

Smithsonian Astrophysical Observatory Response to the Visiting Committee Report

2017 SAO VC Members:

- Dr. You-Hua Chu, Director, Institute of Astronomy and Astrophysics, Academia Sinica
- Dr. Hugh Hudson, UC Berkeley, University of Glasgow
- Dr. Claire Ellen Max, Professor of Astronomy and Astrophysics, University of California, Santa Cruz, Director of the University of California Observatories
- Dr. Matt Mountain, President of the Association of University for Research in Astronomy
- Dr. Eve Ostriker, Professor of Astrophysical Science, Princeton University
- Dr. Eva Pell, retired Undersecretary for Science, Smithsonian Institution (VC chair)
- Dr. Keivan Stassun, Professor of Physics & Astronomy, Sr. Associate Dean for Graduate Education and Research, Vanderbilt University (VC vice-chair)
- Dr. Nicholas White, Senior Vice President for Science, Universities Space Research Association

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Responses are embedded in the original document.

Overview

The Smithsonian Astrophysical Observatory (SAO) was founded in 1890, located adjacent to the Castle on the Mall in Washington, D.C. In 1955 SAO moved to Cambridge, Massachusetts, and in 1973 formally united with the Harvard Department of Astronomy forming the Harvard-Smithsonian Center for Astrophysics (CfA). Today this entity is recognized as one of the most prominent observatories and astrophysics research centers in the world. It is preeminent both in science and engineering. The scale and breadth of its scientific and engineering endeavors and human resources, and arguably its visibility and reputation, are unsurpassed among research centers at academic institutions in the field.

The challenge for the SAO, as with all exceptional organizations, is to maintain itself in an environment that is resource-constrained, where competition is a healthy reality, and within which human potential is cultivated and maximized. In that spirit the 2017 Visiting Committee (VC) submits its report.

The VC met with representative members of the administration, scientific and administrative staffs, predoctoral students and postdoctoral fellows. We met with Federal and Trust employees, and with representatives of the Harvard Department of Astronomy. The VC came away confirming that a great deal of outstanding science is being conducted under the CfA umbrella, and that SAO provides remarkable leadership in science and engineering.

This report will focus on: (1) the progress made since the last Visiting Committee in 2012; (2) the status of the strategic plan; (3) reflections on major science initiatives; (4) human resources; and (5) the Harvard-Smithsonian interface.

SAO's response to the 2011 Visiting Committee Report

The 2017 VC is pleased to note that SAO had undertaken a number of steps to be responsive to the last VC Report in February 2011. Our observations are as follows:

1. The principal recommendation from the last VC was that the Smithsonian Astrophysical Observatory develop a 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).”* At the meeting this year we were presented with a Draft Harvard-Smithsonian Center for Astrophysics strategic plan, which outlined priorities and challenges for the Harvard-Smithsonian partnership. A detailed discussion of the SAO approach to strategic planning is discussed in more depth in the body of this VC Report.
2. Within the High-energy Astrophysics program, the 2011 VC noted its enthusiasm for 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”*. We note, and commend SAO that they now consider this technology to be one of SAO's two strategic science pillars. The development of the Lynx (or X-Ray Surveyor) concept will be considered in the upcoming 2020 Decadal Survey of Astronomy & Astrophysics, as discussed further in this VC Report.
3. With respect to the SMA and ALMA, we noted that a number of new initiatives are under way. *The new correlator technology developed for the SMA being considered for ALMA and the coordination required for the Event Horizon Telescope are two examples of refreshed leadership in the submillimeter domain*. Importantly, SAO appears to be collaborating rather than competing with ALMA as was recommended by the 2011 VC.
4. In the area of exo-planet research, the 2011 VC *“was pleased to see that SAO scientists maintain open lines of communication with scientists charged with developing future GMT instrumentation”*, and this year the VC saw a very focused instrumentation effort building a high-resolution spectrograph for exo-planet characterization on the GMT.
5. SAO Council: this year's VC was very pleased to meet with the broadly representative Council, as recommended by the 2011 VC.

Finding: From the examples above, the VC finds the SAO has been quite responsive to the previous VC report. There are, however, some significant lingering themes that carry over into this year's report: key areas for scientific leadership by SAO; the future roles of the MMT, GMT and SMA in SAO's future; demographics and office space; Human Resources issues; and the strategic planning process itself. The VC fully acknowledges that some of these issues may not be under the direct control of SAO Leadership Team.

SAO Strategic Plan and Strategic Planning Process

In its 2011 Report, the VC recommended 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).*” This year the VC was pleased to see a 2017 Draft Harvard-Smithsonian Center for Astrophysics Strategic Plan. The principal science priorities articulated were the development and use of the GMT “to advance discoveries in astrophysics”, and to develop the X-Ray mission Lynx, building off SAO’s expertise in Chandra. These were followed by a list of “opportunities”, which included the Event Horizon Telescope, the San Pedro Mártir Telescope and a Data Sciences initiative. In addition, the plan included an articulation of the need to strike the right balance between “strategic projects” and individual research, as well as strengthening the ties between Harvard and the Smithsonian Institution, which included a renewed MOU and a vision for a new joint building.

