SMITHSONIAN ASTROPHYSICAL OBSERVATORY
VISITING COMMITTEE REPORT

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Overview

The Harvard-Smithsonian Center for Astrophysics (CfA) is one of the world-leading centers for astronomical research. CfA scientists are doing outstanding research from the radio to the optical to gamma rays. The CfA has strong experimental, observational and theoretical programs and is playing a leading international role in the production of astronomical research, the training of graduate students and postdoctoral fellows, and the dissemination of astronomical information.

Since the last visiting committee meeting, there have been significant external changes that will have a major impact on the SAO:

- One of the SAO's greatest strengths is its high-energy astrophysics group. While the Chandra satellite will likely continue its successful operations for a number of years, the NAS decadal survey report priorities and the strains in the NASA budget imply that there will not likely be another major US X-ray mission started within the decade. One of the SAO's major strengths and major source of financial support will likely decline and there is not likely to be another single mission that will play as important a role at the CfA as Chandra has.
- The SAO's major experimental effort has been the SubMillimeter Array (SMA). While the SMA is producing exciting scientific results, the international ALMA project will soon be much more capable for many projects. This is an opportunity for CfA scientists, as their SMA experience will position them to do some of the most exciting ALMA science as well as contributing to the continuing development of ALMA capabilities.
- Three major international consortia are moving forward with their plans to construct 20+ meter class telescopes. These telescopes will conduct a significant fraction of the state-of-the-art optical observations in the coming decade.

In addition to its involvement in these large programs, the Harvard-Smithsonian Center for Astrophysics has many diverse strengths including its flourishing exoplanet effort, the

Institute for Theory and Computing, and its solar astronomy program which is playing a significant role in explorer missions and its gamma ray astronomy program.

The SAO has a range of very ambitious projects under consideration, commensurate with its broad ranging, talented and innovative staff. The principal recommendation of the VC is that the SAO generate a new strategic plan that will respond to these new realities, outline a vision for the CfA to continue to play a leading role across a wide swath of astrophysics research and prioritize SAO's major new initiatives (e.g., playing a major role in GMT).

The VC report is divided into two parts: a strategic overview that begins by reviewing a number of the SAO's research areas and highlights the demographic challenge facing the SAO. This section concludes with a recommendation that the CfA consider developing an alternative to its 60 Garden Street site. The development of the Allston campus may offer an opportunity for the CfA to have a facility that will enable its continued eminence in the 21st century. The second section of the report offers a number of policy recommendations for the SAO for improving the working environment for the students, scientific and non-scientific staff.

Scientific Research Program

High Energy Astrophysics

The high-energy astrophysics group at CfA is arguably the strongest in the world. The cornerstone of the program is the Chandra observatory, which is entering its second decade of observations. Chandra continues to be extremely productive, the oversubscription rate remains high, and with the spacecraft functioning well Chandra will likely remain the centerpiece of X-ray astronomy in the US in the coming decade. However, resources for operating the observatory and general science support are declining slowly.

In the coming decade it will be critical for the high-energy group to develop a strategy for retaining its vibrancy in the post-Chandra era. Even in the most optimistic scenario, in which the International X-ray Observatory (IXO) moves forward in Europe in the next few years, it seems clear that there will be no significant development funds in the US until after the launch of JWST in the last part of this decade. In response to the harsh budget realities, both the US and European community are developing scaled downed version of IXO. The obvious challenge is how to retain the best technical and scientific staff, and to position the group to take a lead role in future X-ray missions.

Retaining, and even enhancing advanced technology development activities will be critical to future success in space research. The VC was enthusiastic about the effort to develop high angular resolution (<1") lightweight X-ray optics, which if successful could be transformative for the field, and lead to interesting missions on both the Explorer and flagship scale. The VC also noted that aspects of this development are crosscutting, and

have overlap with deformable optical and IR mirror; technologies that could become relevant to SAO's interest in exo-planet detection. In addition there are clear synergies between x-ray and optical-IR instrument technologies. Consequently, we encourage the SAO to consider forming an instrumentation group that is wavelength-independent, or at least finding means to maximize interactions and collaborations on cross-cutting technology development.

Finally, the VC noted the strong interactions between the high energy and solar groups. Strengthening similar cross-divisional co-operation will enhance SAO's competitiveness in future mission selections.

ALMA and the SMA

The SMA, a partnership of the SAO and the IAA of the Academia Sinica in Taiwan, is currently a unique facility at the cutting edge of millimeter and submillimeter astronomy. The facility has produced very important results in a broad range of topics, including proto-planetary disks, star formation, high z submm galaxies, solar system objects and astrochemistry. The SMA is a major facility within the SAO and has placed the SAO in a leading position in the field of submm astronomy, in particular submm interferometry, with an excellent scientific and technical staff. It has also trained a generation of postdocs and students in this important discipline.

