ASTRONET

The US Decadal Survey's: Now and the Next Decade

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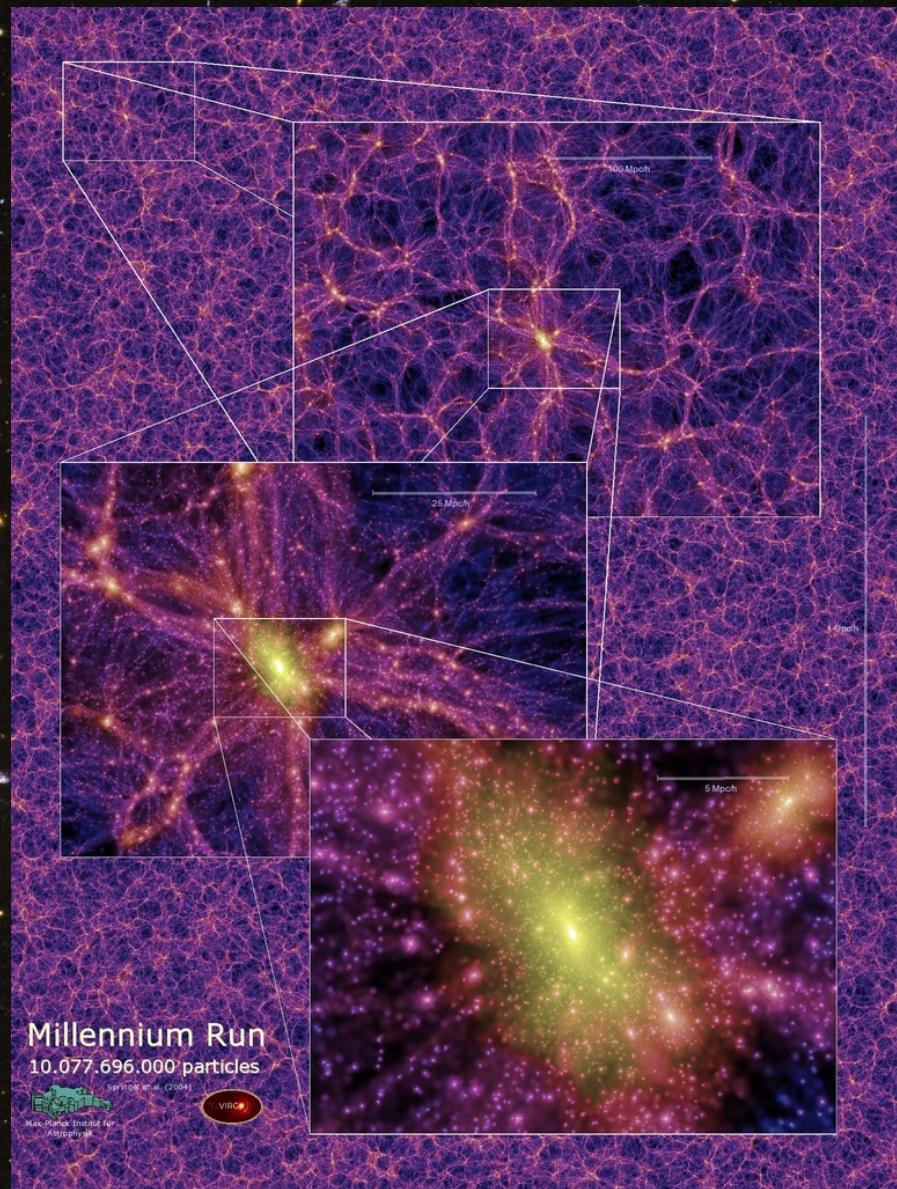
University of California, Santa Cruz
Chair, Astronomy and Astrophysics Advisory Committee (AAAC)

Poitiers Jan 07



The Changing Landscape…

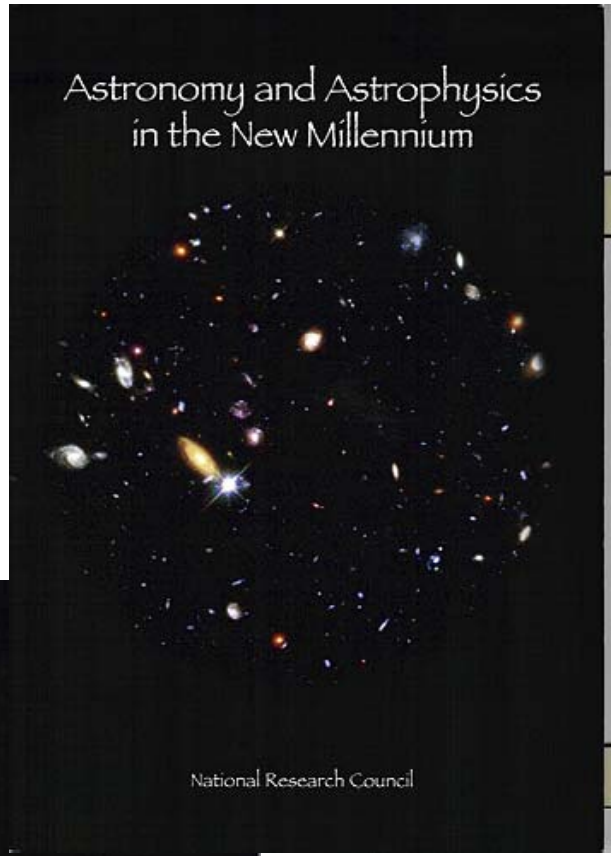
Astronomy has undergone a dramatic change in the last decade => period of great productivity