The VC learned that SAO staff input was via a series of internally generated White Papers, which were then synthesized into the draft plan. In talking to the Senior Science Staff and the SAO Council it was not clear that these constituencies knew how this synthesis was undertaken, nor was it clear who had been consulted on the prioritization. Indeed, it became apparent to the VC that some of the science staff were either not aware of the strategic planning process at all, or only came to realize because of our questions that they had participated in it.

Finding: The community was afforded opportunity to provide input for the strategic plan, but the actual development of the plan appeared top-down and somewhat insular.

The Draft Strategic Plan jumps immediately into proposed observatory and/or project implementations, rather than setting a long term scientific vision, making an assessment of SAO strengths and capabilities, and deriving the implementation from those goals. In addition there were some noticeable absences from the Draft Strategic Plan presented to the VC, such as the role of the Sub-Millimeter Array (SMA), as well as certain specific major scientific directions (most notably heliophysics, exoplanet science, and theory), in SAO’s strategic thinking. In contrast to the emphasis we heard from many of the science staff regarding the experience of working at SAO, the Draft Strategic Plan does not include any strategic components focused on personnel. We also noted that in Dr. Alcock’s SAO summary provided to the VC, there were some very real “Challenges” the SAO faces, which were notably absent from the Draft Strategic Plan.

Finding: The Draft Strategic Plan appears to be a “facilities first” document; it does not present a clear *science-driven* vision nor does it articulate the aspirations of the organization with regards to its *people*.

Recommendation: Our Committee believes the SAO has endeavored to be responsive to the 2011 VC recommendation to develop a new Strategic Plan. We suggest that the plan be

revisited before it is released. As several members of the VC have had experience with strategic planning, we offer the following thoughts. It can be helpful to have an external facilitator guide the development of such a plan, since the temptation is always to extrapolate from today forward, and simply “bake in” existing attitudes and assumptions which can result in lists of initiatives an organization already has on its “to do list.” Other strategic planning models try to envision what a future organization should look like—what are the organization’s aspirations, what should it be like to work in that organization—and then extrapolate back to today, which can have the beneficial effects of questioning existing assumptions and cultures, and opening up the possibilities of real organizational change. In addition, there is always a “cost-benefit” analysis to be done on the appropriate balance between all-staff participation, and a more focused decision making by a small leadership team. However, in developing its strategic plan the SAO should note the famous Eisenhower quote, “Plans are useless, but planning is indispensable.” To be successful, SAO staff must see themselves in the plan, and “buy in” to SAO’s strategies, and in particular see tangibly how the plan advances both SAO’s science and SAO’s people. Good ways to achieve this include involving a broader set of people, asserting the value of everyone’s engagement in the planning, and being more transparent about the planning process itself.

Response: We completely agree that the SAO staff must “see themselves in the plan”.

The Director’s Office is revisiting the Draft Strategic Plan, for completion by early calendar year 2018. We will enlist individuals to participate in the revisions.

To date we have held three CfA-wide meetings (announced and open to all staff, fellows, and interns), one of which was focused only on the possibility of a data initiative. (CfA meetings are held in Phillips and webcast live at the CfA.) The SAO Council also participated in discussions with the Director of the draft goals. In advance of the Visiting Committee visit, the Draft was circulated among the Associate Directors. Furthermore, 75 individual SAO staff members participated in the development of at least one white paper.

We will hold an additional CfA-wide meeting early in the Fall to discuss the Draft Strategic Plan.

Scientific Agenda

High Energy Astrophysics

The 2017 VC was very impressed with the quality and effectiveness of the SAO’s role in CfA’s stewardship of the Chandra X-ray Center (CXC) and its service to the community. This is a premier astronomical facility that enables high spatial resolution X-ray observations of the universe. It will have no peer for the foreseeable future. Chandra is now in its 18th year of operation, with no technical reasons why it cannot continue for at least another decade. As reported by the 2016 NASA Senior Review the CXC continues to maintain a high science output

for this “NASA Great Observatory” with excellent community engagement. The Senior Review notes the fact that this is “due in no small measure to the dedicated and highly capable staff who continue to encourage and support users...”, which is a testimony to the ability of SAO to recruit and retain the very best.

The CXC represents a significant fraction of the SAO staff and when the Chandra mission eventually does end, this will have a major impact on the institution. SAO management is keenly aware of this and wisely has started to plan for the eventual end of contract, and its implications for the institution.