The international ALMA project is near completion. In many areas, ALMA's capabilities will far exceed those of SMA. While this will force the SMA to focus its activities, ALMA also presents exciting opportunities for the CfA. The SAO astronomers are well aware of the situation and are planning on how to best use the SMA in the ALMA era. The SMA group will be very well positioned to take advantage of ALMA, but also has a great deal to offer the ALMA community.

The challenge for the SAO radio community will be to pursue a path that maximizes scientific return and exploits both the SMA and ALMA. ALMA should be seen as a great opportunity for the SMA group, both in terms of contributing to the ALMA capabilities in many areas and to leverage the SMA experience and expertise for fully exploiting the power of ALMA. In addition, there may be mechanisms that the SMA/SAO contributions to ALMA may result in guaranteed time for the SAO, if they can be demonstrated to be over and above the agreed to North American contributions. We encourage the strategic plan to outline a vision for the CfA's SMA that is collaborative, instead of competing, with ALMA.

Exoplanet Research

The VC was impressed with the quality and breadth of the exoplanet research at SAO, and the seamless integration with the strong Harvard group. This research is an excellent example of the benefits that flow from the organizational principle of the Center for Astrophysics. The VC was particularly pleased to see the strong SAO involvement in

Kepler, the re-invigoration of HARPS-North, and the continued success of the HAT survey. We find that SAO makes excellent use of its own facilities, such as the 48-inch with KeplerCam, for important follow-up of exoplanets discovered by HAT, MEarth and other surveys. There is great potential for continued important discoveries from current and near-future surveys such HAT-south. The strong TESS proposal, with significant SAO involvement, promises to extend the success of Kepler to nearby stars, capable of atmospheric characterization using JWST or GMT. Exoplanet research is developing into a major strategic strength of SAO, and may receive further impetus from the development of GMT. The importance of exoplanet research, and its relation to GMT, should be a major consideration for the next Strategic Plan. The VC was pleased to see that SAO scientists maintain open lines of communication with scientists charged with developing future GMT instrumentation.

Institute for Theory and Computing

With approximately 100 scientific and staff personnel, it is the largest center devoted to theoretical astrophysics in North America. Of the 21 senior ITC members, just over half hold SAO or joint SAO/Harvard appointments.

The ITC has as its primary mission to serve the CfA as a center for research excellence, providing theoretical leadership for conceptually understanding astrophysical phenomena, as well as for the practical demands of observational modeling. The VC views the ITC as one of the CfA's successes.

The ITC has fostered an active and vigorous interaction between the SAO and the Physics and Astronomy Departments of Harvard University. It enjoys an international reputation for scientific excellence, drawing about 150 short-term visitors and half a dozen sabbatical visitors each year. The institution also successfully runs the biennial Sackler Conference Series on topical, important areas of research in theoretical astrophysics.

Concerns were expressed to Committee members by some SAO researchers, including notably some graduate students, stemming from these researchers' inability, without direct involvement by an ITC member, to obtain time on ITC computational facilities. The Center for Astrophysics has flourished by giving all of its staff access to both Harvard and Smithsonian facilities (e.g., MMT and Magellan). The same principle should apply to computing facilities. While the need to maintain control over machine access is not a point of contention, the Committee strongly urges that a system be implemented whereby CfA researchers without a formal ITC affiliation could apply for, and be allocated, time. Not only would this have the effect of enhancing good will between the SAO and ITC, it would also productively contribute to the fulfillment of ITC's primary mission of science excellence and service to theory research in the CfA.

Discovery and Explorer Opportunities

Both the recent Astrophysics and Planetary Science decadal surveys advocate an increased rate of Principal Investigator class space mission opportunities. These Discovery and Explorer mission competitions are a significant opportunity for SAO scientists. For example, SAO was the lead institution on the SWAS mission, which was a Small Explorer (SMEX) Project designed to study the chemical composition of interstellar gas clouds. SWAS was launched in December 05, 1998 and made observations until July 21, 2004. SAO has also teamed in non-lead roles, such as working with Lockheed-Martin to provide the telescope for the Transition Region and Coronal Explorer (TRACE) mission. SWEAP and KEPLER are two very different and very successful models for SAO playing a significant intellectual role in a scientifically compelling mission.

A successful proposal requires a compelling scientific question and a realizable technology-ready mission design that must meet a specified cost cap with substantial conservatism. Recently NASA has viewed PI experience as a very important selection criterion. For this reason, SAO must be especially attentive to hiring outstanding young scientists with leadership capabilities, and then building on their leadership to create a small cadre of excellent scientists poised to take on the PI role for these missions.

