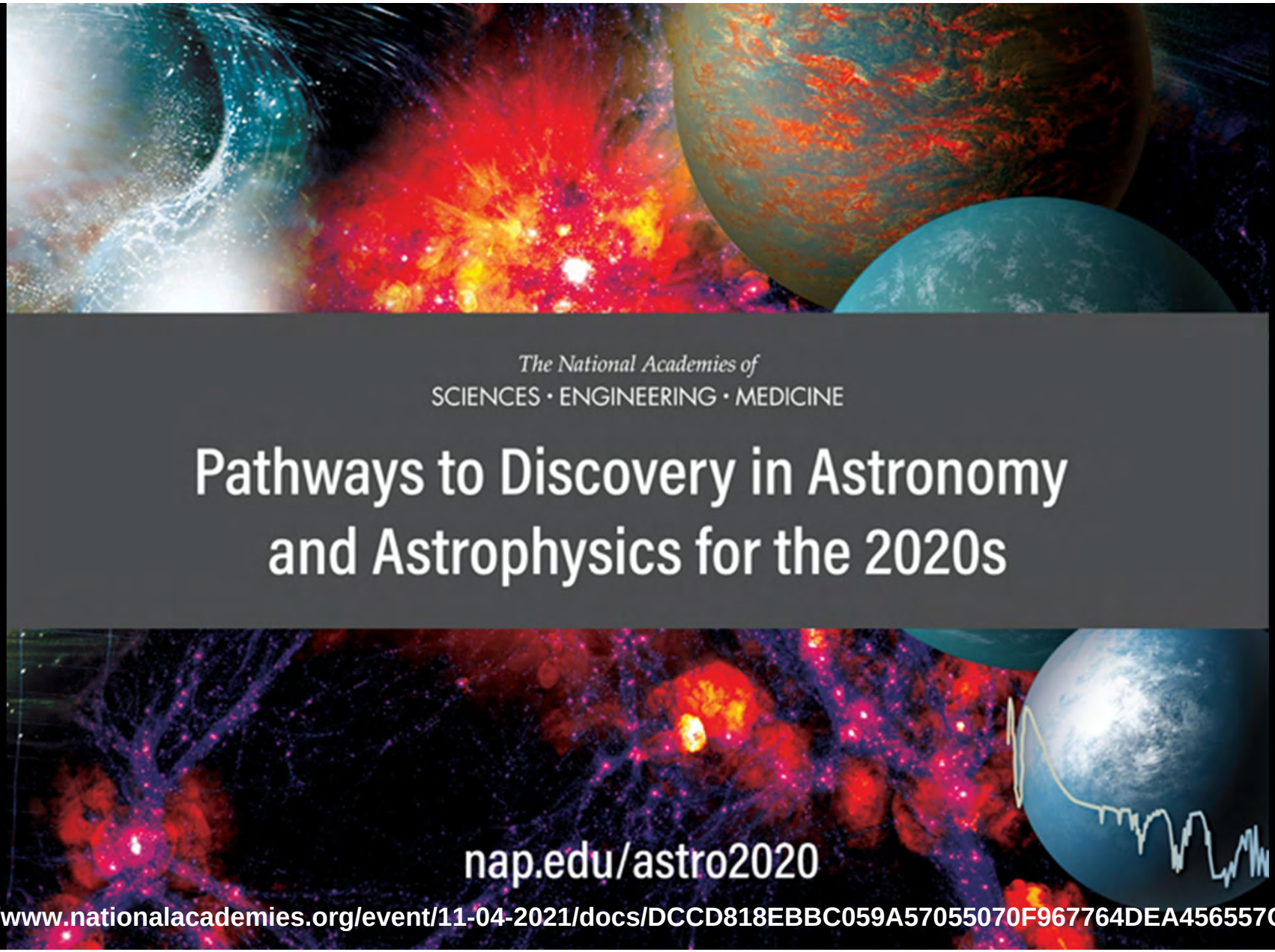
Future Planning Process In the US

Hitoshi Murayama (Berkeley, Kavli IPMU)

NAOJ Future Planning Symposium, Dec 7, 2022



https://www.nationalacademies.org/event/11-04-2021/docs/DCCD818EBBC059A57055070F967764DEA456557CCBDC

Basic Idea

- Funding agency (NASA, NSF, DOE) asks National Academies of Sciences to come up with plans for the next ten years by spending millions of dollars
  - Concrete budget scenarios
  - detailed “Statement of Task” to request specific advice
  - Chooses the Chair
- NAS and chair forms the steering committee and various panels
  - Approx. 150 people get involved
  - Panels for both science and techniques
- Solicit White paper
  - Talks and discussions at Town hall
- Each panel comes up with recommendations
- Steering committee comes up with a *single* recommendation

基本的な考え方

- Funding agency (NASA, NSF, DOE)が数億円のお金を出して、次の10年の計画を練ることを National Academies of Sciences に注文
  - その際、今後の予算のシナリオをいくつか提示
  - 何についてアドバイスが必要か、詳細な Statement of Task
  - Chair を選ぶ
- NAS と chair で steering committee, 各パネルを構成、約150人が参加
  - サイエンスが軸のパネル、手法が軸のパネル両方ある
- White paper を募集
  - Town hall で講演、議論
- 各パネルが recommendation をまとめる
- Steering committee が一つの recommendation にまとめる

National Academy of Sciences

- Non-profit non-governmental organization
  - Physical and Mathematical Sciences
  - Biological Sciences
  - Engineering and Applied Sciences
  - Biomedical Sciences
  - Behavioral and Social Sciences
  - Applied Biological, Agricultural, and Environmental Sciences
- 2400 scientists with US citizenship, 500 international members, including 190 Nobel laureates
- Members recommends new members, elected, lifetime
- Has dues, but the main income is endowment and NRC reports
- *The three Academies work together as the National Academies of Sciences, Engineering, and Medicine to provide independent, objective analysis and advice to the nation and conduct other activities to solve complex problems and inform public policy decisions. The National Academies also encourage education and research, recognize outstanding contributions to knowledge, and increase public understanding in matters of science, engineering, and medicine. The National Academies' service to government has become so essential that Congress and the White House have issued legislation and executive orders over the years that reaffirm its unique role.*

National Academy of Sciences

- 私的非営利団体
  - Physical and Mathematical Sciences
  - Biological Sciences
  - Engineering and Applied Sciences
  - Biomedical Sciences
  - Behavioral and Social Sciences
  - Applied Biological, Agricultural, and Environmental Sciences
- 2400人のアメリカ人研究者、500人の国際メンバー、内ノーベル賞190人
- メンバーが新メンバーを推薦、選出、終身
- 会費有り、しかし収入は endowment と NRC reports
- *The three Academies work together as the National Academies of Sciences, Engineering, and Medicine to provide independent, objective analysis and advice to the nation and conduct other activities to solve complex problems and inform public policy decisions. The National Academies also encourage education and research, recognize outstanding contributions to knowledge, and increase public understanding in matters of science, engineering, and medicine. The National Academies' service to government has become so essential that Congress and the White House have issued legislation and executive orders over the years that reaffirm its unique role.*

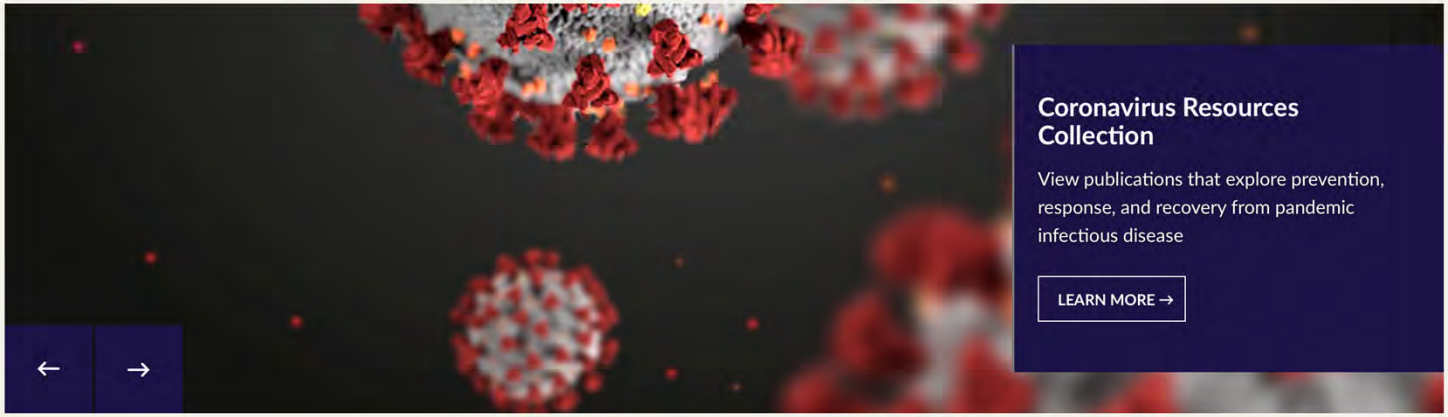
NATIONAL ACADEMIES Sciences Engineering Medicine

SEARCH GLOBAL MENU

BROWSE MYNAP HELP CART

National Academies Press

The National Academies Press (NAP) publishes the publications of the National Academies of Sciences, Engineering, and Medicine. NAP publishes more than 200 publications per year on a wide range of topics in science, engineering, and medicine, providing authoritative, independently researched information on important matters in science and health policy.

