Analysis of Low-Thrust only Spacecraft for Libration Point, Lunar and Science Missions

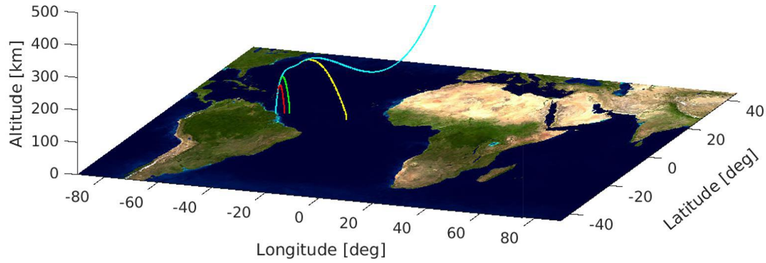
TECHNISCHE UNIVERSITÄT DARMSTADT

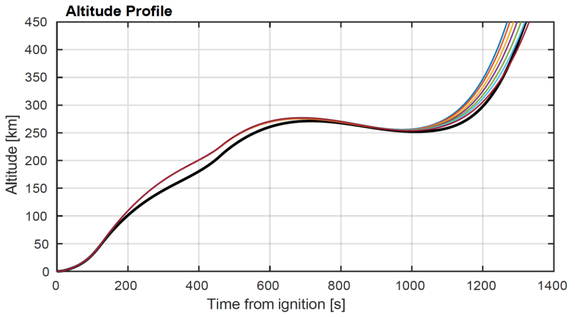
Our Team and Mission:

The Mission Analysis Section is entrusted with mission studies for future terrestrial, lunar and interplanetary missions as well as scientific missions located in planetary or lunar libration points with emphasis on trajectory and attitude related aspects, and on supporting ground segment design and operations. This includes trade-offs for selection of the nominal mission trajectory, definition of manoeuvring strategies, optimisation of orbital manoeuvres (low- and high-thrust propulsion, including rocket ascent trajectories), calculation of propellant budget, analysis of launch window, analysis of orbit perturbations and navigation. The task also includes development of the necessary analytical and numerical methods and software tools.

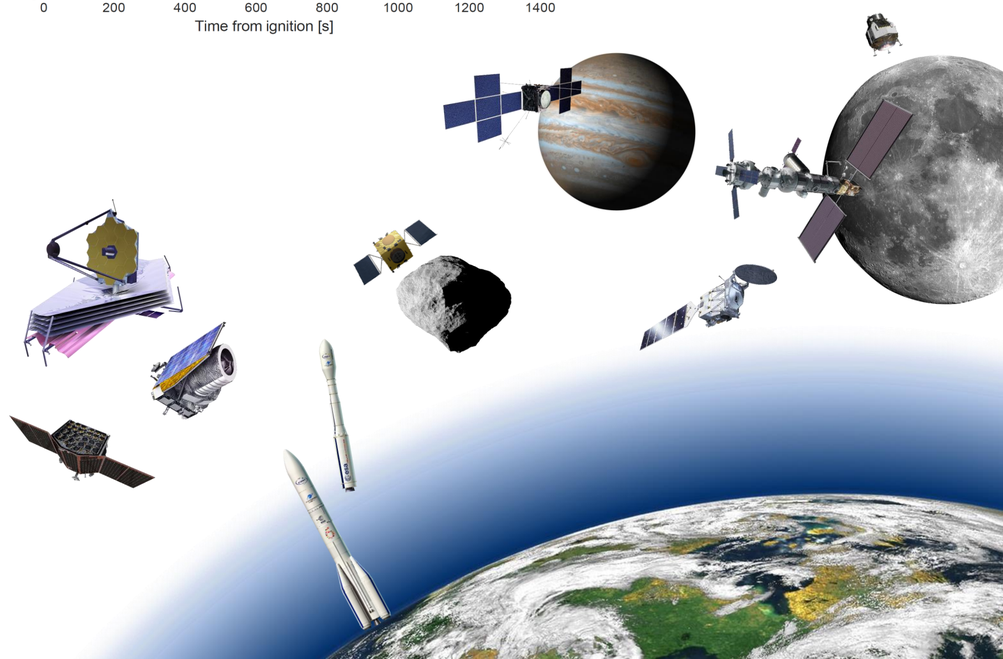
Field(s) of the Activities/Research:

Many missions have been or will be launched towards the Sun-Earth Libration regions, into cis-lunar or interplanetary space. All such missions first have to be launched into a transfer trajectory. While today's launchers provide an extraordinary injection accuracy into these transfers, some inaccuracy in the separation state is inevitable. This so-called launcher dispersion must be corrected by the spacecraft after separation from the launcher. The correction manoeuvre may be time-critical as its cost often increases strongly with the time from separation. Furthermore, for technical reasons related to the control of the ascent, a launch vehicle might not always be targeted directly at the required transfer. The payload must also compensate the resulting offset by appropriate manoeuvres. While for some missions the required size and timing of these correction manoeuvres has been considered prohibitive for electric propulsion, the current trend towards miniaturisation of spacecraft and the ever-increasing accuracy of the launcher have reached a point were all-electric low-thrust spacecraft may become feasible. Within this study the student shall investigate the limits for all-electric spacecrafts.





credit: ESA



The tasks include:

- Familiarisation with launch systems (e.g. Ariane 6 and Soyuz-Fregat) and their technical limitations
- Familiarisation with the typical transfer trajectories and the transfer navigation requirements towards for Sun-Earth Libration Point, cis-lunar and interplanetary trajectories. This includes a familiarisation with the three body problem
- Familiarisation with numerical integration methods and the equations of motion
- Familiarisation with CubeSat and Micro Satellite Designs and state-of-the art electric propulsion systems to establish realistic thrust-to-mass ratios for the required analysis
- Adaptation of the existing transfer navigation design tools from high/impulsive manoeuvres to low-thrust trajectories
- Applying the new transfer navigation tools to realistic launch scenarios and performing a parametric analysis
- Documentation of the results

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