October 17, 2002

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Dear Wayne and Guenter:

By this letter, I am transmitting to you some recommendations and observations generated by the National Astronomy and Astrophysics Advisory Committee (NAAAC) during its first meeting. The order of these recommendations does not imply their relative priority. We recognize that the suggested joint efforts must be reconciled with on-going programs at the two agencies and near-term existing priorities, all of which are subject to the appropriate peer review process. Nevertheless, we strongly encourage NSF and NASA to explore the implementation of our recommendations as soon as practicable.

1. We note that NASA and NSF have already participated in very successful collaborations which have been extremely beneficial to the advance of astronomical science. These provide a strong basis for further joint efforts by both agencies to achieve many of the science objectives identified by recent Decadal Surveys. Especially notable examples, in which both agencies have invested substantial funding, are the 2MASS Infrared Sky Survey, IRTF operations support and instrumentation development, the antarctic meteorite program, and the Sloan Digital Sky Survey. Numerous additional collaborations of more limited scope have provided opportunities to further NASA's mission science goals in space while at the same time enabling NSF's innovative new ground-based initiatives. A recent example is the Near Infrared Chronographic Imager (NICI), funded by NASA for use at the NSF funded Gemini 8-m observatories.

We encourage NASA and NSF to find some common ground for collaboration on the more substantial projects that have been recommended by the Decadal Surveys. Several such projects we can identify at once are Large Synoptic Survey Telescope (LSST), National Virtual Observatory (NVO), James Webb Space Telescope (JWST), and the Giant Segmented Mirror Telescope (GSMT). The LSST Project appears to offer some immediate and compelling opportunities for a collaboration that would advance the science objectives of both agencies. These are described in detail in an attached addendum that is strongly endorsed by the NAAAC. Joint support by NSF and NASA will encourage rapid development of the NVO to support the large array of new space- and ground-based observatories that are coming online over the next few years. The NVO has been identified as a top priority for both NASA's and NSF's astronomical science programs. We laud their decision to collaborate in the immediate pursuit of this concept, but note with concern that the effort to establish a viable archiving system for the (relevant) ground-based data lags far behind such systems already available for

space mission data through NASA. We encourage NSF to obtain adequate resources to accelerate their effort to address this situation by getting a prompt head start during FY2004.

2. The Committee notes that there is an important difference in the external advisory structure between NASA/OSS and NSF/AST. NASA/OSS obtains both strategic and tactical level community input through standing FACA committees and subcommittees. There is no corresponding external committee to advise NSF/AST on, for example, strategic priorities and the balance in funding among various AST activities. The committee believes that the NASA model allows more timely response to community needs than can be obtained, for example, through the decadal NRC review process. Moreover, the absence of a similar advisory structure makes coordination between NASA/OSS and NSF/AST more difficult than it might be otherwise At the NSF, a formal mechanism within AST for establishing strategic priorities and funding schedules for the several mid-sized projects recommended by the Astronomy and Astrophysics Survey Committee is essential. To interact effectively with NASA funding schedules will require NSF to develop and follow a roadmap for each project that falls within its area of responsibility. This approach is a change from the traditional practice of responding to proposals, and requires community support and participation to be successful. Such mechanisms are already in place at NASA in the form of the SScAC, the SECAS, the OS, and the SEUS. In the unfortunate absence of an Advisory Committee for the NSF Astronomy Division, NAAAC urges the Division to continue to explore mechanisms to obtain input and advice from the astronomical community on the priorities and strategic directions for the Division. A process which is transparent so that input provided is summarized for and available to the community would be most useful.

3. The Committee reviewed a preliminary report on computational efforts in gravitational wave science that is being prepared by an ad hoc committee commissioned jointly by the Astronomy and Physics Division of NASA/OSS and the Physics Division of NSF. The report points out the imminent difficulties in interpretation of the gravitational wave experiments LIGO (NSF sponsored, high-frequency sensitivity) and LISA (high-priority NASA facility-class mission, low-frequency sensitivity). These experiments simultaneously detect large numbers of individual sources and the individual source signals can be disentangled only with long temporal baselines and theoretical templates for the behavior of various types of sources. The committee notes that the absence of detailed theoretical templates severely compromises our ability to extract meaningful results from the raw data. As a remedy to this situation, the ad hoc committee recommends a major initiative in modeling gravitational wave sources. Current funding for this sort of activity from all US sources is about $1M per year, mostly from NSF. The committee recommends at least a five-fold increase in this amount. Clearly new funds would be required to meet this level, since the theory programs from which these funds are drawn total only $4.5M and $7.5M from NSF and NASA, respectively. It is further noted that over a 10-year baseline, this request totals only 5% of the capital costs of LIGO and LISA. As a guideline, the most recent NRC Decadal Report suggests that about 3% of the overall costs of major astronomical projects should be devoted to theoretical support. Given the difficulty and complexity of the extensive numerical relativity calculations that need to be made, and given the urgency of this effort (especially for LIGO), this seems reasonable.

The Committee recommends that NASA and NSF initiate a joint program in computational gravitational wave modeling in support of the two complementary gravitational wave experiments that are being undertaken. Care should be taken,

however, to not compromise other important theoretical efforts currently funded by NASA and NSF.