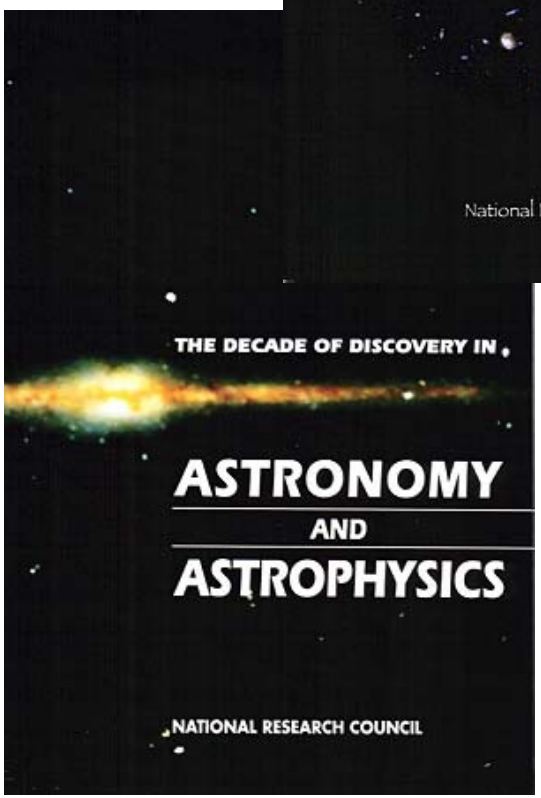
Powerful space missions

Large collecting area ground-based facilities

Sophisticated detectors and data processing

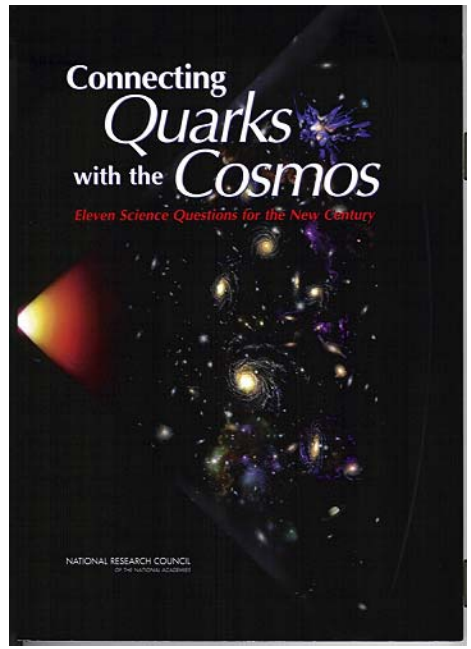
Dramatic advances in theory/computer modeling



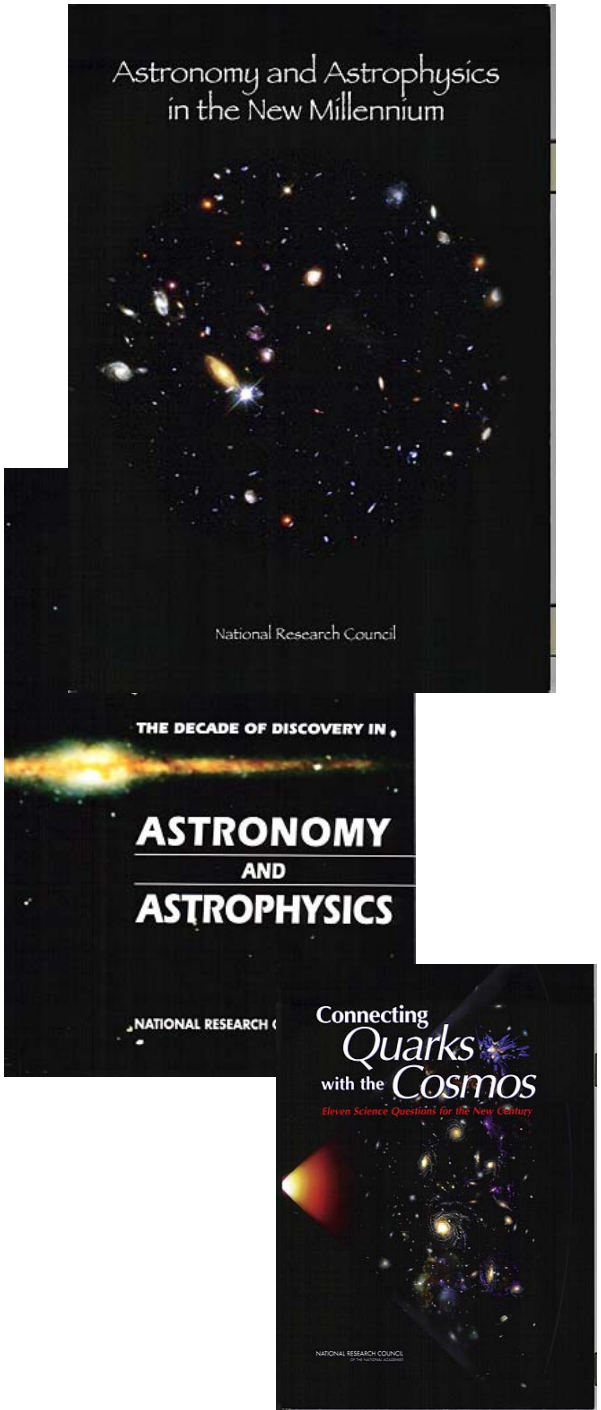


Decadal Surveys

and other major National Academy studies



1) Decadal Surveys
2) AAAC
3) How are we doing in the US?
4) Current budget situation & issues
5) Changes for 2010 survey



Decadal Surveys

Held every 10 years

Organized by National Academy of Sciences through its National Research Council (NRC)

Run by Astronomers/Astrophysicists/NRC staff

Funded by Agencies (NASA+NSF - DOE?)

Supplemented by other studies

AAAC

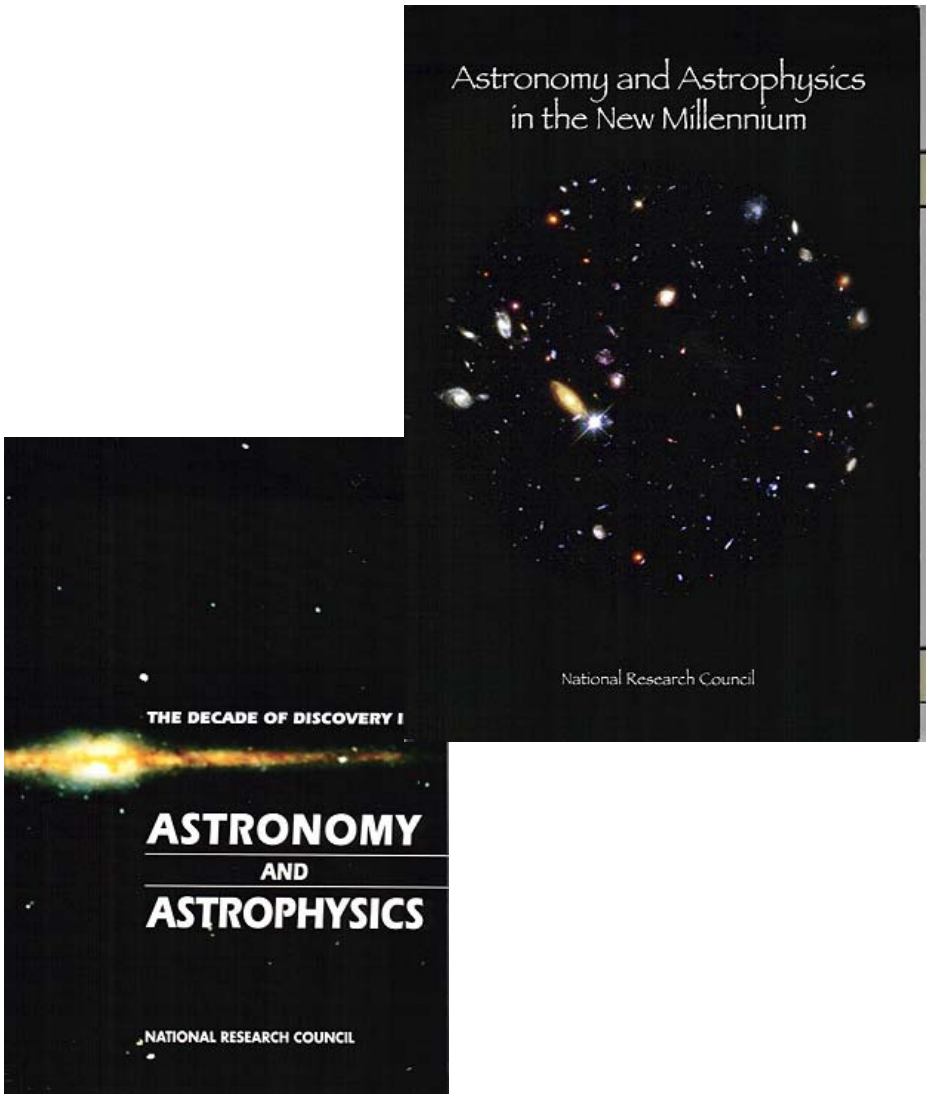
Astronomy and Astrophysics Advisory Committee

