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Supervisor Expression of Interest
MSCA - Marie Sklodowska Curie Action - (PF) Postdoctoral Fellowship 2024

Supervisor name: Francesco Topputo
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Link "Pagina docente": dart.polimi.it
Department Name: Department of Aerospace Science and Technology

Research topic:

- ☐ MSCA-PF Research Area Panels: CHE_Chemistry
- ☐ ECO_Economic Sciences
- x ENG_Information Science and Engineering
- ☐ ENV_Environmental and Geosciences
- ☐ LIF_Life Sciences
- ☐ MAT_Mathematics
- ☐ PHY_Physics
- ☐ SOC_Social Sciences and Humanities

Brief description of the Department and Research Group (including URL if applicable):

Polimi's Department of Aerospace Science and Technology (**DAER**) is the body that implements research in the field of Aeronautics and Astronautics. In 2023 DAER has been ranked 7th in the QS world ranking under the topic "Mechanical, Aeronautical & Manufacturing Engineering".

The **DART** (Deep-space Astrodynamics Research and Technology) team at Polimi's DAER is committed to advance the knowledge in the field of deep space exploration by virtue of interplanetary CubeSat missions. The team is composed of 28 people (1 full professor, 1 associate professor, 2 assistant professors, 4 PostDoc fellows, 20 PhD students) and conducts both basic and applied research in the field of astrodynamics, guidance, navigation & control, and space mission design. The team's experience in this field builds upon the activities into three ESA project involving deep-space CubeSats missions (LUMIO, M-ARGO, MILANI) and four ERC-funded projects: EXTREMA, worth a Consolidator Grant, TRACES, worth a Starting Grant, and two Proof-of-Concept grants (SENSE and GUIDO). For more information, visit dart.polimi.it.

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TITLE of the project: Enabling self-driving spacecraft

Brief project description:

A new era in space is approaching fast. Soon, several miniaturised probes will permeate the inner Solar System, by targeting the abundantly variegated minor bodies in it. The space sector is enthusiastically embracing a new paradigm for space science and exploration, carried out by interplanetary CubeSats. Nevertheless, the current modus operandi can hamper this momentum: while the system development costs scale with its size, the same is not true for flight dynamics operations, which are still expensively performed from ground, so requiring personnel and ground assets, which -at this pace- will soon saturate. Self-driving spacecraft are the solution: futuristic probes shall travel in a totally autonomous fashion, inferring their position from the surrounding environment and computing their guidance trajectory onboard. If proven feasible, this technology will boost large missions as well.

The main idea of the proposed research project is to contribute to the ERC-funded project EXTREMA by developing and realizing autonomous guidance and navigation solutions suitable for the next generation of stand-alone, deep-space CubeSats. EXTREMA (or Engineering Extremely Rare Events in Astrodynamics for Deep-Space Missions in Autonomy) emerges from three main pillars, each answering a specific operational research question. *Pillar 1* faces the problem of self-determination of the spacecraft position, *Pillar 2* treats the autonomous guidance and control of the spacecraft motion, *Pillar 3* studies how to achieve ballistic capture in autonomy (this is an extremely rare event that occurs in astrodynamics). Three experiments are foreseen within each pillar, whose outcome enables creating the Orbital Simulation Hub (OSH). This is an infrastructure to simulate the spacecraft-environment interaction, in which the fundamental hypothesis has to be validated. Within this context, the research fellow will conduct research in one (or more) of the three pillars, or alternatively on the design, development, and operation of the OSH.