June 14, 2010

Dr. Sidney Wolff and the LSST Board of Directors
LSST Corporation
933 N. Cherry Avenue
Tucson, AZ 85721-0009

Dear Dr. Wolff and LSST Board:

We are pleased to submit the George Mason University (Mason) petition for membership into the LSST Corporation, in accordance with the Bylaws of the Corporation.  We understand that there are annual membership dues and that Institutional Members are expected to play an active and significant role in the LSST project.  We are committed to providing those tangible benefits to LSST.  We have identified the funds for this purpose and will meet the required financial obligation.

This petition comes from two departments (the Department of Computational & Data Sciences and the Department of Physics & Astronomy), both of which include astronomers involved with sky survey-based astronomical research.  In addition, we are regularly engaged in multi-disciplinary research programs with faculty from other Mason departments, who are also interested in research opportunities with the LSST data collection.  Those other departments include Statistics, Applied Mathematics, and Computer Science, whose researchers focus in these areas: statistics, machine learning, data mining, visualization, informatics, data-intensive applications, semantic search, intelligent databases, and more.

Mason has been one of the top two "universities to watch" in recent US News and World Report nationwide university rankings.  We earned this distinction through our innovative, forward-looking programs and our commitment to excellence in all aspects of academic pursuit.  One of the distinctive programs at Mason is the program in Computational Science and Informatics, which has existed since 1991 and has graduated nearly 200 PhDs.  This is a "21st century" science graduate program that emphasizes computational and data science approaches to modern science, including high-performance computing, numerical methods, simulations, scientific databases, visualization, statistics, data mining, and more.  The program includes concentrations in astrophysics and several other scientific disciplines. Faculty members in this program are in the Department of Computational & Data Sciences (CDS) – these include astronomers Kirk Borne, John Wallin, Robert Weigel, Jie Zhang, and Peter Becker, all of whom also hold either joint or affiliate appointments in the Department of Physics and Astronomy.  In addition to

computational and data sciences faculty, Mason has an active and productive astronomy research faculty in the Physics and Astronomy department. These include Mario Gliozzi, Merav Opher, Jessica Rosenberg, Shobita Satyapal, Michael Summers (department chairman), and Joe Weingartner. Several of these researchers are either already working on LSST-related research, or sky survey-related research, or else planning to develop such research programs. In addition, astronomy staff who are doing research in astronomy education are interested in the application of LSST data and citizen science activities in astronomy courses and labs. These staff members include Rebecca Ericson and Harold Geller.

Mason has had a role with LSST for many years, beginning in 2001, when Dr. Kirk Borne attended the Aspen Center for Physics workshop on large digital sky surveys. At that workshop, he initiated discussions with LSST Director Dr. Tony Tyson on the Education and Public Outreach (EPO) opportunities with such a large sky survey, and how to design effective web interfaces to the survey. Dr. Borne firmed up his involvement with the LSST by attending the 2004 Workshop on *Science with LSST: Community Access and Utilization of Future Archives*. As a result of this workshop, he became involved with the LSST EPO group and the LSST Data Management (DM) group, including the Data Products Working Group. Through the years, he has become the senior scientist working with the LSST EPO group, he continues to consult with and work with the LSST DM group, and he is a member of the LSST Galaxies research collaboration team and the AGN research collaboration team. Most recently, he became the chairperson of the new LSST Informatics and Statistical Sciences Collaboration (ISSC) team. The ISSC team consists of over 30 astronomers, statisticians, and computer scientists whose focus is on the data mining and statistics algorithms, applications, and research opportunities that the LSST database will offer.

Kirk Borne's research in scientific data mining has focused on combining data from multiple sky surveys (e.g., SDSS, 2MASS, and GALEX) to explore fundamental properties of galaxies. He is also exploring algorithms for classifying and characterizing the thousands of real-time alerts that the LSST will generate each night. He has published several papers in collaboration with computer scientists in these areas – they have developed new algorithms for mining large distributed databases. He has also presented numerous conference talks, poster papers, and articles on LSST-related topics, including EPO, citizen science, galaxies research opportunities, alert classification, scientific data mining, large-database astronomy, and astroinformatics. Much of this work was summarized in the two position papers that he submitted to the Astro2010 Decadal Survey in Astronomy & Astrophysics, in collaboration with many members of the LSST project team ("Astroinformatics: A 21st Century Approach to Astronomy"; and "The Revolution in Astronomy Education: Data Science for the Masses"). The results of this research, and new work now taking place, will benefit the LSST scientific research community and will enable more effective explorations of the large LSST data collections (object databases, time series, alerts, etc.).

