



PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 40th cycle

**THEMATIC Research Field: PROGETTO SPACE IT UP CONTRATTO DI FINANZIAMENTO
ASI N. 2024-5-E.0 CUP MASTER I53D24000060005 CUP POLIMI D43C24000350006 -
AUTONOMOUS OPERATIONS OF MINIATURIZED PLATFORMS IN DEEP SPACE**

Monthly net income of PhDscholarship (max 36 months)

€ 1600.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

**Motivation and objectives of the research
in this field**

Bando di finanziamento ASI decreto n. 687/2022 - Deliberazione n. 71/2022 ? Tematica 15 Attività spaziali, di cui all'avviso MUR n. 341/2022 per Partenariati estesi. Progetto di ricerca "SPACE IT UP!" approvato con decreto ASI n. 53/2024. Contratto di finanziamento ASI n. 2024-5-E.0 (CUP Master I53D24000060005; CUP POLIMI D43C24000350006).

ASI Funding Notice Decree No. 687/2022 - Resolution No. 71/2022 - Topic 15 Space Activities, referred to MUR Notice No. 341/2022 for Extended Partnerships. Research project "SPACE IT UP!" approved by ASI Decree No. 53/2024. ASI Funding Agreement No. 2024-5-E.0 (CUP Master I53D24000060005; CUP POLIMI D43C24000350006).

The current proliferation of space assets will soon become unsustainable from ground-based tracking facilities. Most of the deep-space spacecraft navigation techniques rely on radiometric tracking and ground-based orbit determination. Radiometric measurements yield accurate orbit determination, but the drawback relies on the interaction with the ground station, which is unavoidable. This in turn dictates the costs to operate spacecraft in deep space. New methodologies for determining and controlling the orbit of spacecraft must be devised to reduce the exploitation of ground-based tracking facilities.



	<p>The objective of this PhD project is to advance the state of the art in the operation of deep-space miniaturized spacecraft, with a focus on guidance, navigation, and control. The aim is to develop technologies for space environment perception, onboard data processing, autonomous navigation, and orbit control in view of typical requirements of lunar and deep-space CubeSats. The technologies will be tested with hardware-in-the-loop experiments, possibly using/upgrading the existing infrastructures. This is to verify the requirements and validate the performances of the devised autonomous operations for exploitation in next-generation deep-space CubeSat applications.</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>The proposed project has the ambition to enable autonomous operations, with a focus on but not limited to guidance, navigation, and control of space platforms. The research involves the development, integration, and validation of both software and hardware solutions and tools to support the assessment of autonomous GNC for deep-space CubeSat. To this purpose, the navigation, guidance, and control have to be interconnected to test the validity and robustness of the developed algorithms in a fully functional facility that will simulate the transfer of a spacecraft from an initial condition towards a target located in deep space. The methodologies will be tested using the already-existing integrated infrastructures, which reproduce dynamic simulations of the spacecraft-environment interaction, allowing high-fidelity testing, validation, and verification, through Hardware-In-the-Loop (HIL) simulations of deep-space autonomous GNC systems for CubeSats. The proposed PhD project combines renown expertise in the field of space guidance, navigation, and control simulation and miniaturized space systems integration and test. These two branches are both at the edge of research in their fields, and they are merged here to forge a novel research line. The research lies within the ASI/MUR-funded project "Space It Up!". In particular, the research is framed within Spoke 1, WP1.4</p>



	of “Space It Up!”.
Educational objectives	<p>The objective of this PhD is to develop skills in space system modelling and simulation, including both digital and hardware means. The candidate will gain relevant expertise in deep-space missions. Through this project, the candidates will develop skills in mathematical modeling, numerical analysis, computer programming (Matlab, Python, C++, or similar), and image processing. Moreover, the candidate will develop skills on both computer and processor/hardware-in-the-loop simulations. Soft skills in disseminating the research, writing reports, performing outreach, and preparing industrial progress meetings will be also achieved through the PhD project. The PhD student could spend 6 months in a foreign university/research center/company. The timeframe and location of the period abroad will be defined during the PhD career development plan, to be developed within the first semester after the kick-off of the activity.</p>
Job opportunities	<p>The current research prepares the PhD candidate to both academic and industrial careers. Knowledge of model-based system engineering, modeling and simulation of space systems, as well as autonomous guidance, navigation, and control are fundamental skills for careers in space-related companies and universities.</p>
Composition of the research group	<p>1 Full Professors 1 Associated Professors 2 Assistant Professors 20 PhD Students</p>
Name of the research directors	Prof. Francesco Topputo

Contacts
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web site: www.aero.polimi.it or <https://dart.polimi.it>

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	800.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

The PhD candidate will receive a desk, possibly through a hot-desking procedure, and a personal computer, if needed. Apart from the compulsory ones, the PhD candidate will have the opportunity to follow additional courses and receive economic support to attend summer schools and participate in conferences. There will be the possibility of paid teaching assistantship.