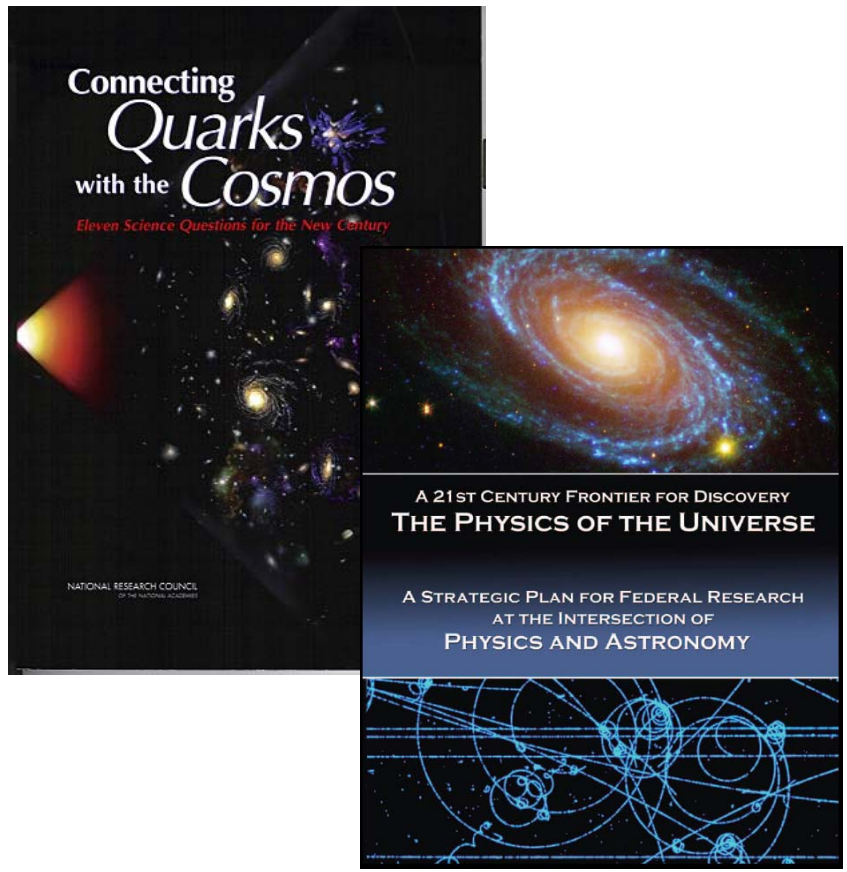
Astronomy and Astrophysics Advisory Committee

AAAC

Garth Illingworth, UCSC - Chair

Reports/Letters etc: www.nsf.gov/mps/ast/aaac/





AAAC

Astronomy and Astrophysics Advisory Committee Background

- Grew out of Office of Management and Budget (OMB) and Congressional interest in optimizing return on astronomy investment - minimizing duplication of effort coordination => cost-effectiveness (maximize science return for $$)

- COMRAA study (NAS/NRC Committee on the Organization and Management of Research in Astronomy and Astrophysics)
  $\Rightarrow$ explicit recommendation for AAAC-like committee

- Established by Congress in 2002 NSF Authorization Act and formally constituted late 2003, modified 2005 to add DOE. 13 members selected by science agencies (NASA, NSF, DOE) and the Office of Science Technology Policy - OSTP

Astronomy and Astrophysics Advisory Committee Background cont.

AAAC

- AAAC meets four times per year
- Updates from agency astronomy representatives, plus discussions with science community groups, OSTP staff, OMB examiners, Congressional staff, agency leadership…..
- AAAC is constituted under FACA (Federal Advisory Committee Act) rules so can formally offer advice to the government (can advise agencies). Required through its annual report (March 15), but also through letters at other times of the year
- Annual Report sent to Chairs of several Congressional committees plus NASA Administrator, NSF Director, (DOE) Secretary of Energy; widely distributed to other Congressional committees, OMB, OSTP and agency personnel, NAS/NRC committees.

AAAC

Congressional Language: "the charge"

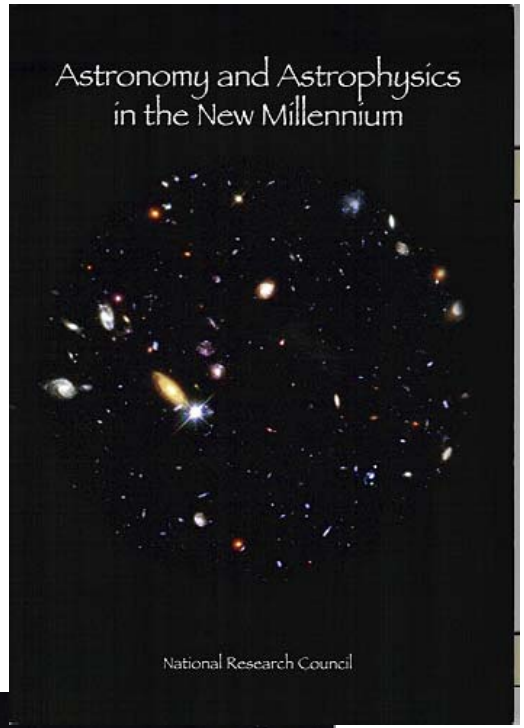
(1) assess, and make recommendations regarding, the coordination of astronomy and astrophysics programs of the Foundation and the National Aeronautics and Space Administration, and the Department of Energy

(2) assess, and make recommendations regarding, the status of the activities of the Foundation and the National Aeronautics and Space Administration, and the Department of Energy as they relate to the recommendations contained in the National Research Council's 2001 report entitled ``Astronomy and Astrophysics in the New Millennium'', and the recommendations contained in subsequent National Research Council reports of a similar nature *(….Decadal survey…)*

