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Dr. Wes Huntress, Chair
NASA Advisory Council Science Committee

Dear Wes,

The NASA Advisory Council's Astrophysics Subcommittee (APS) met via teleconference on 6 November 2012. In attendance for all or part of the teleconference were APS members Louis Allamandola, Gary Bernstein, Jamie Bock, Edna DeVore, Scott Gaudi, Gabriela Gonzalez, Mary Elizabeth Kaiser, Vicky Kalogera, Chris Martin, Gary Melnick, John Nousek, Terry Oswalt, Paul Ray, Karl Stapelfeldt, Steven Ritz, and myself as Chair, as well as Paul Hertz (Director, NASA Astrophysics Division) and APS Executive Secretary Joan Centrella (NASA Astrophysics Division). During the course of this meeting, Paul Hertz updated the APS on activities in the Astrophysics Division (APD) at NASA HQ. He also engaged the members in a discussion about preparation by the APD of a white paper on strategic implementation of the National Research Council's (NRC) Decadal Survey recommendations in the context of the current budget realities. Since the white paper is still in preparation, we will withhold comment pending the final version. We also had a presentation from Larry Smarr, Chair of the NAC Information Technology Infrastructure Committee (ITIC), on a 2012 March recommendation from the ITIC that "NASA should formally review the existing national data cyberinfrastructure supporting access to data repositories for NASA SMD missions. A comparison with best-of-breed practices within NASA and at other federal agencies should be made." The ITIC has requested a joint meeting of the ITIC and the NAC Science and Education Committees. We will focus on our initial reaction to this recommendation in the remainder of this report.

Background: The NASA Astrophysics Division oversees operations of several discipline-specific data centers:

- The High Energy Astrophysics Science Archive Research Center (HEASARC), located at the NASA Goddard Space Flight Center (GSFC) in Greenbelt, Maryland, is the primary archive for high-energy astronomy missions in the extreme ultraviolet, X-ray and gamma-ray wavelengths, as well as for cosmic microwave background research. This is the portal for the *Chandra X-Ray Observatory* and *Fermi Gamma-Ray Space Telescope* archive.

- The Barbara A. Mikulski Archive for Space Telescopes (MAST), located at Space Telescope Science Institute (STScI) in Baltimore, is a NASA funded project to support and to provide to the astronomical community a variety of astronomical data archives, with the primary focus on scientifically related data sets in the optical, ultraviolet, and near-infrared

parts of the spectrum. It is the portal for the *Hubble Space Telescope* and the *Kepler Space Telescope* archive.

- The Infrared Science Archive (IRSA), located at Infrared Processing and Analysis Center (IPAC) at the California Institute of Technology in Pasadena, is NASA's archive of infrared and submillimeter data and the legacy site of the *Spitzer Space Telescope.*

In addition to their role as repositories of space-mission data, these centers manage additional astronomical databases:

- The NASA Exoplanet Science Institute (NExScI) is the science operations and analysis center for NASA's Exoplanet Exploration Program. It provides tools and archives for the exoplanet community and is physically located at IPAC.

- The NASA Extragalactic Database (NED) at IPAC is a searchable master list of extragalactic objects for which cross-identifications of names have been established. The database contains accurate positions and redshifts and other basic data.

- The NASA Astrophysics Data System (ADS) at Smithsonian is a NASA-funded project which maintains three bibliographic databases containing more than 5.6 million records. It is an online archive of astronomical, astrophysical, and physics literature.

ITIC concerns: The ITIC recommendations are apparently based on the rapidly increasing amount of astronomical data in the archives and the increasing demand for both space-mission and ancillary data, combined with their perception that NASA lags behind other government agencies in high-performance computing and the obvious need to keep costs contained.

APS reaction: The initial reaction of the APS is that there is a general perception that the astronomical user community is quite happy with the existing NASA data centers and archives. While we recognize that data and network infrastructure needs to continue to grow and we support efforts to keep our data centers modernized, we do not believe that centralization is a good means to achieve this. We note the following:

- The current data center and archive structure has proven to be highly effective. Each of the data centers grew out of a mission (or multi-mission) archive that was established by astronomers with appropriate scientific, technical, and programmatic expertise.

- NASA has already developed a multi-agency (i.e., with NSF) US Virtual Astronomical Observatory[1] that integrates astronomical data and software tools and services on a global scale and provides straightforward access to individual researchers around the world. VAO is a "federated archive," where the individual assets are held separately, but are managed collectively.

- The data centers are scrutinized as part of the NASA Senior Review process every three years. The most recent review was in 2011. The Senior review Panel specifically noted "some extremely effective instances of collaboration between individual archival centers" and called attention to "the attention all data centers gave to the adoption and use of Virtual

[1] http://www.usvao.org/

Observatory (VO) protocols and standards, issues of interoperability and their modes of engagement with the VAO effort."[2]

- Additionally, at the request of NASA, in 2007 the National Research Council conducted a comparative review of current NASA science centers to identify best practices and lessons learned and to assess whether there are optimum sizes or approaches for science centers. The resulting report, "Portals to the Universe: Best Practices for NASA Science Operations Centers,[3]" describes NASA's science centers as "enormously successful in enabling space-based astronomy missions to achieve their scientific potential. These centers have transformed the conduct of much of astronomical research, established a new paradigm for the use of large astronomical facilities, and advanced the science far beyond what would have been possible without them." The NRC report provided three specific findings:

  1) "The Chandra X-ray Center, the Space Telescope Science Institute, the High Energy Astrophysics Science Archive Research Center, and the Infrared Processing and Analysis Center have sufficient scientific and programmatic expertise to manage NASA's current science center responsibilities after the active phases of all current and planned space-based astronomy missions have been completed.
  2) The ability of the Chandra X-ray Center, the Space Telescope Science Institute, the High Energy Astrophysics Science Archive Research Center, and the Infrared Processing and Analysis Center to provide the appropriate level of support to the scientific community depends critically on the extent to which they can attract, retain, and effectively deploy individuals with the mix of research and engineering skills necessary to maintain continuity of service.
  3) Embedding GOFs (Guest Observer Facilities) in existing science centers, such as the HEASARC, provides for efficient user support, especially when the scope of a space mission does not require establishing a separate center."

  The results of these reviews underscore the exemplary stewardship of the NASA data centers.

- The NASA data centers and archives are highly motivated to maintain both high capacity and low cost as they compete directly for funding with new and operating research facilities. Embedding the data archives within the Astrophysics Division program ensures that the balance among archival research, research with operating facilities, and investment in future facilities and capabilities is decided by the scientists who are best equipped to assess the trade-offs.

Finding: The APS believes that the astrophysics data archives are highly functional, efficient, and interoperable already, and that they might serve well as a "best practice" for other Federal data centers.

Any recommendation to change the current structure and function of the NASA science centers and archives should be based largely on scientific considerations. The APS remains pleased to support the Science Committee in any further discussion of the NASA Science Centers.

[2] https://science.nasa.gov/media/medialibrary/2011/08/10/ApArchSR_2011report_final.pdf .
[3] http://www.nap.edu/catalog.php?record_id=11909

Sincerely yours, on behalf of the Astrophysics Subcommittee,

Bradley M. Peterson, Chair
NAC Astrophysics Subcommittee

Cc: Paul Hertz
Joan Centrella