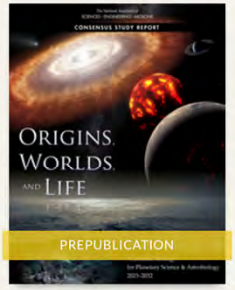


Featured Titles

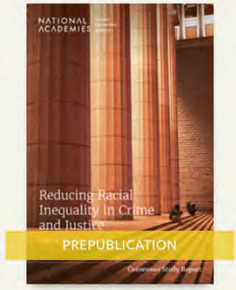
Featured Titles

Guidance on PFAS Exposure, Testing, and Clinical Follow-Up

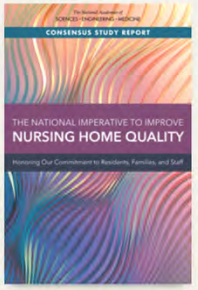
Reckoning with the U.S. Role in Global Ocean Plastic Waste



Origins, Worlds, and Life: A Decadal Strategy for...



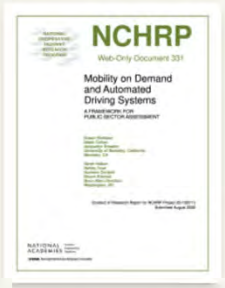
Reducing Racial Inequality in Crime and Justice: Science...



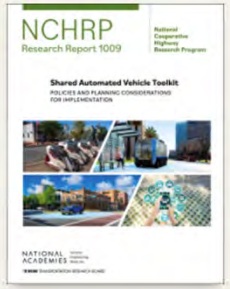
The National Imperative to Improve Nursing Home...

New Releases

more



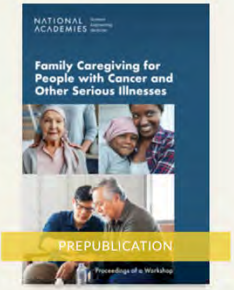
Mobility on Demand and Automated Driving Systems:...



Shared Automated Vehicle Toolkit: Policies and Planning...

China-U.S. Scientific Engagement: Strengthening...

Context Classification Application: A Guide

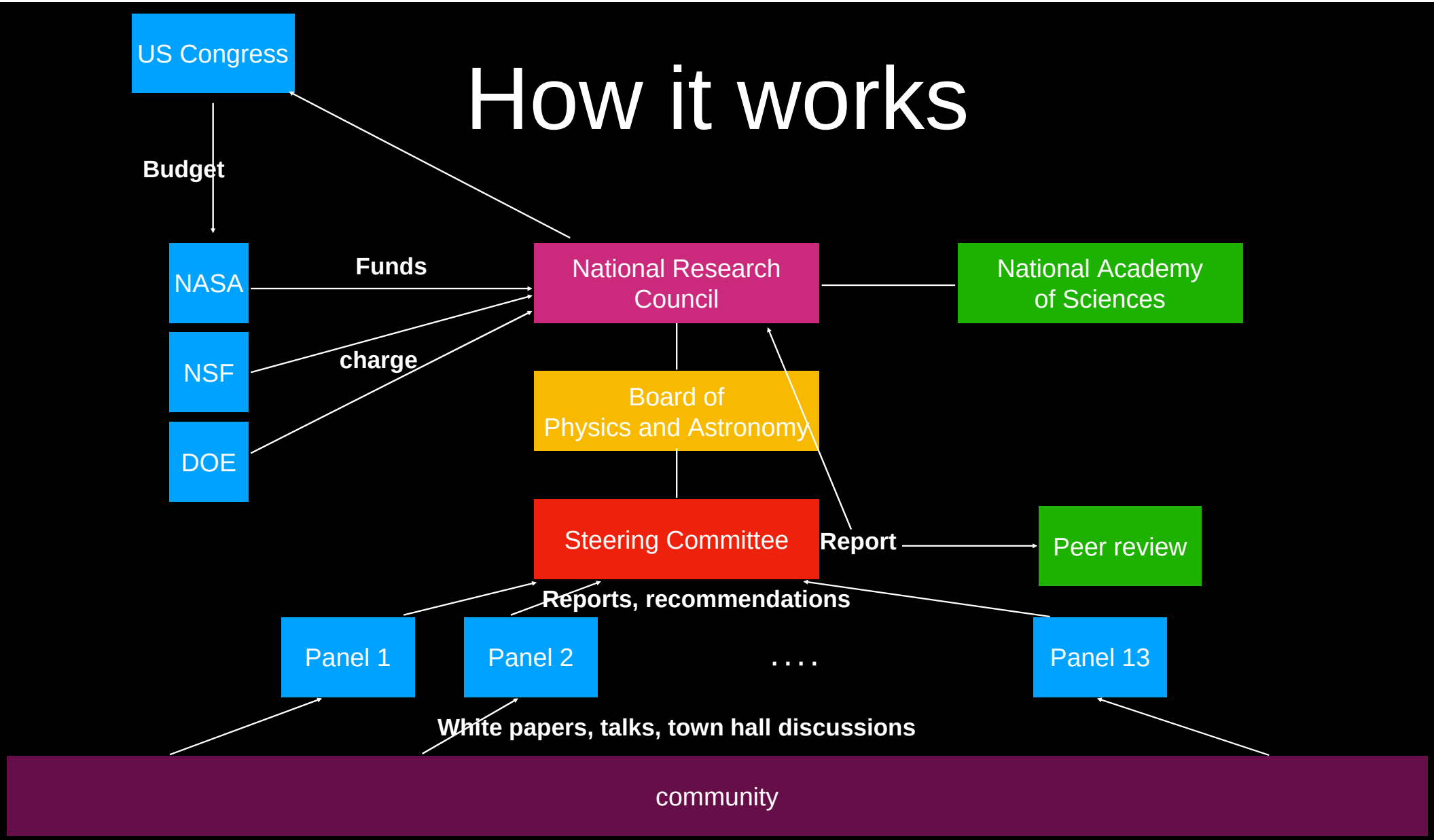


Family Caregiving for People with Cancer and Other...

Most Downloaded (last 7 days)

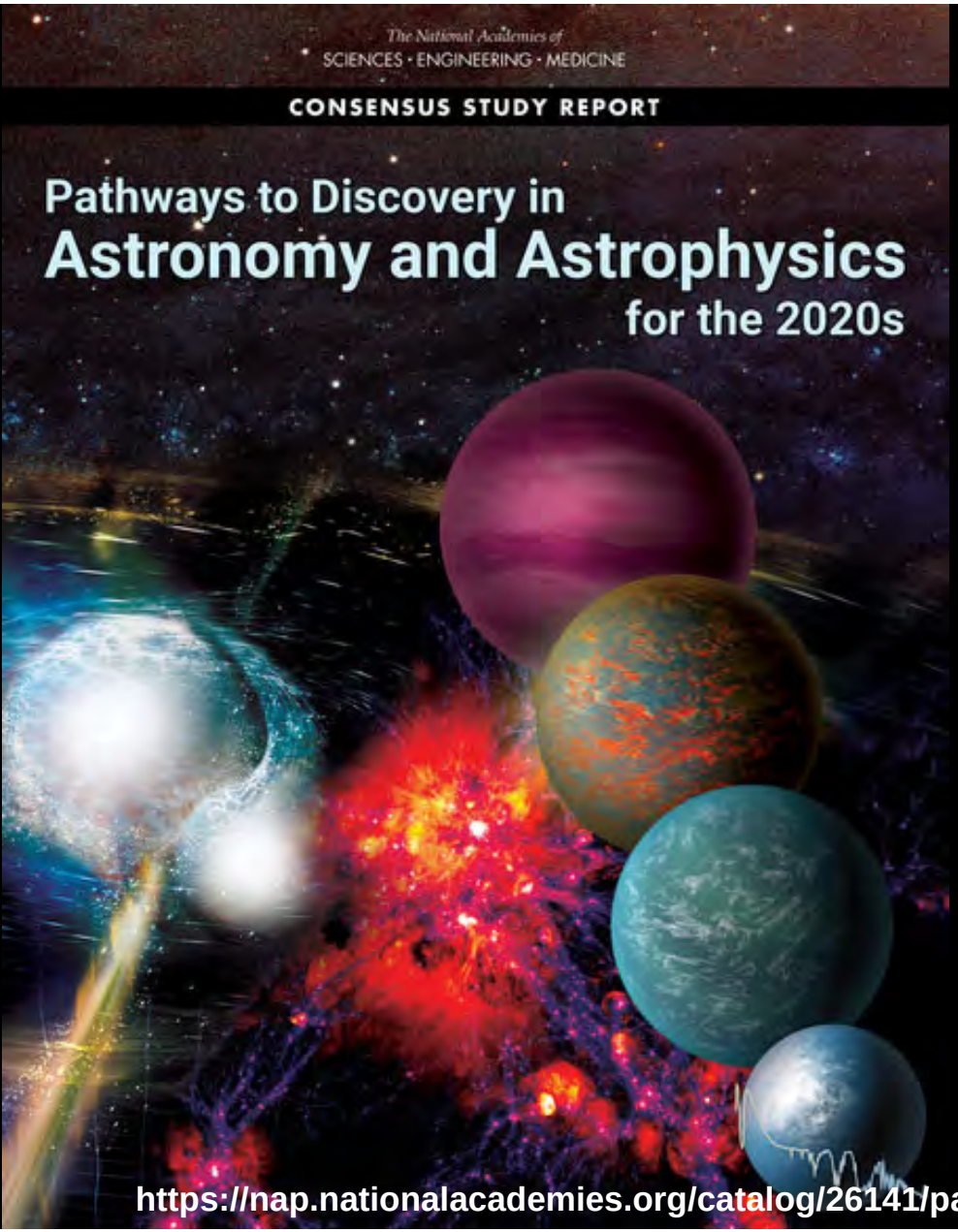
more

How it works


US Congress
Budget
NASA
NSF
DOE
Funds
charge
National Research Council
National Academy of Sciences
Board of Physics and Astronomy
Steering Committee
Report
Peer review
Reports, recommendations
Panel 1
Panel 2
. . . .
Panel 13
White papers, talks, town hall discussions
community

