

ASTRO2010 Town Meeting at UCLA

We held a Town Meeting at UCLA to discuss the Astro2010 decadal review on April 24, 2009. The principle organizer was Mark Morris, with encouragement from Lynne Hillenbrand. Notes were taken by James Larkin, with help from Marshall Perrin.

Registered Attendees

Lee Armus	Chris Hirata	Harald Pfeiffer
Barry Barish	Scott Horner	Mike Rich
Aaron Barth	Dayton Jones	Steve Schectman
Bidushi Bhattacharya	Mike Jura	Michael Shao
Andy Boden	Mike Kesden	Alice Shapley
Theo ten Brummelaar	Quinn Konopacky	Kartik Shet
Deepto Chakrabarty	Adam Kraus	Tom Soifer
Kuenley Chiu	Ivo Labbe	Gordon Squires
Will Clarkson	James Larkin	Karl R. Stapelfeldt
Judy Cohen	Janice Lee	Susan Stolovy
Jeff Crane	Jessica Lu	Angelle Tanner
Ian Crossfield	Matt Malkan	Wes Traub
Curt Cutler	Ryan Mallory	Jean Turner
Tuan Do	Jay Marx	David Tytler
Sally Dodson-Robinson	Patrick McCarthy	Steve Unwin
Steve Edberg	Ian McLean	Andrea Urban
Steve Furlanetto	Anna Moore	Schuyler van Dyck
Andrea Ghez	Mark Morris	Ned Wright
Varoujan Gorjian	David Murphy	Shelley Wright
Fiona Harrison	Rene Ong	Sylvana Yelda
George Helou	Kevin Parsons	Ed Young
Alaina Henry	Marshall Perrin	
Lynne Hillenbrand	Annika Peter	

Mark made a general introduction about the meeting organization and schedule. He pointed out that among the registered attendees, there were representatives from the following institutions: UCLA, UCI, Caltech, UCSD, IPAC, Spitzer, Herschel, JPL, CHARA array, LIGO, Lockheed Martin, Northrup Grumman, and the Carnegie Institution.

Lynne Hillenbrand gave an introduction as a representative of the decadal survey committee. Other committee members in attendance were Fiona Harrison and Lars Bildsten. About seven other members of panels were also present. Lynn walked us through the history of the decadal survey process. She told us about the three pillars of the current survey: Science Assessment, State of the Profession/Infrastructure, Science Programs. She also repeated the charge to the committee. She mentioned that there were 320+ science white papers plus many on the state of the profession, technology, infrastructure, etc... The purpose of the local town hall meetings is to gather broad input

from the community. She went over some of the details of each of the panels and their responsibilities. She described how some members of the community will be asked to appear in person before the committee of programs on June 8-11 in Pasadena to more fully explain their project. This is NOT a selection process, but simply an opportunity to gain clarification. A major focus will be on full life cycle costing of programs. Lynn went over the planned schedule of the committees. The first closed meeting of all the panels is May 11, 2009 in Irvine, CA. The goal is to publish the report in 2010.

Jean Turner: Who are the independent contractors to determine the costing of programs? What programs where will be reviewed?

Lynne: This is on-going process with emphasis on programs that are not too mature and not too nascent.

Pat McCarthy: Follow-up: There has been short notice between when past information has been requested and when it is due. The costing analysis could be quite time consuming. How much time will be available?

Lynne: Marcia Rieke is responsible for this and will be requesting information on May 18.

Pat: There will be a single commercial reviewer of costs across all projects?

Lynne: Yes, it will be consistent across the board. We recognize the concern within the community about the fairness of this process and are trying to do our best with the RFI's.

Steve Unwin: Commends Roger Blandford about making the survey guidelines clear. I'm unclear about the roles of the scientific program and the program panel. Can you elaborate?

Lynne: I may have been a bit unclear. Each of the panels on both Subcommittees are independent NRC committees and each will write a roughly 40 page report on their area. Each should be a true decade long document that can be used as a guideline for future funding programs. And each individual document can be referenced in future funding proposals and not just the final survey report.

David Tytler: You mentioned that the panels are looking for balanced criteria for determining which programs will receive costing analysis. Since many science projects are fairly low cost, how will the decision be made about costing?

Lynne: The process is still being decided. We've been asked to address different funding scenarios for the different agencies, including a flat costing profile. We don't have final guidance on how low to go in terms of costing or the specifics of the budget profiles to investigate.