The SAO with the CfA is taking the community lead in planning a major new X-ray observatory to succeed Chandra called Lynx (X-ray Surveyor). This is one of four major mission concepts that NASA is supporting to be considered by the next Astronomy and Astrophysics Decadal survey in 2020. The key science objectives are to observe the growth and evolution of black holes in the early universe, hot baryons in clusters of galaxies, the inter-galactic medium and the cosmic web, as well as many other contributions to astrophysics. SAO has given this high priority in the strategic plan. This community leadership is essential and critical for the future of X-ray astronomy in the US. The essential investments are being made by SAO in developing and demonstrating mission enabling lightweight X-ray optics, to achieve the Chandra-like angular resolution, but with a 50 times increased collecting area.

We note that the Decadal survey will be very competitive and SAO should have plans to mitigate the risk that the Lynx mission turns out not to be the first-ranked mission. The fact that the European Space Agency is planning the major X-ray observatory *Athena* in the same timeframe, with NASA participation, is a concern and a crisp justification was lacking as to why a second large X-ray mission is needed.

Finding: The VC endorses the high priority SAO has placed on advocating for and developing a successor to the Chandra mission.

Recommendation: It is important that the Lynx leadership at SAO fully engage the US science community in the development of the science drivers and resulting implementation for this mission. It is critical that they are complementary to the planned ESA-led *Athena* mission currently planned for launch in 2028.

The VC did not hear about missions that are being proposed under the NASA Explorers programs, and was disappointed to not explicitly see competitive NASA mission opportunities as a key part of the strategic plan. NASA Explorer missions are incredibly scientifically productive opportunities and SAO certainly has the proven capability to lead in this area. Winning such a mission would bring mission diversity to the high energy astrophysics group leveraging off the CXC capabilities. Winning such a mission could also help to address the possible loss of workforce when the Chandra mission ends, and provide a stimulus and vision to attract and retain staff.

Response: Discussion of the *Lynx* science drivers and implementation took place during the *Chandra* to *Lynx* Workshop held here in Cambridge in early August. As recommended by the VC, considerable attention was paid to the distinctions between and potential overlaps with the *Athena* mission. In addition, with strong encouragement from the SAO Director, the *Lynx* leadership have developed a comprehensive communication plan to reach influential scientists, with particular attention paid to those outside the High Energy Astrophysics community.

Recommendation: The strategic plan should explicitly call out the importance of pursuing NASA competitive mission and instrument opportunities.

Response: We agree and will explicitly address pursuing large NASA opportunities in the Strategic Plan.

We note in this regard that SAO is involved in two of the recently selected Midex Phase A studies: (1) *Arcus*, led by SAO PI Randall Smith (www.arcusxray.org), and (2) *SPHEREx*, led by JPL, with a significant SAO role led by Co-I Gary Melnick (spherex.caltech.edu).

The VERITAS GeV to TeV ground based gamma ray instrument is an enormous success and is delivering high quality science. SAO is to be commended for its leadership in this program. The next generation Cherenkov Telescope Array (CTA) program that will follow on from this represents a major increase in capability.

Finding: The VC was very pleased to hear CfA has proposed to be the managing organization for the proposal to NSF for funding the US portion of this international enterprise.

Solar Astrophysics

Solar/Heliospheric physics has always had a strong representation at SAO, and the groups involved (HEA and SSP) participate in many space missions (the Interface Region Imaging Spectrometer, IRIS, and the Solar Dynamics Observatory, SDO, and *Hinode*, to name the most recent missions). The group has an excellent record in EUV/X-ray optics and has an active interest in new missions in this area, including microsats as well as Explorer-class instruments. The VC noted participation in one of the most exciting and exploratory new NASA missions, *Solar Probe Plus*.

There is broad international interest, both academic and commercial, on the risks posed by extreme space-weather events, which could significantly jeopardize technical aspects of human activity in space and on the ground, and for which astronomical remote-sensing observational techniques must play a major role. Here SAO is involved in major contributions via their space-based programs, such as SDO. New small space programs such as the MaGIXS rocket provide excellent opportunities. Indeed, the VC heard about remarkably innovative observations planned from an airplane platform in the forthcoming total eclipse (August 21, 2017). The groups in this area are also well-positioned scientifically to take advantage of new ground-

based initiatives, specifically in the IR and in work with the U.S. flagship solar observatory, the Daniel K. Inouye Solar Telescope (DKIST).

Finding: Although the SAO research activities in solar and heliospheric area include much that is world-class and at the forefront of discovery, this area does not feature in the SAO draft priority list except in the item “Maintain balance between the few strategic projects and research carried out by individuals and small groups.” This was addressed in a “white paper” activity within the SAO, in which many contributions were received, presumably including ones in the solar/heliospheric areas. The VC did not get a thorough look at the “white paper” exercise, and the priority for support in these areas is unclear.

