



PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 39th cycle

**THEMATIC Research Field: EVOLUTIONARY PREDICTIVE MODEL OF THE SPACE DEBRIS
POPULATION**

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

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**

The privatisation of Space and the Space Economy led to an increase in the number of orbiting objects in space. As the number of launches increases, as well the number of space debris objects in space is following exponential growth. Many sources cause the creation of new debris, such as launcher upper stages, satellite failures, inoperative satellites left in orbit at the end of life, fragments from in-orbit explosions and collisions, etc. As our life is becoming more and more interconnected thanks to satellites, and space is more easily accessible, Space can be seen as the extension of our planet's biosphere. As such, the long-term sustainability of space activities will be possible in the next decades only if a change of behaviour is put in place by space-faring nations. The mitigation of space debris requires the active control of its population and the definition of feedback action onto it. Models of the overall population on the other side need powerful tools of high-performance computing due to the very high dimensional problem and advanced formulation of the dynamics to integrate their evolution in a stable and efficient manner.

**Methods and techniques that will be
developed and used to carry out the
research**

This PhD research is part of the GREEN SPECIES project. In this we will model the dynamical evolution of space debris as a dynamical system, considering the accurate definition of all the sources, sinks of the space debris population and the underlying dynamics of orbit perturbations. The density of space debris objects in the



	perturbations. The density of space debris objects in the space of the orbital elements will be used as an adjoint variable. The continuity equation will be applied for the first time to an N-dimensional space debris environment to directly output the space debris density time history for a given orbital shell. The analysis of transient and asymptotic behaviour of the complex dynamical system as such will be performed to reveal its sensitivity to sources, sinks and control parameters. Uncertainty propagation techniques will be implemented to consider all uncertainties of physical, economic and political nature. Robust control techniques will be devised to account for model, processes, and parameter uncertainties and to account for uncertainties in the prediction of economic and policy nature. HPC will be employed thanks to participation in the HPC national centre. Finally, quantitative indexes will be devices to assess the impact of space missions towards sustainable development goals and to assess the impact of space missions on the use of the overall space capacity. www.compass.polimi.it
Educational objectives	The objective of this PhD is to develop skills in the modelling of space debris and the control of the space environment and the definition of indexes using the Life Cycle Assessment approach. Through this PhD project, the candidate will develop skills in mathematical development, simulations, and programming (Matlab, Phyton). Soft skills in presenting the research, writing reports, outreach, dissemination, and preparing industrial progress meetings will be also achieved through the PhD project. The PhD candidate will be also involved in the research, industrial projects, and organisational and outreach activities of the group. For further information on the project visit: www.compass.polimi.it
Job opportunities	Job opportunities after a PhD o this topic can be in any of the space agencies, in particular the European Space Agency and the several European companies involved in space traffic management, space situational awareness, space policies and mission design.
Composition of the research group	0 Full Professors 1 Associated Professors



	2 Assistant Professors 6 PhD Students
Name of the research directors	Prof. Camilla Colombo

Contacts	
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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	700.0 €
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.