NASA’s success in human space exploration, an endeavor spanning more than 50 years, can be credited to the national ability to surmount a wide range of complex and difficult biomedical, physical science, and engineering-related obstacles. NASA’s historical achievements have been possible because of its strong and productive commitments to microgravity research (space life and physical science research) supporting human space exploration, and utilization of human space exploration infrastructures for scientific discovery on Earth. NASA is the only federal agency mandated to carry out microgravity research that includes support of university research in microgravity science; and research not directly related to human exploration. (PL 111-314 National and Commercial Space Programs)

Currently NASA has major space transportation programs in development for the journey beyond Low Earth Orbit. But in parallel with the engineering solutions in development, questions need to be answered such as where is the threshold with human systems (e.g., 15, 24 months, etc.), and with mechanical systems humans will need for journeys to Cis-lunar and beyond? Fundamental research needs significant investment to drive towards solutions for exploration and enable research pathways for terrestrial applications. In 2011, the National Research Council released a Decadal Survey, entitled "Recapturing a Future for Space Exploration: Life and Physical Sciences for a New Era, mandated by Congress in 2008. The report identified scientific and programmatic priorities regarding future space exploration for the 2010-2020 time period. The study had the foresight to not focus on a destination, but categorized recommendations based on criteria such as the potential to enhance mission options, reduce mission costs, or ability to translate results to terrestrial needs. As stated in the report it is important to support a sufficiently robust extramural research program now to ensure that there will be a stable community of scientists and engineers prepared to lead future space exploration research and train the next generation of scientists and engineers.

ISS Research
Flight research is a continuum of efforts that extend from laboratories and analog environments on the ground, through other low-gravity platforms as needed and available, and eventually into extended-duration flight. Research on the ISS is a component of this continuum, and the capabilities provided by ISS are vital to addressing many of the most important research questions detailed in the NRC decadal survey. For example, long duration studies with animals, e.g. 3-6 months or more, will determine how the musculoskeletal system changes overtime in microgravity, as well as the impact of long duration flights on the immune system. Fundamental physical science research in heat and mass transfer for porous media under microgravity conditions will help determine the effect of variable gravity on multiphase flow systems critical to closed loop life support systems. However, decadal research activities have been relegated to the lowest priority for crew time within the current ISS science prioritization process determined by the ISS Program Science Control Board (PSCB). This effectively reduces the flight research plan to near 0 hours on the ISS, precluding NASA from executing a microgravity flight research program, including critical open science initiatives. Flight experiments are on hiatus, and high priority research involving rodent research has been delayed at least until 2018. NASA has put several short term mitigation

ASGSR believes the FY17 President's budget request for NASA continues to allocate insufficient resources for a sustainable and forward leaning space life and physical science national research program. ASGSR believes basic research is an essential translational step in the execution of space exploration missions but has the dual advantage to significantly reduce uncertainty for research pathways that have potential high value life and physical science applications on earth.
plans in place: cancellation or delay of current flight research grants, extension of ground research objectives and delay of annual calls for research but a long term solution is needed. Adding another crewmember will increase crew time, but the prioritization process still does not provide support for NASA space life and physical sciences research.

The current NASA Space Life and Physical Sciences research budget is embedded within the overall ISS research budget that bears significant costs for the operation of on-orbit research facilities. The current NASA space life and physical sciences program is not robust enough to support a sufficient extramural research program to ensure that there will be a stable community of scientists and engineers prepared to lead future space exploration research.

<table>
<thead>
<tr>
<th>ISS Research budget ($M)</th>
<th>FY15 Actual</th>
<th>FY16'</th>
<th>FY17 request</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Space Life and Physical Sciences (SLPS) Division Overall Budget</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• SLPS Academic Research (grant funding)</td>
<td>75M (&lt;20%)</td>
<td>20M (&lt;5%)</td>
<td>similar to FY15</td>
</tr>
<tr>
<td>3. Center for the Advancement of Science in Space (CASIS)</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>4. In space Robotic Servicing</td>
<td>103</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

1. Awaiting release of FY16 op plan numbers for enacted $$$
2. In space robotic servicing budget moved to Space Tech
3. MUSS provides strategic, tactical, and operational support to all NASA sponsored and non-NASA sponsored payloads, including the five international partners' research payloads. This includes maintenance and operation of the ISS research infrastructure.

**Recommended actions:**

1) Articulate to NASA the importance of fundamental Space Life and Physical Sciences research. Using the NRC Decadal Survey on Biological and Physical Sciences in Space, and NASA's Human Research and Technology Roadmaps direct NASA to seek input from external academic, commercial, and other governmental agency stakeholders to identify a framework to select projects of the highest overall value for execution on the ISS; no less than 15% of ISS flight research projects shall be fundamental space life and physical science national research conducted by NASA and/or Other Government Agencies (OGA'S)

2) In accord with elevating the priority of life and physical sciences research, allocate funding within the ISS research program to $150M for space life and physical science research to engage extramural ground and flight research and prepare the next generation of scientists and engineers.

3) Future authorization - recommend use of language from NASA FY15 Authorization H.R.810, section 718

About the Organization

The American Society for Gravitational and Space Research (ASGSR), founded in 1984, provides a forum to foster research, education and professional development in the multidisciplinary fields of gravitational research. ASGSR brings together a diverse group of scientists, engineers and students from academia, government and industry to promote research, education, training and development in the areas of Space Life and Physical Sciences research. The knowledge gained leads to a better understanding of the effects of gravity on living and physical systems on Earth and enables human space exploration.

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