Recommendation: The VC suggests the continued encouragement of activities in solar and heliospheric physics, in particular in the role of small space missions at the Explorer class and below.

Response: We will add discussion of the solar group in the Strategic Plan. The Coronal Spectroscopic Imager in the Extreme Ultraviolet (COSIE) has been selected as a Mission of Opportunity as a Category III program. SAO also flew AIR-SPEC (NSF-funded) successfully during the recent Great American Eclipse.

Exoplanet Science, Cosmology, and Gravitational-Wave Astrophysics

While intellectually very distinct areas of research, exoplanet science, cosmology, and gravity-wave astrophysics arguably represent the “big three” areas most rapidly and dramatically transforming astronomy and astrophysics. Even so, we position these brief remarks at this point in the VC report because the Draft Strategic Plan, as currently structured, embeds these areas within the discussion of facilities priorities (see Science Facilities below).

Finding: For SAO to remain a preeminent astronomical observatory, it should be seen as leading in the areas of exoplanet science, cosmology, and gravitational-wave astrophysics. The VC was pleased to see all three of these areas discussed as central to the GMT.

Recommendation: The strategic plan should explicitly articulate the scientific vision that requires pursuit of these three areas of astrophysical research.

Response: We thank the VC for noticing a significant lack of clarity in the draft strategic plan. These three areas were intended to be illustrative/representative, but certainly not a defining core of our effort. We will rewrite this material with greater clarity!

Theory

Finding: The SAO has a vigorous and thriving theoretical research group, considered amongst the strongest in the world. Many of the functions that were previously under the “umbrella” of the SAO’s Theory Division have now been taken on by the Institute for Theory and

Computation, which is formally a unit of HCO rather than SAO. However, SAO theorists are fully integrated into the ITC, and the ITC is an important part of the CfA.

In addition, the Draft Strategic Plan identifies a Data Science Initiative as a new priority activity.

Recommendation: The strategic plan should explicitly articulate the scientific vision for continued leadership in theoretical and computational astrophysics.

Response: See response to previous recommendation.

Science Facilities

Giant Magellan Telescope

As was discussed with the last VC in 2011, a substantial partnership in The Giant Magellan Telescope (GMT), an ambitious next-generation 20m Optical/Infrared groundbased telescope, is a key priority of the SAO and the Harvard-Smithsonian Center for Astrophysics. Since GMT's inception the SAO has been an active partner in its development, building on existing strengths in science leadership, instrumentation and operating telescopes such as the MMT, and its partnership (through Harvard) in the Chile-based 6m telescopes. The VC was particularly impressed with the science focus SAO was bringing to its GMT instrumentation contribution, directly supporting its commitment to exo-planet research through the provision of a high-stability, high-resolution spectrograph that on a 20m telescope could potentially detect Earth-like planets orbiting nearby red-dwarf stars.

However, for GMT to become a reality will require substantial, continuing fund-raising by the GMT Partners, including both SAO (through the Smithsonian Institution) and by the Harvard Astronomy Department and Harvard College Observatory. At the time of our meeting, neither SAO nor Harvard had reached their goals, nor had a clear path forward to meet these goals been identified. Fund raising for the GMT does not appear to be the highest priority for either institution. The other US-led Thirty Meter Telescope (TMT) is also targeting first-light in a similar timeframe to GMT, but in the Northern hemisphere: this project too has its funding challenges. In the context of international competition, the European Southern Observatory is committed to building a 39m Telescope in Chile with target first-light date in the 2024-2026 timeframe, with a substantial portion of its funding in place.

Finding: Given the global competition, SAO's existing world-class strengths in Astrophysics, and in operating and instrumenting existing large telescopes it seems imperative for the scientific and technical vitality of SAO that it have a continuing, major role in forefront optical/infrared observational astrophysics.

Recommendation: Partnership in GMT seems the most appropriate route to maintain SAO's existing strengths in astrophysics, and specifically for advancing SAO's leadership in exoplanet science, cosmology, and gravitational-wave astrophysics.

However, the committee was concerned that the completion of GMT was presented as an “all or nothing proposition” for SAO. Given the substantial challenges all three of the 20m – 40m projects still face in raising the billion dollar-plus capital resources required for a single telescope, it may be wise for SAO leadership to consider possible “off-ramps” (contingency plans) to retain SAO’s institutional strengths if the GMT schedule stretches out significantly, or (disastrously) fails to reach closure on raising adequate capital, and/or subsequent operational funds.

Response: We note that Harvard has committed \$26 million to the GMT (with an aspiration to contribute >\$40 million) in addition to the ~\$11 million that SAO has committed. Furthermore, we note that SAO’s participation in instrumentation such as G-CLEF is supported by the GMT. In the event of a significant stretch-out or failure to obtain adequate funding for the GMT, SAO will continue as is, with our existing facilities and intermediate-scale opportunities, as well as with individual PI-led science projects.

