human spaceflight

Physical Sciences research in microgravity

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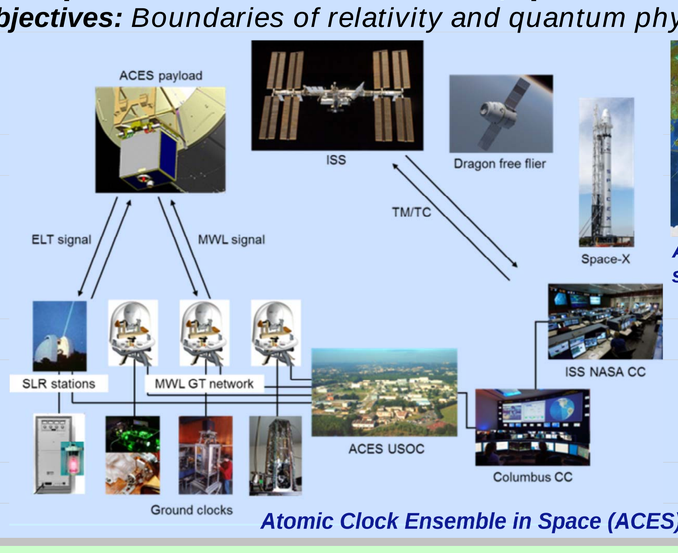
Physical Sciences research in space environment, typically assessing the effect of gravity on physical processes is managed within ESA's SciSpacE (*Science in Space Environment*) programme, which is part of the optional *European Exploration Envelope Programme* (E3P). The relevant activities utilise the entire spectrum of reduced gravity platforms available for ESA: drop tower, parabolic flights, sounding rockets, unmanned orbital capsules and the *International Space Station* (ISS). The scientific programme is built around a set of specific research roadmaps of the pillar disciplines as well as so-called "*Self-standing and multidisciplinary research*" topics. The main pillars of the Physical Sciences programme are:

Ultra-precise cold atom sensors, quantum information and high energy particles (fundamental physics) | Soft or Complex matter | Boiling, evaporation, condensation and two-phase heat transfer | Advanced material processing

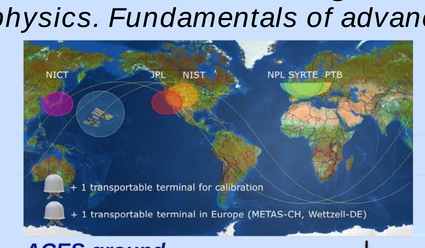
The research in SciSpacE programme is predominantly fundamental in nature, fuelled by leading members of the global research communities, meaning that (micro)gravity research is often only a small portion of the scientific interest of the participants. Scientists team up, nurture and follow up on space experiments under the umbrellas of ESA-supported fora, called "*Topical Teams*". Furthermore, the use of the knowledge gained from activities in space (analogue) environment is promoted to be transferred into practical (typically ground-based) systems or industrial processes through the so-called "*Micrograviy Application Programme*" of SciSpacE.

Ultra-precise cold atom sensors, quantum information and high energy particles (fundamental physics)

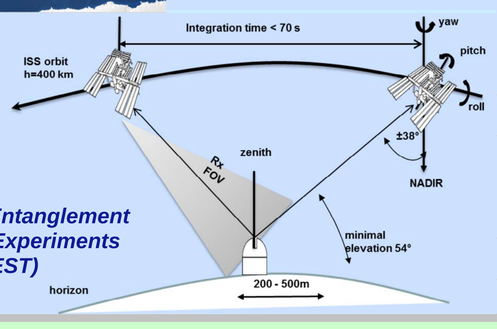
Objectives: *Boundaries of relativity and quantum physics. Fundamentals of advanced navigation and communication.*



Atomic Clock Ensemble in Space (ACES)



ACES ground stations

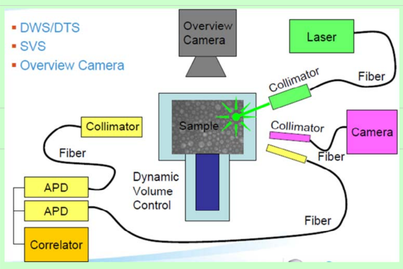


Quantum Entanglement for Space Experiments (SpaceQUEST)

Space Optical Clock: Sr-lattice

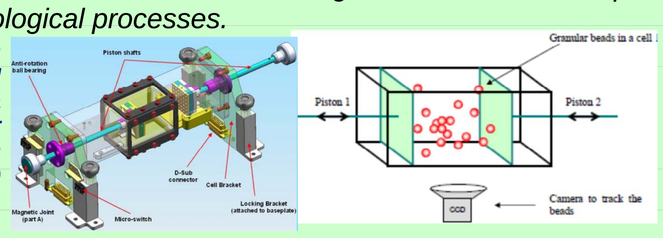
Soft or Complex matter

Objectives: *Interactions and self-organisation in foams, emulsions, granular matter, atmospheric dust and colloids. Fundamentals of food and (petro)chemical industry, physics of biological processes.*