David: Let me recommend that you prioritize programs all the way down.

What will be the impact of the discussion today given that you already have the white papers? Lynne: There have been many valuable pieces of information gained through the town hall meetings and the notes from this meeting will be sent to the committee. There is always a benefit of having everyone in the same room to come common understanding

Ed Weiler has mentioned that international participation will be important to help with future funding. How will the survey handle this? Lynne: This is a federal process but it is widely recognized that private entities and international groups are important funding partners for projects. For NASA there have been statements that above certain budget levels international partnerships are critical and this is being considered in NSF funding issues as well.

Discussion points:

What are the leading science questions of the coming decade that warrant prioritization?

David Tytler – There are very generic goals. But we always notice that much of the progress comes from unexpected areas. There should be a diversity of science goals and capabilities.

Kartik Sheth – It would be important to keep in mind related non-astronomy topics like global warming. We get tunnel vision when talking about our topics and miss some of what the public is very interested in.

Judy Cohen – Black holes. We will have unique capabilities to investigate stellar and super massive black holes. There is also the future ability to probe them with gravity waves etc.... We need to engage the public.

Sally Dodson-Robinson – Where does the solar system fits into the process? Mark – The solar system certainly fits into the more global question of planet formation, planet migration, etc... Lynn: The Solar System is included in one of the other decadal surveys. Solar system planet missions are not included in the astro2010 survey but spectroscopic

Dayton Jones – Most observatories become famous for things different from what they were original justified for. It is important to recognize that flexibility should be sought.

Mike Kesden – There is the technical risk for a mission that it might fail, but there is the risk on the theoretical side that in some cases like dark energy we don't know if another order magnitude of improvement will make a major impact on the science. So there is a bigger science risk with missions like Lisa and Dark Energy because of theoretical uncertainty.

What criteria should be used to make community choices?

Mark Morris – some thoughts might be cost, scientific importance

Marshall Perrin – the phrasing of the question is fundamentally wrong. There are so many differences between projects and the benefits of training grad students etc... so it is very difficult to address this question. Mark – We've faced this problem many times and we have to bring in many criterion

Theo ten Brummelaar – We must be able to blend these things together. We have to support a broad spectrum of capabilities.

Patricia – We have to do this in the context of overall funding.

Kartik Sheth – Reiterate this. Congress has agreed that science is highly valued, but science funding is always tied to our perceived national needs. So we have to stay away from the argument of just give us more money and we'll do great things.

Dayton Jones – There has to be a balance between large and small projects, but we have to have a process of rebalancing things if funding changes. We need a method for defining how decisions will be made in the future.

David Ardille - There is a recognition that there should be the possibility for smaller parts of our community to be heard. We should have mechanisms for local communities to make decisions about what they want to do. There must be the ability for small projects to start from the bottom up and not just from the top-down. So there must be funding

Pat McCarthy – Still puzzled about the question. The process of evaluating science priorities and setting facilities priorities sets down the basic framework. The decision to deal with smaller issues must be a second-order effect after you've set up a framework of major initiatives and programs.

Mark – How do we decide what should be the priorities

Lynne – As we know the queue is oversubscribed. We are not going to recommend what really can't be funded. So we have to balance the programs – big and small and choices will have to be made. The comments have been relevant but there has to be a bottom line.

Jay Lars – I must point out the possibility of risk and the fact that some projects can go over budget and cause a loss of credibility within the community and the public.

Marshall Perrin – Costing problems are very apparent, but these are often surprises.

Chris Hirata – The alternative for a large project is to have descope options. There is also the issue of community supportability for 3-5 years. We don't want to come back in five years and have to consider cancelling some high priority.

Janice Lee – Uncertainty. Does the panel or the process allow for mid-course correction?

Lynne – There is a committee called CAA which is also a National Academy panel which will shepherd the report through the decade and offer advice and recommend changes. There is now AAAC which has a similar charge and is additionally tasked to look at how to get more cooperation between agencies. There is some vagueness about the committee responsibilities and there is a panel to come up with a plan for shepherding the report through the decade. Janice – Will there be feedback in that process?