In the past year, Drs. John Wallin and Kirk Borne became actively involved with the Zooniverse Consortium, which includes the original Galaxy Zoo project team as well as new citizen science and outreach personnel.  Dr. Wallin and his students have developed the new Galaxy Mergers Zoo (at mergers.galaxyzoo.org) and are developing a prototype applet for the Gravitational Lens Zoo in collaboration with Phil Marshall, the chair of the LSST Strong Lensing research collaboration team. These citizen science projects are core features of the LSST EPO strategic vision and plans.  Mason will be a major contributor to those LSST EPO projects in the coming years, including Dr.Borne's current participation on the design team for the LSST Light Curve Zoo that will be designed and prototyped during the LSST Final Design Phase in the coming 2 years.

Drs. Wallin and Borne are also co-PIs on an NSF undergraduate education grant (for CCLI: Course, Curriculum, and Laboratory Improvement) that is specifically focused on data sciences education for science undergraduates. This program trains students to access large distributed data repositories, to conduct meaningful scientific inquiries into the data, to mine and analyze the data, and to make data-driven scientific discoveries.  All of this is of course directly related to LSST (science, data management, and EPO), but it is also relevant for the training of all science students of the 21$^{st}$ century.  We will bring these many talents, research collaborations, and educational endeavors as benefits to the LSST project.

Dr. Shobita Satyapal's research group is focused on the study of low mass supermassive black holes in the centers of bulgeless disk galaxies, which are an important and thus far largely unexplored population.  Study of this population of black holes will provide critical insight into the origin of black hole seeds and to their subsequent growth and evolution in the centers of galaxies.  Detecting such black holes has been extremely challenging since any traditional accretion signatures are swamped by emission from the host galaxy.  As a result, only a handful of black holes in such galaxies are currently known.  LSST's temporal information can be a powerful technique to identify such accreting supermassive black holes, vastly increasing the number of known cases.  In addition, Dr. Satyapal has worked with over 20 undergraduate researchers in her career.  Such studies of black holes in galaxy centers not only evoke strong interest in students at all levels, but AGN variability studies (e.g., time series analyses) are accessible to undergraduate student researchers.

Dr. Jessica Rosenberg is a recent NSF CAREER grant recipient.  This grant supports a project to combine the data from SDSS galaxies with data from ALFALFA, a large blind 21 cm survey using the Arecibo telescope.  The combined data sets will be used to study the baryonic content of local galaxies but will also be provided to the community as a valuable resource for a wide range of scientific investigations.  This database might be a prototype Level 3 federated database for the LSST research community.

Dr. Mario Gliozzi's research is focused on the investigation of the physical conditions of matter around black holes. His research is mainly based on the analysis and

interpretation of X-ray data from several satellites complemented with ground-based multi-wavelength data, with particular emphasis on the characterization of the variability properties which is performed with linear and nonlinear techniques. Dr. Gliozzi, who is the PI of several projects funded by NASA, pursues a unified picture on three different levels: (1) the unification among the different classes of Active Galactic Nuclei (AGN); (2) the unification between active and normal galaxies; and (3) the unification between supermassive black holes in AGN and stellar mass black hole systems.  The addition of LSST survey data to this research will be a major step forward, since LSST will provide multi-passband temporal coverage over 10 years for significant numbers of AGN, sampled across each of the major classes and subclasses. It is anticipated that such a large time-domain sky survey as LSST will also discover new subclasses of AGN behavior, thus revealing more details of the fundamental physical conditions of matter around black holes.

Dr. Merav Opher's Space Weather and Astronomy research is focused on how magnetic effects reveal themselves in astrophysical environments, particularly in how stars interact with the surrounding media, how the solar system interacts with the local interstellar medium, and how extra-solar planets interact with their host stars.  She also studies how magnetic disturbances are driven and propagate from the Sun to Earth. She uses state-of-the-art 3D computational models to investigate these phenomena. She was awarded the prestigious NSF CAREER award and the Presidential Early Career Award for Scientists and Engineers (PECASE) for studies of shocks in the interplanetary space.  She also received the Mason Emerging Researcher / Scholar / Creator Award.  She involves undergraduates, graduate students, and postdocs in her research, which will be a characteristic of all of our faculty members' involvement with the LSST project – engaging students actively in the data analysis and astronomical research.

