

THE NATIONAL SPACE GRANT COLLEGE & FELLOWSHIP PROGRAM

FISCAL YEAR 2020
ANNUAL PERFORMANCE REPORT (APR)

FUNDING SOURCE:
OFFICE OF STEM ENGAGEMENT
SPACE GRANT

MANAGING ORGANIZATION
NASA HEADQUARTERS OFFICE OF STEM ENGAGEMENT

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ACTIVITY/PROGRAM DESCRIPTION:

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is

primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The MA Space Grant Consortium is a Designated Consortium funded at a level of \$760,000 for fiscal year 2020.

ACTIVITY/PROGRAM GOALS:

Affiliate Project; Goal; Objective; Target Number of Students

- Mt Holyoke College; Develop new tools for astronaut EVAs on planetary surfaces; Select, analyze, test and calibrate best devices; 2 per year
- Christa McAuliffe Center; Public outreach, Space & Earth Science Research; Challenger Learning Center, Research on climate change and exoplanets; 6 per year
- University of Massachusetts/Amherst; Interdisciplinary research on Mars analogs, Astronomy research; Study remote sensing and robotic instruments for Mars, Study galactic structure and evolution; 8 per year
- Wellesley College; Planetary research; Exoplanet studies using NASA TESS candidates, analysis of lunar and Martian surfaces; 9 per year
- University of Massachusetts/Dartmouth; Astrophysics research; Research in cosmology and general relativity using Hubble data; 2 per year
- Williams College; Solar physics studies; Research using data from previous solar eclipses; 2 per year
- Maria Mitchell Observatory; Astronomy Research and Outreach; Biannual women in astronomy symposium, research with data from NASA and local telescopes; 32 per year
- University of Massachusetts/Lowell; Space-based instrumentation development; Build CubeSat, data analysis from NASA Earth observations satellites and from ISS data; 8 per year
- 5 College Astronomy Department; Astrophysics research; New instrumentation and use of data from NASA telescopes and Data Bases; 7 per year
- Boston University; Astrophysics research; Research relate to the Universe, Solar System, Missions, or science and technology; 3 per year
- Worcester Polytechnic Institute; New aerospace technology development; Research propulsion, dynamics & control, materials and structures; 4 per year
- Bridgewater State University; Astronomy Research and Outreach, photonics research; 21 per year
- Olin College of Engineering; Space Flight Safety, develop new space technology; Work with NASA offices of Space Debris and Planetary Protection, Additive manufacturing and adaptive structures for UVAs; 11 per year
- Rocket Teams; Develop new sounding rocket technology; Get above the Karman boundary (100km); 20 students per year/number of launches - 1 per year
- Students for the Exploration and Development of Space (SEDS); Space Seminars, outreach, student competitions; Year-long seminar series, K-6 Space Camp, Competition related to commercial space; 30 per year; number of competitions – 1 per year

- Student Space Experiment Program (SSEP); Student experiments on ISS; Support individual school projects for spaceflight; 300 students per year; 10 teachers per year, 1 experiment per year
- Middle School Ballooning; Student involvement in high-altitude ballooning; Support design, build, test operation and data analysis for balloon flights; 20 students per year, 5 teachers per year, 2 launches per year
- MIT-IAP Aerospace Exploration; Introduction to aerospace careers; Hands-on visits and briefings; 20 per year

ACTIVITY/PROGRAM CONTRIBUTIONS TO PERFORMANCE GOALS (PG) AND SUCCESS CRITERIA

- Mt Holyoke College; Develop new tools for astronaut EVAs on planetary surfaces; Select, analyze, test and calibrate best devices:
Work could not be done remotely
- Christa McAuliffe Center; Public outreach, Space & Earth Science Research; Challenger Learning Center, Research on climate change and exoplanets. Projects include:
 1. Simulate life and work in a microgravity and low earth orbit environment. Accomplished modeling and texturing the Cupola module's interior, Node 3 "Tranquility" and redesign the web interface.
 2. SpaceViz, an online experience that allowed a wide range of users to view and interact with a 3D replica of the International Space Station (ISS) interior and other low earth orbit environments. Both coding and modeling work was completed for 3D modeling and texturing.
 3. Create short module on different astronomy topics for use in the Christa McAuliffe Center's educational program in the planetarium. Successfully completed an entire module explaining the discovery, origins, and applications of the cosmic microwave background as a tool in astronomy.
 4. Create a series of short modules based on the NASA theme: Origins and Evolutions of the Universe. Goal was to create a show between 3 and 10 minutes that could be shown both in the planetarium and in remote settings. Created two different versions of the show: one for remote viewing (rectangular version) and one for the planetarium (dome version).

