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Subject: Astrophysics Subcommittee Report

22 July 2008

Dear Dr. David,

I write to summarize the discussions of the Astrophysics Subcommittee for the NASA Advisory Council.

First, we acknowledge and thank those who took the time and energy to prepare and make presentations to our Subcommittee: Dave Barrett, Jon Morse, John Huchra, Alan Smale, Julie McEnery, David Leckrone, Preston Burch, Hashima Hasan, and Jonathan Lunine. We are also grateful that Jack Burns joined our meeting, which is helpful for coordinating with the NAC.

General Remarks

The subcommittee shared a general sense of enthusiasm for an exciting and forward-looking ongoing program in Astrophysics at NASA. To choose the most recent example, the Gamma Ray Large Area Space Telescope (GLAST) was successfully launched just a few weeks ago. We heard from GLAST team member Julie McEnery that the systems are all performing well and returning spectacular data; the first all sky image was being collected during our meeting and the first science results will be made public in a few weeks. This mission will expand and deepen our knowledge of the gamma ray sky by orders of magnitude. It will reveal many thousands of new sources, and probably many types of new sources never known before. On the exoplanet side of our portfolio we look forward to breakthroughs in a few months with the launch of Kepler, which will vastly expand our knowledge of planet populations around other stars. Many other triumphs of the past year emerged during our GPRA review and will appear in that report.

At the same time, ongoing contraction of the astrophysics budget has led to long delays in realizing the exciting scientific programs put forth in the last decadal survey and in the Quarks to Cosmos report. The recently recommended Joint Dark Energy Mission (JDEM) is being funded at about half the level envisioned by the Beyond Einstein Program Assessment Committee (BEPAC) that recommended it, and other Beyond Einstein missions are indefinitely suspended in a technology development phase. As described above, there are many exciting missions in operation and about to be launched, missions that have the potential to significantly alter our understanding of the cosmos, but these are based on investments that began years ago. We were impressed by the quality of the planning being done by the Division in the face of a severely constrained budget, but the fact remains that after the launch of James Webb Space Telescope (JWST), new missions will be few and far between.

Program-based named postdocs

The committee had a lively discussion about the idea of replacing current mission-based postdoctoral programs (Hubble, Chandra, Spitzer,....) with three high profile named programs centered around the proposed new main science themes of the Division. We broadly agreed on the merits of this proposal such as flexibility, durability, and competitive science review. Our enthusiasm was tempered by the perceived risks of tampering with successful, high profile programs. The risks include possible dilution of science quality standards, political vulnerability to cuts or general program volatility, net reduction of resources, and loss of critical manpower for mission support. The success of this program depends on details of implementation such as the transparency and the choice of contractors to run the award programs, which should be recognized centers of the highest scientific caliber. The names of fellowships must be chosen with care to preserve high profile “brand recognition” while at the same time not implying a preferential

treatment for specific missions within each theme. We did not reach a conclusion about the best way to institutionalize these fellowships in NASA.

Senior fellows

We also discussed the idea of senior fellowships and although we found much to commend the proposal, the discussion fell far short of an endorsement. Once again, we did not come to a definite conclusion about what size and shape such a program should take. Some reform of this kind may increase the science impact of senior support funds but to the extent it becomes a significant program, it also is likely to alter significantly the career and research choices of NASA supported scientists. It is possible that such a program would have a beneficial effect on balancing the demography of the subject to open more senior positions as young scientists advance in their careers, but such a result also depends on the response of universities to the increased stability of senior support. The range of possible consequences and the advisability for implementing the program should be discussed at greater length in a future meeting.

Senior review

The committee heard a report about the recent Senior Review of operating missions. We found the process to be fair, reviewers to be competent and sufficiently broad for the range of reviewed programs, and the charge to represent sound management practice. The review centered on the science effectiveness of future operations (rather than past achievements) and we agree that this is appropriate for a forward-looking program. We recognize the special challenges of reviewing operations for HST but agree that a review next Spring after SM-4, and subsequent inclusion in the regular Senior Review, may be appropriate for positioning resources optimally in the program, and could also help HST to optimize its own competitive position for the Decadal Survey. We agree with the conclusion of the need for continued support for research and analysis for science missions generally.

GPRA (Government Performance Results Act)

The committee agreed on scores of "green" for the main categories of science outcomes for the Division. A few specific examples were subtracted from the candidate list and a few others were added, notably exciting discoveries from the Swift gamma-ray burst mission, the historic five-year achievements of Wilkinson Microwave Anisotropy Probe (WMAP), and NASA-funded advances in theoretical modeling of complex astrophysical systems, such as the formation of the first stars and the coevolution of massive black holes and their galaxy hosts. Overall we found that even a fairly long list of examples of first rate discoveries does not do justice to continuing rapid advance of astrophysical science propelled by the Division. The Committee will help the agency staff draft details of the GPRA report, which will appear separately from this letter.