Dr. Robert Weigel is the PI of the Virtual Radiation Belt Observatory (ViRBO), which is a NASA-sponsored virtual observatory in Heliophysics.  His experience in development of large-scale data management and visualization systems for both metadata and time series data (autoplot.org), as well as his research focus on scientific analysis of time series data, are applicable to science and data management problems being addressed by the LSST.  In the area of education, Dr. Weigel has participated in laboratory improvement efforts for the undergraduate introductory astronomy course, and is actively developing course material for Mason's new undergraduate program in the Computational and Data Sciences along with Drs. Borne and Wallin.

Dr. Joseph Weingartner models cosmic dust, with applications to the interstellar medium and circumstellar disks.  LSST data on asteroid size distributions and collisional events will yield helpful information on dust generation in debris disks. LSST determinations of visual extinction and reddening for a large set of stars with parallaxes will help constrain models of dust distribution and evolution in the Milky Way. This is critical science, insofar as LSST's plans to map the "Digital Galaxy" strongly depend on a detailed and accurate mapping of the extinction and

reddening, using the billions of stars in the LSST photometric/astrometric catalogs as probes of the dust distribution.

Dr. Michael Summers is on the science team for NASA's Pluto mission, New Horizons, which reaches Pluto in mid-2015.  One of the significant activities associated with this mission is the search for and identification of KBOs (Kuiper Belt Objects).  These studies will complement the discovery and characterization of KBOs anticipated by the LSST.  He is also interested in studying the rotation and variability properties of the centaur class of minor planets (which have characteristics of both asteroids and comets), some of which now appear to have atmospheres.  Long-term temporal multi-band coverage of these asteroids by LSST will provide essential observational evidence for this very interesting class of "planetary" atmospheres.  In addition to these activities, Dr. Summers has recently negotiated plans for the establishment of a science data center on campus, to manage and curate various astronomical (and other science) data collections.  This facility adds to an already strong cyberinfrastructure environment at Mason: supercomputer and Beowulf clusters.

In addition to the strong astronomical research activity described above, Mason staff are also engaged in astronomy education research.  Notably, Mason's current Quality Enhancement Plan focuses on building a culture of "scholarship, creativity, and research that stretches beyond disciplinary boundaries."  In line with this goal, Mason's general education astronomy laboratory classes have piloted a lab exercise (written by CDS graduate student Anthony Holinchek, under the supervision of Dr. John Wallin) based on Galaxy Zoo and Galaxy Mergers Zoo, which introduces non-majors to both citizen science and the idea of modeling as a key part of science inquiry.  An informal assessment of the lab carried out in Spring 2010 showed that students react positively to the lab, based on a survey of the students long after the lab was finished.  (Mason staff are now preparing a journal article for Astronomy Education Review that summarizes the findings from the survey.)  In collaboration with faculty from both CDS and Physics and Astronomy, astronomy lab coordinator Rebecca Ericson plans to develop and incorporate more such lab experiences for general education students to allow them to experience authentic investigations using real data.  LSST will eventually be a major component of these lab exercises and authentic research experiences in the classroom.  The goals of these lab exercises are to enhance scientific literacy in the general education student population and to introduce students of all backgrounds to skills and the practice of inquiry that will benefit them in their own fields.  Experiences of this sort will also be incorporated into an inquiry-based course currently under development for Mason honors students.  Students in this course will develop research questions, and follow through with semester-long projects that are designed to probe the questions they have posed.  The rich collection of data available from sky surveys, and eventually through the LSST program, will allow students to pursue any topic of interest in planetary, stellar, galactic, or extragalactic astronomy.

The above examples of Mason's faculty, research programs, current activities, and future plans are representative of our passionate interest in LSST scientific research

opportunities and the LSST project.  We hope that the LSST Board will find these examples to be sufficient indicators of our strong commitment to the success of LSST and of our plans to contribute in multiple ways to the LSST project in the years to come, and we hope that the Board will accept this petition for George Mason University to become an LSST Corporation Institutional Member.  We look forward to building upon and expanding the already established collaborations between LSST and Mason.

If you require any further information, please send your requests to Kirk Borne (kborne@gmu.edu; 703-993-8402).

Sincerely,

Kirk Borne, Associate Prof. of Astrophysics and Computational Science
Dimitrios Papaconstantopoulos, Chair, Dept. of Computational & Data Sciences
Michael Summers, Chair, Dept. of Physics & Astronomy
Vikas Chandhoke, Dean, College of Science