A Modest Proposal for
A future for physical sciences

Briefing to
HEO Research Subcommittee

March 7, 2016
Where do the physical sciences in the squid chart?
Elements of Physical Sciences

Physics in space
Gravity Probe – B
Lambda Point Experiment
... Cold Atom Laboratory

Engineering Science for Exploration
Pool Boiling Experiment
Solid Surface Combustion Experiment
... Constrained Vapor Bubble Experiment

Materials Processing in Space
Vapor Growth of HgI₂
Protein Crystal Growth
...
Exploration-Related Research

Current content in low-g process research – flight experiments in:

- Fluids management
- Boiling and condensation
- Solid fuels ignition and flame spread
- Process operations

Future activity?

- Clear potential overlap of non-ISS activities with Space Technology’s Research Grants Program
- What can physical sciences contribute to exploration technology development?
Technologies for human space flight often developed as a unique art

   Ex: Life support systems

A unit operations foundation for space technologies, including

   In-situ resource utilization

   Surface nuclear power

   Surface operations

The 10-20 year goal – A Space Unit Operations Handbook

Would allow more flexible, timely, and more physics-based engineering, and would have long-term value for space exploration. It would improve the engagement of the academic community in space technology development, with value to education of the future space work force
Commercialization is a long-held goal of civil space – it’s in the National Aeronautics and Space Act: “(c) Commercial Use of Space.-Congress declares that the general welfare of the United States requires that the Administration seek and encourage, to the maximum extent possible, the fullest commercial use of space.”

We’ve been looking for commercialization ideas for a long time
Where do ideas come from?

Three examples –

1) Colloidal system phase transitions
Began as a center-led technology project for microgravity polymer research. Project at risk of cancellation. Refocused on colloid physics. Two members of initial science team became flight PI’s and after flight experiments became PI’s of NSF MRSEC’s

2) Cold atom physics
Idea for low gravity experiments in atomic physics proposed at a workshop focused on He phase transitions. Two grants awarded in 1994. Flight project with “stellar” science team to fly 2017

3) Three-dimensional tissue culture
Began as a support technology for planned electrophoresis experiments. Recommended for cancellation by post-Challenger review. Project manager working with local cancer researcher saw encouraging results. NRA engaged external community.
A continuing role for NASA

Development of LEO depends on finding economically/scientifically sound new ideas for utilization. Experience shows that finding these ideas requires persistence, creativity, and resources.

No other Federal agency has a mission to develop space utilization.

While encouraging other Federal agencies and the private sector to step up their involvement in LEO utilization, NASA should consider maintaining an effort to develop new ideas for LEO utilization. New ideas are a crucial factor in attracting new participants.
Conclusions

A program that combines space exploration and engineering science should have a central place in NASA’s portfolio.

An engineering foundation for exploration technologies in handbook form would be a lasting foundation for future missions. It could be the focus of a 10-20 year program for physical sciences through the end of the ISS program.

LEO commercialization needs a continuing flow of sound utilization concepts to be successful. Physical sciences research should be a source of new, validated uses for the space environment.