4. Solar Physics provides an opportunity where collaboration between agencies can lead to greater science benefit from the investments of both. NASA's Solar Dynamics Observatory (SDO) has been approved for launch in 2007 to study how changes in magnetic fields at and below the solar surface lead to heating and activity in the corona above. The National Solar Observatory's proposed Advanced Technology Solar Telescope (ATST) can provide critical observations not possible with SDO, such as simultaneous measurements of the coronal magnetic fields directly responsible for the heating and activity. The scientific payoff that would be gained from joint observations far exceeds what could be achieved individually. We therefore recommend that NSF and NASA take advantage of this synergism and work to ensure that ATST and SDO are phased together.

5. We recognize that a number of challenges to effective cooperation between the two agencies must be overcome to produce a successful outcome. The foremost of these is a perception in the astronomy community that there is a clear separation of responsibility for ground-based and space-based astronomy. The agencies need to find those opportunities where a relaxation of this traditional separation will benefit the broader strategic scientific goals of astronomy. Promotion of collaborations that blend ground- and space-based capabilities can produce joint missions that have enhanced value compared to the value separate missions would have standing alone.

While the Committee sees a strong record of inter-agency cooperation, that record comprises many smaller-scale projects in which collaboration has occurred as a matter of individual initiative rather than through strategic policy. At the grassroots level, the spirit of cooperation is strong, but to achieve the challenging science opportunities outlined in the Decadal Surveys will require a stronger level of commitment by the agencies and a higher degree of joint strategic planning than has heretofore been possible. Increased flexibility in the roles that both agencies play, as well as some changes in operating procedures at both agencies will likely be needed to see the real benefits that could accrue from cooperation.

NASA has traditionally played role in support of ground-based science initiatives that are essential components of space missions, and this important role must be recognized by the community and within NASA itself. While NASA rightfully should not accept the burden of building and operating ground-based facilities, NASA's missions are unquestionably strengthened by ground-based supporting and follow-up science investigations. Continued participation by NASA in essential ground-based science initiatives through such activities such as technology development, data pipelining, and data management will benefit NASA, the community, and the science and are a wise and appropriate investment of taxpayer dollars.

We thank you for the information and assistance that you and your staff members provided in support of our deliberations.

Sincerely yours, on behalf of the Committee,

Robert D. Gehrz, Chair

Professor of Physics and Astronomy

attachments: addendum on NASA/NSF collaboration on the LSST Project

ADDENDUM: The Potential for a NASA/NSF Collaboration on The Large Synoptic Survey Telescope (LSST) Project

The Large Synoptic Survey Telescope (LSST) offers a unique opportunity for NSF and NASA to collaborate on a large project that has scientific and programmatic interests to both. LSST is the second-ranked ground-based optical/infrared program of the 2000 Decadal Survey (the McKee-Taylor Committee). Its goals are: (1) the detection of Near Earth Objects (NEOs) down to diameters of 300 meters that pose a significant threat to life on Earth; (2) the study of known variable objects (supernovae, gamma-ray bursts, Galactic variable stars, active galactic nuclei (AGNs), microlensing events, etc.) and the discovery of new phenomena; (3) the accumulation of a very deep sky image; and (4) the production of a "living sky" image. Updated weekly, the "living sky" will be an unprecedented resource in the classroom and a source of fascination for the general public through its availability on the world-wide web. The deep sky map produced by LSST will be the next generation sky survey, and thus a key component of the National Virtual Observatory (NVO) and a resource for future missions such as NASA's Con-X and NSF's GSMT. The synoptic component of the survey will be an unprecedented tool for selecting targets for ground and space observations and will provide a time-space archive for interpreting the nature of newly discovered objects. The planetary community identifies LSST as an essential part of the research infrastructure in its just-completed NRC Decadal Survey, "New Frontiers in the Solar System". Finally, the very deep sky image will represent a giant stride in mapping the dark matter distribution on cosmic scales: studies of dark matter are emphasized in the strategic plans of both NSF and NASA and are highlighted in the NRC report "From Quarks to Cosmos" as central to exploring the boundary between astronomy and fundamental physics.

Clearly, a broad range of scientific programs now supported by NSF and NASA will benefit from LSST's deep, synoptic survey. But LSST offers an additional feature --- the detection of NEOs that is central to NASA's special goals of protecting life on Earth and exploring, and perhaps one day settling, the Solar system. It is the NAAAC's opinion that Congress and the general public consider this to be, quite naturally, a job for NASA, because of NASA's strong leadership and expertise in Solar System science and the fact that NASA would be the principal governmental entity involved in any mission to divert an asteroid from an Earth impact.

Through the national observatories NOAO and Gemini, NSF has acquired extensive experience and demonstrated unqualified success in the construction and operation of large ground-based telescopes. It is expected that NOAO will lead the construction of the LSST, probably with participation of one or more of the university or independent- observatory groups. Though the exceptionally wide field presents some new challenges in optics and instrumentation, LSST is well within the expertise that NSF can draw from the community. NASA's opportunity is to contribute to the development of the very large format detector array and the processing/archiving of data, which will be at the terabyte-per-day. By combining their strengths and experience in LSST, NSF and NASA could demonstrate a willingness and ability to create a partnership that exploits the strengths of the two major sources of support for US astronomy. The NAAAC urges NASA and NSF to seize this unique and important opportunity for collaboration.