Supported 4 students

- University of Massachusetts/Amherst; Interdisciplinary research on Mars analogs, Astronomy research; Study remote sensing and robotic instruments for Mars, Study galactic structure and evolution:
The broad range of student projects included microbiology, engineering, computer sciences, and astronomy described below:

1. Using data from the NASA Space Observatory to both select targets and to provide calibration standards for new instruments that are being built for the Large Millimeter Telescope.
2. Surveying of nearby dwarf galaxies which were observed by the NASA Herschel SPIRE instrument.
3. Stacking images of protoclusters from the WISE mission, adding Herschel imaging data to the stacks, performing aperture photometry and generating radial profiles of the protoclusters in order to produce total light measurements.
4. Investigating the contribution of supermassive blackholes in the mid-infrared spectra of star-forming galaxies, using Spitzer/IRS data of high-redshift galaxies in a regime where separating black hole from star formation contributions is key to understand galaxy evolution.

Supported 10 students

- Wellesley College; Planetary research; Exoplanet studies using NASA TESS candidates, analysis of lunar and Martian surfaces; Student projects:
 1. Used TESS data to search for transiting exoplanets around white dwarfs. Coded and analyzed thousands of 2 minute cadence TESS data of 1411 white dwarfs and deduced that none of the targets that were analyzed had any exoplanets transiting around them.
 2. Developed software to analyze the shape of Martian and lunar impact craters in both satellite images and digital elevation models.

Supported 13 students

- University of Massachusetts/Dartmouth; Astrophysics research; Research in cosmology and general relativity using Hubble data; MASGC-supported students have worked on binary population synthesis and synthetic spectral models of Type Ia supernovae. These models advance our understanding of these Type Ia supernovae and their stellar progenitors, crucial for their use as standardized candles for cosmology. MASGC-supported students in the broad subfield of computational relativity have worked on models of gravitational waveform emission from black hole binary systems in the large mass-ratio limit. High performance (accuracy and speed) are major challenges for these models and our space grant supported students have made promising advances in that context. Such models are needed to ensure the success of upcoming space-borne gravitational wave detectors like the ESA/NASA LISA mission.

Supported 14 students

- Williams College; Solar physics studies; Research using data from previous solar eclipses; Supported 4 students
- Maria Mitchell Observatory; Astronomy Research and Outreach; Biannual women in astronomy symposium, research with data from NASA and local telescopes;

Students worked on optical light curves of tidal disruption events. Performed a close analysis of the the light curves: made measurements of them, identified any important or surprising features and established any areas of interest to explore more deeply. Student also worked to sharpen images of a Pulsar Wind Nebula (PWN) taken with the NASA NuSTAR X-ray Observatory using a method called deconvolution. Testing and refining this image sharpening process resulted in sharper, more detailed images allowing for better analysis while simultaneously probing a large range in X-ray energies. These techniques will help to refine the NuSTAR data analysis methods as well as those of future X-ray telescopes, and ultimately assist astronomers in understanding how complex X-ray emitting celestial objects work.