Lee Armus – How will the large international collaborations be ranked since these are outside of the national budgets? How will these be ranked for example in the case where the science is ranked highly, but there is not an obvious partnership. Lynn – what do you think should happen? Lee – If the goals are worth reaching for, there should be a recommendation to develop international collaboration. We need a mechanism to make these collaborations happen. Not clear how to do it, but it is important that these key goals not drop through the cracks. We need a mechanism to make the collaborations happen.

Where is technology development needed, and how should it be weighed against the funding of research with existing facilities and capabilities?

Mark Morris – We have a certain set of capabilities that won't carry us through the next decade.

Theo ten Brummelaar – We have to keep in mind that we need to have technology development for the next decade as well as the current one.

Sally Dodson-Robinson – Europe has the LHC and will have particle physics dominance for a while. We should try to identify areas where America could be unique for the future.

Kartik Sheth – obviously large data sets. Are we leading the charge on funding for this?

Steve Lord – Points on international collaborations. It occurs to me that the momentum for doing this might fall in lap of other nation. We need an international process similar

to this decadal process to set international priorities, perhaps through the IAU. Maybe we should think proactively on international partnerships.

Jay Marx – There has been an emphasis on developing new capabilities, but there should be some funding in the less glamorous aspect of reducing cost.

Jessica Lu – We should not just support technology geared towards the science goals but that may prove valuable in the future.

Varoujan Gorjian – Competing model in biology about deciding which disease research to fund. They had overall goal of increasing funding and let community decide what to attack. We should have some emphasis on increasing technology funding rather than just picking what to fund

Jay Marx – Physics community often sets aside blue sky money to let the community develop unexpected technologies. Does the current committee have a similar goal?

Lynne – We are investigating how much funding was set aside for such developments.

Alice Shapley – Why was this survey set up with this structure?

Fiona Harrison – I can give my opinion. There were good things and limitations about previous surveys. One widely recognized limitation in previous survey was a lack of costing analysis. This structure allows us to approach the goals in a more realistic way.

Lynne – There was a concerted effort to make some changes. Roger is trying to set up a way to address previous deficiencies and to look at some of the new areas that have developed in the last 10 years. There is a lot more detailed work being done this time.

Fiona – There is a lot more of the community involved this time. Over 300 people on these panels

Annika Peter – Has there been a discussion of how computational facilities have been funded and organized? Sometimes there are national facilities, department and individual groups.

Lynne – The panels are supposed to identify capabilities that are needed to carry out the science. And there is a study group of computation simulation and data handling. Specifically computing power group is surveying department chairs about computing groups and use of national facilities. This is being looked at, but I'm personally uncertain about how

Jessica Lu – Are groups being asked for their computing and other scientific needs?

Lynne – Yes, we are asking about archives, dissemination

Anna Moore – I'd like to see some technology development that benefits many groups over just one specific technology.

Ian McLean – I agree with Anna. I think detector technology is much weaker than what most people in the community think. We have specific needs that are quite different from the public or the military.

Scott Horner – That problem has been exacerbated by the downturn in the economy. Military spending isn't what it used to be. There is also a major downturn in the optics industry. There is a generation of retirements and those vendors aren't able to hire new young engineers.

Varoujan Gorjian – Something that combines detectors and allowing something new. We could use detectors that have low spectral resolution built in. That would change things fundamentally.

The future of large telescopes: emphasis on TMT

Relationship to the national effort

National funding for instrumentation efforts

UC and Caltech focusing a lot of attention on TMT and Carnegie and others on GMT. What is the relationship of these efforts to the national effort?

James Larkin – We need to have increased cooperation between the partners.

Pat McCarthy – The decadal survey should have the basic goal of “do no harm”. The national government should be directed in how to be cooperative. There are some decisions about site selection and prioritization. There are many ways

We need to have a dialog about how to coordinate the efforts of both.

Judy Cohen points out that laser cooperation is a great example of how to pool resources and technology.

Annika Peter – CCDs are also very important to other areas besides astronomy. Are there other partners we should be looking at?

Ian McLean – Not really. Military needs real time and is far less concerned about thermal backgrounds.

Mark Morris – National funding of large telescopes – How much should we be looking for national support?

Judy Cohen – Caltech and UC's represent large amount of US community.

Back and forth about California membership versus national funding

(Chara) – Are there strings attached about who gains access based on funding?

Marshall Perrin – the minimal scale of projects seems to continue to increase. It is daunting as a potential faculty member to come up with the funding necessary to build even a starter instrument.

