



Fifth Microgravity Fluid Physics and Transport Phenomena Conference
Cleveland, Ohio, August 9-11, 2000

Physical Sciences Research in Microgravity

E.H. Trinh
NASA Headquarters
Code UG

9/29/00

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Outline

- NASA Program Organization
- Physical Sciences Research in Space - Biology Connection
- Fluid Physics Program Dual Thrust - Integrating Function
- Immediate and Future Plans

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Physical Sciences Research Division Goals

- To carry out cutting-edge, peer-reviewed, and multi-disciplinary basic research enabled by the space environment to address NASA's goal of advancing and communicating knowledge
- To develop a rigorous cross-disciplinary scientific capability bridging physical sciences and biology to address NASA's human and robotic space exploration goals
- To establish the ISS facilities into a unique on-orbit science laboratory addressing targeted scientific and technological issues of high significance
- To enhance the knowledge base impacting Earth-based technological and industrial applications



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***Proposed
Organization***

**Division of
Physical Sciences in Space***

- Fundamental Research
 - Fundamental Physics
 - Materials Science
 - Fluid Physics
 - Combustion Science
 - Exploration Research
- Biomolecular Physics
 - Atomic and Molecular Processes in Biosystems
 - Biological Sensing Phenomena
 - Cellular Components Assembling Mechanisms
- Biotechnology & Earth-based Application
 - Cellular Biotechnology
 - Macromolecular Biotechnology
 - Earth-based Applications
- Manage Division Education & Outreach, Unique Facilities Utilization, Internat'l Science and CSC Research Collaborations

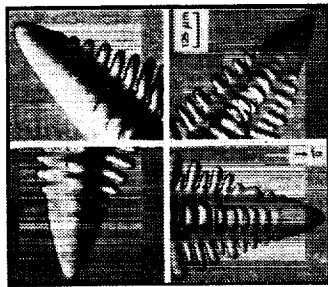
**Cross-disciplinary Science and Technology Working Group
Commercial Space Centers**

***Research and technology development from TRL 1 - 3**

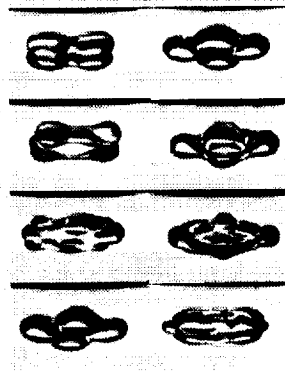
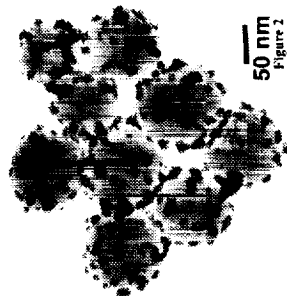
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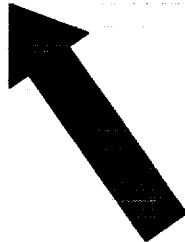
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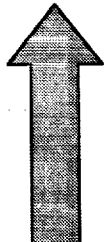
**Goal-oriented basic
and applied research**



**Fundamental research
enabled by the microgravity
environment**



**Basic research targeting
human space exploration
goals**



**Microgravity research in
support of Earth-based
applications**





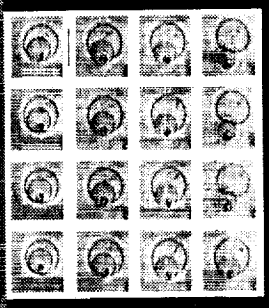
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- The Microgravity fundamental research carried out in Code U (Office of Fundamental Research) involves a substantial multi-disciplinary scientific community
- This peer-reviewed research is laying the groundwork for the development of enabling technologies for future human exploration
- This research is complementary to the technology development efforts carried out in both Code R (Office of Aerospace Technology) and Code M (Office of Space Flight): The Knowledge generated by basic research in code U can be transferred to Codes R and M for the development of Capabilities, and finally to Code M for integration of Products into systems and platforms.

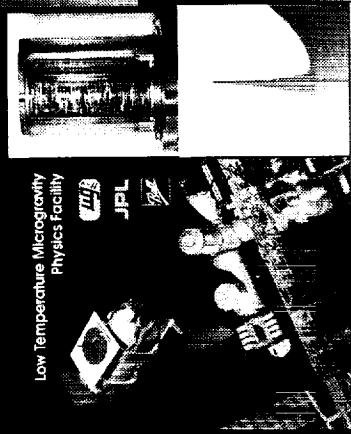
Physical Sciences and Microgravity: Fundamental and Applied Research



Artist's Rendition of Cesium clock

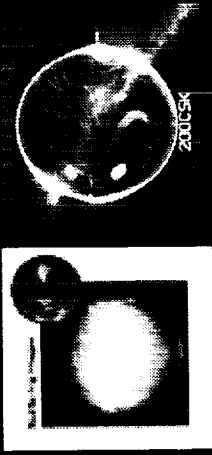


Biological Physics



Low Temperature Microgravity Physics facility

Low Temperature and Condensed Matter Physics

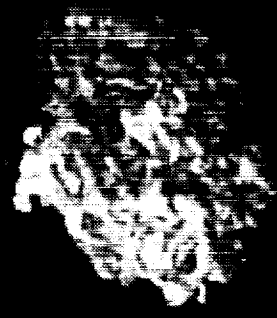


Fundamental Fluid Physics



Materials Science

Chemistry Of Reactions



Structural Biology

Fundamental Research Atomic Physics/Laser Cooling

Applied Research:

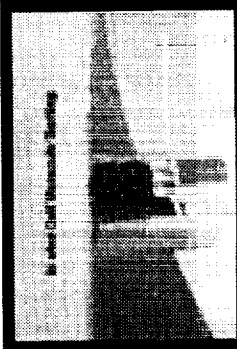
Cellular Biotechnology



Fluid Flows and Management



Micro-G Fire Safety



Biomolecular Physics & Chemistry



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Microgravity Fluid Physics Pls Currently in the Program

<u>NRA</u>	<u>Flight Definition/Flight</u>	<u>Ground-based</u>
Prior	1	-
91	3	-
94	9	<71
96	6	33
98	14	61
Total Current	14	<165
00	16**	50**
**Planned		
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Fluid Physics Program Dual Thrust:

- Peer-reviewed research based on scientific value and exploiting advantages of the microgravity environment
- Peer-reviewed research based on engineering applications and relevant to human space exploration endeavor

The second component will be strengthened with a rigorous research program coordinated with other NASA enterprises



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Fluid Physics Relevance to NASA Biology Program:

- Fluid Physics is “The Foundation for all other Microgravity science Disciplines”

This statement must be validated by implementing an Integrating function across the physical sciences disciplines as well as across the entire the biological sciences relevant to the Code U program

Example in current research program: *S. Garoff's Micro-Scale Hydrodynamics near Moving Contact Lines*

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Microscale Hydrodynamics Near Moving Contact Lines (μ SCALE)

Objective:

To understand the wetting of solids by fluids.

Payoff:

Value and Benefit: A correct understanding of wetting physics would have a significant impact on:

- The design and optimization of coating processes, including rapid coating of optical fibers, and durable coatings on metals.
- Materials for oil recovery processes.
- The design of MEMS and BIOMEMS devices.
- Design of processes for preparation of pharmaceuticals.

PI: Steve Garoff
Carnegie Mellon University

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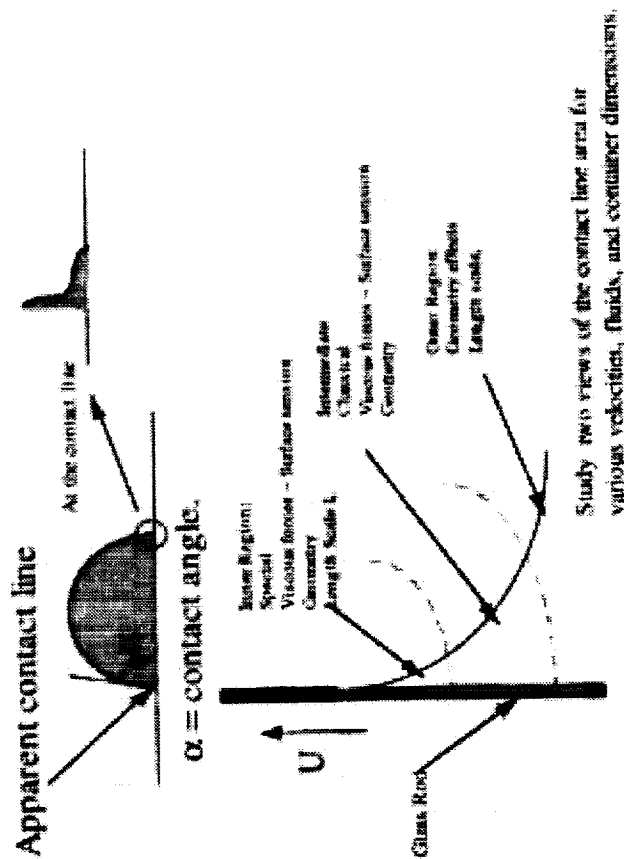
PS: David Jacqmin
NASA Glenn Research Center

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PM: Amy Jankovsky
NASA Glenn Research Center

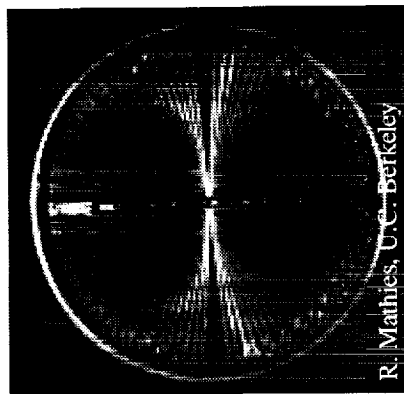
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Contact Line Hydrodynamics (f2)

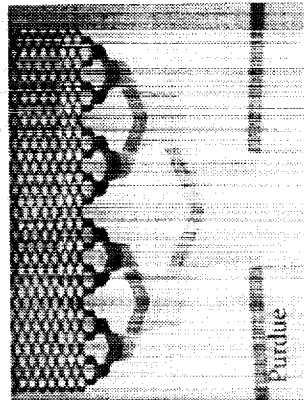




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**Microfluidic devices
 for fundamental biology
 investigations in space**



Liquid Management in μ G



**Interface Dynamics
 in multiphase flows and
 heat transfer systems**



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Immediate and Future Plans

- Establish and sustain an engineering-oriented research program coordinated with NASA's Offices of Space Flight and of Aerospace Technology
- Define a discipline roadmap to implement an integrating function across the physical and biological sciences
- Create a vigorous research program with a mix of "high risk" research combined with rigorous, detailed oriented tasks to strengthen its status within NASA, and to advocate for growth

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