COMMITTEE FOR A DECADAL SURVEY ON ASTRONOMY AND ASTROPHYSICS 2020 (ASTRO2020): STEERING COMMITTEE

FIONA A. HARRISON, NAS,[1] California Institute of Technology, *Co-Chair*
ROBERT C. KENNICUTT JR., NAS, University of Arizona and Texas A&M University, *Co-Chair*
JULIANNE DALCANTON, University of Washington
TIM DE ZEEUW, Leiden University
ANDREW S. DRIESMAN, Johns Hopkins University Applied Physics Laboratory
JONATHAN J. FORTNEY, University of California, Santa Cruz
GABRIELA GONZÁLEZ, NAS, Louisiana State University
JORDAN A. GOODMAN, University of Maryland
MARC P. KAMIONKOWSKI, NAS, Johns Hopkins University
BRUCE MACINTOSH, Stanford University
JACOBUS M. OSCHMANN, Independent Consultant
RACHEL A. OSTEN, Space Telescope Science Institute, *Executive Officer*
LYMAN A. PAGE, JR., NAS, Princeton University
ELIOT QUATAERT, NAS, Princeton University
WANDA A. SIGUR, NAE,[2] Independent Consultant
RACHEL SOMERVILLE, Flatiron Institute
KEIVAN G. STASSUN, Vanderbilt University
JEAN L. TURNER, University of California, Los Angeles
PIETER VAN DOKKUM, Yale University
ELLEN G. ZWEIBEL, NAS, University of Wisconsin, Madison



Product

- 616 pages
- *We live in a time of extraordinary discovery and progress in astronomy and astrophysics. The next decade will transform our understanding of the universe and humanity's place in it. Every decade the U.S. agencies that provide primary federal funding for astronomy and astrophysics request a survey to assess the status of, and opportunities for the Nation's efforts to forward our understanding of the cosmos. Pathways to Discovery in Astronomy and Astrophysics for the 2020s identifies the most compelling science goals and presents an ambitious program of ground- and space-based activities for future investment in the next decade and beyond. The decadal survey identifies three important science themes for the next decade aimed at investigating Earth-like extrasolar planets, the most energetic processes in the universe, and the evolution of galaxies. The Astro2020 report also recommends critical near-term actions to support the foundations of the profession as well as the technologies and tools needed to carry out the science.*
- Typically 3 space, 3 ground based highest priority projects
- Typically only 1 or 2 among 3 happen

https://nap.nationalacademies.org/catalog/26141/pathways-to-discovery-in-astronomy-and-astrophysics-for-the-2020s

Statement of Task and Panel Descriptions

STATEMENT OF TASK

The National Academies of Sciences, Engineering, and Medicine shall convene an ad hoc survey committee and supporting study panels to carry out a decadal survey in astronomy and astrophysics. The study will generate consensus recommendations to implement a comprehensive strategy and vision for a decade of transformative science at the frontiers of astronomy and astrophysics. The committee, with inputs from study panels covering the breadth of astronomy and astrophysics, will carry out the following tasks:

1. Provide an overview of the current state of astronomy and astrophysics science, and technology research in support of that science, with connections to other scientific areas where appropriate;
2. Identify the most compelling science challenges and frontiers in astronomy and astrophysics, which shall motivate the committee's strategy for the future;
3. Develop a comprehensive research strategy to advance the frontiers of astronomy and astrophysics for the period 2022-2032 that will include identifying, recommending, and ranking the highest priority research activities—taking into account for each activity the scientific case, international and private landscape, timing, cost category and cost risk, as well as technical readiness, technical risk, and opportunities for partnerships. The strategy should be balanced, by considering large, medium, and small activities for both ground and space. (Activities include any project, telescope, facility, experiment, mission, or research program of sufficient scope to be identified separately in the final report.) For each recommended activity the committee will lay out the principal science objectives and activity capabilities, including assumed or recommended activity lifetime, where possible;
4. Utilize and recommend decision rules, where appropriate, for the comprehensive research strategy that can accommodate significant but reasonable deviations in the projected budget or changes in urgency precipitated by new discoveries or unanticipated competitive activities;
5. Assess the state of the profession, using information available externally and, if necessary, data gathered by the study itself, including workforce and demographic issues in the field. Identify areas of concern and importance to the community raised by this assessment in service of the future vitality and capability of the astronomy and astrophysics work force. Where possible, provide specific, actionable and practical recommendations to the agencies and community to address these areas. This report shall be made available following the completion of the study.

- 6 Science Panels
  - Compact Objects and Energetic Phenomena
  - Cosmology
  - Galaxies
  - Exoplanets, Astrobiology, and the Solar System
  - Interstellar Medium and Star and Planet Formation
  - Stars, the Sun, and Stellar Populations
- 6 Program Panels
  - Enabling Foundation for Research
  - Electromagnetic Observations from Space 1
  - Electromagnetic Observations from Space 2
  - Optical and Infrared Observations from the Ground
  - Particle Astrophysics and Gravitation
  - Radio, Millimeter, and Submillimeter Observations from the Ground
- Panel on the Profession and Societal Impacts

Approach

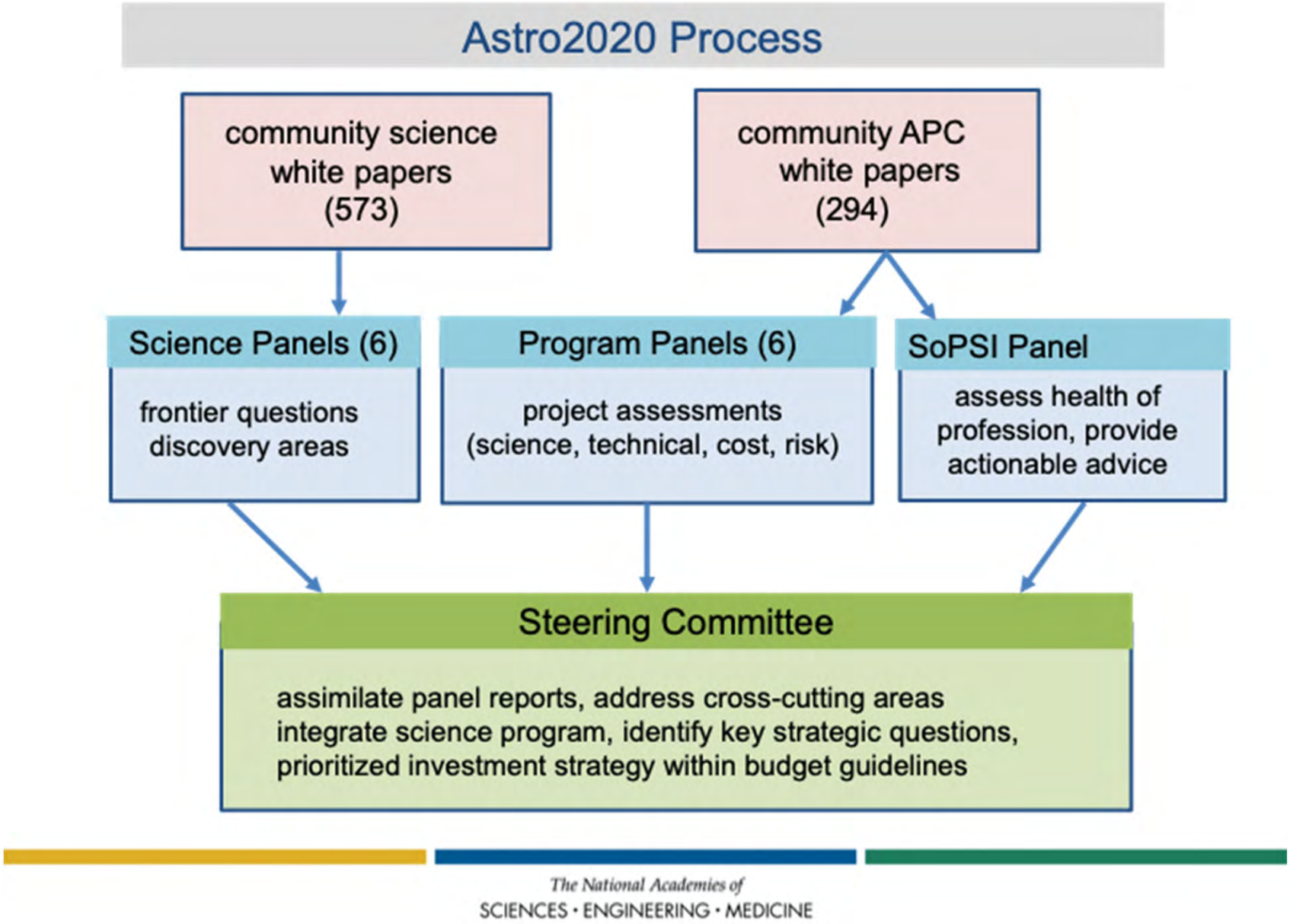
NASA, NSF, and DOE provided budget guidance, bounded by ambitious and conservative scenarios