Supported 3 students

- University of Massachusetts/Lowell; Space-based instrumentation development; Build CubeSat, data analysis from NASA Earth observations satellites and from ISS data; Supported one student
- 5 College Astronomy Department; Astrophysics research; New instrumentation and use of data from NASA telescopes and Data Bases;
Students worked on the use of EAzY, a photometric redshift fitting software developed by Brammer et al (2008), to scan the background of eight Hubble Space Telescope images of lensed galaxy clusters from the REQUIEM Galaxy Survey in search of high redshift ($z > 5$) candidates b)re-affirmed a well-established sensitivity of lensing statistics to the mass/energy content of the universe, observed a so far unexplored link between the fluctuations in mass of large spherical halos in the universe and the distribution of lensing events.
Supported 3 students
- Boston University; Astrophysics research; Research relate to the Universe, Solar System, Missions, or science and technology; Supported 5 students
- Worcester Polytechnic Institute; New aerospace technology development; Research propulsion, dynamics & control, materials and structures;
A comprehensive 8 week program delivered during the summer. Provided research projects to undergraduate and graduate students. Students supported by SOAR (Summer Opportunities in Astronautics Research) advanced research in astronautics, clustered in areas of Fluids & Propulsion, Dynamics & Controls and Material & Structures. Projects were: Hypersonic Flows, RF Cathodes for Electric Propulsion, Application of Electrosprays for Fuel Injection in Combustors, Aerospace Structural Health Monitoring for Polymer Bonded Explosives and UAVs for Estimation of Contaminant Plumes.
Supported 5 students
- Bridgewater State University; Astronomy Research and Outreach, photonics research;

Students worked at the BSU Observatory as part of the BEAR (Bridgewater Experimental Astrophysics Research) Team. Students calibrated, stacked, and did photometry on Type Ia Supernova data of ASASSN-18bt and participated in group meetings about the supernova project, one student calibrated and did preliminary photometry on various exoplanets imaged during Summer 2019-early Spring 2020. Supported 9 students

- Olin College of Engineering; Space Flight Safety, develop new space technology; Work with NASA offices of Space Debris and Planetary Protection, Additive manufacturing and adaptive structures for UVAs;
Olin College students worked on the following projects: SWARM-EX Cube-Satellite project. Structural analysis, mechanical design, and system integration for Cube-Sats for swarm communications experiment. Fall 2020. Equivalent Power Flux Density software development. Create MATLAB software for EPFD calculations for communication systems. Summer and Fall 2020. Mechanical Design and Finite Element Analysis for Flexible and Hyperelastic Structures. Performed computation simulations (FEA) on highly deformable structures. Development of Remote Laboratories and Experiments. Develop Raspberry Pi and Arduino based systems to remotely control, monitor, and collect data from laboratory hardware and experiments through VPN connection to the Olin College computer network.
Supported 7 students
- Rocket Teams; Develop new sounding rocket technology; Get above the Karman boundary (100km); 20 students per year/number of launches - 1 per year The Consortium is supporting the MIT rocket team which is building a two-stage rocket, Phoenix, that will break the team's altitude record. The team has an impressive track record: from their first launch to 10,000 ft in 2014 to 32,400 ft in 2019. Support to the team will provide the necessary foundation to launch a future rocket beyond the Kármán Line – the boundary of space.
- Students for the Exploration and Development of Space (SEDS); Space Seminars, outreach, student competitions; Year-long seminar series, K-6 Space Camp, Competition related to commercial space; 30 per year; number of competitions – Delayed due to the Pandemic
- Student Space Experiment Program (SSEP); Student experiments on ISS; Support individual school projects for spaceflight; Delayed due to the Pandemic restrictions and school closings
- Middle School Ballooning; Student involvement in high-altitude ballooning; Support design, build, test operation and data analysis for balloon flights; Delayed due to the Pandemic restrictions and school closings
- MIT-IAP Aerospace Exploration; Introduction to aerospace careers; Hands-on visits and briefings; Delayed due to the Pandemic travel restrictions

PG 3.3.3: Provide opportunities for students to engage with NASA’s aeronautics, space, and science people, content, and facilities in support of a diverse future NASA and aerospace industry workforce.

PG 3.3.3 Success Criteria: Meet or exceed the national average in two of the four categories of student diversity for NASA STEM enrollees in internships, fellowships, or other student engagement opportunities. Diversity Categories: (1) students across all institutional categories and levels (as defined by the U.S. Department of Education), (2) racially or ethnically underrepresented students (Hispanics and Latinos, African Americans, American Indians, Alaska Native, Native Hawaiians and Pacific Islanders), (3) women, and (4) persons with disabilities at percentages that meet or exceed national averages for science and engineering enrollees, as determined by the most recent, publicly available data from the U.S. Department of Education’s National Center for Education Statistics.