Exoplanet task force report

Jonathan Lunine presented highlights from the Exoplanet Task Force (ExoPTF) report to our subcommittee. The ExoPTF was convened at the request of the Astronomy and Astrophysics Advisory Committee (AAAC) to develop a 15-year strategy for the detection and characterization of Earth-mass planets orbiting at habitable zone distances. Extensive input was solicited from the community in the form of white papers, presentations and external reviewers of the final report.

In the 0 – 5 year time frame, the ExoPTF recommended continuing existing radial velocity surveys, developing high precision IR spectroscopy (to survey M dwarfs), continuing transit surveys, and operating a warm Spitzer mission for transit follow-up. The Kepler photometric-variability mission is expected to provide statistical estimates of the fraction of stars with Earth sized planets orbiting at habitable zone distances ("η_{EARTH}"). Spaceborn microlensing was supported as a technique that could also provide statistical information regarding exoplanet architecture with the caveat that such a mission should only be launched if it did not negatively impact the ability to carry out the rest of the strategy.

In the 6 – 10 year time frame, the ExoPTF recommended spaceborn astrometry as the most efficient technique for detection of low mass planets around the nearest 100 stars. Because microarcsecond precision is critical for success, a recommendation was made that a Blue Ribbon panel be commissioned to examine technical readiness. Astrometry was recommended in advance of direct imaging because dynamical measurement of planetary mass eliminates the need to fold in assumptions about planet albedo and permits the most robust scientific conclusions. It was noted that the range of internal structure in known transiting exoplanets already surpasses that observed in our solar system and the ExoPTF preferred a step-wise, empirical approach that minimized solar system assumptions. In addition, pre-identification of the best exoplanet targets (with positional orbit information) improves the efficiency of direct imaging mission and is particularly important if "earths" are rare.

The ExoPTF recognized the need for investment in technology throughout the 15-year timeline in order to reach the ultimate goal for the final 11 – 15 year time frame: direct imaging and spectroscopic observations of terrestrial planet atmospheres.

During subsequent discussions with our committee, Jon Morse asked whether a de-scoped astrometric mission, sensitive only to Neptune-mass planets, would be appropriate in the event that Kepler finds that η_{EARTH} is close to zero. In the ExoPTF discussions, it was felt that such a result would be surprising in light of the growing number of exoplanets with masses down to 5 M_{EARTH}. However, a null result would significantly impact the exoplanet strategy for NASA and would therefore require independent confirmation. Microarcsecond spaceborn astrometry is still the best way to confirm a null result. The committee had a useful discussion with Jon Morse about how to handle budget and decadal timing on the astrometric mission; one possibility is current support for technology development in mandated areas, with a later downselect when path forward is clearer in terms of best size and pace.

Advice for the Transition Team

Jack Burns attended our subcommittee meeting and solicited input from us for the NAC concerning general advice for the future during a time of transition for NASA, associated with a change of Administration.

This strategic question highlighted the need to make public a current science plan and mission statement for the Division based on the new thematic program structure currently undergoing an approval process within NASA. The new structure for example will retire the “Beyond Einstein” brand and subsume these and other efforts on fundamental physics into a multi-mission “Physics of the Cosmos” program, a theme description better suited for aligning NASA’s programs with other science agencies. Our committee stands ready as always to assist in the development of text and in helping to align agency practice with the vision of the science community.

One feature that distinguishes the Astrophysics Division from non-science activities of NASA is our adherence to the principle that the major priorities are set by the scientific community. Paraphrasing Winston Churchill’s famous statement on democracy, peer review is an imperfect way to make decisions but it is better than all the other ways: whenever possible, on scientific issues, we recommend seeking the advice of the science community. Our committee is one part of that system of advice. A major step in the near future will be the Decadal Survey of astronomy and astrophysics that will shape strategic policy directions for the Division, as these surveys have for the last four decades.

About 30% of the NASA budget is related to scientific activities and missions. Science is one of the most visible and successful Agency activities as perceived both in Congress and with the general public. In our view, NASA's ultimate product is the scientific research and new knowledge enabled by its missions and not only the missions themselves. NASA's scientific discoveries have reached the hearts and minds of people world-wide and continue to inspire the next generation of Americans. NASA provides significant scientific research infrastructure (at relatively low cost), such as scholarly tools and databases, that greatly add to the knowledge productivity of scientists nationwide. By offering new challenges at the frontiers of known physics, NASA’s Astrophysics missions present unique incentives to American aerospace industry, in areas including multiwavelength detector development, space optics, cryogenics, remote position sensing, precision thrust and positioning control, communications and data handling. Development of these mission technologies contributes to American fundamental technological infrastructure and economic

competitiveness.

It was noted at that at present the NAC subcommittees such as the NASA Astrophysics Subcommittee are not directly connected to the NAC itself. For example, my only communication with you has been through letters such as this one. A better policy protocol might be to ensure that the chairs of the subcommittees are actually NAC members or in some other way are engaged more interactively with the NAC.

On behalf of the Astrophysics Subcommittee,

Yours Sincerely,

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