David Arve – Can we help with ITAR issues. Fionna – Probably not. This is well above our level of discussion. Judy Cohen – Presidents of places like Caltech have tried to change ITAR restrictions without success.

Unknown – There are efforts to open up ITAR. We have to do something to improve communications and data availability. It might help if the decadal survey said something about it.

The balance of resources between space and ground-based research

What is current split? Lynne – NASA science is \$1.4 Billion. NSF is closer to \$200 million. There are a few other places where money comes from.

Judy Cohen – Just came from AURA annual meeting. Matt Mountain tried to start a discussion about a 16-meter space telescope for optical and UV telescope to follow up JWST. I thought about where are the first planets detected, studied and transits found... it's always been the ground.

Unknown - There is an old adage that if you can do it from the ground, then you should. We should investigate Antarctic.

The moon and mars projects of NASA should be directly confronted. We need to make it clear that Moon and Mars exploration are not science.

Andy Boden – To what extent does the community and decadal committee think the relevant agencies want this advice.

Lynne – The agencies are paying for the survey but they did not ask for input on this issue.

Chris Hirata – John Moore has told me that space money is space money and it is not ground money.

Steve Lord – We should explore dome A as a meeting place of space and the ground.

David Tytler – I hope that the different deliberations address the strength of instrument groups that have been getting weak.

Judy Cohen – I agree with David that instrument and detector groups are struggling and that the only groups doing well are part of large groups.

Annika Peter – are there proposals for how to fund smaller projects.

Lynne – this is part of the state of the profession committee. These issues are not unique for this particular discussion.

??? This links in to the opportunities for young astronomers. We are entering an area of big instruments few and far between. There need to be opportunities for smaller projects to fill in gaps and train instrumentalists.

Kartik Sheth – Does NOAO do this?

Judy Cohen – They have never taken this up.

Pat McCarthy – They get their budget slashed every year.

Resuming After lunch break.

Short presentation from George Helou about mid/far IR astronomy from space. This is part of the discussion of how to balance priorities across many areas. He told us about a micro survey of far-IR and submm community. There was a workshop May 28-30, 2008 open to everyone including international participants. Martin Harwitt wrote a paper summarizing the meeting. There were two main recommendations: 1. US participation in the Japanese-led Great Observatories mission SPICA which is a 3.5 m far-IR/submm telescope launched in 2017. 2. Propose a 10-m cooled single aperture far-IR telescope called SAFIR. He then presented a very quick summary of the science of the missions and the far-IR in general. Pointed out that over half of the energy ever generated in the universe is now visible in the far-IR. The SPICA instrument BLISS was presented as an excellent science instrument.

Lynne Hillenbrand commented on when projects would be notified about when more info would be requested. Early June projects will be informed if they will be part of the detailed costing. In late June requests for additional information (RFI2). This may depend on the identified contractor for costing. The costing exercise is likely to be completely in August, so groups would have 4-6 weeks to provide costing information.

The balance of resources between major facilities and individual research efforts. Funding models - budget allocations accompanying observing time allocations.

Mark Morris – what funding models should be examined that aren't currently available.

Judy Cohen – NASA does fund approved observing including at Keck. That was confirmed.

Mark – individual research efforts are under strain.

David Ardille – Having funding coupled with space observing means less effort with proposals.

Mark Morris – already NRAO supports student travel

Sean Casey – important to select funding models with science goals. So if big missions are required to meet science goal then funding must reflect that.

Kartik Sheth - because it is a zero-sum game, will that be a concerted effort by the contractor to look at current expenditures and look at waste?

Lynne – That is not part of the task of the contractor.

Karl Stapelfeldt – A key measure is how many people get observing

Kelly Cruz – another parameter is how many people use space-based funding to supplement ground based observing. General discussion about doing this.

Steve Lord – Some space telescopes do allow funding for supporting ground astronomy.

Judy Cohen – We need to find ways of funding groups and not just competitive individuals. Can we form block grants more like DOE grant structures.

Mark Morris – In France they are now going in the opposite direction where they previously had an institution and group funding model and that often led to complacency.

Aaron Barth – Beneficial to think about group funding to support students. Hard to cobble together small grants to give long-term support for a group of students. Funding cycles don't match grad student lifetimes.

