

Pima County Planning and Zoning Commission
130 W. Congress St.
Tucson, AZ 85701

November 22, 2016



info@apss-az.org

Dear Members of the Planning and Zoning Commission:

Thank you for contacting Kitt Peak National Observatory (KPNO) for comment on the re-zoning application for land use at Star Valley Village Block 6. The Observatory, along with the consortium of professional research organizations that rely on Arizona dark skies, APSS, welcomes the opportunity to give input at this critical junction in the planning process.

The parcel under consideration (SW corner of Valencia Rd. and Wade Rd.) falls within the Kitt Peak protected area E1c, as called out by the 2012 City of Tucson / Pima County Outdoor Lighting Code (OLC), section 301.1.6. Within that area, all outdoor lighting is required to conform to the requirements specified in Table 401.1 of the OLC. These requirements include both lumens caps and full cutoff shielding of fixtures; both are essential to limiting light pollution in the near vicinity of the Observatory.

On the strength of its still-dark skies, KPNO has recently been awarded major new research projects, representing investments of tens of millions of dollars by the National Science Foundation, the Department of Energy and NASA. Tenant observatories on Kitt Peak include those operated by the National Radio Astronomical Observatory, the University of Arizona, the California Institute of Technology, and more than twenty other institutions of higher learning across the United States. All of these technology development, research and educational endeavors rely on adherence to the Outdoor Lighting Code. Thus we urge the Commission to encourage adherence to the OLC throughout the planning process, and to discourage any requests for variances in outdoor lighting.

Attached is a previous economic impact study for our professional research enterprise. We note that the \$250M per year impact is statewide, but with a substantial concentration in Southern Arizona, and, as described above, that impact is ongoing. The astronomy, planetary, and space science enterprise has been a strong driver for other key industry sectors, such as the Optics Industry. It also impacts the tourist industry. The annual figures for the Kitt Peak Visitor Center show that 15,000 visitors participated in tours or nightly programs, up 13% from the previous year. (This does not count local school groups and other more local impact, including the many thousands per year that guide themselves around the mountain.) Astro-tourism is called out as an attraction on the Tucson Visitor Bureau website. All these economic drivers are obviously dependent on the public commitment to protect the regional asset of dark skies.

Lowell Observatory

*University of Arizona
Steward Observatory*



*University of Arizona
Planetary Sciences Department*

Kitt Peak National Observatory

Fred Lawrence Whipple Observatory

Vatican Observatory

We understand that residents near the site of the proposed new shopping center need access to goods and services. We believe that with proper adherence to existing code, their needs can be met while protecting the skies for the future security of astronomical research in Southern Arizona, a unique and valuable asset to the region.

Thank you for considering our input.

With best regards,

Lori Allen
Director
Kitt Peak National Observatory

Buell Jannuzi
Director, Steward Observatory
University of Arizona

G. Grant Williams
Director
MMT Observatory

Richard Green
Assistant Director
Steward Observatory

Emilio Falco
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Jeffrey Hall
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Director
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Timothy Swindle
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Director
Mt. Graham International Observatory

Fortin Pascal
Site Director
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Lowell Observatory