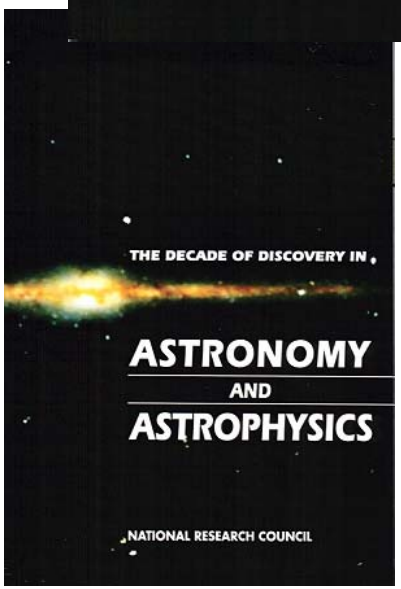
AAAC

AAAC is focused on implementation of Decadal Survey(s), and other comparable NAS/NRC reports, particularly involving interagency coordination.

Strategic framework: NAS/NRC
Tactical implementation: AAAC

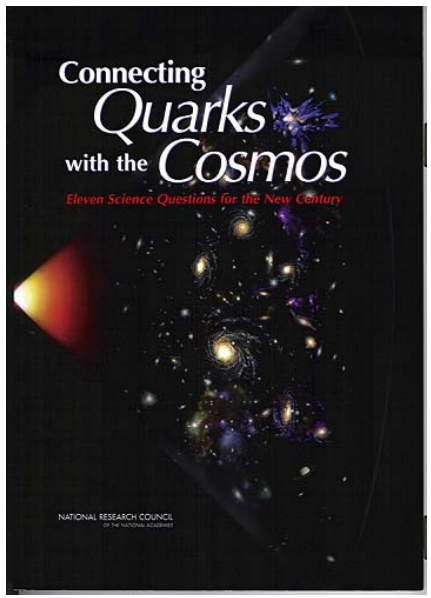


2000



1990

ExoPTF
ExoPlanet Task Force



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TFCR
Cosmic Microwave Background Task Force

DETF
Dark Energy Task Force

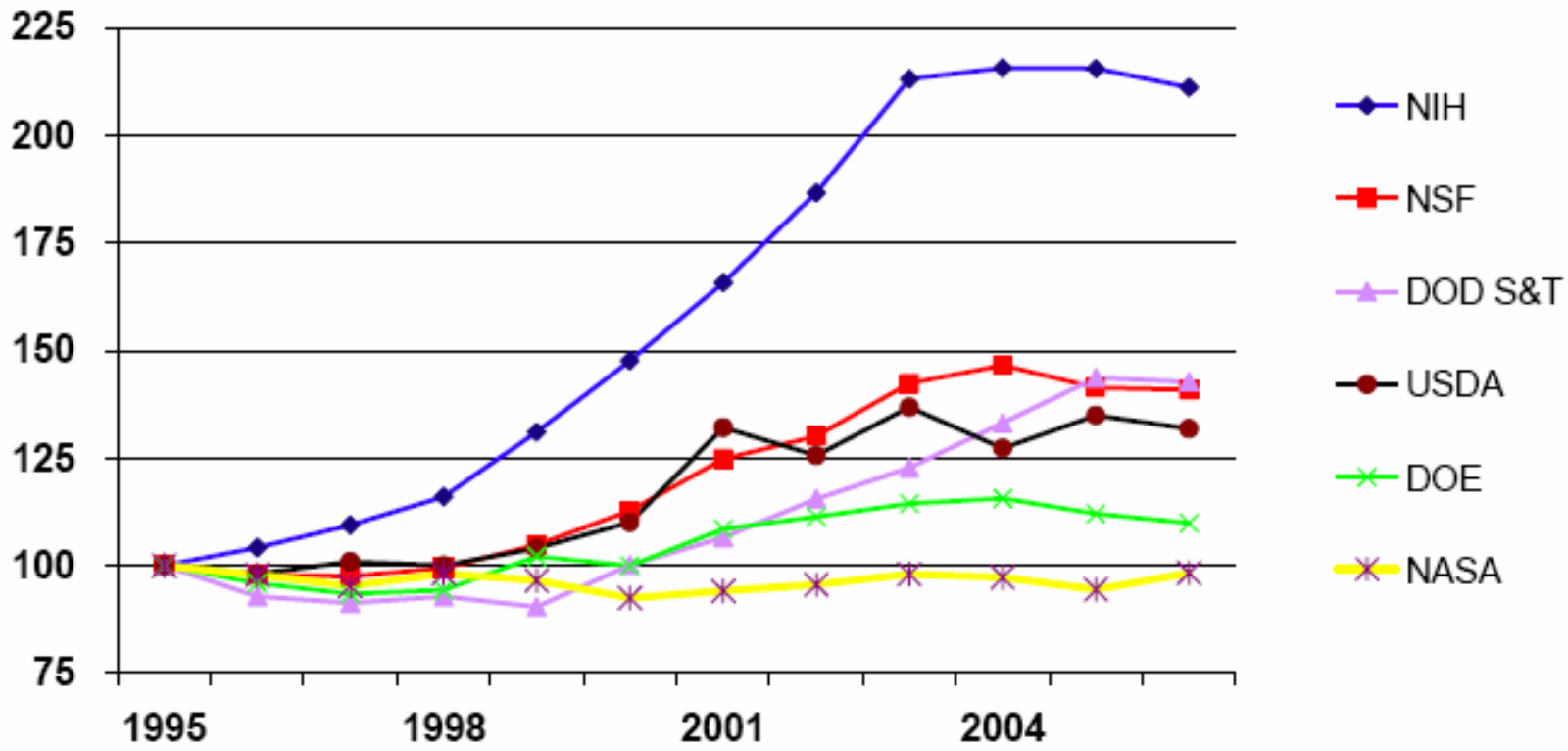
DMSAG
Dark Matter Science Assessment Group

AAAC + HEPAP

Budgets and Funding for Science: Astronomy and Astrophysics

Trends in Federal R&D, FY 1995-2006

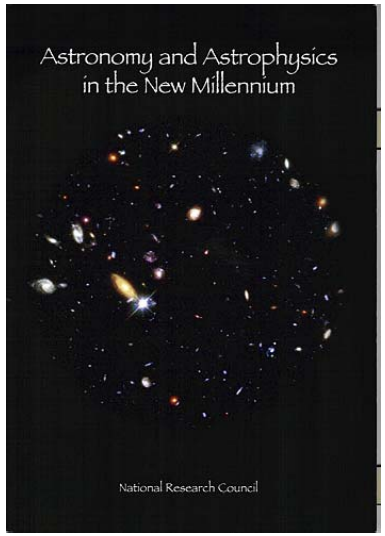
selected agencies in constant dollars, FY 1995=100



Source: AAAS analyses of R&D in *AAAS Reports VIII-XXX*. FY 2006 figures are AAAS estimates of final FY 2006 appropriations.
R&D includes conduct of R&D and R&D facilities.