It is unavoidable that a major setback to the GMT will have some adverse consequences for SAO. We structure our involvement to minimize “collateral damage” to other programs and projects, but the loss of opportunity will be real.

Submillimeter Array (SMA)

The SMA was the first array telescope operating in the sub-mm wavelengths. It continues to be productive, generating ~60 refereed publications each year with a healthy oversubscription rate of 3:1. The SMA conducts sciences that cover a wide range of astrophysical processes and distances, including near-earth asteroids, magnetic fields in forming stars, molecular clouds in galaxies, and ISM in high-z galaxies. The SMA’s detection of CII at $z = 5.24$ is particularly impressive. SMA science workshops were held in Boston (2014) and Taipei (2016) to showcase scientific results.

The inauguration of Atacama Large Millimeter/Sub-millimeter Array (ALMA) presents challenges to the SMA because ALMA provides superb angular resolution and sensitivity. Still, the SMA offers wider bandwidth, larger field-of-view, faster response to targets of opportunity, access to northern sky, pilot observations prior to ALMA proposals, testing sites for new instrumentation, and training ground for graduate students; thus, the SMA remains an excellent forefront facility. To raise the scientific impact of SMA, a new class of large observing programs began in 2013; these large programs are at different degrees of completion and should produce results soon.

Finding: Having a large overlap in wavelengths, ALMA provides an opportunity for the SMA receiver lab to develop future instrumentation for ALMA and SMA, taking advantage of the “Development Upgrades of ALMA” program. The SMA is also poised to help ALMA expand its bandwidth in the future.

The VC also heard about the SMA Workshop held in Taipei (2016), which included discussions about an upgrade to wSMA that could be completed by the end of 2019. The wSMA would upgrade the receiver systems with new streamlined optical systems, cryostats and receiver inserts, and wideband detectors. To handle the larger bandwidth, the signal transmission system and the correlator capacity would also be upgraded. The final wSMA could provide dual polarization in dual frequency, 230 and 345 GHz, each with 28 GHz spectral coverage.

Finding: To make SMA more competitive, upgrades beyond the recently acquired wideband, new receivers, and new digital backend may be needed.

Recommendation: SAO should continue discussions with ASIAA regarding a plan for possible upgrades and continued operations.

Response: We agree. We are also interested in exploring new partnerships with ASIAA and other institutes.

Event Horizon Telescope (EHT)

The EHT uses the Very Long Baseline Interferometry (VLBI) technique to achieve the highest angular resolution in order to study the event horizon of supermassive black holes (SMBHs). The two primary targets are the SMBH Sgr A* in the Galactic center and the SMBH in the center of the giant elliptical galaxy M87. The goal is to resolve and image the shadow cast by the event horizon against the hot accretion flow and track the dynamics of orbiting material near the event horizon, in order to test Einstein's theory of gravity at the black hole boundary. The EHT, led by Shep Doeleman, is an international collaboration of SAO, ASIAA, MPIfR, MIT, NAOJ, EAO, ERC, Perimeter, IRAM, LMT, U. Chicago, and U. Arizona.

The three most important stations of EHT are ALMA, SMA (+JCMT), and SPT. The first EHT campaign with ALMA was conducted in 2017 April, and is expected to resolve the shadow of the SMBH in Sgr A* for the first time. The SMBH in M87 is in the northern sky, not visible to the SPT, and thus needs the strategically located Greenland Telescope to leverage the northern baselines for the highest resolution.

Finding: The Event Horizon Telescope (EHT) is a very impressive project that captures the public imagination, as well as being high priority science. The EHT will provide the most exciting observations of SMBHs in Sgr A* and M87 in the coming years. These modest, high impact projects such as the EHT are to be encouraged.

Greenland Telescope (GLT)

The NSF awarded an ALMA North America Prototype antenna to SAO in 2011. Through a collaboration between SAO and ASIAA, this antenna has been retrofitted for operation in cold polar conditions, and is being deployed to Thule, Greenland. This Greenland Telescope (GLT) is

expected to be assembled by the end of 2017, see the first light in early 2018, and operate at Thule Air Base for 2-3 years. If the operation in Thule is successful and adequate funding is secured, the GLT will be moved to the Summit Station for both single-dish and VLBI observations at THz. The Risk Review Committee of the GLT recommended not to spend funds on the Summit Station until successful Thule operation has been demonstrated.

Finding: It is crucial that the GLT begins to operate in Thule Air Base in 2018 and perform well with ALMA in the VLBI observations of the SMBH in M87. According to the original plan, SAO is expected to secure the funding to develop the infrastructure at the Summit Station. It is essential that the SAO make every effort in securing the funding support for the GLT's move to the Summit Station.