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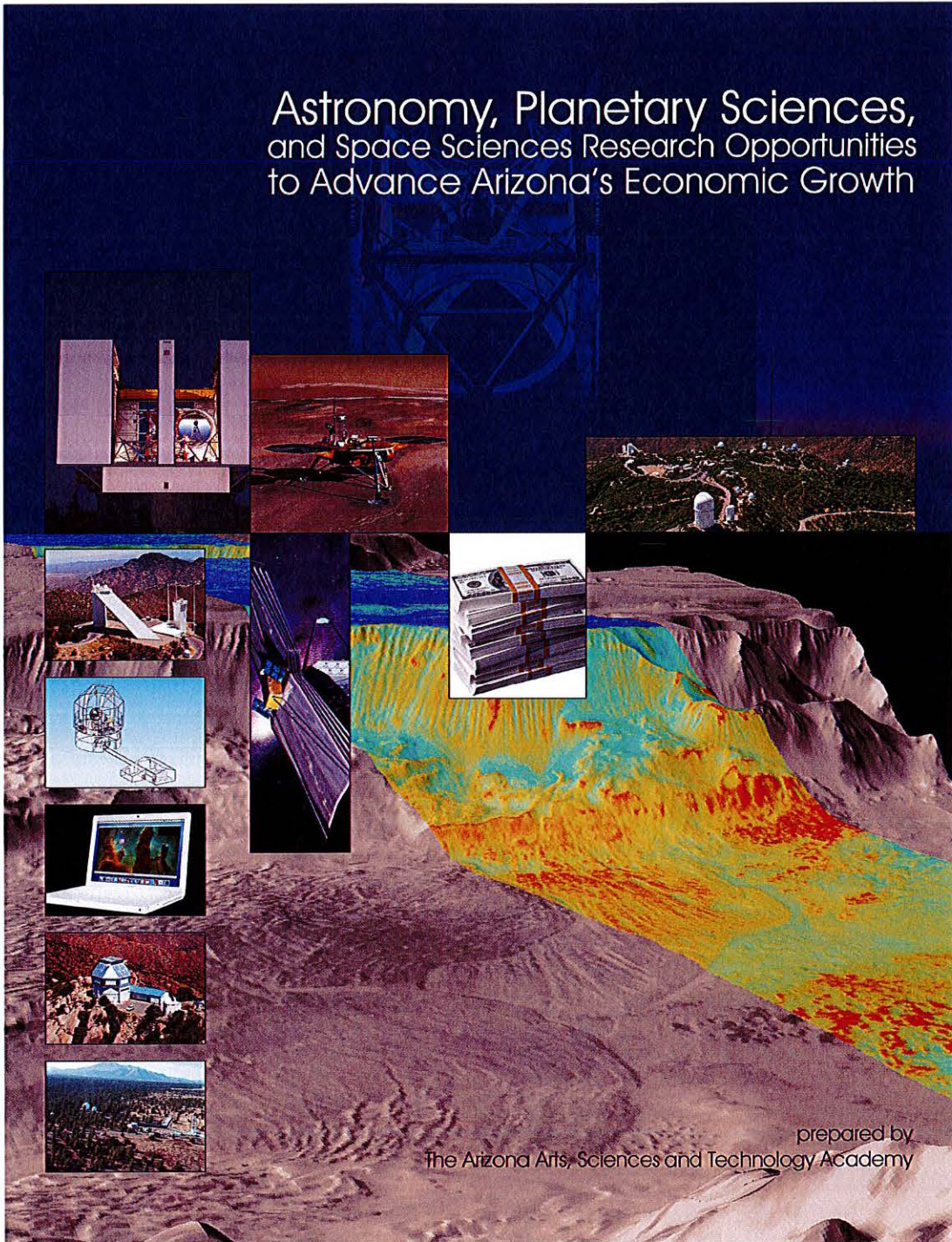
*University of Arizona
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Kitt Peak National Observatory

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Vatican Observatory

Astronomy, Planetary Sciences, and Space Sciences Research Opportunities to Advance Arizona's Economic Growth



prepared by
The Arizona Arts, Sciences and Technology Academy

Abstract



Kitt Peak: (U of A)



Mars Launch: (ASU)

This report is the result of an original research effort led by the Arizona Arts, Sciences and Technology Academy (AASTA).

The goal of the research effort was to quantify, for the first time, the overall economic impact of research activities in the fields of astronomy, planetary sciences and space sciences (APSS) in the State of Arizona.

AASTA contracted with the Economic and Business Research Center at the University of Arizona Eller College of Management to conduct the data collection and economic impact analysis portions of the study. The findings of the U of A team are appended to this report.

AASTA analyzed the ancillary economic data also collected during the study.

The scope of the study was limited to impacts generated by investments and expenditures associated with APSS research at Arizona's three universities, federal laboratories, and astronomical observatories. The economic impact of related industrial activity (e.g., optics) are not included in this study.

For definitional purposes, these fields of study include ground based astronomy, space based astronomy, solar system missions, earth observing missions, instrumentation and data analysis, related studies such as astrogeology and astrobiology where clear connections to planetary and solar system research can be drawn, and space related technology development.

