

Key questions addressed in the different disciplines with the Research Plan of the ELIPS programme developed by ESA's Advisory Groups

General physics	Materials sciences	Physics of fluids and combustion	Exobiology	Biology	Human adaptation and performance
Test of fundamental physics theories and measurement of fundamental constants to unprecedented levels of precision.	What are the thermophysical properties of high temperature melts?	What are the dynamics and the properties of interfaces?	Organic compounds and mineral interactions under space conditions	How does gravity alter development and performance of organ systems?	What are the mechanisms orchestrating organ systems interaction and recovery under variable gravitational levels (system homeostasis)?
Universal time scales, time transfer, and clock comparison at world scale	What is the influence of convection on the formation of different microstructures in alloys?	What are the key mechanisms of phase separation when coupled to evaporation and heat transfer in particular?	Polymerisation, stability and replication studies under space conditions	What are the molecular mechanisms for sensing and adaptation to variable g-levels by cells (microbial, fungi, plants and animals)?	What factors impair physical and cognitive performance?
Dynamics and properties of degenerate quantum gases in microgravity conditions	What is the influence of the processing conditions on the features of crystalline and amorphous phases of biological, organic and inorganic materials?	What is driving the stability of complex fluids? How does coarsening happen?	Response of pre-biotic building blocks to extraterrestrial conditions.	How do different gravitational levels interfere with the formation of multi-cellular structures (cell-cell, cell-extracellular matrix/cell wall interactions)?	How can we assess and monitor health, psychological well-being and interpersonal relationships in conditions of isolation?
Matter waves interferometry from atoms to large molecules	Understand the fundamental link between materials processing, structure and properties of new light-weight structural metallic or intermetallic materials	Measure the chemical physics of bulk homogeneous samples of supercritical fluids	Mechanisms of survival and adaptation of extremophiles to extraterrestrial conditions	How does gravity modify the lifecycle from embryonic development to senescence?	What are the factors governing the inter-individual variability in the response to spaceflight conditions?
Higher performance atomic clocks in space, from the microwave to the optical domain		Understand the combustion process of dispersed systems		What are the biological responses to multiple stressors?	What are the human responses to multiple stressors?
Test of entanglement over long distances and quantum communication in space		Understand fundamentals of convection with model fluids systems. Study convective instabilities under conditions not realisable on Earth.		How do evolution and cross-interactions between organisms occur under space conditions?	Can one identify and validate optimal countermeasure strategies based on physical, pharmacological, nutritional and psychological interventions

**Key questions that call for an interdisciplinary approach
promoted in the ELIPS programme**

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Atmospheric physics	What is the relation of space-atmosphere interactions with climate change?		What are the interactions of dust with hydrometeors in the atmosphere?	How do organic compounds (biomolecules and micro-organisms) form in planetary atmospheres, and how are they transported?		
Soft matter physics	Measure time and length scales in dust aggregation, phase transitions in colloidal systems and granular materials	What is the influence of gravity on the time and length scales of nucleation and growth?	What are the rheological properties of homogeneous samples of complex fluids? What drives the self-organisation of nanoparticles at surfaces and in liquid films?		How does fluid dynamics influence biological systems?	
Dealing with radiation	Model the cosmic radiation environment and its interaction with matter.	What are the possible strategies to adequately shield crew and systems from space radiation?		What are the effects of UV and cosmic rays on pre-biotic molecules and micro-organisms?	What are the molecular mechanisms of heavy-ion impact on cells?	Quantify the risks to humans of exposure to space radiation (acute and chronic)
Life support systems (Sustaining life)		How can one extract and exploit the elements contained in planetary regoliths to support exploration missions?	How do gas exchanges take place in (bio)reactors in space? How to complete waste recycling to 100%? What is the flammability of materials in space? How to best manage heat fluxes and air flows in manned spacecraft?		Can one develop sustainable closed loop biological life support systems?	What are the consequences of artificial life support systems (microbial environment, air composition, dust, etc.) on human health and well-being?