Human Resources

The VC met with a number of groups representing personnel from a number of different cohorts within the SAO: senior scientists, mid-career scientists (including the SAO Council), postdoctoral researchers and fellows, and predoctoral fellows (i.e. PhD students). Overall, there was great satisfaction expressed with the opportunities and support for cutting-edge science that the SAO fosters. At all levels, from students to senior scientists, the SAO clearly has an energetic, engaged, highly-collaborative work force; they are doing world-class science and are dedicated to maximizing the intellectual contributions that SAO can bring to the larger astronomical community.

Nevertheless, several personnel-related issues emerged in the discussions the VC held with various constituencies. Some are common to all large institutions, while others are particular to the SAO; some should be quite simple to address while others may remain as ongoing challenges. Below we highlight key issues that we identified in each group, also providing recommendations.

Predoctoral Fellows

The predoctoral program brings in PhD students enrolled in programs external to the Harvard Astronomy Department, for research with SAO scientists. Overall, the predocs that the VC met seem extremely well integrated within their research groups, and expressed great appreciation and satisfaction with the research opportunities and mentoring that they receive. However, they appear to be less well connected to other parts of the SAO than best serves their interests. Furthermore, they do not appear to be well integrated with the Harvard Astronomy PhD students; they have a separate journal club (which is organized by an SAO staff member, rather than self-organized), and they are not always aware of/included in Harvard Astronomy graduate student events. This does not appear to be intentional exclusion; Harvard faculty that we met with expressed great enthusiasm for folding the predocs into the general graduate-student-related activities (other than courses). As there are 15 predocs and 60 Harvard students, expansion of activities to include predocs does not appear to present any significant management difficulties.

Finding: While some of the predocs may continue to feel the greatest connection to their research groups, welcoming them into the larger CfA community would be beneficial to all.

Recommendation: The VC recommends that the SAO predoctoral fellowship staff program director notify the Harvard Astronomy Director of Graduate Studies whenever a new predoc PhD student starts. The Harvard faculty will then be able to include the predocs in faculty-organized events, and also to pass on contact information to the Harvard graduate students who organize informal predoc events.

Response: We agree.

Postdoctoral Researchers and Fellows

Postdoctoral Scientists overall were extremely satisfied with the scientific aspects of their positions, but expressed a number of concerns related to the formal status/benefits associated with their positions, and to professional development issues.

Finding: there appear to be inequities for SAO postdocs relative to Harvard postdocs. For example, the SAO postdocs do not have the same preferential access to daycare, gym, housing office, etc, that the Harvard postdocs have. While this may be constrained by the MOU between the SAO and Harvard, if it is possible to provide greater access for postdocs, the VC would encourage this. A related issue is that some of the postdocs would like to have access to HPC resources that Harvard postdocs use, but are unsure whether they are eligible or how to gain access for computing resources.

Finding: there are no clear policies enunciated to the postdocs and their supervisors/mentors regarding the benefits to which they are entitled; they are currently in a position of having to “work it out” informally. This will in part be addressed in the future when the current “stipend fellows” positions become regular SAO employees. However, the Clay Fellows and potentially other SAO prize-fellows positions will remain.

Finding: the postdoctoral fellows felt that it would be valuable to have more structured mentoring for professional development. For example, some institutions have a series of career seminars at which invited speakers discuss a range of career paths (beyond academia and pure research). Having a career seminar series or other forum for postdocs to discuss these issues would be highly beneficial for the postdocs.

Recommendation: The VC recommends that clear written policies regarding benefits be provided to all postdoctoral scientists, whether SAO employees or fellows, as soon as they arrive to take up their positions. This should include information regarding their rights for parental leave, holiday/personal leave, sick leave, and flex work/time rules. The same written information should also be provided to supervisors or mentors for postdoctoral employees and fellows.

Response: We will do this.

SAO mid-career and senior scientists

Overall, the permanent staff expressed great satisfaction with their work at SAO. However, they raised a few issues related to resources, communication, and hiring (see also Hiring section below).

Finding: Though salaries, at least for senior scientists, may be lower when compared to some other institutions, this may be a structural issue that the SAO cannot autonomously address.

Finding: Resources for research support (e.g. travel, students) are limited, and it is not always clear how resources can be obtained by individual scientists. There appears to be variations across SAO divisions.

Finding: Communication between the Director's Office and the staff as a whole could be improved. For example, there was a sense of lack of transparency in a recent senior search, which was not completed. More generally, the SAO staff felt that mechanisms for input to the management team are lacking. As was discussed in an earlier section of this report, input by staff in the strategic plan process appeared somewhat diffuse. The staff as a whole would like to understand better how the implementation of the SAO's strategic plan will translate into a long-term hiring plan, e.g. how it will be decided, what areas will be targeted for junior and senior hires. The VC offers a general recommendation at the beginning of this report regarding increased engagement of the science staff in strategic planning.