This study found substantial capital investment (in excess of \$1 billion) in, and economic return (nearly a quarter of a billion dollars annually) from APSS research in Arizona. The data also suggest the untapped potential of these research fields to expand the State's economic base. The study revealed levels of active research funding that well exceed other fields in the State, such as bioscience funding from the National Institutes of Health.

Executive Summary



Sub Millimeter Telescope:
(ARO)

The State of Arizona urgently requires the development and implementation of a science and technology roadmap as well as an investment strategy to leverage the exceptional base of research assets it has amassed in the fields of astronomy, planetary sciences and space sciences.

Arizona's world-class leadership in astronomy, planetary sciences and space sciences features an extraordinary investment of facilities and equipment that yield a significant economic return to the State.

The depth and breadth of research talent and innovation in these fields, however, has not yet been successfully tapped by the State to expand and diversify its high wage, advanced technology economic base.

Further, ever-growing levels of light pollution associated with urban development are degrading the State's competitiveness as a site for ground based optical astronomy.

This report's findings strongly suggest the need for policymakers to act affirmatively to effectively leverage Arizona's competitiveness in these fields while protecting the unique research base that exists within the State.

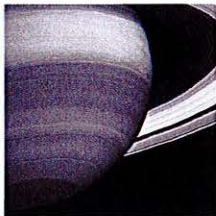
Specifically:

Recommendation 1

The Arizona Department of Commerce and the Arizona Aerospace and Defense Commission, working in collaboration with the APSS research institutions in the State, should immediately begin developing a strategic plan and roadmap for investing in and leveraging Arizona's competitive research assets in the fields of astronomy, space sciences, planetary sciences and related technologies.

Recommendation 2

The Arizona Department of Commerce, Arizona's APSS research institutions and APSS related industry organizations should immediately begin a cooperative effort with Arizona's federal delegation to ensure stable and growing funding for the fields of astronomy, space sciences and planetary sciences, and it should also encourage additional funding for the federal installations located in the State (NOAO, NSO, U.S.G.S., and the U.S. Naval Observatory) so that new collaborations can be formed. Furthermore, the State should act aggressively in partnership with its federal delegation to maintain these federally-funded installations in Arizona.



Saturn Image: Cassini-
Huygens Mission:
(U of A)



Phoenix Lander:
(U of A)

Recommendation 3

Research institutional leaders and scientists based in the State's astronomy, space sciences and planetary sciences facilities should create a formal collaborative organization to more effectively compete for limited federal APSS research funding to Arizona. APSS institutional leaders from across the State should form a development committee, establish goals for this organization and a timetable for its implementation.

Recommendation 4

The Arizona Legislature, counties, municipalities and Tribal Nations should revisit the adequacy and enforcement of existing statutes and ordinances in a new effort to reduce light pollution associated with rapid industrial and population growth as well as old lighting installed before effective codes were in place. Arizona Title 49, Chapter 7 calls for the elimination of mercury vapor lighting fixtures by 2011. All counties in the State and many municipalities have used the 1973 State law to enact light control ordinances. However the sheer rate of population growth, particularly in Maricopa County, and more recently in Pinal County, as well as lax enforcement of many existing ordinances, threaten to undo that protection. State law also severely limits the ability of authorities to bring old, obsolete and badly polluting lighting into compliance with modern codes and professional lighting standards.

Purpose

The purpose of the study is to provide quantitative measures of the importance of astronomy, planetary sciences and space sciences research in Arizona's economy in an effort to stimulate public policies designed to preserve and enhance the State's competitive advantages in this domain. This report summarizes common measures of economic activity and associated impacts such as the number of jobs, wages, output and tax revenues.¹ It further analyzes trends in capital investment and other measures not normally associated with economic impact models.

The public benefit of this project is to underpin decision-making and future policy development aimed at exploiting Arizona's world-class research talent and facilities in astronomy, planetary sciences, space sciences, and related technology fields. By better defining the economic opportunity that exists and the future directions that these research units plan to pursue, business and policy leaders will be better positioned to attract, grow and retain engineering and technical firms that provide services and instrumentation for these fields.