Sally Dodson-Robinson – one solution might be NASA; astrobiology centers can provide stable support for students.

Chris Hirata – DOE and other block grant models do provide more stable funding model.

David Tytler – I agree that the US is relatively weak in supporting projects that require 10's of people over several years. We have funding models that support many PIs and fewer

Annika Peter – Other research communities have done this transition. Are there ways for us to learn from these groups? No general

Theo ten Brummelaa – We feel the awkwardness. You have to go to NSF and justify all the individuals and projects and can't ask for keeping a group together.

Marshall Perrin – Learning from particle physics is a good example, but also NASA has very large groups together.

George Helou points out that NASA project funding just funds bigger projects and not really groups. He points out that particle physics model of few very large groups is not satisfactory for astronomy where both large and small groups are essential. Hard to convince NSF

James Larkin – Analogy with Keck proposals - most proposals are on 6 month timescales, but there are also long duration programs. There needs to be a mechanism to direct a small amount of resources to these longer-term goals. The relative proportion needs to be figured out depending on context.

Adequacy of opportunities for students and young scientists. What programs or mechanisms warrant new emphasis?

Steve Lord – Want to broaden this to undergraduate and even potentially high school students. Because they can be involved in projects that have real products. College and grad school education has been given too little focus. There is a recognition that there is a science illiteracy in the country. They are very internet literate but we are not tapping into this directly. We have too little effort going toward education and student involvement.

Money doesn't always go towards training students. A major US problem is that we have a very high level of scientific accomplishment and meager science literacy in the public.

Judy Cohen – NASA and NSF both impose rules on educational involvement. HST and other publicity machines are very effective. Maybe there needs to be more focus

Chris Hirata – Much of that education funding is regionally concentrated and scattered. There is often money being spent on many small efforts.

Bidushi Bhattacharya – JPL and others do a great job on broad dissemination of knowledge, there isn't much effort for potential young scientists.

Kartik Sheth – My experience is that half of the faculty searches this year were cancelled. Perhaps there should be 3 year grants to help new faculty members to help departments. 90% think they'll get a faculty position and less than 40% will.

Mike Rich – there will be increasingly few retirements and other financial restrictions like the 2-body problem. Many who choose the career research path that are not faculty need more respect. There are few research scientists on the panels.

[Others disputed this.]

Janice Lee – Growth of projects to larger scales. There is a need for training of students and postdocs for management and not just science. We need a pool of people to draw from to lead large projects.

Mike Kesden – Surveying conversation today, we are an observationally driven field. While it is valuable for there to be a decadal survey for observational astronomy, there seems to be a gap in theoretical astronomy in the decadal process.

[Lynne and others commented that it is covered.]

Annika Peter – Agree with earlier comment about students being primarily be trained in science and not in other areas like management and teaching.

Kelly Cruz – The AAS meetings could serve as career development workshops in management, teaching and other areas that we are not trained in. Current directors are not proper models for management. There are tried and true methods from business to solve management problems.

Marshall Perrin – The CfAO as a successful example addressing many of the above issues: A long term program stably funding a group, developing tech, providing opportunities for education and professional training workshops for grads and postdocs. Personal & anecdotal evidence is that this has been very influential & positive for many/all of the associated grads & postdocs. A model to build on/expand?

Emily Rice – Agree that there seems to be a disconnect between what students are trained in and what they need to do. The CfAO provided us an opportunity to providing outside education.

Mark Morris – we started talking about including undergraduates into the mix. There is the REU programs to get people involved in science. More aware that this is working well but it caters to top students and is limited in duration. Students have additional interest throughout the year. Undergraduate research could be encouraged and expanded because of the strong impact it has on getting people into science.

Sally Dodson-Robinson – I was in an REU and another student in my cohort used the REU program to decide NOT to go into astronomy. But it was a good experience and prevented her from spending fruitless years.

Theo ten Brummelaar – We could argue getting students involved even younger. Students are often already turned off to science before getting to college

Steve Edward (JPL) – kids in grades 4-6 are very excited about science. It takes very little to get them excited. We are not going to the effort to get these grade school kids involved and getting them into planetariums and other science projects. Part of learning how to teach kids.

What should be done at the national level for public outreach of our science? How can the appeal of astronomy and related technical fields be enhanced in order to draw more top-echelon participants?