The VC was impressed by the engineering capabilities at the SAO and the tight coupling between the engineers and scientists towards building new instruments and missions. Our tour of the off-site Laboratory capabilities demonstrated the investments SAO is making in this area. The number of institutions that have such a capability are shrinking nation-wide and it is paramount that SOA preserve and nourish this capability. This critical mass of engineering and science in one institution is the essence of SAO's very fabric. We do note though that there appeared to be no well-defined career track for the engineers to reach or be hired into the highest ST/SL ranks. This is very important to maintain this national capability.

Recommendation: The VC suggests that SAO review the career development path for engineers to ensure SAO attracts and retains the best.

Response: We have tasked our Head of Central Engineering with this review.

Finding: The internal research and development (IRAD) program is an excellent resource to prime the pump to enable new projects. Such programs necessarily involve high risk, high reward and it is important that the IRAD program be used to allow a full range of ideas, including blue-sky projects.

Recommendation: For the next VC we suggest a more detailed presentation on the IRAD program and the process by which resources are allocated.

Response: Great suggestion.

Hiring

A number of issues related to hiring were raised during the VC's discussions with various groups. Here we focus specifically on hiring of federal scientists, trust-fund scientists, and the SAO hiring plan more generally.

SAO Hiring Strategy and Plan

As described below, the science staff expressed frustrations regarding the lack of an apparent hiring plan. This could be a communications issue between SAO management and staff, or a choice by management not to share information about its hiring plan. However, if there is a hiring strategy and/or plan, the VC was not provided with a copy; it was the sense of the VC that a hiring strategy may not at present be formally part of the SAO strategic planning.

For example, what is the strategy with respect to the SAO "portfolio balance" between facilities and science staff? Does SAO seek principally to "hire the best scientist to fill the job" or does it seek to "hire scientists broadly and enable them to do the best science"? To what extent does SAO aspire to become a leader in hiring for inclusive excellence?

Recommendation: Whether or not it is widely shared, SAO should develop a hiring plan and a strategy that informs it.

Response: We agree. In general, we plan to continue cluster hiring (three at a time) at the junior level. While the Director formally makes all appointments, we will ask the Federal Scientist Appointments Committee to conduct searches and make recommendations to the Director. These searches will be broad and open.

We also intend to make a limited number of appointments at more senior levels for strategic purposes, as determined by the Director. The Director will appoint an *ad hoc* committee for each search.

Recruitment of junior federal scientists.

Finding: There is a widespread concern among the staff that the workforce is aging, and that there are not enough new hires. However, there is no widespread knowledge among the staff of what the SAO Director's plans for long-term hiring plans are, as well as what the budgetary and strategic inputs are to the hiring plan.

As explained to the VC, the Director's policy has been to make cluster hires, because this has been demonstrated to lead to better outcomes in diversity.

Recommendation: The VC is supportive of the cluster-hire approach, and recommends that it be communicated to the staff as a whole so that there is better understanding of institutional planning with respect to hiring, and so that the staff can be more effective in helping to identify and recruit candidates for positions when they become available.

Another issue with hiring is that the current junior scientist hiring process, although formally open, appears to be attracting many fewer candidates than for similar open junior faculty positions at universities. All recent hires were themselves postdocs at the CfA; outside candidates may not understand that a position advertised as a 4-year position may in fact lead to a permanent position.

Response: In future searches, the Director will send a CfA-wide email to the staff announcing the open positions and encouraging staff to let their colleagues in the community know about the positions. This communication will also describe the process, including the rationale for cluster hiring.

We have done some analysis in response to the VC's concern about the number of candidates applying for our junior positions. While we have been very pleased with the quality of applicants we see, we share this concern. We have come to conclude that the mismatch between the federal ("civil service") career structure and the conventional academic ladder has caused some confusion among potential applicants. We plan to add clarifying language to our postings and to our website.

Finding: Although the specific wording in advertisements is constrained by federal requirements, better outreach to the community beyond the CfA would help to explain the nature of advertised positions. Greater effort in recruiting would enhance the candidate pool, and would reduce the potential for a community perception of the SAO as insular.

Recommendation: The VC encourages the SAO to disseminate information about hiring of permanent staff more broadly when federal openings are posted, e.g. by emails to department chairs (US and international) announcing and explaining the nature of these posted positions beyond the formal text of the advertisement.

Response: We agree that we should make greater efforts to reach out to the community. We are currently exploring what language is formally allowed. For more than a decade, junior scientists appointed for term positions have all received more permanent (federal) appointments.

Recruitment of Trust staff

Finding: The VC met with SAO staff who expressed frustration with the process of hiring to fill positions in their groups.

Recommendation: More support from HR staff would be valuable in training to write suitable advertisements, such that the downselect process performed by the HR staff will select the candidates that are most desirable to the individual who is attempting to make a hire.