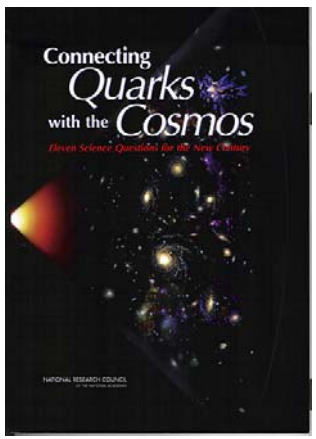
AAAS

Federal Funding for Astronomy



Times of significant uncertainty and change: budgets for R&D are flat or slightly decreasing, when inflation-corrected (especially in FY07 if Continuing Resolutions leave the budget at FY06 levels).

Future of American Competitiveness Initiative (ACI) for NSF and DOE is in doubt.



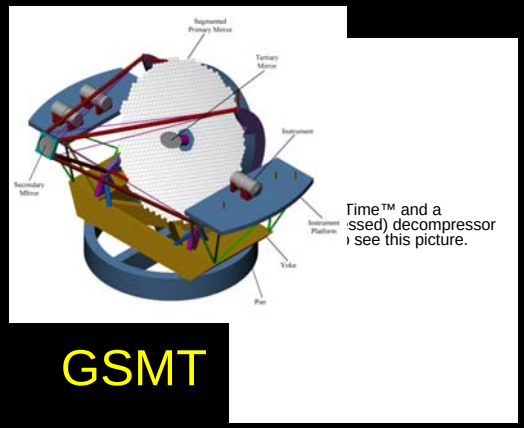
These **modest** budget cuts combine with significant ramp-up of number of major programs and cost increases in programs are stressing the science agencies budgets (substantial cost growth in most Decadal projects - medium as well as large)

Decadal projects are not getting done

Decadal Survey(s)

How well is the US doing in meeting the goals of its last (Astronomy and Astrophysics) Decadal Survey?

Ground-based in Decadal Survey(s)



GSMT

ATST

LSST

ALMA (1990)

EVLA

Ground-based in Decadal Survey(s)

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1990

Completed this decade….

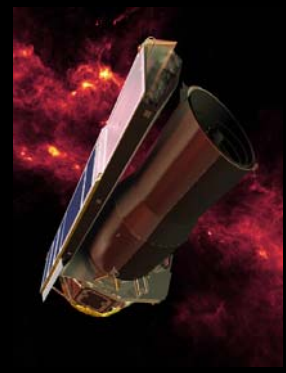
Space in Decadal Survey(s)

SM3 + SM4

SIM

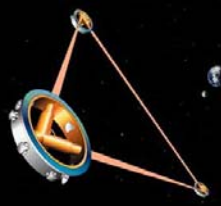
1990

SOFIA



SIRTF

LISA



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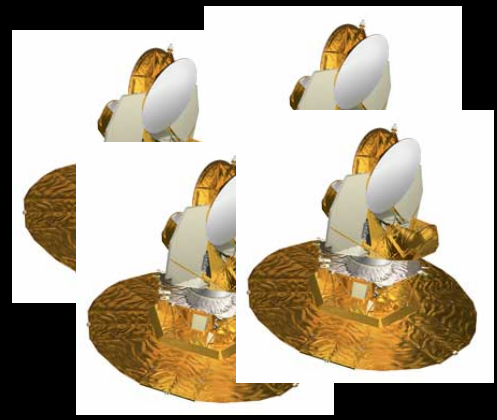
Con-X

NGST



~4 Explorers

Beyond Einstein

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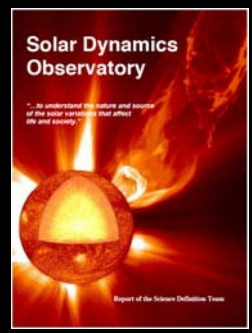
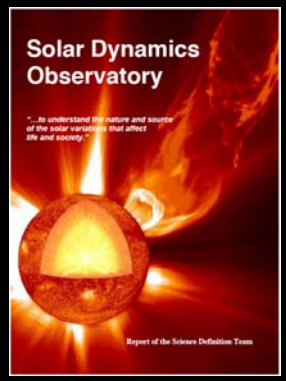
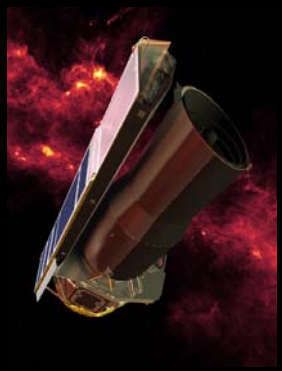
GLAST

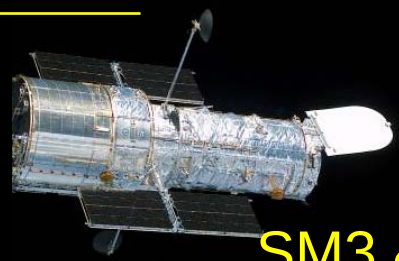


SDO

Space in Decadal Survey(s)







SM3 & SM4

Completed in Decade….

2000 Decadal Recommendations

Carryover: ALMA
SIM SIRTF
SOFIA

- JWST
- GSMT
- Con X
- EVLA
- LSST
- TPF Tech Dev
- SAFIR

- TSIP
- GLAST
- LISA
- ATST
- SKA Tech Dev
- Solar Dynam Obs
- Carma
- EXIST
- VERITAS
- ARISE
- FASR
- SPST

2000 Decadal Recommendations

Carryover: ALMA (2014)
SIM ?? SIRTF (2004)
SOFIA (2010)?

- JWST 2013
- GSMT X ??
- Con X X ?
- EVLA X (1)
- LSST ?
- TPF Tech Dev ?
- SAFIR X

- TSIP 2003
- GLAST 2007
- LISA X ??
- ATST 2013
- SKA Tech Dev ?
- Solar Dynam Obs 2008
- Carma 2006
- EXIST X
- VERITAS ? 2008
- ARISE ?
- FASR ?
- SPST 2007

Decadal Survey(s)

2000: Too much cost growth and too many projects
Federal budget predictions too optimistic

2010: Major challenge for the US is to develop a program for the next decade that is cutting edge but achievable, with a better understanding of the costs and of the budget environment

Issues that are Impacting the Implementation of the 2000 Decadal Survey

- Poor cost estimates
- Technological readiness issues and management concerns
- Government priorities (Administration; Federal Agency; Congress)
- Evolving science goals (e.g., Dark Energy)
- Federal budgets

Current Situation for Astronomy and Astrophysics (& Planetary & Solar)

FY07 Budgets

- Major issue is science budget at NASA. Dramatic change removes ~$3B from FY07-FY11; 1% growth is decrease after inflation. Severe dislocation to research programs - from R&A to Flagship missions.
- Good news is DOE Office of Science up 14% FY07 (HEP up ~8%)
- NSF up 7.9%. AST up 7.7%.
- Contrast with NASA is large. American Competitiveness Initiative?
- NSF and DOE will be OK in FY07
- NASA unclear: + ~$1B in Senate, slight cut in House - at most a modest increase in overall NASA budget?

