White papers due. #1 in Fig, 1. |
| | FY Q2 | CY (N-1) | CY Q1 | JAN | 1. HQ negotiates with Centers. #2 and 3 in Fig. 1.<br>2. FY (N) funding adjustments made during PPBE(N+1).<br>3. DWP descriptions submitted to external review. #4 in Fig. 1.<br>4. DAAR certifies funding balance.<br>5. Funding memo/award letters sent to Centers. #5 in Fig. 1. |
| | | | | FEB | |
| | | | | MAR | |
| | FY Q3 | | CY Q2 | APR | |
| | | | | MAY | |
| | | | | JUN | |
| | FY Q4 | | CY Q3 | JUL | |
| | | | | AUG | |
| | | | | SEP | |
| FY (N) | FY Q1 | | CY Q4 | OCT | DWPs start first year. |
| | | | | NOV | |
| | | | | DEC | |
| | FY Q2 | CY (N) | CY Q1 | JAN | |
| | | | | FEB | |
| | | | | MAR | |
| | FY Q3 | | CY Q2 | APR | |
| | | | | MAY | |
| | | | | JUN | |
| | FY Q4 | | CY Q3 | JUL | |
| | | | | AUG | |
| | | | | SEP | Annual Progress Reports due. #6 in Fig. 1. |

| | | | | | |
|---|---|---|---|---|---|
| FY (N+1) | FY Q1 | | CY Q4 | OCT | DWPs start second year. |
| | | | | NOV | |
| | | | | DEC | |
| | FY Q2 | CY (N+1) | CY Q1 | JAN | |
| | | | | FEB | |
| | | | | MAR | External mid-point Review. #7 in Fig. 1. |
| | FY Q3 | | CY Q2 | APR | |
| | | | | MAY | Go/No-go/Tweak decisions made & communicated. #8 in Fig. 1. |
| | | | | JUN | |
| | FY Q4 | | CY Q3 | JUL | |
| | | | | AUG | 1. Annual Progress Reports due.<br>2. Final Reports from terminated DWPs due. |
| | | | | SEP | |

| | | | | | |
|---|---|---|---|---|---|
| FY (N+2) | FY Q1 | | CY Q4 | OCT | DWPs start third year. |
| | | | | NOV | |
| | | | | DEC | |
| | FY Q2 | CY (N+2) | CY Q1 | JAN | |
| | | | | FEB | |
| | | | | MAR | |
| | FY Q3 | | CY Q2 | APR | |
| | | | | MAY | |
| | | | | JUN | |
| | FY Q4 | | CY Q3 | JUL | |
| | | | | AUG | |
| | | | | SEP | Final Reports due. |
| FY (N+3) | FY Q1 | | CY Q4 | OCT | |
| | | | | NOV | |
| | | | | DEC | |