ExoDaedalus mission concept : solar wind sample return, Sun study and solar sail magnetic storm monitoring. K. Barbey, [1]EPFL 1024 Ecublens, kent.barbey@epfl.ch.

Introduction: In the early 2000's, missions to the Sun-Earth libration points L_1 and L_2 took a turn thanks to the implementation of dynamical systems theory and machine learning techniques to trajectory design. The *Genesis*[1] mission was the first one to make use of these methods with the goal of returning solar wind samples back on Earth. Unfortunately, the return capsule crashed violently in the Utah desert upon re-entry, severely contaminating the samples. Concomitantly, predicting magnetic storms due to solar flares became of interest as more and more artificial satellites orbited the Earth. In fact, a *Geostorm*[2] mission design concept was written by the JPL. These types of mission have the objective to warn Earth before a magnetic storm hits it and prepare the protection of the satellites' systems adequately. The first libration point of the Sun-Earth system is optimal in this case as it provides enough warning time, can communicate with Earth and monitor the Sun at all times. The downside being that station-keeping at this point requires a lot of fuel. Solar sails were as a result studied. The recent development of this kind of propulsion notably with *Ikaros* and *L'Garde*'s TRL 6 10'000m^2 sail[3] puts this kind of mission concept back on the table.

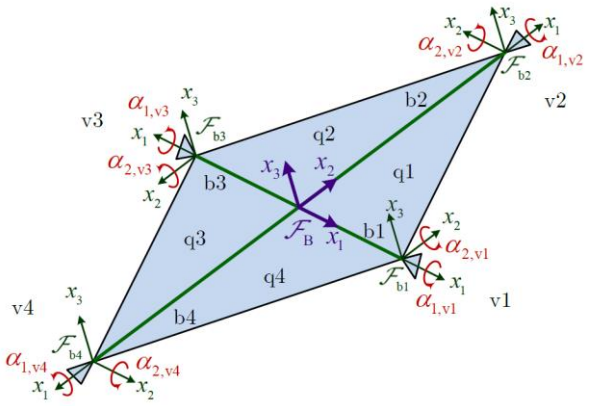
Objectives: The goal of *ExoDaedalus* is to efficiently combine the two concepts described above :

1. Return new solar wind sample to the Earth in the same fashion as *Genesis* with the *Exodus* module.
2. Provide a first solar monitoring mission using a solar sail with the *Daedalus* module.

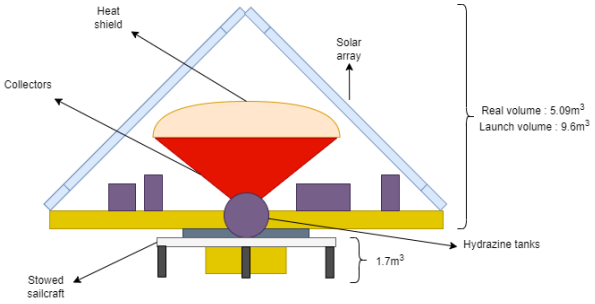
to successfully accomplish the three following objectives :

a) Return intact solar wind samples to Earth.
b) Study the solar wind in a never studied regime for a complete solar cycle(11 years).
c) Demonstrate the Geostorm mission design concept with a solar sail.

Mission scenario: The optimal mission scenario spans on 11 years with a launch by a Vega-C in Kourou, GF. The first part of the mission focuses on sample return. The S/C is inserted into a L_1 halo orbit, collects solar wind samples for 30 months and returns them back to Earth thanks to the sample return capsule. The remaining S/C is sent back to L_1, deploys its sail and inserts itself into a so-called Sub-L_1 orbit in order to study the Sun with its scientific instruments and provide solar storm monitoring. Station-keeping is provided with the tipping vanes[4] of the solar as shown on the figure below.



Spacecraft: *ExoDaedalus* is composed of two modules : *Exodus* and *Daedalus*. The former is in charge of collecting and returning the solar wind samples. The latter provides all other life and scientific systems of the S/C, having therefore the objectives to demonstrate the sail technology, study and monitor the Sun. Below a diagram of the full spacecraft in its launch configuration :



References:

[1] Martin Lo et al. (1998) *Genesis Mission Design.*
[2] Chen-Wan L. et al (2004) *Solar sail warning mission design*.
[3] David Lichodziejewski et al. (2003) *Bringing an effective solar sail to TRL 6*.
[4] Soroosh Hassanpoor et al (2018) *Linear structural dynamics and Tip-Vane attitude control for square solar sails.*