A typical NASA Announcement of Opportunity might result in about 40 - 50 proposals so that the statistical chance of success is only a couple of percent per call. An organization like SAO can do substantially better given it breadth, depth, and excellence. The odds of proposal success can be multiplied by participating as co-Investigators on multiple proposals, while aiming at leadership in a more limited number of missions. Again, SAO can expand its Explorer and Discovery proposal success rates by selective hiring and training, especially concentrating on hardware-oriented candidates. For hardware-oriented candidates, SAO must rise to the challenge of establishing a stable laboratory environment and ensuring the job permanence that a leading candidate would expect. Since SAO has historically been engaged in technology development, sufficiently mature new technologies can be used to advantage to win Explorer and Discovery programs.

Whipple, MMT and Magellan Telescopes

The SAO is endeavoring to maintain ambitious observational program through access to a range of ground-based optical telescopes from 1.2m though to 6.5m. This program includes the operation of Whipple Observatory, the SAO's partnership in the MMT, and Harvard's participation in the two Magellan telescopes.

CfA scientists are using these facilities to produce excellent science. However the VC is concerned about the balance of resources across this range of facilities, and the future challenges of finding sufficient resources to maintaining such a broad range of facilities operating at world-class levels, especially if SAO were to formally commit to GMT. The

VC recommends that priorities for staff and instrumentation resources across a range of telescopes be based on a combination of the competitiveness of these facilities relative to other international facilities, their oversubscription rates and scientific productivity. For example, the new strategic planning process should consider whether the MMT shift from a general-purpose observatory into a specialized single instrument facility.

The Giant Magellan Telescope

Over the coming decade, international consortia will be making major investments in 20-30 meter class telescopes. These telescopes will enable a wealth of new science. If the CfA is to remain at the cutting edge of observational astrophysics, Harvard and SAO must be significant partners in these telescopes. The CfA's current strategic plan advocates a substantial investment in the Giant Magellan Telescope, one of the two US-led telescope consortia. This plan builds upon the CfA's very effective use of the Magellan telescopes and positions the CfA to be part of the next generation of large telescopes.

While the VC strongly endorses the CfA's plan to play a major role in GMT, and see participation in GMT as an essential element in SAO' continuing success we encourage the CfA to develop a clear set of ranked priorities for all of its future projects.

Education

The SAO is playing a leading role in astronomy education. The VC was impressed by presentation on the diverse outstanding activities in Cambridge. The Smithsonian may benefit by closer ties between the SAO education work and efforts in DC.

People and Space

Demographics

The SAO civil service scientists are the ultimate source of the institution's intellectual strength. This distinguished group is aging and has not been replaced. While there have been a handful of recent hires, the SAO desperately needs to hire a new generation of researchers. The current staff is overwhelmingly male with few members of traditionally underrepresented groups.

The VC recommends that the Smithsonian Institution devote resources to hiring the next generation of SAO civil servants and strongly encourages the SAO to conduct broad searches that will enable them to identify outstanding scientists and to increase the diversity of their staff.

Office Space

The CfA has outgrown its facility at 60 Garden Street. The lack of common spaces and meeting rooms limits interactions between its scientific staff, postdoctoral fellows and students. While off-site spaces are sufficient for some of its activities, the space shortage is a serious and ever worsening problem.

While a lack of office space is a significant problem, the most serious problem is the lack of common spaces for interaction at the CfA. One possible solution would involve converting the library into public space. With the easy availability of journals on-line, the library is a much less essential physical space in the 21st century.

For the long-term the VC recommends that the CfA explore the possibility of a move to a new facility at the Allston campus. The Allston campus would not be significantly further from Harvard's current "center of mass" and could provide a modern facility that would enable the CfA to playing a leading role in astrophysics in the coming century.

Policy Recommendations

Staff Council

The scientific council of the CfA is playing an important role in involving the scientific staff in the operation of the center and will hopefully play an important role in updating the SAO's strategic plan.

The VC recommends the establishment of a Staff Council, similar to that currently existing for the scientific staff, but representative of non-scientists at CfA. This could provide feedback to the Director that is unfiltered by the senior administrative staff and improve communication between the staff and the CfA administration.