The project oversight consortium, coordinated by AASTA, consisted of leading scientific representatives from Arizona's three State universities, three federal research organizations based in Arizona, and a number of other university related and independent observatories.

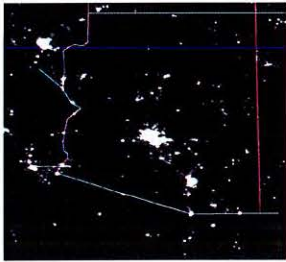
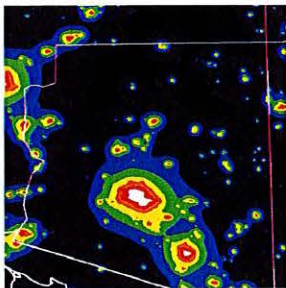


Photo taken from space (Elvidge et al. 1999) showing Arizona outdoor lighting as seen from overhead.



The 2nd figure, (Cinzano, P. et al. 2000) demonstrates how the effects of light pollution spread far from the source of the lighting in cities

¹ See Appendix A for the full University of Arizona report.

Background

The study builds on the findings of Battelle's 2003 report entitled, "Positioning Arizona and its Universities: Science and Technologies Core Competencies Assessment", an analysis for the Arizona Department of Commerce to better quantify the level of capital investment, degree of external funding, technology development, partnering, and production of highly skilled talent that can be leveraged by the private sector.



Mars Rover: (ASU)

This study's premise rests on the strong anecdotal information already available and Battelle's conclusion suggesting, "(t)he combination of astronomy and planetary sciences at U of A, ASU, and NAU makes the state a national leader in space science and engineering." Battelle further noted, "(c)ompetitors include the University of Colorado, Cornell, and the University of Chicago, but Battelle could not find any state university system that possessed the combined strengths of astronomy and planetary sciences that Arizona has, hence the interest in the integration of these research capabilities."



Hubble Image: Pillars of Creation (ASU)

Battelle's report summarized the core competencies and competitiveness of Arizona's universities as follows, "(a)ll three universities are engaged in very valuable basic science concerned with observations in our solar system and the emerging area of biogeochemistry to study materials on earth and other planets. However, the focus of this core competency is the engineered devices and systems that are the means to that end (i.e., powerful telescopes and satellites, measuring instruments, and related materials, optics and electronics developments). The combination of astronomy and planetary sciences at the U of A, and ASU makes the State a national leader in space science and engineering. This unique position is supported by the fact that, of four proposals selected in December 2002 for final consideration by NASA for its Mars Scout mission, two are from Arizona, U of A and ASU, while the other two are from NASA laboratories. The Arizona proposals offer innovative instruments to both examine and retrieve materials from Mars." Battelle's report, however, did not closely examine the possibilities associated with other observatories and federal research groups based in the State.

Only one institutional study documenting the economic impact of an Arizona based observatory has been completed in recent years. That study², completed in 2004 for the National Optical Astronomy Observatory and the National Solar Observatory, noted average salaries of \$50,515 and total external funding of \$21.2 million. It also noted several examples of technology transfer including optical coatings, solid state devices, software and hardware.

For the fiscal year ending June 30, 2006, new contractual obligations from NASA³ and the Jet Propulsion Laboratory⁴ to institutions in the State of Arizona totaled \$147.45 million. Additional astronomy related expenditures from the National Science Foundation into the State were approximately \$60 million⁵. The combined total of these new obligations for expenditures compares favorably with the State's total new awards from the National Institutes of Health for biosciences research, \$160.7 million⁶, for the same period.

² The Arizona Economic Impact of the National Optical Astronomy Observatory and the National Solar Observatory, NOAO, 2004

³ NASA Procurement Data View (<http://prod.nais.nasa.gov/cgi-bin/npms/npms.cgi>)

⁴ Data provided by JPL.

