Program Formulation

Moderator: Alan Dressler

Panel Members:

- **Rick Anthes (NCAR) – earth sciences**
- **Colleen Hartman (NASA) – agency perspective**
- **Todd Hoeksema (Stanford) -- heliophysics**
- **Steve Mackwell (LPL) – planetary**
- **Marcia Rieke (U. of Arizona) – astrophysics**

Program prioritization is one of the key activities of a Decadal Survey. This is where scientific aspirations – *what we would like to do* – come face-to-face with *what we can do*.

The four divisions of NASA Science Mission Directorate – Astrophysics, Planetary Science, Heliophysics, and Earth Sciences – have in their recent Decadal Surveys developed different approaches based the nature of their science programs, their responsibilities to the Nation, and the unique culture of each discipline.

This "Program Formulation Session" will discuss how these diverse communities are using the Decadal process to reach consensus about how best to accomplish each disciplines science and service goals, and to move their field forward.

All Decadal Studies have an Executive (Steering, Survey) Committee as well as sub-discipline panels that prioritize science, evaluate individual initiatives, and construct programs. The panels represent more of the community than the Executive Committee can, and the Panels themselves reach even further into their respective communities.

For example, in earlier Astrophysics Surveys, program prioritization at a theme level was done by panels that had both the responsibility for prioritizing science as well the potential missions. After their work was done, the Executive Committee made a final, combined prioritization and program based on all the Panel reports.

In recent Surveys program formulation has become a shared activity among many elements of the Survey. For example, in Astro2010 – New Worlds, New Horizons, the Executive Committee, Science Frontier Panels, and Program Prioritizing Panels worked independently, but also interacted and influenced each other. There was also considerable oversight by the Executive Committee of the entire process as it evolved. Final responsibility for the recommended program continues to reside exclusively in the Executive Committee.

In Astro2010, 5 'Science Frontier Panels' reviewed ~100 'white papers solicited from the astrophysics community. Over many months, each SFR Panel prioritized the science in their sub-discipline, wrote a detailed report, highlighted by 4 key questions, and 1 discovery area.

Planetary and star formation

Stars and stellar evolution

Galactic Neighborhood

Galaxies Across Cosmic Time

Cosmology & Fundamental Physics

Science Frontier Panel Question/Discovery Area	WFIRST	IXO	EXO-PLANET	BLISS SPICA	UV-opt Telescope
PSF-1 What determines star formation rates and stellar masses?					
PSF-2 How do circumstellar disks evolve to form planetary systems?					
PSF-3 How diverse are planetary systems?					
PSF-4 Do habitable worlds exist around other Sun-like stars? Can we detect biosignatures?					
PSF-D Can we identify and characterize a nearby Earth?					
SSE-1 How do rotation and magnetic fields affect stars?					
SSE-2 What are type Ia supernovae?					
SSE-3 How do massive stars end their lives?					
SSE-4 What controls the masses, spins, and radii of compact stellar remnants?					
SSE-D Large time domain surveys					
GAN-1 What are the flows of matter and energy in the circumgalactic region?					
GAN-2 What controls the mass-energy-chemical cycles within galaxies?					
GAN-3 What is the fossil record of galaxy assembly and evolution from the first stars to the present?					
GAN-4 What are the connections between dark and luminous matter?					
GAN-D1 Time-domain Astronomy					
GAN-D2 Astrometry					
GCT-1 How do cosmic structures form and evolve?					
GCT-2 How do baryons cycle in and out of galaxies and what happens while the are there?					
GCT-3 How do black holes work and influence their surroundings?					
GCT-4 What were the first objects to light up the universe and when did they do it?					
GCT-D Exploring the epoch of reionization					
CFP-1 How did the universe begin?					
CFP-2 Why is the universe accelerating?					
CFP-3 What is dark matter?					
CFP-4 What are the properties of the neutrino?					

EOS “virtues”

Science issues:

- Addresses science panel questions – some or many?
- "Transformational" science, or incremental?
- A fundamental physics measurement?
- Science of interest to the general public?
- An observatory (broad science) with a focus?
- Along a path of scientific investigation that has great future promise?

Mission issues:

- Technically feasible?
- Mature technology, or requiring further development?
- Technology useful outside of astronomy?
- Straightforward mission, or complex -- with irreducible risk?
- Strong EPO component?
- Ready to go sooner (first half of the decade) rather than later?
- A bargain, moderate cost, or killer expensive?
- International collaboration, or going it alone?
- Along a path of technological development that is valuable for future missions?