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- NASA unclear: + ~$1B in Senate, slight cut in House - at most a modest increase in overall NASA budget?
- Key issue now is Congressional action on FY07 budget ("Continuing Resolution": Funding at FY06 level => CUTS)

Challenges for science at NASA

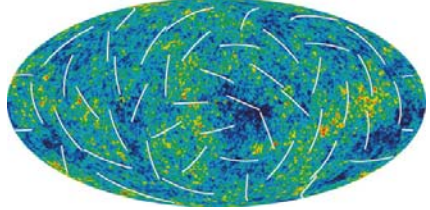
- Within the current budget constraints, NASA is being asked to complete ISS, ramp down the existing Shuttle program, and to initiate the Exploration Vision, while retaining a vibrant, broadly-based science program.

- This is a challenge - and Science (and Exploration) lost out for FY07-11 to STS (shuttle) and ISS (station). Is “Go-as-you-pay” viable?

- Key issues for science at NASA:
  - SMD budget
  - Advisory Committees
  - Balance between small/medium/large
  - R&A funding
  - Development funding for Flagships (Con-X, LISA, TPF)
  - Cost of major projects

07 BUDGET

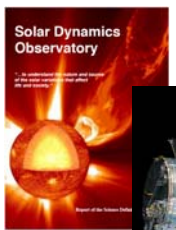
The Issue of Balance….



- The FY07 cuts to the NASA science budget are leading to a serious imbalance in the science program.
- The balance between small, medium and large programs has been undermined
- R&A funds and smaller missions (e.g., Explorers) serve a critical role in supporting the broad fabric of research for realizing the science from future large missions and in enabling the development of the necessary personnel and skills.
- Develop a strategic approach to R&A (i.e., importance for NASA objectives - not “welfare”) - clear tactical goals (e.g., technology development, theory, data analysis techniques, novel approaches to archival data…)

“Flagship” Missions

- Flagships like the NASA/ESA JWST are very important - great science and public visibility (HST).
- Unique aspects - International cooperation; a driving force for a large Astrophysics budget (~$1.5B)
- Flagship missions cost a lot - especially when “lifecycle” costs are used (development+construction+operations)
- Lifecycle costs are substantial (~FY06$ inc full cost accounting)
  HST: ~$9B; Chandra: $3.5B; Cassini: $3B; Spitzer: $1.3B;
  JWST: $4.5B; SIM: $3.2B; SOFIA: ~$2B



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“Flagship” Missions

- Essential to pick missions whose scientific return and public visibility will be commensurate with the cost
- Crucial to make correct choices in the Decadal Survey.
- A modest but consistent level of funding is needed for major programs to develop the required level of technical maturity and realistic cost estimates
- The AAAC strongly recommended that the conceptual and technology development funding for missions such as Con-X, LISA, and TPF be at least ~$10M per year

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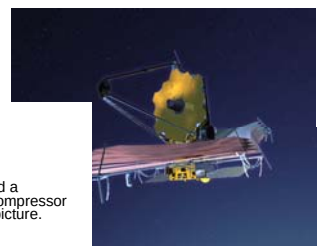

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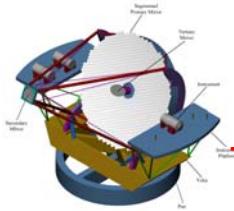
Challenges for NSF and NSF Astronomy

- Senior Review recommendations and need to phase out facilities. Planning for operations of major new facilities.
- Construction funding (MREFC) and private funding (international also?)
- ALMA cost increase
- Responding to new small initiatives
- Supporting R&D for new major facilities

07 BUDGET

NSF MREFC



TMT/GSMT

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GMT/GSMT

- An effective construction (MRFEC) funding process is key: ALMA now; ATST in readiness; LST and GSMT in the future

- The multi-stage process for major, high technology projects recommended by the AAAC will make the MREFC program more robust, lessen cost growth during construction and enhance science return during operations.

- "Lifecycle" costing => several phases:
  (1) conceptual development [Division]
  (2) pre-construction {Agency?}
  (3) construction MREFC
  (4) commissioning {Agency?}
  (5) operations/science return [Division]

LST

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ATST

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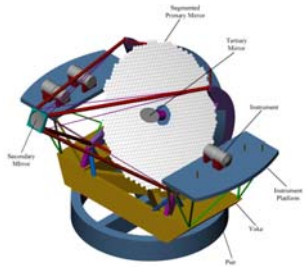


NSF - GSMT

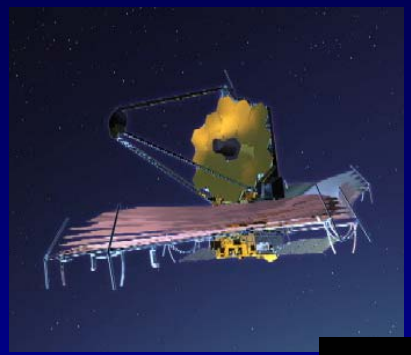
- GSMT: Giant Segmented Mirror Telescope (~30-m) - #1 major project for NSF in Decadal Survey: Private/government/international(?) collaborative venture.

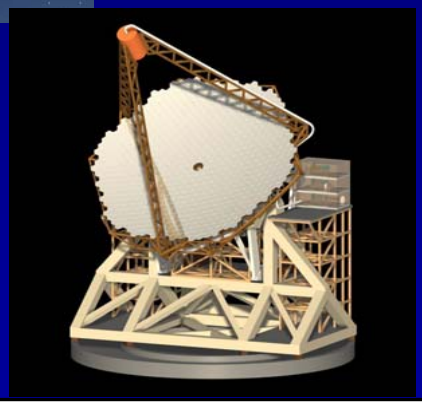
- TAKING ADVANTAGE OF PRIVATE FUNDING: Key policy issue regarding how to optimally develop private-public partnerships.

- SHARED ACCESS N & S: Dialog with ESO re cooperation and coordination. Shared access - especially if N + S Extremely Large Telescopes (ELT), but even if both in S (expensive instruments).