Parental Leave

Sufficient formal parental leave is not available for junior researchers at SAO. Informal arrangements can make up for this lack in some (possibly most) cases, but individuals are not always aware or confident that this is the case. Clarity is particularly lacking for predocs and postdocs supported by individual grants. These groups are paid from grants which cannot be used to pay for leave time, and PIs are not always confident that they can get no cost extensions for this purpose even if the leave time were to be funded in a different way. For many postdocs and predocs, unpaid leave is not an effective solution in most cases—good daycare arrangements are crucial for a quick return to work, and daycare in the Cambridge area is very expensive. Young scientists generally have not yet been able to save a large amount of money. Currently, Harvard graduate students have been granted 3 months of paid informal maternity leave on a case-by-case basis, using funds from HCO. It is not clear that similar accommodation is available for SAO

predocs. SAO postdocs with fellowship support, either internal or external, generally arrange their own schedules and can likely arrange flexible work hours and work from home. Since no statement to this effect is available, individual postdocs may fear that their research unit may not be flexible. SAO Federal and Trust employees formally may use any accumulated sick leave. When sick leave is exhausted, employees can take 6 weeks unpaid leave as per the Family and Medical Leave Act. Informally, scientists can likely arrange flexible work hours and work from home. Again, because there is not a statement to this effect, different individuals may lack confidence in their options and may be accommodated to different degrees.

Day Care

No financial support for daycare or access to on site daycare is available to SAO personnel at any level. SAO people may add themselves to the waiting lists for Harvard daycares, but these are prohibitively oversubscribed—it is difficult to get spots even with Harvard affiliation and almost impossible for SAO personnel not affiliated with the university. Daycare at Harvard-affiliated centers costs approximately $2k/month per child, a cost that is out of reach for predocs. While Harvard employees have access to Parents in a Pinch, a service that provides emergency babysitter placement, this service is not available to Smithsonian employees. The SAO should aim to provide day care/childcare support comparable to that offered to Harvard employees.

Predoctoral Program

SAO sponsors a large pre-doc program, in which students from other research universities can spend a year (as a visitor) or more at SAO. These students often complete a large fraction of their research co-advised by a mentor at SAO and a faculty member at their home institution. The degree of involvement of the mentor at their home institution varies significantly. Although these pre-docs get a PhD from their home institution, for many of them SAO is their graduate school; it is where they will complete the bulk of their research; and it is where they will form the majority professional relationships. They will largely rely on SAO advisors for mentorship and career advice.

The SAO graduate training program is among the largest in the world. However, the program is somewhat ill defined and lacks both a coherent vision and operating principles. Does the program exist to provide Smithsonian scientists access to graduate students or to help train the next generation of scientists? The committee was not briefed on the career tracks of SAO graduates nor does there appear to be a consistent program of tracking the students either while there are at the SAO or after they have received their PhDs.

For the majority of the pre-docs, the opportunity to do research at a world-leading institution like SAO is a tremendous asset to their career. Education is also a formal part of SAO's charter, and it is a benefit to the Nation to have students educated in this vibrant and active research environment. However, because SAO is not formally responsible for

the formal graduate classroom education, candidacy and qualifying exams, or ultimately the decision to grant a PhD, these students lack the local structure and sense of "community ownership" that seems to exist for the Harvard graduate students. This can create a situation where students become isolated and disconnected from the broader program. A pre-doc's success relies more directly upon the engagement of the individual SAO advisor that it would in a program in which students are also tracked by the department faculty as a whole.

The VC met privately with a group of pre-docs for about 40 minutes. The students prepared for this meeting by gathering input from their colleagues, and they attempted to summarize a consensus view. Overall these students seemed content with their experience. Since the last VC, there have been significant improvements in health insurance, they are now allowed to sit in on Harvard Astronomy graduate classes, and they have a weekly Predoc coffee hour, a good environment for meeting new postdocs. In addition, a pre-doc liaison, an SAO staff member familiar with administrative requirements of the program, has been appointed

There are, however, some significant issues that need to be addressed to make sure that all students gain maximum benefit from their experience. Many students reported that they do not know who the other postdocs and scientists are, even if they are working in a similar field. When new pre-docs and visitors arrive, there is no central location (website or bulletin board) where this is announced. There are a many seminars, but no central location where students can find out about them all in one place. (This was a shortcoming mentioned by postdocs and other junior researchers as well). Further, while some students are well integrated into a larger research group, and have opportunities to meet and interact with a range of scientists, others feel very isolated. Some mentors apparently do not feel responsible for providing a more global advising role that includes helping students connect to the community, discussing career options, and enabling the students to develop into scientists.

The communication problem is easy to remedy: a central, organized web site that announces new members of the community, and perhaps a monthly or bi-yearly gathering to welcome visitors to the community would probably solve this problem. The issue of the non-uniformity in advising and isolation of some students is harder to solve, but the VC recommends that efforts be made to correct the problem. These could include appointing a scientific liaison that would be the counterpart of the administrative liaison established after the last VC. Scientists who wish to advise graduate students should be given either verbal or written input on the scope of their role, and they should be encouraged to play an active mentorship role. We also recommend more active tracking of student progress both during the stay at SAO and as they move towards their first astronomy (or non-astronomy) job.