The agencies urged the survey to develop an "ambitious", "aspirational", and "inspirational" plan

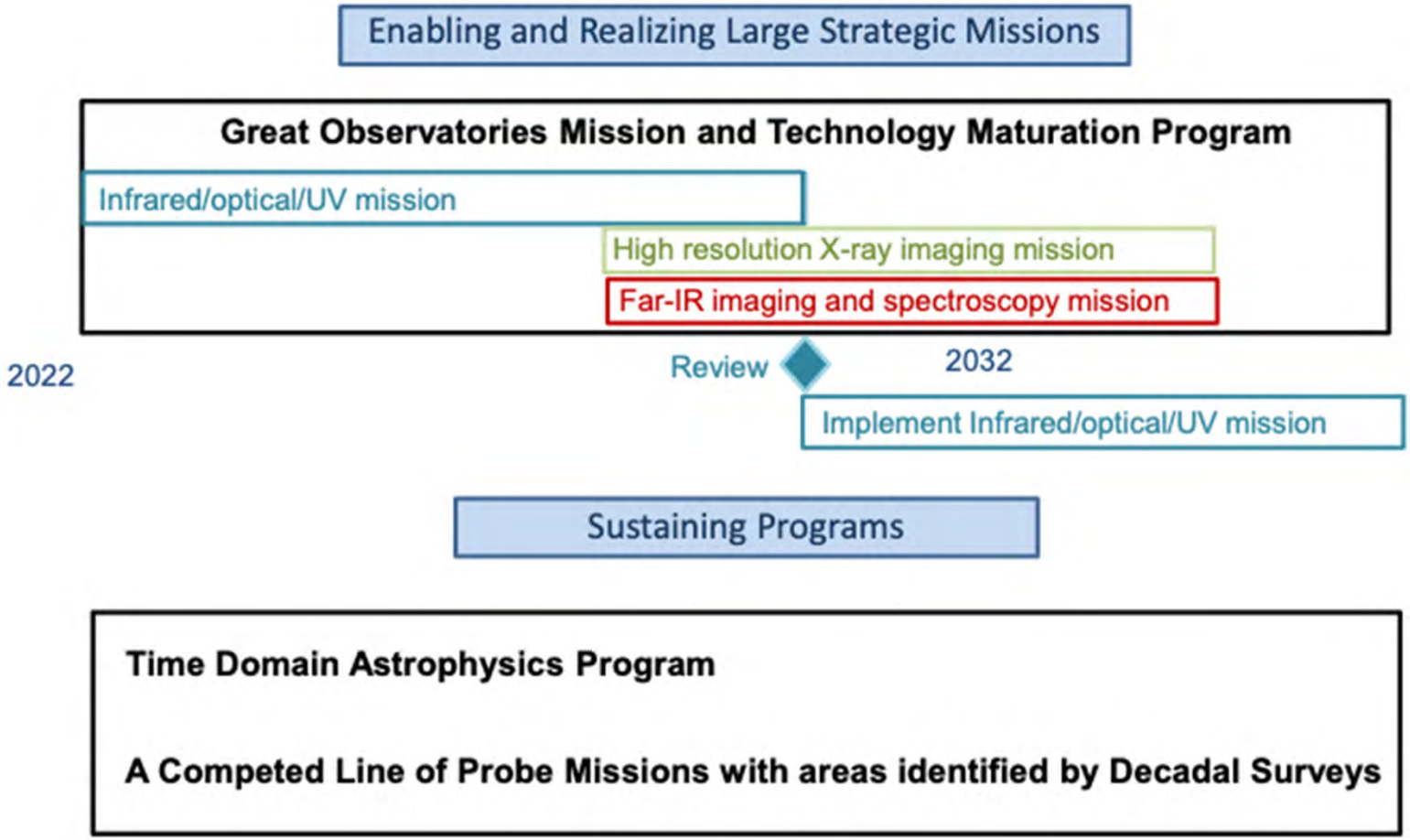
But a plan also needs to be realistic, responsible, achievable, sustainable

The Survey's Approach:

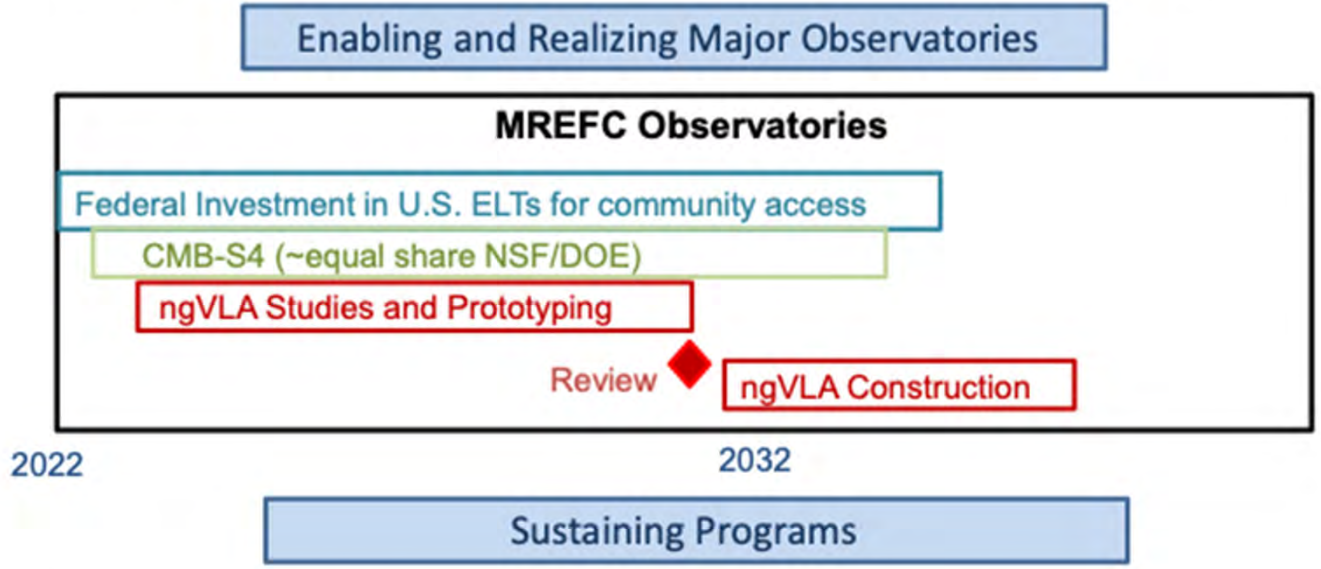
- Propose an ambitious program, but with decision rules, decision points, and contingencies
- Emphasize phased development of many projects to lower risks and provide flexibility to agencies
- Present a strategy, with details of implementation resting with agencies and their advisory committees


Astro2020 Process
community science white papers (573)
community APC white papers (294)
Science Panels (6)
frontier questions
discovery areas
Program Panels (6)
project assessments
(science, technical, cost, risk)
SoPSI Panel
assess health of profession, provide actionable advice
Steering Committee
assimilate panel reports, address cross-cutting areas
integrate science program, identify key strategic questions,
prioritized investment strategy within budget guidelines
The National Academies of
SCIENCES · ENGINEERING · MEDICINE

Space Program Medium/Large Programs Overview



Ground Medium/Large Program Overview



Enhancements to Astronomy Mid-scale Programs

Endorsements for Programs in NSF/PHYS

Technology Development for Future Gravitational Wave Observatories

The IceCube-Generation 2 High Energy Neutrino Observatory

3 Science Themes

- Worlds and Suns in Context
  - *The quest to understand the interconnected systems of stars and the worlds orbiting them, from the nascent disks of dust and gas from which they form, through the formation and evolution of the vast array of extrasolar planetary systems so wildly different than the one in which Earth resides*
- New Messengers and New Physics
  - *New Messengers and New Physics captures the scientific questions associated with inquiries ranging from astronomical constraints on the nature of dark matter and dark energy, to the new astrophysics enabled by combined observations with particles, neutrinos, gravitational waves, and light*
- Cosmic Ecosystems
  - *The universe is characterized by an enormous range of physical scales and hierarchy in structure, from stars and planetary systems to galaxies and a cosmological web of complex filaments connecting them*

Astro 2010

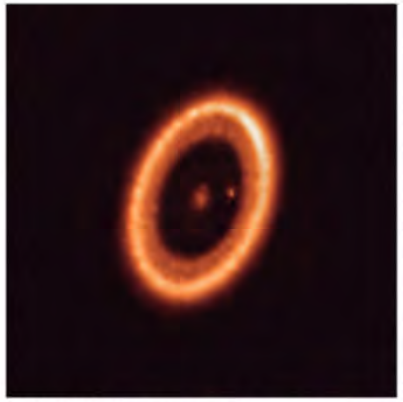
- Cosmic Dawn:
  - Searching for the First Stars, Galaxies, and Black Holes
- New Worlds:
  - Seeking Nearby, Habitable Planets
- Physics of the Universe:
  - Understanding Scientific Principles