Kartik Sheth- what the community does just reflects what is rewarded by the community - Spending time on education/outreach is disrespected, even punished. So why should anyone do it?

Sally Dodson-Robinson - you have to change the incentive system, or no one will do it. Kelly Cruz - the broader impact requirement of the NSF policies is a big deal. This is slowly changing the community. But it has to have a reward system. Right now it's a negative, that doing outreach etc is negatively seen at tenure decisions. It needs not just funding but more respect.

Steve Lord - Would like to challenge the decadal survey to make public education as high profile as a major mission. The time is right - the country is aware of its many challenges. We are in position to advocate for major change and use our high profile to leverage for a major nationwide effort, not just piecemeal or tiny steps.

Annika Peter - New Jersey actually has annual school standards for students. Project Astro teaching materials focused on this.

Marshall Perrin- echoes the point about the incentives stream and rewards. Given finite time, which is more likely to get you a permanent job: writing papers or doing outreach? This is a real challenge.

David Ardille- ultimately you have 100 people applying for a faculty job, and how do you decide who to short list? Number of papers, right? If that doesn't change, then why are we even talking about this here? You can't spend time doing anything other than write.

Brad Hansen - there's an explicit assumption in this conversation that everybody has to do outreach. This is a problem with the NSF policies. Institutions should hire full-time people to do this, with specialized expertise.

Kelly Cruz - we don't want to have outreach as a full-time job, we want it as part of the normal things that we do, like teaching 101 and training grad students, etc.

Theo ten Brummelaar - there are some people who should NOT do outreach. Need changes in paradigm. People who like to build instruments or do outreach need to be equally respected to pure research faculty.

Varoujan Gorjian - I've been privileged to do both, with JPL funding to do both outreach and research. One activity that has high impact is outreach to teachers, which multiplies the effect.

After the paradigm shift that rewards teaching and outreach, the way to do it most effectively is to be systematic, not the scattershot collection of projects right now.

Steve Lord - the decadal survey is the time and place to think about these sorts of paradigm shifts.

Kartik Sheth - It's a zero sum game. We should not be viewing mentorship of young

people as an additional thing on top of all your other tasks that takes away from those tasks; your department chair or supervisor should notice and account and give credit for this during job reviews.

Steve Edward - NASA ROSES announcements of opportunity a few years ago had outreach option at first, then was dropped after a year or two. Not sure why. But this is clearly an area where the survey could make an impact.

Brad Hansen - two issues in this discussion - 1) people not being valued for what they do, or 2) paradigm shift. If you want to make a real impact, it's not people dabbling 5-10% of the time, it's full-time experts really focused on it. 10% of 10 people is not the same as 100% of one professional.

Chris Hirata - Life is more interesting if you do more than one thing, but you do need focused & sustained effort to achieve goals over time. So we need positions which support people who have varied interests. Not that each person needs to have 1/8 of their time devoted to each part of the field, but that we need a larger set of allowable fractions for how people balance their time.

Janice Lee - How to move beyond the occasional outreach, Speaking as a former middle and high school teacher: A real curriculum sponsored by the AAS, with associated training for teachers, and ability to build relationships and improve skills, not just occasionally give a public talk.

The most compelling and/or indispensable capabilities of the coming decade. Top priorities for the capabilities of future ground and space-based projects.

Mark - this is contingent on the leading science questions.

Mike Shao - JPL - I'll plug my mission - Exoplanets is very active, Kepler just launched; proposed mission SIM. This will be a very high profile mission which will get good public spotlight. And SIM does a wide range of other great science as well. We've spent a lot of money and are about ready to go, just need the approval.

Annika Peter - General capability of high precision astrometry. GAIA also.

Steve Unwin - Astrometry as a field. Is taught very well in Europe, but not taught as directly in the US right now. We're missing an opportunity here. GAIA, SIM, VLBA, others. This field has a reputation for being last-century but really it's not. A renaissance now. Everything in the sky moves. Would like to promote the AAS's set of astrometry sessions at June AAS mtg, and also a meeting on prospect of microarcsecond astrometry at Socorro.

Mike Rich - I fully support that. Important to focus on the major questions: dark energy, terrestrial planets, etc. The danger is that administration/congress will want to focus on the most high profile ones, as opposed to less high profile but very useful fundamental subjects: galactic archaeology, stellar abundance analysis, UV spectroscopy, etc. There needs to be a balance to push back against too single-minded a focus on just the really high profile stuff.