⁵ NSF Awards Search (<https://www.fastlane.nsf.gov/a6/A6Start.htm>)

⁶ NIH Award Trends (<http://grants.nih.gov/grants/award/awardtr.htm>)



Mars Image: (ASU)

Research in astronomy (ground and space based), planetary sciences, space sciences and associated technologies is acknowledged as one of Arizona's key competitive strengths. Scores of millions of dollars have been invested in talent and infrastructure to build this capacity, but limited advantage has been taken to grow corollary industries and businesses in the State. The participants in the survey conducted by AASTA and the University of Arizona reported the spin-off of 17 companies.

General Dynamics, Orbital Sciences and Raytheon stand out as significant employers benefiting from Arizona's research base in these fields, however companies such as Lockheed Martin and Ball Aerospace, both located in Colorado, are much more likely to be the beneficiaries of research and mission related awards won by Arizona scientists than are companies located in State.

The Commission on the Future of the U.S. Aerospace Industry noted that the State of Arizona was ranked 2nd in the nation in 2001 for total employment in the market segments of guided missiles, space vehicles and related parts manufacturing. This same report noted average salaries of approximately \$65,000 for these sectors⁷. Expanding this base of high value jobs can add significantly to Arizona's economic vitality.

APSS technologies embedded within Arizona based research institutions include biosensing, communications, computing, imaging, instrumentation, materials, microelectronics, navigation, optics, power, propulsion, sensors, software and systems integration.

Unpublished data from the University of Arizona indicates that the optics industry has grown tenfold in the past decade in both annual revenue and employment.

Arizona risks losing ground and consigning itself to a "grant funding pass-through" state unless steps are taken to develop investment strategies and better leverage its competitive advantages.

Finally, federal agencies such as NASA, and the civilian/defense private sector both face an aging technological workforce⁸. Arizona graduate students and undergraduates with significant experience on federally funded projects from NASA, the Department of Defense, and the National Science Foundation related to space science, space based astronomy, earth orbiting missions, and space technology development are aggressively recruited. Creating additional economic opportunity for this talent in Arizona will both preserve the investment that has been made to train them and expand the State's economic base.

⁷ Final Report of the Commission on the Future of the United States Aerospace Industry, 2002
(<http://trade.gov/td/aerospace/aerospacecommission/aerospacecommission.htm>)

⁸ Issues Affecting the Future of the U.S. Space Science and Engineering Workforce: Interim Report, Committee on Meeting the Workforce Needs for the National Vision for Space Exploration, National Research Council, 2006

**Economic and Tax Revenue Impacts of Astronomy, Planetary and Space Sciences
 In Arizona, FY 2006**

Non-earnings expenditures (dollars in millions)

Operations-related expenditures in Arizona	\$21.4
Capital investment	\$11.8
Locally spent benefits	\$5.2
Out-of-state visitor spending	\$16.1
Total direct expenditures	<u>\$54.5</u>

Earnings (dollars in millions)

Earnings in APSS organizations	\$84.0
Indirect and induced earnings	\$54.6
Total earnings impact	<u>\$138.6</u>

Tax revenues (dollars in millions)

State revenues	\$6.8
County revenues	\$2.0
City revenues	\$3.1
Total tax revenue impact	<u>\$11.9</u>

Additional value added **\$47.8**

Total monetary impact **\$252.8 million**

Employment impact

Direct jobs in APSS organizations	1,830
Indirect and induced jobs	1,498
Total employment impact	<u>3,328</u>

NOTICE: The Board of Governors of the Arizona Arts, Sciences and Technology Academy (AASTA) approved the project that is the subject of this report. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

Support for this project was provided by: The Arizona Department of Commerce, The University of Arizona, the Large Binocular Telescope Observatory, John* and Ginger Giovale (*Chairman Lowell Observatory Advisory Board), William** and Kathryn Putnam (**Lowell Observatory Trustee), Northern Arizona University, the National Optical Astronomy Observatory, Research Corporation, and the Vatican Observatory. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the AASTA Writing Committee and do not necessarily reflect the view of the organizations or agencies that provided support for this project.

This report is based on a joint survey conducted by AASTA and the Economic and Business Research Center at the University of Arizona Eller College of Management.

Additional copies of this report are available from:
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The Arizona Arts, Sciences and Technology Academy

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