- Timescale set in part by desire for synergy with JWST

A Giant Segmented Mirror Telescope:
Synergy With JWST
The Power of Two





GSMT Synergy with JWST

- AAAC highlighted JWST-GSMT concurrent operation - requested report on Synergy
- Concurrent operations enhance utilization of resources - improve science return.
- Timescale is a concern: JWST to launch in 2013 - likely 10 year lifetime
- ELT(s) come on-line in 2015+ GSMT even later unless private funds do construction
- How much overlap?

DOE/High Energy Physics
Increasing involvement in Astrophysics

- HEP response to recent NRC study (EPP2010) recommendations
- Astrophysics #4 (after #1 LHC and #2+3 ILC)
- Astrophysics:
  1) Dark Matter;
  2) CMB;
  3) Dark Energy

07 BUDGET

- Planning for astrophysics activities - coordination with NSF and NASA
- GLAST, VERITAS, CMB experiments, JDEM; Dark Matter direct detection; Dark Energy likely to follow

AAAC Dark Energy Task Force

- Dark Energy has two major programs as its baseline goal - Large Survey Telescope (LST) on the ground and Joint Dark Energy Mission (JDEM) in space. AAAC Task Force on Dark Energy of particular interest to DOE

- Excellent set of findings and recommendations for a variety of near-term activities and framework for long-term programs. Important DETF finding => Multiple Techniques needed at all stages:

- *"No single technique is sufficiently powerful and well established that it is guaranteed to address the order-of-magnitude increase in our figure-of-merit alone. Combinations of the principal techniques have substantially more statistical power, much more ability to discriminate among dark energy models, and more robustness to systematic errors than any single technique. Also, the case for multiple techniques is supported by the critical need for confirmation of results from any single method."*

ADEPT

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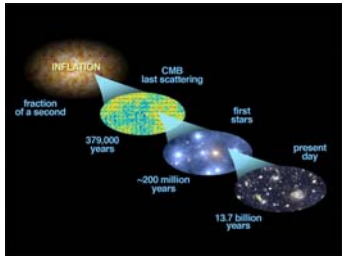
Pan-STARRS



AAAC Task Forces and Studies

Reports: www.nsf.gov/mps/ast/aaac/

- TFCR - Task Force on CMB Research (2005) - Polarization => Inflation Probe. (EPP2010 Action Item #4_2) To NSF/NASA/DOE?
- DETF - Dark Energy Task Force (2006) - near-term programs, JDEM, LST (EPP2010 Action Item #4_3). Very strong community interest. To NSF/NASA/DOE.
- DM-SAG - Dark Matter Science Assessment Group - (early 2007). (EPP2010 Action Item #4_1) Direct Detection. For DOE/NSF.
- ExoPTF - ExoPlanet Task Force - first meeting 02/2007; report late 2007. Searches for (and characterization of) extra-solar planets - many techniques - ground and space roles? For NASA/NSF. International coordination.

Public Reports are input to 2010 Decadal Survey

Costs of Projects at NSF and NASA

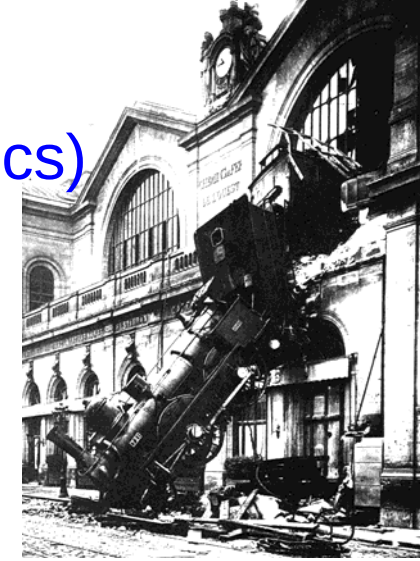
Need to use “Lifecycle” Costs

“Lifecycle” Project Costs

- Focus on construction costs underestimates impact
- Decadal Survey implementation/operation timescales: 10-15 yrs
- Important to use lifecycle costs to account for impact on budget over their “lifetime”
- NASA - Flagships ~$3-4B lifecycle; intermediate ~$1-2B lifecycle (small: Probes - $600M; Discovery ~$450M; Explorer ~$300M)
- NSF - major programs are also costly (ALMA ~$1.2B lifecycle US cost; LSST $430M + operations => ~$800+m for 10 years)
- DOE - jointly with NASA/NSF, but totals still very high (JDEM ~$0.8B; LSST ~$0.8B)

NASA - Project costs through ~2020

(Funds~$13-15B *TOTAL/Decade* for Astrophysics)



- JWST (Flagship) construction 2008-2012 - 2013 launch ($4.5B lifecycle) $3.4B
- SIM (~Flagship) launch NET 2015/16 as per FY07 budget =>$3.4B lifecycle. 2015 launch $2.9B
- Con-X_Lite, LISA, TPF "deferred" (~Flagships - all ~$1.5-2+B projects lifecycle - - much greater for TPF) For one: ~$1.5-2B
- SOFIA (intermediate) ~$2B lifecycle ~$1.2B
- JDEM/Einstein Probes ("Quarks") - $0.8+B x2 ~$1.6+B
- Need to do more Explorers and increase R&A ~$1.5B
- And Operating missions carried into Decade!! ~$1B

- Suggests we may do 1 Flagship (SIM?) + 1 intermediate (Con-X_Lite or LISA?). Challenge for next Decadal.

NSF - Construction and Operations costs through ~2020

Astronomy Operations funds ~$1.5B *TOTAL/Decade*

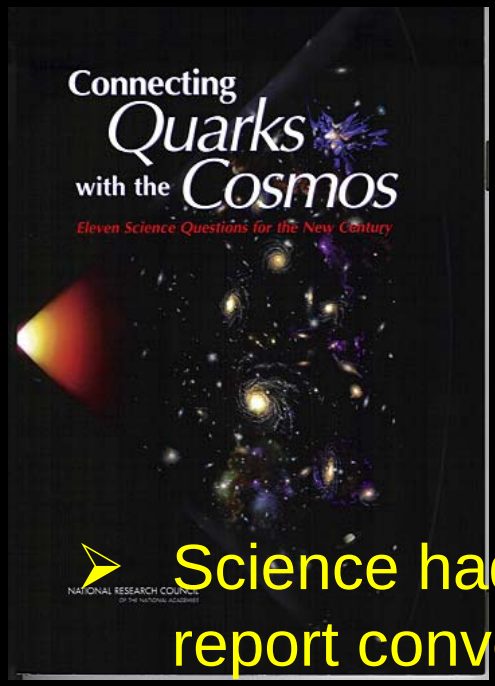
- ALMA construction to 2013 $499M + $300M Operations
- ATST is new start NET 2009? $170M + $100M Operations
- LSST new start NET 2010/11+ (some DOE 1/4-1/3?; private 10-20%?) - proposal 2007 - $430 + $300M Operations
- GSMT (GMT, TMT) construction ~$6-700M+ each (largely private??)
  GSMT new start NET 2012-3+ Federal $0-300M Ops $TBD?
- How many overlapping construction projects in MREFC in Astronomy?
- How many current facilities get supported? Senior Review.
- Operations $ total is a major challenge for the next Decadal