Steve Lord - NASA Herschel - astrobiology has come of age. Chemistry of the universe is being opened up, we're on the threshold of connecting pre-biotic chem to life, and this should be a dedicated theme for the decade.

Varoujan Gorjian - Time domain astronomy. LSST, Pan Starrs, etc. Opening up long-term time domain followup. If we can somehow retask all the small 1-m telescopes for

followup, we could do a lot. Doesn't necessarily need a large amount of funding. Theo ten Brummelaar- agree completely. Lots of ability to do long-term studies with the small telescopes. Astrometry is an example of this - you've got to be patient, and you can't get the time on the big scopes.

Judy Cohen - I read a lot of cases about dark energy, and at what point do we not understand dark energy enough to decide to wait for the physicists? Is JDEM worth it when we're still so lacking in physical insight?

Mark - a thought shared by many.

Chris Hirata - if you wait for the theorist you're going to be waiting for a long time. I say that as one of them...

Mike Kesden - LISA. LIGO is ongoing, has completed 5th year run, will start up in June with advanced capability. In the next decade LIGO **will** discover gravitational waves from black holes. We want to be in the position to follow up from space. LISA is an astronomy mission, not just GR tests: We'll learn about SMBHs mergers, relevant to galactic assembly, etc. Complementary data between absolute luminosity and distance from LISA plus redshifts from spectra to probe expansion of universe. Need to start planning now.

David Ardille- HST/Herschel - More steady stream of MIDEX calls. SMEX are really very small, hard unless you're very imaginative, but MIDEX is the right size to do interesting things. The problem is the proposal cycle is hard to predict and intermittent. Internal NASA politics and we have little impact, but I would like to see the decadal review recommend a sustained, regular, predictable stream of MIDEXes, every couple of years.

Kartik Sheth - It seems like this question is hard; let's invert it. What can we do *without*? If we have JWST, ALMA, etc, then what do we have to drop?

?? - we have a large list of really great science, even left over from last decadal survey. Everyone can make a strong pitch for everything. Suggest that a reasonable criterion is bang for the buck - what is the science per dollar? It's hard to get an actual number, but you can try to order them anyway.

Kartik Sheth - cautionary tale is that Spitzer came out fifth in a previous ranking, yet has done spectacular science, but it was just barely not cut back then.

Mark - what is the unit of science? It's very hard to measure science per dollar.

George Helou - question about whether there will be one ranked list, or different ones at different size scales?

Lynne - not discussed yet. Trying to not pre-ordain the operations of the main report yet until after the first two stages have their input.

Mark - high angular resolution, interferometry, AO, etc. Lots of new results have come out of the milliarcsecond regime.

Pat McCarthy - prioritization of ground-based optical facilities, large all sky/survey/time domain versus focused GSMT capabilities.

Large photometric databases versus spectroscopy or angular resolution.

Jessica Lu - clearly you need both, but what is the ratio?

***** Within the coming decade, what balance of resources should be devoted to large long term versus small short term projects?**

Annika Peter - this is like asking about investing in the stock market, and as unlikely to be successful in terms of detailed predictions.

Lynne - another way to articulate - if there are cost categories, what is the slope? what are the bins?

Marshall Perrin - Cost and duration are separate axes. There are small long term projects as well, that keep a group alive or develop technology, etc.

Sally Dodson-Robinson - Right now, too focused on short term. 2-3 years is barely enough time to get a paper out. It would be better if there were more focus on longer term.

Mark - NASA's 3 year and occasional 5 year allocations, versus the common 1 year allocations.

Mike Kesden - The longer you drag out a large mission, the more it ends up costing. This ties into many issues.

e.g. one of the things that divides the community is that when project X goes over budget, other groups feel threatened and turn against it. Real hard cost-estimates and honesty in up-front estimation would go a long way to fixing this tension/competition in the community. Solidarity through better accounting!

Mike Shao - Is the decadal survey being asked to comment on issues like that, or is it off the table?

Lynne - the intention to write a report that is versatile to changing circumstances during the decade. There will be language about estimated costs going up by some percentage should lead to reviews or re-prioritization. There will be more focus in that area.

Fiona - another example is tech development. Do mission X if tech is ready by date Y, otherwise do something else.