- (1) Students across all institutional categories and levels (as defined by the U.S. Department of Education)
 - Supported 80 students
- (2) Racially or ethnically underrepresented students (Hispanics and Latinos, African Americans, American Indians, Alaska Native, Native Hawaiians and Pacific Islanders)
 - Supported 18 underrepresented students
- (3) Women
 - Supported 42 women

PG 3.3.4: Enhance the effectiveness of education investments using performance assessment and evaluation-driven processes.

PG 3.3.4 Success Criteria: Achieve milestone(s) in the implementation of performance assessment and evaluation of STEM engagement investments. Milestone: Award one competitive agreement to conduct a multi-year, third-party, project-level evaluation of the National Space Grant College and Fellowship Project.

MASGC employs numbers of students, numbers of institutions for support criteria. The results have been consistently positive. The consortium also uses reports, feedback and testimonials to assess the impact on student education and career objectives from students and their mentors.

PG 3.3.5: Provide opportunities for students to contribute to NASA’s aeronautics, space, and science missions and work in exploration and discovery.

PG 3.3.5 Success Criteria: Number of paper presentations and peer-reviewed research publications (and beginning in FY2021 to include student proposed solutions and products) resulting from STEM engagement investments. (Target number is 1,300)

5 papers were presented resulting from MASGC’s support to students

ACTIVITY/PROGRAM ACCOMPLISHMENTS:

Starting in 2006, MASGC has carried out longitudinal tracking of students who have participated in the Consortium's programs. The impressive **STEM retention results (87.5%)** are as follows:

Over 15 years, of the **793 students have graduated with the initial degree** they were pursuing when supported by MASGC:

- **347** are pursuing advanced STEM-related degrees
- **72** were actively seeking STEM employment when last contacted
- **102** are employed by aerospace contractors
- **106** are employed in non-aerospace STEM positions
- **15** are employed by NASA/JPL
- **15** are employed in K-12 STEM
- **36** are employed in "other" STEM academic fields
- **100** are employed in non-STEM fields.

Awarded 80 student awards for graduate fellowships, undergraduate support awards, higher education and research across 13 affiliates.

Women participation: **52.5%**

Underrepresented minority participation: **22.5%**

ACTIVITY/PROGRAM IMPROVEMENTS MADE IN THE PAST YEAR:

The consortium has been able to focus on on-line education and remote research opportunities to continue to engage and support students at all our member institutions.

ACTIVITY/PROGRAM PARTNERS AND ROLE OF PARTNERS IN ACTIVITY EXECUTION:

The Massachusetts Space Grant Consortium has 16 academic affiliates and 3 institutional (outreach) affiliates, covering the entire state from Cape Cod and the Islands to the Berkshires. Members are listed below, together with the name of each affiliate's representative to MASGC. MASGC affiliates play an important role in execution of the consortium's goals and programs. Each affiliate is responsible for selecting the most competitive and deserving programs and students for space grant funding to assist NASA's education mission.

- Massachusetts Institute of Technology (Lead) – Prof. Jeff Hoffman
- Boston University – Prof. John Clark
- Bridgewater State University – Prof. Martina Arndt
- Five College Astronomy Dept – Prof. Alexandra Pope
- Framingham State College – Dr. Irene Porro
- Harvard University – Prof. Jonathan Grindley
- Mount Holyoke College – Prof. Darby Dyar

- Olin College of Engineering – Prof. Christopher Lee
- Tufts University – Prof. Danilo Marchesini
- University of Massachusetts, Amherst – Prof. Daniela Calzetti
- University of Massachusetts, Dartmouth – Prof. Robert Fisher
- University of Massachusetts, Lowell – Prof. Supriya Chakrabarty
- Wellesley College – Prof. Kim McLeod
- Williams College – Prof. Jay Pasachoff
- Worcester Polytechnic Institute – Prof. Nikos Gatsonis
- Worcester State University – Prof. Nabin Malakar

Institutional Affiliates (Outreach)

- McAuliffe Center at Framingham State – Dr. Irene Porro
- Boston Museum of Science – Dani LeBlanc
- Maria Mitchell Observatory – Dr. Regina Jorgenson

CURRENT AND PROJECTED CHALLENGES:

The current challenge is the pandemic and its effect on all of our member institutions. Consequently, we have had to make adjustments to either increase student support for on-line or remote learning or research, or, delaying it until the next year.