Response: These complaints have come to the Director's Office through the SAO Council and in the annual Employee Survey, and we are beginning to address them. Human Resources has started with trainings for the Division Administrators, who work with the scientists at the division level. Further trainings are in the planning stages.

Diversity

The previous VC report in 2011 noted that the SAO staff is “overwhelmingly male with few members of traditionally underrepresented groups.” Demographics data did not feature prominently in the information provided to this VC, so there is not much opportunity for comment here. However, it is unfortunate that the ways in which SAO is in fact advancing diversity in the field are not seen more integrally as part of the institution or of its strategic plan.

For example, the VC is aware of the strong efforts by the predoctoral program to attract strong students from underrepresented minority backgrounds. Similarly, the VC is aware of SAO's support through CfA for, and participation in, Harvard Astronomy's signature Future Faculty Leaders postdoctoral program for underrepresented minority postdocs. Such efforts make perfect sense in the context of the Smithsonian Institution's broader engagement in advancing diversity in science at all levels.

Finding: As a part of the Smithsonian Institution, and as an aspirational leader in all areas of astronomy and astrophysics, SAO is in a strong position to incorporate the goal of inclusive excellence more fully and explicitly into its strategic planning.

The Smithsonian Institution is arguably one of the most widely recognized and respected of all American public institutions. To be sure, a major part of this visibility and reputation is the presence of the Smithsonian's several museums on the National Mall in Washington, DC. Thus, the Smithsonian is most often associated with large-scale educational and outreach programs, as well as major efforts focused on diversity and the engagement of all of America's citizens in the history, art, industry, and science of the nation. However, the Smithsonian also conducts a number of other prominent programs and facilities more focused on pure research, such as the Smithsonian Tropical Research Institute in Panama.

Finding: The SAO's connection to the Smithsonian Institution is much less visible. Indeed, it

would not be a large stretch to say that the SAO-Smithsonian relationship is nearly invisible. For example, despite the SAO's educational and scientific training programs, and the successes of SAO's diversity efforts noted above, SAO has not a single mention in the Smithsonian's recent 187-page report¹ of educational and diversity-focused programming around the world. This is a missed opportunity for both SAO and the Smithsonian to mutually benefit, especially at a time when SAO's major scientific aspirations will require ever greater public support.

Harvard-Smithsonian Relationship

The CfA was formally established in 1973. Since its inception as a formal entity the CfA has grown to be one of the most respected and accomplished centers for astronomical research in the world.

At the scientist-to-scientist level the relationship between Harvard and SAO is very strong and relatively seamless. Harvard provides SAO with access to excellent students and postdocs. In turn, Harvard students and postdocs find it very appealing to have access to observing time and major projects. With the exception of the Director of CfA, there are no dual appointments. Federal employees must be citizens, a requirement that Harvard does not impose. And Federal employees cannot carry tenure appointments.

The distinctions between Harvard and the Smithsonian have restricted Smithsonian staff access to some Harvard-related privileges. In some cases this is necessary, and in others perhaps inadvertent. At other institutions (e.g. the University of California System), research staff are able to participate in some aspects of University life (e.g. voting rights), even if they did not have other University-related privileges. As has been discussed in the HR section of this report, more opportunities could be made available to SAO students, postdocs and staff if there were some increased flexibility.

In the section on the GMT, the VC calls out the risk involved in raising funds to support this critical venture. Neither Harvard nor the Smithsonian have successfully completed its fund-raising goal. Collaboration between the two institutions would seem to have potential synergistic benefit.

The current CfA home at 60 Garden Street is leased by SAO (60%) from Harvard. The 1843 structure has great historical significance but is no longer suitable in either scale or quality to house a major 21st century astrophysics observatory. The aspiration to relocate to a new facility in Alston appears to be a significant opportunity for the SAO and CfA.

Finding: At this juncture the VC was informed that a new MOU is in the process of being developed. This presents an important opportunity for the Harvard Astronomy Department and the Smithsonian Astrophysical Observatory. For example, the new MOU might describe ways

¹ https://www.si.edu/content/oeema/DIIR_FY2016.pdf

for the Harvard faculty to become more formally involved in the educational/training programs of SAO, and ways for the SAO science staff to become more formally involved in the mentorship of Harvard students and postdocs.

Recommendation: The VC encourages development of a more granular MOU that spells out, in detail, the relationship between staff, faculty, students and postdoctoral fellows, and the two institutions. The MOU should also address facilities, to the extent possible. The MOU should also define a mechanism for joint fund raising, not just for the GMT, but for future major projects.

Response: We agree in part. The new MOU will be more granular, but our legal counsel (at both the Smithsonian and at Harvard) advise us not to be very prescriptive. Our task now is to navigate the middle ground!

Note that joint fund raising has implications at the institution level that we may not be able to influence. Nevertheless, SAO already includes Harvard faculty, as appropriate, at SAO Advisory Board meetings and in other prospect outreach efforts.