Science Theme: Worlds and Suns in Context

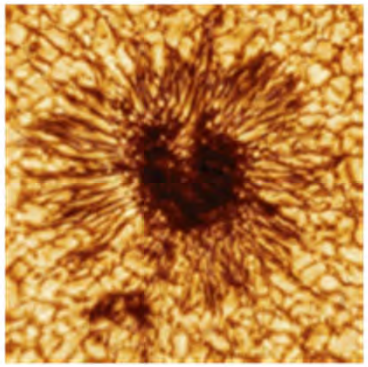
The quest to understand the interconnected systems of stars and the worlds orbiting them, from the nascent disks of dust and gas from which they form, through the formation and evolution of the vast array of extrasolar planetary systems so wildly different than the one in which Earth resides

This theme is forefront this decade because of:

- The extraordinary rate of discovery of new exoplanets– understanding the demographics and finding the nearest planets for detailed study
- The promise of JWST to make pioneering observations of exoplanet atmospheres
- The revolution DKIST will bring to understanding the Sun's atmosphere
- The revolution in studying planet formation by imaging protoplanets and their accretion disks using large ground-based telescopes (OIR and ALMA)



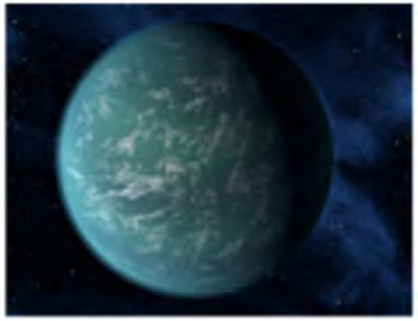
ALMA image of a young planet-forming star



DKIST image of a sunspot

Priority Area: Pathways to Habitable Worlds

We are on a path to exploring worlds resembling Earth and answering the question: "Are we alone?" The task for the next decades will be finding the easiest of such planets to characterize, and then studying them in detail, searching for signatures of life.



The needed capabilities include:

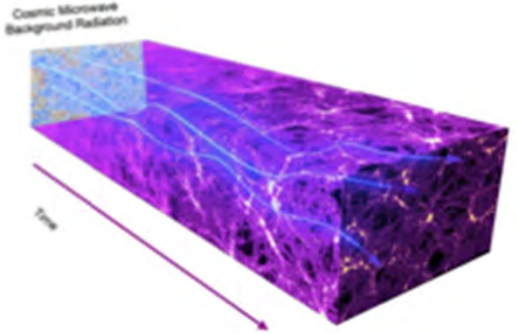
- Ground-based ELTs equipped with high-resolution spectroscopy, high-performance AO, and high-contrast imaging
- A large space-based IR/O/UV telescope with high contrast imaging and spectroscopy capable of observing planets 10 billion times fainter than their host star
- High spatial and spectral resolution X-ray observations to probe stellar activity across the entire range of stellar types
- Laboratory and theoretical studies

Science Theme: New Messengers and New Physics

New Messengers and New Physics captures the scientific questions associated with inquiries ranging from astronomical constraints on the nature of dark matter and dark energy, to the new astrophysics enabled by combined observations with particles, neutrinos, gravitational waves, and light

This theme is forefront this decade because of:

- Tremendous progress in observations of the Cosmic Microwave Background
- Time domain surveys that have uncovered an astounding array of transient phenomena
- The discovery of compact object mergers with LIGO, and the detection of electromagnetic counterparts
- Ice Cube's detection of high energy neutrinos of astrophysical origin



Priority Area: New Windows on the Dynamic Universe

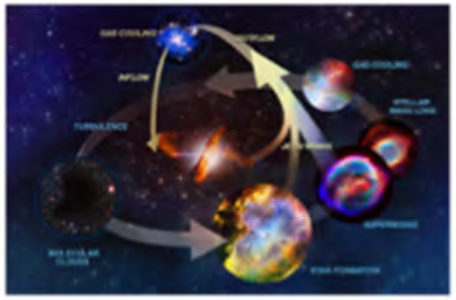
The New Windows on the Dynamic Universe priority area involves using light in all its forms, gravitational waves, and neutrinos to study cosmic explosions on all scales and the mergers of compact objects

The needed capabilities include:

- Facilities to discover and characterize the brightness and spectra of transient sources as they appear and fade away
- Ground-based ELTs to see light coincident with mergers
- A next-generation radio observatory to detect the relativistic jets produced by neutron stars and black holes
- Next generation CMB telescopes to search for the polarization produced by gravitational waves in the infant universe
- Upgrades to current ground-based gravitational wave detectors, and development of next generation technologies
- Improvements in the sensitivity and angular resolution of high energy neutrino observatories

Science Theme: Cosmic Ecosystems

The universe is characterized by an enormous range of physical scales and hierarchy in structure, from stars and planetary systems to galaxies and a cosmological web of complex filaments connecting them



This theme is forefront because:

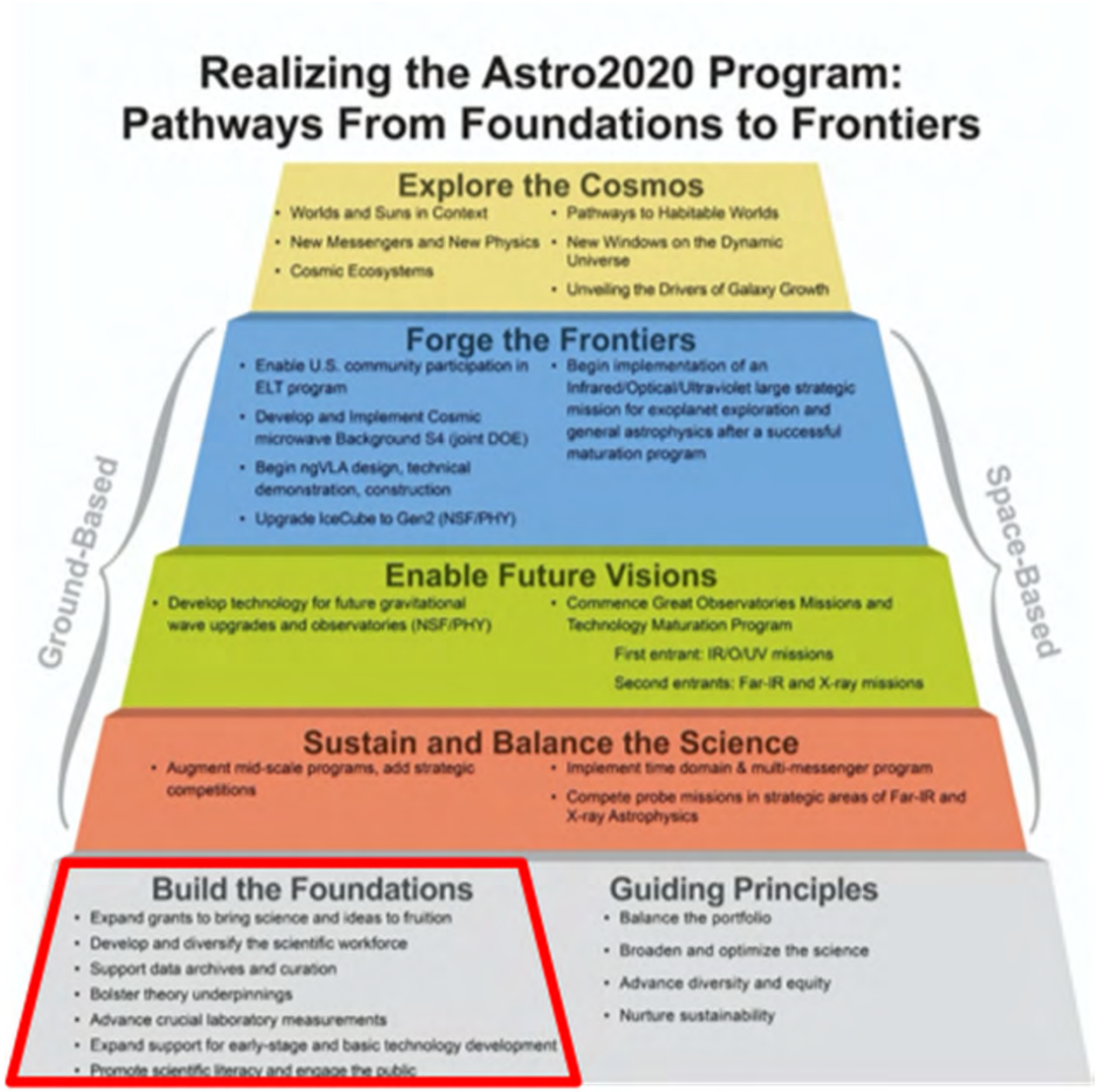
- JWST will provide definitive observations of the earliest stages of galaxy formation and evolution
- The Rubin Observatory, Roman, and Euclid will provide imaging and spectral energy information for millions of galaxies, complementing the in-depth observations from JWST
- Progress in numerical simulations is evolving rapidly and is driving our understanding of the observations

Priority Area: Unveiling the Drivers of Galaxy Growth

The priority area involves unveiling the drivers of galaxy growth, focusing on processes affecting galactic scales

The needed capabilities include:

- ELTs to observe galaxies in the young universe
- A next generation radio telescope to map emission lines of molecular gas, tracing cold gas
- A next generation IR/O/UV space telescope to trace the details of the nearby, evolved universe
- FIR and X-ray missions to peer into the dusty hearts of galaxies to reveal enshrouded black holes, and trace the hottest gas phases
- Investments in theory to realize a new scientific foundation for understanding galaxy evolution



The National Academies of
SCIENCES · ENGINEERING · MEDICINE

The Profession and its Societal Impacts

> *"The pursuit of science, and scientific excellence, is inseparable from the humans who animate it."*
> *-- Panel on the State of the Profession and Societal Impacts*

Guiding principles: diversity, equitable access, benefits to the nation and the world, sustainability and accountability

Astro2020 report includes 10 recommendations in this area

Here we provide a brief synopsis: see the full report for additional discussions of education, career paths and pipelines, public outreach and engagement, climate change, and benefits to the nation

The Profession and its Societal Impacts

Areas of key recommendations for the state of the profession

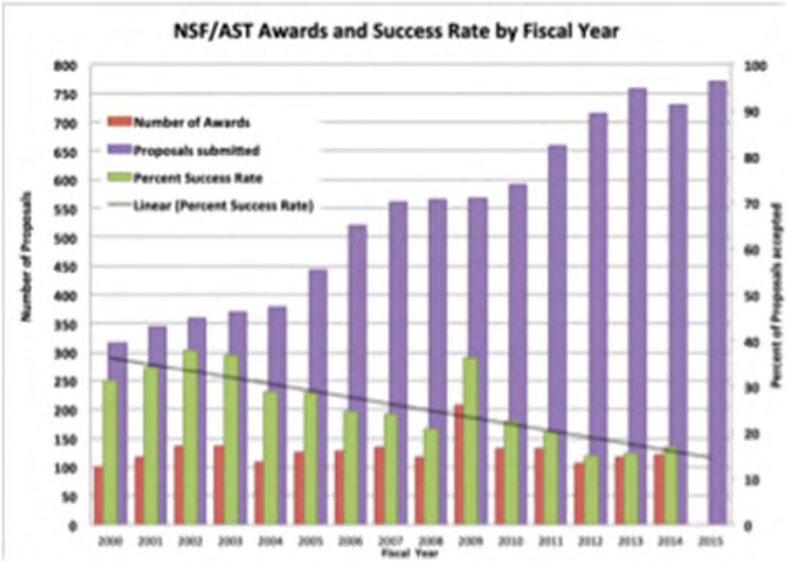
- Collecting demographic data to understand equity in funding
- Diversity of the profession
  - Improving diversity of project and mission teams
  - Investing in and sustaining workforce diversity "bridge" programs
  - Undergraduate and graduate traineeship programs
- Professional policies related to harassment and discrimination
- Community relations
- Dark skies and protecting the radio frequency spectrum

NSF Investigator Grants Programs

The NSF AAG program is a cornerstone of the enabling research foundation

Over the past 20 years success rates have steadily declined from 45% to 25% or lower; much lower for first-time proposers

These grants are crucial for achieving the scientific goals of the decadal survey



Recommendation: NSF should increase funding for the individual investigator Astronomy and Astrophysics Research Grants by 30 percent in real dollars (i.e. above the rate of inflation) over five years from 2023-2028 starting with the FY 2019 budget inflated appropriately. This will have the effect of restoring success rates to a healthy competitive level

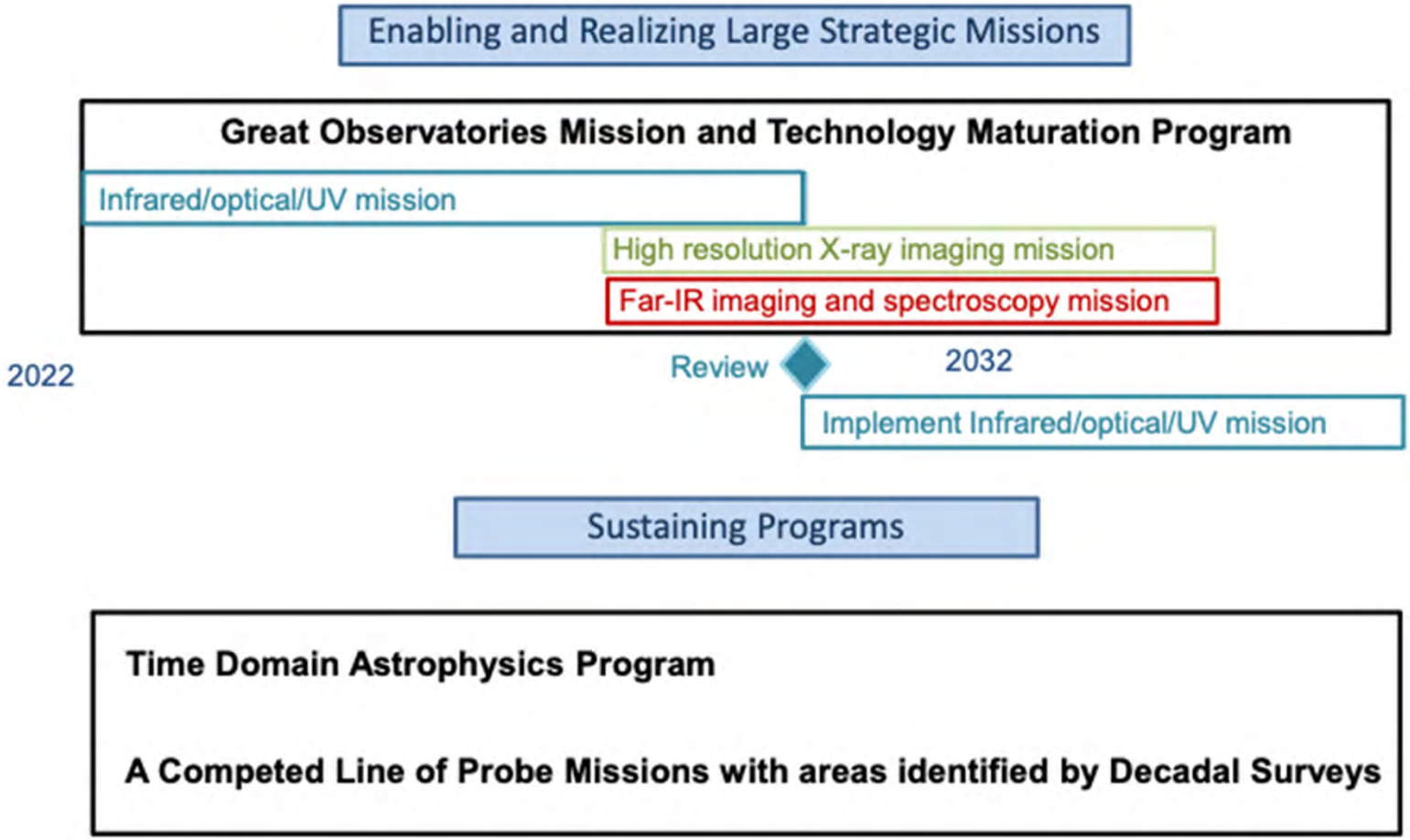
The Frontiers: Major New Projects and Sustaining Programs

The compelling programs recommended by past surveys are vital to the scientific vibrancy of the coming decade

Ground	Space
• Midscale Innovations Program	• Explorer Program Augmentation
• Daniel K. Inouye Solar Telescope	• James Webb Space Telescope
• Vera Rubin Observatory	• Roman Space Telescope
	• US Contribution to Euclid
	• US Contribution to Athena
	• US Contribution to LISA

Conclusion: The Survey's recommendations for advancing the new programs or augmentations are predicated on the assumption that the major astrophysics facilities and missions in NASA, NSF, and DOE's current plans are completed and fully supported for baseline operations and science

Space Program Medium/Large Programs Overview



Recommended Missions for Maturation

Highest Priority:

- *An IR/O/UV Large Telescope Optimized for Observing Habitable Exoplanets and General Astrophysics*

  To the program as soon as possible. Target cost for mission: 11B$ (FY20). Analysis estimates maturation program of ~six years, $800M required before review and transition to mission adoption

Of Co-equal Priority:

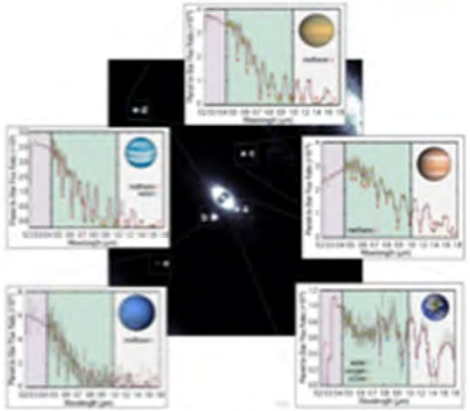
- *A far-IR spectroscopy and/or imaging strategic mission*

  To start mid-decade. Target cost for mission: 3 – 5 B$ (FY20). ~40M$ per year required for maturation program this decade

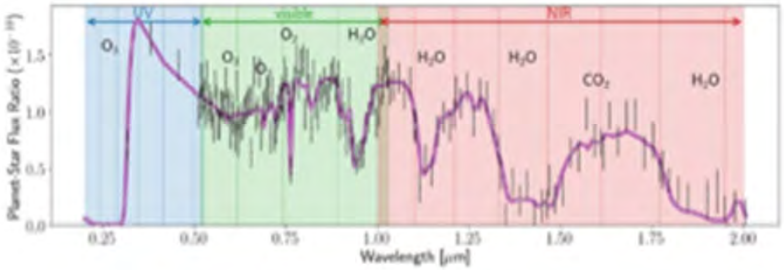
- *A high spatial and spectral resolution X-ray strategic mission*

