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

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Department Name: Department of Aerospace Science and Technology

Research topic:

MSCA-PF Research Area Panels:

- ☐ 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
- ☐ CHE_Chemistry

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

The Department of Aerospace Science and Technology (**DAER**) of Politecnico di Milano (**PoliMI**) is the largest Italian university department fully dedicated to aerospace research. In the 2023 QS world ranking by subject "Engineering - Mechanical, Aeronautical & Manufacturing" DAER is placed at 7th position.

The **COMPASS** (Control for Orbit Manoeuvring through Perturbations for Application to Space Systems) team at PoliMi's DAER is committed to advancing methods and technologies for a sustainable use of the space system. COMPASS is led by Prof. Camilla Colombo and it is composed of 15 people (1 associate professor, 1 senior assistant professor, 1 junior assistant professor, 2 PostDoc fellows, 10 PhD students). Activities span from basic and applied research in the field of mission analysis, prediction of debris population evolution, collision avoidance manoeuvring, and guidance navigation and control for multi-satellite missions. The team is involved in several research and industrial projects. For more information, visit https://www.compass.polimi.it/.

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TITLE of the project:

Swarm missions to enable innovative space services.

Brief project description:

Space services benefit social and economic development of mankind. The long-term sustainable exploitation of the outer space calls for the design of space systems compliant with high level of operational safety and proper implementation of end-of-life mission disposal.

Distributed Space Systems (DSS) may enable technological applications of scientific and societal relevance when standard monolithic solutions fail. Multi-satellite missions, swarms, and fractionated systems are key assets to build extended, flexible, and scalable space endeavours. Possible applications range from distributed sensors for Earth observation, distributed sensors for space observation, formation-flying missions around small bodies, and on-orbit-servicing technologies.

The objective is to conceive an innovative space service/instrument that leverage the DSS architecture. The feasibility of such mission concept will be assessed by investigating the following themes (T).

T1. *Development of relative GNC (guidance navigation and control) algorithms*, to support the relative navigation and the establishment and maintenance of the required relative configuration between the elements of the DSS. The relative GNC system entails all the functions that complement the standard orbit/attitude determination and control functions of single-satellite missions. The typology of the algorithms implemented in such relative GNC systems depends on the geometry of the configuration (e.g., range, orbital environment) as well as on the structure of the architecture (e.g., level of cooperation, means to share the information among the units).

T2. *Management of the safety of the DSS*, in terms of collision avoidance monitoring and manoeuvring. Multi-satellite systems require a special treatment of element-element collision avoidance compared to the standard methodologies applied to single-satellite missions encountering an external satellite or debris. This is mainly due to the different time scales of the encounters and to the possible use of relative trajectories that are not passively safe. The safety management involves different layers of the system, namely: the sensing sources providing observations, the algorithms to assess the collision risk, the strategy to (actively) ensure collision avoidance, and the hierarchy/priority of protective measures to ensure collision avoidance during operations.