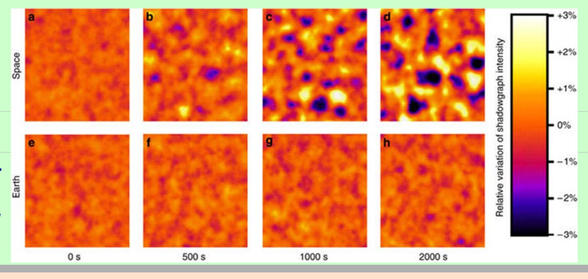


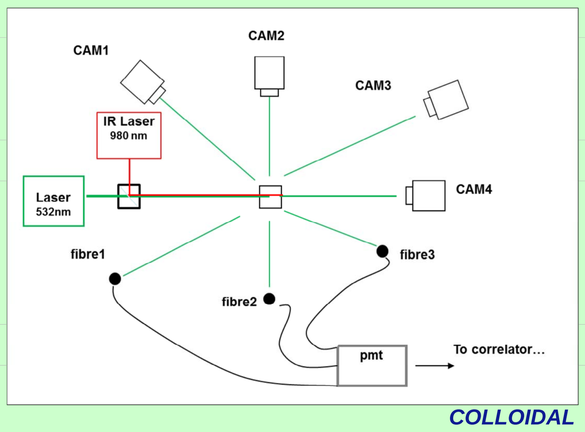
Soft Matter Dynamics

Vibration Induced Phenomena in GRANular materials (VIP-GRAN)



GRADFLEX (FOTON M3, 2007); Precursor for "Non EqUilibrium Fluctuations during Diffusion In compleX liquids" (NEUF-DIX)

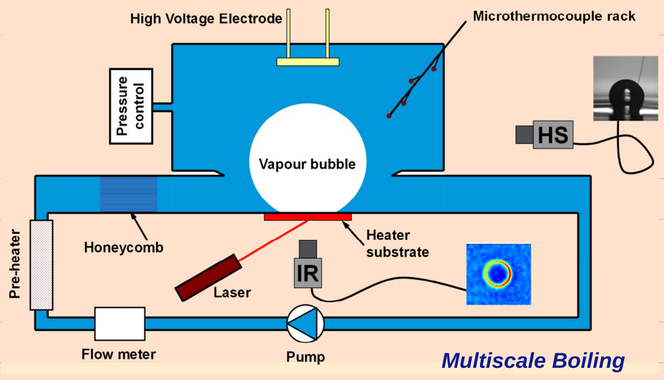




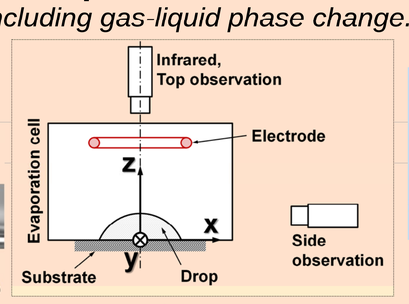
COLLOIDAL SOLIDS

Boiling, evaporation, condensation and two-phase heat transfer

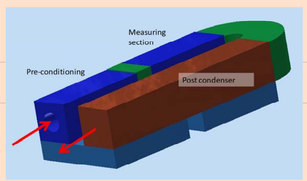
Objectives: *Multi-scale modelling of fluid physics including gas-liquid phase change. Fundamentals of efficient cooling of microelectronics, industrial boilers and power plants.*