  To start mid-decade. Target cost for mission: 3 – 5 B$ (FY20). ~40M$ per year required for maturation program this decade

A Future IR/Optical/UV Telescope Optimized for Observing Habitable Exoplanets and General Astrophysics



Simulated space-telescope image of a complete planetary system including a life-bearing Earth-like planet



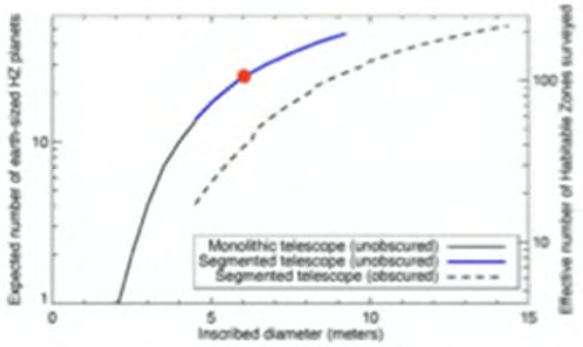
Simulated spectrum of an Earth-twin planet observed from the UV to near-IR by a space coronagraph

Recommendation: After a successful mission and technology maturation program, NASA should embark on a program to realize a mission to search for biosignatures from a robust number of about ~25 habitable zone planets and to be a transformative facility for general astrophysics. If mission and technology maturation are successful, as determined by an independent review, implementation should start in the latter part of the decade, with a target launch in the first half of the 2040's

A Future IR/Optical/UV Telescope Optimized for Observing Habitable Exoplanets and General Astrophysics

IR/O/UV Telescope Characteristics

- ~6 m off-axis inscribed diameter provides robust sample of ~25 spectra of potentially habitable planets, and would be transformative for general astrophysics
- Estimated cost: 11B$
- Target launch: first half of 2040's

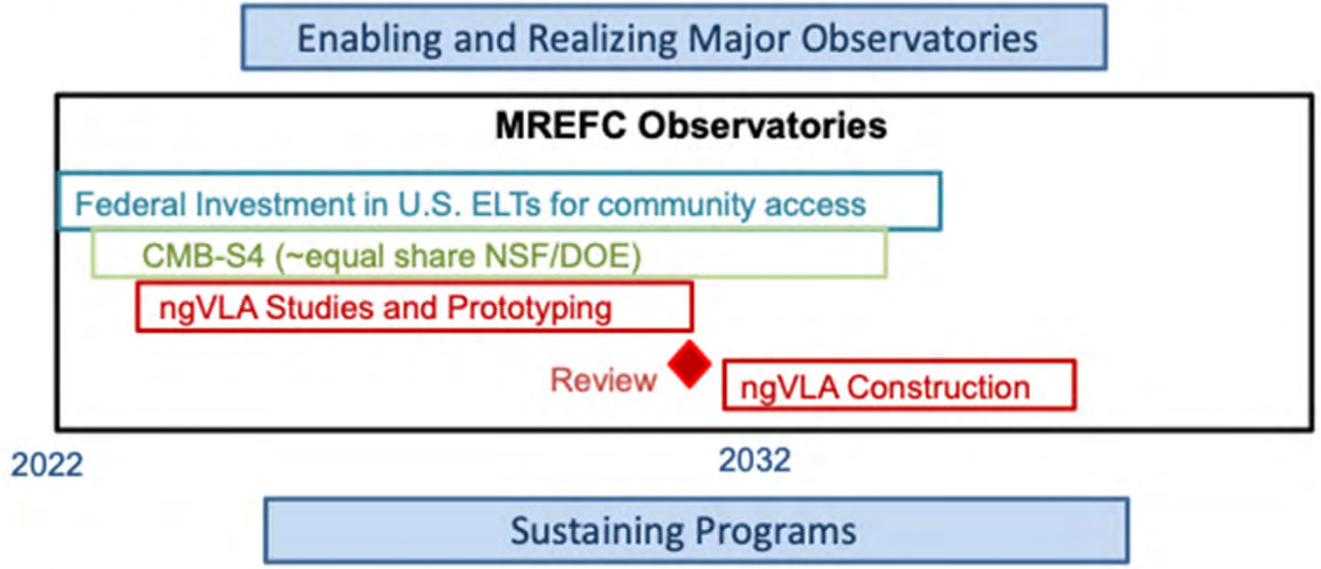


The scientific goals of this mission, when achieved, have the potential to change the way that we as humans view our place in the Universe

With sufficient ambition, we are poised to make this transformational step

This is a quest at the technical forefront, and of an ambitious scale that only NASA can undertake, and where the U.S. is uniquely situated to lead

Ground Medium/Large Program Overview



Enhancements to Astronomy Mid-scale Programs

Endorsements for Programs in NSF/PHYS

Technology Development for Future Gravitational Wave Observatories

The IceCube-Generation 2 High Energy Neutrino Observatory

NSF Funding for Major Research Facilities

Astronomy frontiers have been driven by new observatories

Construction costs have been borne by MREFC

Operations costs then transfer to AST

This is not sustainable

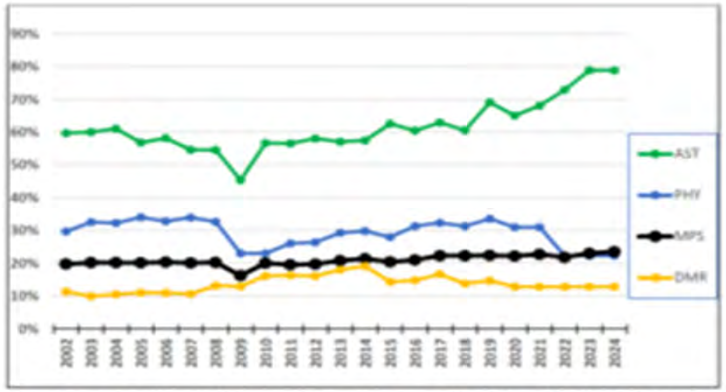
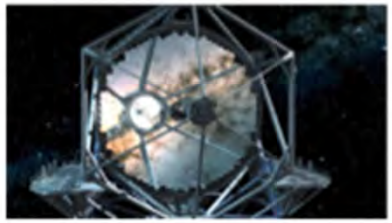


Figure 2, Percentage of Selected MPS Division Budgets to Facilities (O&M) and Overall MPS Share. AST: Division of Astronomical Sciences, PHY: Division of Physics, MPS: Directorate of Mathematical and Physical Sciences, DMR: Division of Materials Research

Recommendation: The NSF should develop a sustainable plan for supporting the operations and maintenance costs of its astronomical facilities, while preserving an appropriate balance with funding essential scientific foundations and the remainder of the NSF AST portfolio. *The addition of new MREFC facilities should be contingent on implementation of this plan*

U.S. Extremely Large Telescope Program



Thirty Meter Telescope

Giant Magellan Telescope

The scientific potential of 20-40m optical-infrared telescopes is vast

- resolution of 0.01-0.02 arcsec with adaptive optics

  1-2 au @ 100 pc, 0.8-1.6 pc @ Virgo cluster, 60-120 pc @ z=2.5 (!)

- 36-81x gain for point sources over 10-m telescopes (scales as D^4)
- immense range of scientific goals

  detection, imaging, spectroscopy of rocky planets, exoplanet atmospheres, protoplanetary disks; high-z supernovae and GRBs, cosmological yardsticks; spectroscopy of faint JWST sources; spectra of CGM/IGM, stellar fossil records of Galaxy, …

The combination of TMT, GMT, and NOIRLab (for community and science support) would provide the U.S. community with essential access to these transformative capabilities

US-ELT Program

Recommendation: The NSF should achieve a federal investment equal to at least 50 percent time for the U.S. community in at least one and ideally both of the two extremely large telescope projects – the Giant Magellan Telescope and the Thirty Meter Telescope, with a target level of at least 25% of the time on each telescope. If both projects are viable, then that time should be distributed across the two proposed telescopes. If only one project proves to be viable, the NSF should aim to achieve a larger fraction of the time, in proportion to its share of the costs and up to a maximum of 50 percent

Participation in both projects is the optimal outcome

- full-sky access
- maximizes public nights available (~180/yr total)
- exploit complementary instrumentation

If circumstances preclude participation of one observatory (financial, site availability) goal should be to obtain as large a share on the other as available

This is the survey's top priority MREFC recommendation due to the timeliness and transformative potential

US-ELT Program: Decision Rules

Prior to major investment by the NSF, a review must determine that:

- The projects have demonstrated financial viability with agreed-upon commitments from partners for all necessary capital and operations funds, pending only NSF investment
- A final site selection has been made in the case of the TMT
- A public share of telescope time (run through the NSF's NOIRLab) roughly equivalent to the NSF's share of total federal investment of construction and operations expenses
- Development of a management plan and governance structure for the joint project, including the relevant observatory corporations and the NSF

Success of both projects at the levels presented to the survey represents an NSF investment of 1.8 B$*, leveraging private and international investments of 3.6 B$, bringing these transformative observatories on-line early in the 2030's