Personal** Thoughts on Improving the next Decadal Survey

**Based on several years on the AAAC and an awful lot of trips to Washington DC!

Improving the next Decadal Survey

- Enhance the Science framework
- Consider and re-assess “carry-over” projects
- Assess technological and management readiness
- Improve cost realism
- Consider likely Federal budgets
- Plan to deal with both evolving science goals and mission “creep” (technical or management problems that increase cost)

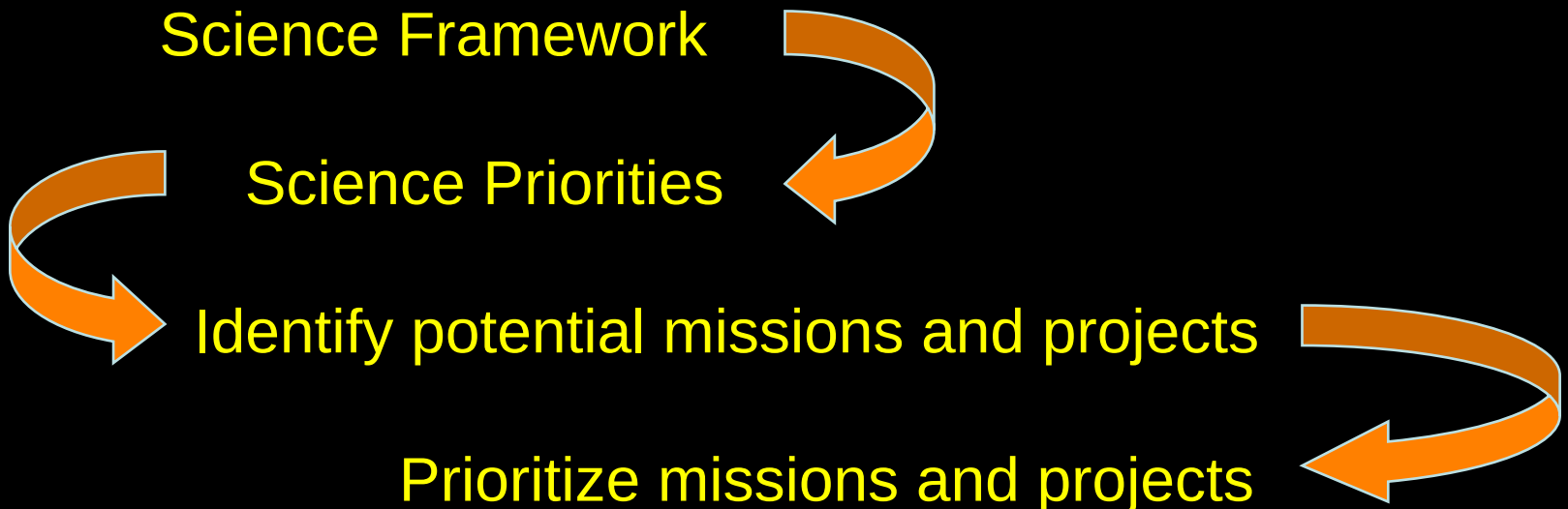


Decadal Survey Science

- Science had a strong role in 2000 Survey, but the final report conveys a mission/project focus
- “Quarks with the Cosmos” had a strong science focus
- But “Quarks” did not develop an implementation plan
- Still deriving a mission/project flowdown from “Quarks”
- Best model is a mix of 2000 Decadal and “Quarks”

Decadal Survey Science, cont

Science first => followed by projects/missions



Decadal Survey Technology and Management Readiness

- Request input from projects on technological readiness
- Independently evaluate state of technology development
- Assess proposed management structure
- Independently evaluate proposed management structure
- Methodology should be "trust but verify"

Decadal Survey Cost Estimates

- Need to establish baseline as “lifecycle” costs
- Develop likely spending profile: R&D, Construction, Commissioning, Operations
- Utilize independent cost estimates (not just costs from the proponents - the project team!!)
- Develop cost methodology with agency
- Be realistic about how well costs can be established at early stages of project
- Fold current projects into consideration - no “carry-over”

Federal Budgets for Science in the coming Decade as a Guide

- Consider likely Federal budget profiles
- Use total available $$ as a guide to set project mix
- Solicit input from agencies on ongoing costs
- Use “lifecycle” costs, along with items like R&A and operations of carryover missions, to evaluate whether proposed program is fiscally realizable.
- Be optimistic - the program will be prioritized so changing budgets can be accommodated later

Evolution of science goals and/or priorities during the Decade

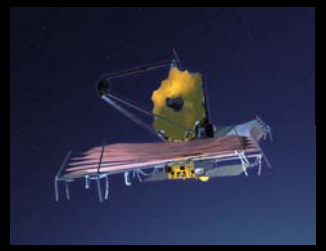
- New discoveries may cause science goals to evolve or cost or technology issues could require a revisit of priorities

- Dark Energy was an excellent science example - but I suspect that this will not happen very often. JWST and SIM and ALMA cost/technology examples of cost growth.

- Set up Decadal Survey committee and its panels with goal of accommodating re-evaluation during Decade

- For example: Small standing (sub)committee of the Decadal committee used, with augmentation depending on the issue, to assess needs for changes in priority or additions (conservative approach a la Supreme Court?)

A (personal) recipe for a successful Astronomy and Astrophysics 2010 Decadal Survey



- Provide a strong science framework and a clear sense of science priorities
- Make the science exciting to a public/political audience
- Make sure that the technological development and management requirements are consistent with timescales and capabilities
- Develop a prioritized mix of small, medium and large
- Provide realistic “lifecycle” cost estimates and cost profiles
- Match, but with some optimism, the likely available funding
- No “carry-over” projects (zero-based assessment - but do wisely!)

MEMBERS (2006-7)

AAAC

Neta Bahcall	**Princeton University**
John Carlstrom (Vice-Chair)	**University of Chicago**
Bruce Carney	**University of North Carolina at Chapel Hill**
Wendy Freedman	**Carnegie Observatories**
Katie Freese	**University of Michigan**
Garth Illingworth (Chair)	**University of California, Santa Cruz**
Scott Dodelson	**FermiLab/Chicago**
Dan Lester	**University of Texas at Austin**
Keivan Kassun	**Vanderbilt**
Rene Ong	**University of California, Los Angeles**
Sterl Phinney	**California Institute of Technology**
Marcia Rieke	**University of Arizona**
Alycia Weinberger	**DTM Carnegie Institute of Washington**

Recent 2005-6: Bob Kirshner, Angela Olinto, Caty Pilachowski, Abhijit Saha