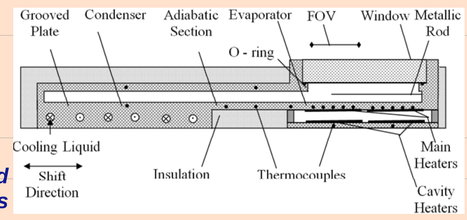
Multiscale Boiling



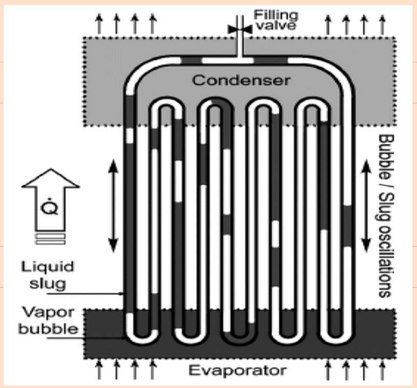
Drop evaporation



In-Tube Condensation



Enhanced Evaporators

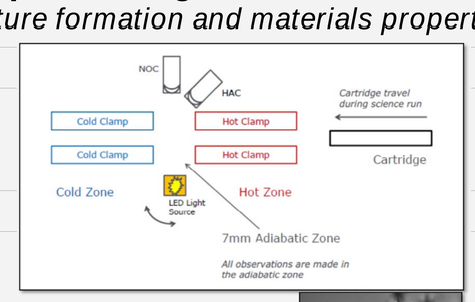


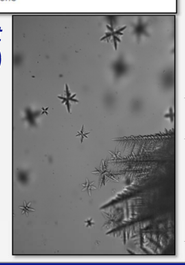
Pulsating Heat Pipes

Advanced material processing

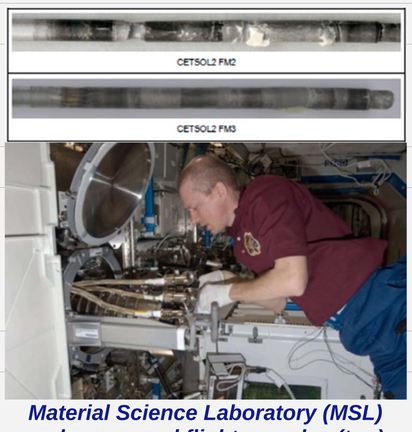
Objectives: *Microstructure formation and materials properties. Fundamentals of casting, automotive and aerospace industry.*

ElectroMagnetic Levitation (EML)

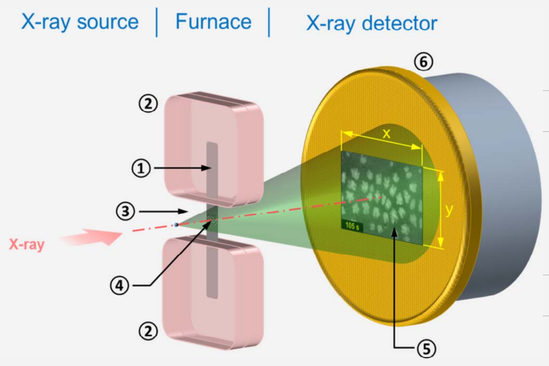




Transparent Alloys (TA)



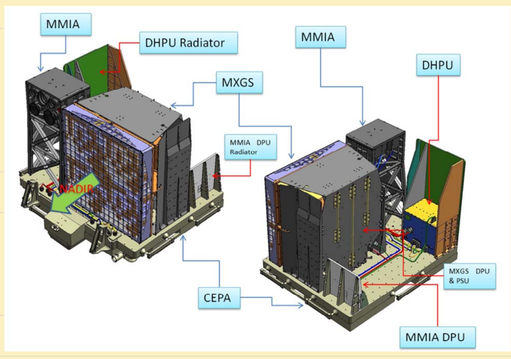
Material Science Laboratory (MSL) and processed flight samples (top)



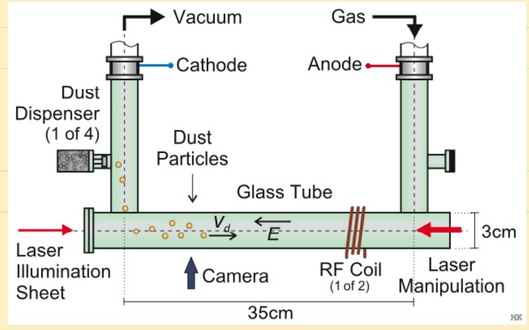
X-ray radiography (XRMON)

Self-standing and multidisciplinary research

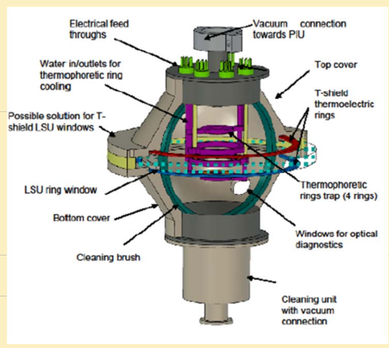
Atmosphere Science Interactions Monitor (ASIM)



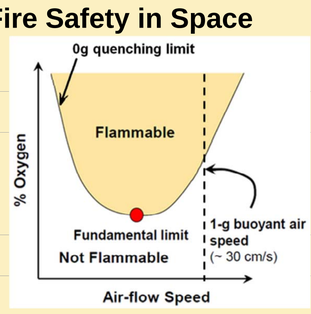
Physics of Plasmas and of Solid or Liquid Particulates (Complex Plasmas — PK-4)



Interaction in Cosmic and Atmospheric Particle Systems

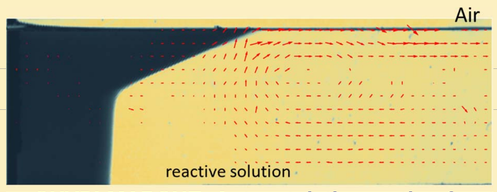


Fire Safety in Space

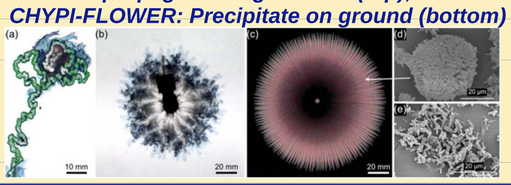


Saffire-I concurrent flow flame spread (NASA)

Chemo-HYdrodynamic Patterns and Instabilities (CHYPI)



CHYPI-MARCHE: Autocatalytic reaction front propagation flight result (top); CHYPI-FLOWER: Precipitate on ground (bottom)



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