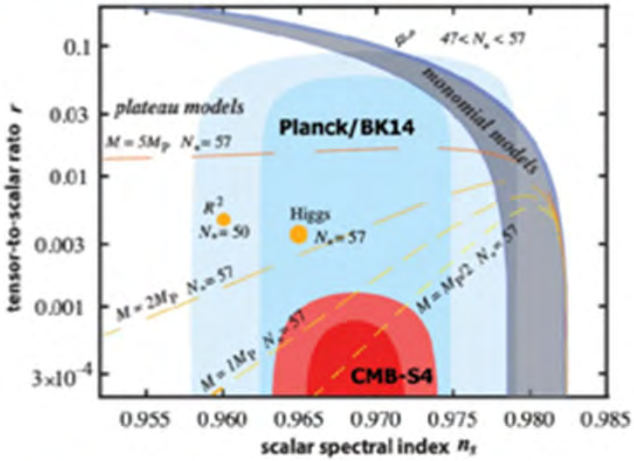
*Based on TRACE evaluation

The Cosmic Microwave Background Stage 4 Observatory

CMB-S4 builds on the foundation of decades of CMB measurements to take a major leap, pushing CMB science to the next level

Scientific goals

- B-mode CMB polarization signatures of primordial gravitational waves and inflation
- Maps 50% sky, every other day from 0.1- 1 cm with unprecedented sensitivity
- Broad science including systematic time domain science



CMB-S4 consists of a systematically planned suite of facilities in Antarctica and Chile designed to sample a wide range of independent frequencies, and probe a combination of large and small angular scales

The Next Generation Very Large Array (ngVLA)

The ngVLA presented to the survey is a very ambitious project

- Estimated cost $3.2B (75% NSF, 25% foreign contribution TBD); operations >$100M/yr
- Up to 224 antennas arrayed across North America; operates from 1.2 - 116 GHz

Astro2020 concluded that the project scope and design need further development before a review determines the scope is appropriate, and before proceeding to construction

Recommendation: The NSF should proceed with a program to support science design, development, cost studies, and antenna prototyping for the Next Generation Very Large Array. After completion of the studies, NSF should convene a review to assess the project's readiness and available budget and proceed with construction if possible.

NSF Mid-Scale Program Background

Mid-scale (4 – 100 M$) competed programs harness the creativity of the community and fuel innovation

A broad, balanced scientific program demands expansion of opportunities at the mid-scale to fulfill strategic needs and harness innovations

Recommendation: The NSF Division of Astronomical Sciences (AST) should create three tracks within the AST Mid-Scale Innovations Program and within (its share of) the NSF-wide Mid-Scale Research Infrastructure Program. The first track should be for *regularly competed, open calls*, the second track should solicit proposals in strategically identified priority areas, and the third should invite ideas for upgrading and developing new instrumentation on existing facilities. All tracks should solicit proposals broadly enough to ensure healthy competition.

Technology Development for Future Ground-based Gravitational Wave Observatories

Gravitational wave detection is one of the most exciting and expanding scientific frontiers impacting central questions in astronomy

- Directly relevant to two Astro2020 priority areas: New Windows on the Dynamic Universe, Hidden Drivers of Galaxy Formation

More advanced detectors in the current LIGO facility (beyond A+) and planning for future generation facilities such as Cosmic Explorer are essential

Conclusion: … Continuous technology development will be needed this decade for next generation detectors like Cosmic Explorer. These developments will also be of benefit to the astrophysical reach of current facilities.

IceCube-Generation 2 Neutrino Observatory

IceCube at South Pole detects 100 TeV – 10 PeV cosmic neutrinos

Upgrade to Generation-2 observatory will add detector elements and a radio array to increase sensitivity (5x), detection rate (10x), and energy range (to 1000 PeV)

- resolve diffuse (currently) cosmic neutrino background
- localize, identify individual astrophysical sources
- coordinated multi-messenger observations

Conclusion: The IceCube-Generation 2 neutrino observatory would provide significantly enhanced capabilities for detecting high-energy neutrinos, including the ability to resolve the bright, hard-spectrum TeV-PeV neutrino background into discrete sources. Its capabilities are important for achieving key scientific objectives of this survey

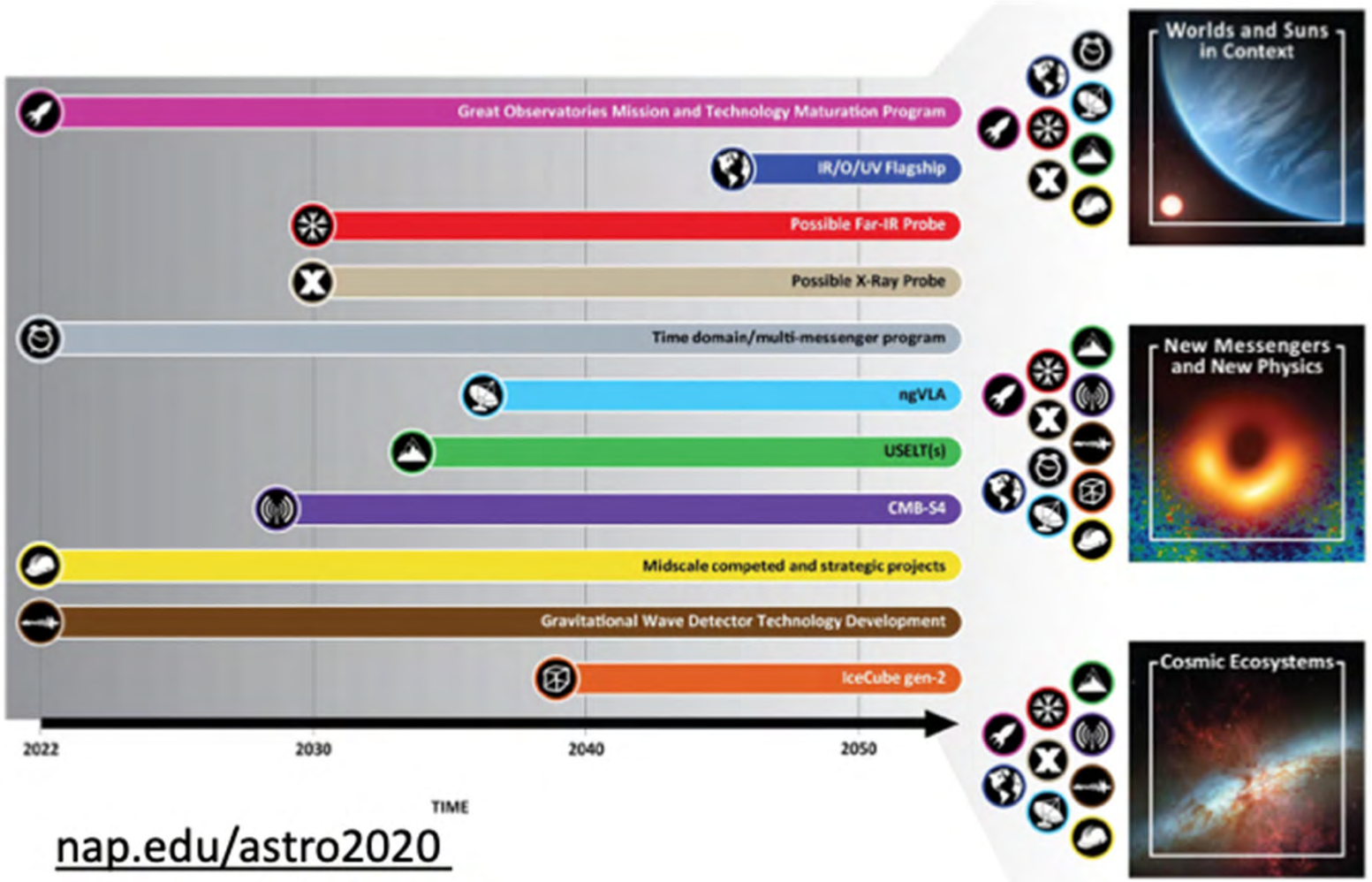
Consistency with Budget Guidance

Agency budgets projected forward are uncertain

We planned our program to be within the optimistic scenarios provided by the agencies (time averaged)

The program we set forth allows for future opportunities

We live in exciting times for astronomy and astrophysics. Amazing scientific opportunities lie in front of us that strongly motivate increased investment in the future



nap.edu/astro2020

www.nap.edu/26141

The National Academies of
SCIENCES · ENGINEERING · MEDICINE

Can we do this in Japan?

- Science Council has very different characters/roles
  - Policy recommendations to the government and public
  - International activities
  - Promotion of scientific literacy
  - Establishment of networks among scientists
- No mechanism for the funding agencies to be involved in the process
  - MEXT forms their own committees
  - No direct connection between planning and budget process
  - No master plan, no connection to “Frontier” budget
- Need a “Japanese model”

日本でこれができるか？

- 学術会議が持つ性格・役割はかなり違う
  - 「日本学術会議の役割は、主に以下の4つです。
    - 政府・社会に対して日本の科学者の意見を直接提言
    - 市民社会との対話を通じて科学への理解を深める
    - 地域社会の学術振興や学協会の機能強化に貢献
    - 日本を代表するアカデミーとして国際学術交流を推進」
- 省庁が関わる仕組みがない
  - 文科省は自前で委員会を作る
  - 予算に結びつくプロセスにならない
  - マスタープランはなくなってしまい、学術フロンティアに結びつかない
- 日本独自のモデルが必要