Marshall - The timescale for building hardware is longer than a postdoc; I'm faced with moving elsewhere right when we're going to be commissioning the instrument I've spent years on. Longer-term fellowships (> 3 years) would be beneficial in this area, as suggested by the "Training instrument builders" white paper by Elias et al.

??? - writing a state of the art computational physics code takes longer than an existing postdoc grant, too. A theme here - longer term, more predictable funding would be beneficial

Kartik Sheth- Need for multiple sources of funding to balance things out. Example of CARMA which is joint university and NSF funding. Longer-term funding is made more palatable by having a buy-in from the various partner institutions, out of baseline state or institutional funds.

Theo ten Brummelaar - Not just paying for a postdoc who can stay long enough is challenging, but also obtaining operations funds. It's very hard to write a science-based proposal for long-term operational funds.

Judy Cohen - Would you be happier to ask for funding for 10 years in a block, if you never got any money after that ever? We can't fund everything forever.

Theo ten Brummelaar - no, that's not the point. Of course it doesn't have to last forever, we just want a call for proposals or opportunity where we can propose for operations funds not science.

Judy Cohen - we're all just scraping along, Palomar and everywhere else. Not sure if it's

the federal government's job to fix this problem.

**** How can we argue for more funds when there are so many more pressing needs?**

Annika Peter - goes back to the question of education and out reach.

Kartik Sheth - We know that the demand for sci and tech jobs is supposed to double, but undergrad science students are not. We are one of the best ways to get people into science. We're an entry point for lots of people.

Judy Cohen - I don't believe astronomy should get more money. So many other pressing economic needs. We need to learn how to live within the generous amount we already have, and optimize as best we can.

Mark - so do we have to argue hard just to maintain what we've got now?

Sally Dodson-Robinson - We're a tiny tiny fraction of the overall federal budget, so in that sense it is not hard to argue for more money.

Kelly Cruz - if someone said we're going to cut astronomy budget to zero, how would you respond?

Judy Cohen - It's an adventure of the human spirit, something which we can afford when we're rich, and not when we're poor, and today America is in the middle somewhere.

There are so many more urgent needs today.

Sean Casey - a lot of the things we do in astronomy are general purpose. Remote sensing, computing etc. We need to talk about tech transfer and multipurpose use when advertising ourselves to the rest of society.

Scott Horner - we have to face the reality that congressional discretionary funding is a zero sum game. We're not going to get any more, Congress has been saying for years they'll double research funding but it's not going to happen. Talking about going to congress is not going to make any huge difference in the long term.

Steve Lord - I don't pretend to understand congress, but our newest administration does seem to have more focus on science. We have a huge capability to spark young imaginations. I judge the state science fair, and have for years, and you see these kids completely turned on to science. We have a leverage here to make congress and the government aware of, how exciting this science is for young people.

In a year when 700 billion are being spent on stimulus, and the four fundamental problems are education, energy, environment, and health - that's education plus three science issues. We have a huge opportunity to really make a big change there.

**** Any last minute comments on other topics?**

Kartik Sheth - From experience as staff scientist at Spitzer and soon NRAO - the CAREER grants are restricted to people with the title of faculty. Do we need a comparable kind of grant (or extend that program) to any sort of junior faculty on the different tracks?

Theo ten Brummelaar - this came up before. Not having "Faculty" on your name stops you from doing all sorts of things. This is a problem but I have no idea how to fix this.

Mike Kesden - what is the fundamental difference between a faculty member and

someone else? The 0th order distinction is faculty members have students, and research sci don't. The faculty model leads to exponential growth, thus is clearly not sustainable. So there needs to be more focus on these other paths as acceptable/respected careers.

Marshall Perrin - There was a lot of discussion about climate change/energy research in the context of society's needs and funding. But we also need to do our part ourselves - see "Low Energy Astronomy" white paper on CO2 emissions of astrophysics. We need to try to conserve CO2 while producing the same science. Far and away the worst thing we do is air travel.

Kelly Cruz - We spend way too much time reinventing the wheel - especially ground-based data reduction. Every new instrument needs to have a real data pipeline, fully functional to calibrated data. This should be an absolute requirement.

Annika Peter - is there any representation from students and postdocs on the Decadal Survey committees? Answer: Laughter.

Lynne: Not officially seated on panels, no, possibly due to NRC official rules. But we're definitely trying to take input from them.