Criteria for prioritization and ranking from the Astro2010 EOS Panel

	UV/Optical General Astronomy				Extrasolar Earth Searches								Preparing f/ Earth Searches			Other Exoplanet Searches			Far Infrared			Near/Mid-IR and CMBPol			Infrared Cosmology Observatory				X-ray and Gamma Ray				Other	
	THEIA/NWO/WFCT	ATLAST	HORUS	TPF-C	THEIA	NWO	ATLAST	WFCT	TPF-C	New Worlds Probe	DAVINCI	SIM Lite	ACCESS/EPIC/PECO	FKSI	TPF-I	ASTrO	THESIS	EXCEDE	BLISS/SPICA	CALISTO	SPIRIT	Spitzer Warm	ASPIRE	EPIC-IM	JDEM w/ or w/o CIP w/o DMDs	CIP	MPF	NIRSS	IXO	EXIST	WFXT	XENIA	OMEGA	Stellar Imager
Science:	10	7	15	21	10	10	10	10	11	11	11	9	12	15		17	17	16	12	13	13	17	15	13	9	14	14	12	10	17	15	20	17	16
Effectively addresses SFP questions -- some or many?	1	1	2	3	2	2	2	2	2	2	2	2	2	2		2	2	2	1	1	2	2	2	1	1	3	1	1	1	2	2	3	2	3
Effectively addresses anSFP discovery area?	1	1	3	3	1	1	1	1	1	1	1	1	1	2		1.5	3	2	3	3	3	3	3	2	1	3	2	3	2	2	2	2	3	3
Delivers "transformational" science or a fundamental measurement?	1	1	2	3	1	1	1	1	1	1	1	1	1	1		3	2	2	1	2	1	3	3	1	1	1	2	1	1	2	2	3	1	1
Observatory with broad science or mission with narrow focus?	1	1	2	3	1	1	1	1	2	3	3	2	3	3		3	3	3	1	1	2	1	1	3	2	2	2	2	1	3	1	3	3	3
Along promising path of scientific investigaton for the future?	2	1	2	3	1	1	1	1	1	1	1	1	1	2		2	2	2	1	2	2	2	3	2	2	2	3	1	2	3	3	3	3	1
Serendipity?	2	1	2	3	3	3	3	3	3	2	2	1	3	3		3	3	3	2	2	1	3	2	3	1	2	2	1	1	2	2	3	3	2
Interest to disciplines beyond astronomy?	2	1	2	3	1	1	1	1	1	1	1	1	1	2		2	2	2	3	2	2	3	1	1	1	1	2	3	2	3	3	3	2	3
Technical:																																		
Technically feasible?																																		
Cost of required technology development?																																		
Straightforward mission, or complex -- with irreducible risk?																																		
A bargain, moderate cost, or killer expensive?																																		
Cost ($B)	4+	5+	1+	4+	4+	4+	5+	4+	4+	1+	1+	1+													1+				1+					
Programmatic:																																		
Ready to go sooner (first half of the decade)?	1	2	2	1	2	2	2	2	2	2	2	1	1	1		1	1	1	1	2	2	1	1	1.5	1	1	1	1	2	1	1	2	1	2
Simple management structure?	1	1	1	1	N/A	1	N/A	N/A	1	1	1	1	1	2		1	1	1	2	1	1	1	1	1	2	1	1	1	2	1	1	2	1	1
On technology path with value for future missions?	1	1	1	2	1	1	1	1	1	1	1	1	1	2		2	2	2	1	?	1	2	2	1	2	2	2	3	1	2	2	2	2	1
Cannot be done from the ground or other existing missions?	1	1	1	2	1	1	1	1	1	1	1	1	1	1		1.5	2	1	1	1	1	2	2	1	1.5	1.5	1	1	1	1	1	1	1	1
Maintains or establishes U.S. leadership?	1	1	1	2	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.5	2	1	1
Science of interest to the general public?	1	1	1	2	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	2	2	1	1	2	1	1	1	2	2	2	2	2

=on EOS CATE list
=highlight in technology section for potential 2020-2030 missions
=set aside (no further discussion anticipated)

Making a program: Science → Missions → Feasibility → Cost → Program

Questions for the Panel discussion

Q1 – How do the science and service goals of your discipline , community activities, and relationships with government agencies define your decadal process?

Q2 --

In your discipline, what was the source of the "programs" that were evaluated and prioritized? For example:

a) Came from outside the Survey?
b) Generated within the Survey process? If so, role of steering committee compared to sub---discipline panels?
c) "Legacy" from previous survey – no such thing?
d) Was the initial list of possible programs much too large and therefore requiring an early 'winnowing down' phase? If so, how was this done?
e) What role did NASA play in generating mission concepts? (none? prior to Survey? in---process?)

Q3) What were the basic criteria used in the process to prioritize the initiatives and assemble a program? **Scientific merit** and **technical feasibility** are obvious, but what about other issues criteria?

a) Broadness of impact in the field, versus, for example, a potentially transformational and fundamental measurement?
b)
International collaboration? Value to the Nation? Public interest and EPO? c) Part of a system of capabilities, or cross---cutting?
d) Balance across different sub---disciplines and across mission size
e) Cost, readiness, complexity, risk?
f) WHO APPLIES THE CRITERIA and WHEN?
g) HOW WELL DID THIS WORK?

Q4) How did the results of the CATE process influence the program formulation?

a) Were the results critical? Useful? Disruptive?
b) Was there time to absorb the results of CATE
c) Would iteration between proposers and cost evaluators help or hurt?
d) How do **initial** cost estimates play into the process?

Q5) How did the process account for other "health of the field" issues, such as R&A support, student training, infrastructure, technology development, etc.?

Q6) What worked, and what didn't?

a) Did the process fairly represent the community's interests and desires?
b) Was there sufficient time and tools to do the job?
c) Was creative manipulation of the program possible? Desirable?
   (Should panels and/or steering committee **create** missions?)
d) Was there enough, or too much, **feedback** from different parts of the process?
e) Was there sufficient independence of panels from Executive Committee?