

Low Cost, High Energy Missions Using Solar Sail Propulsion

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PPARC KITE Club: Science on low cost space missions

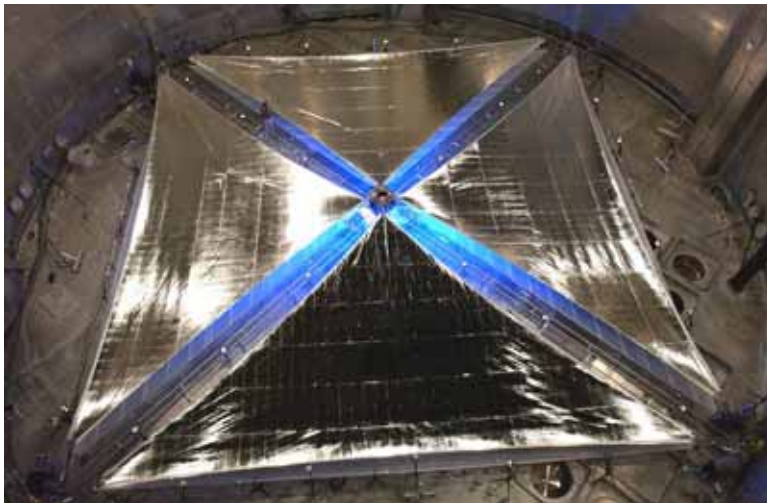
24 January 2007

Space activities

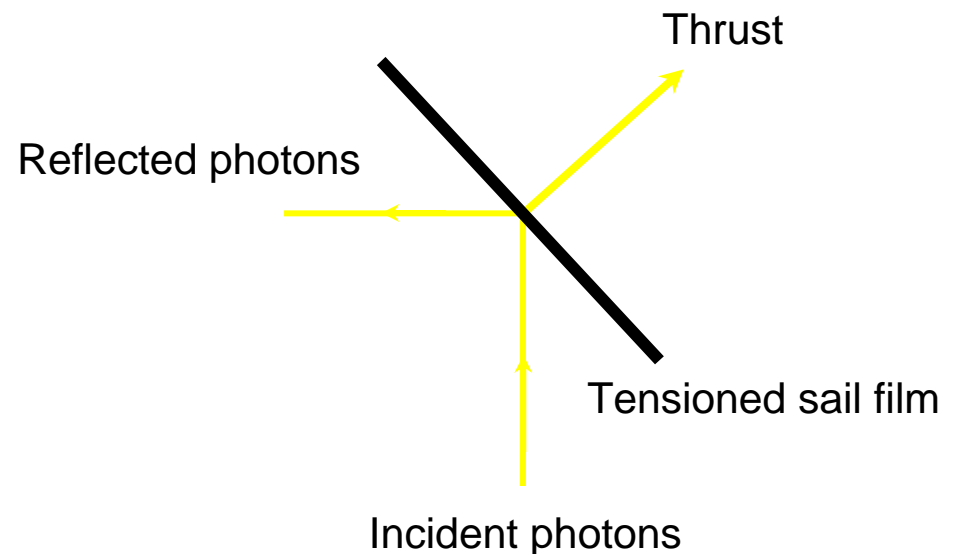
- **Solar sail orbital dynamics and mission analysis (ESA, NASA, EPSRC)**
- **Spacecraft formation-flying collision avoidance (SciSys, Astrium)**
- **Spacecraft autonomy (PPARC CASE with Astrium, Scisys and others)**

Solar sail propulsion

- Utilise light pressure for propulsion – small, but continuous acceleration
- No propellant – can enable new high energy/long duration mission concepts
- ESA/NASA interest – NASA ST-9, DLR/ESA demo, ESA solar sail TRS . . .

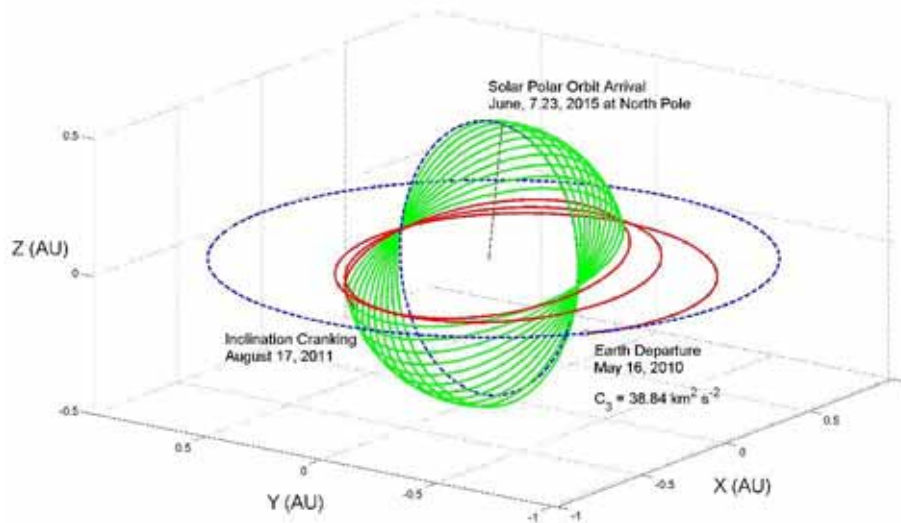


[NASA/ATK - 20 x 20 m ground test, 2005]

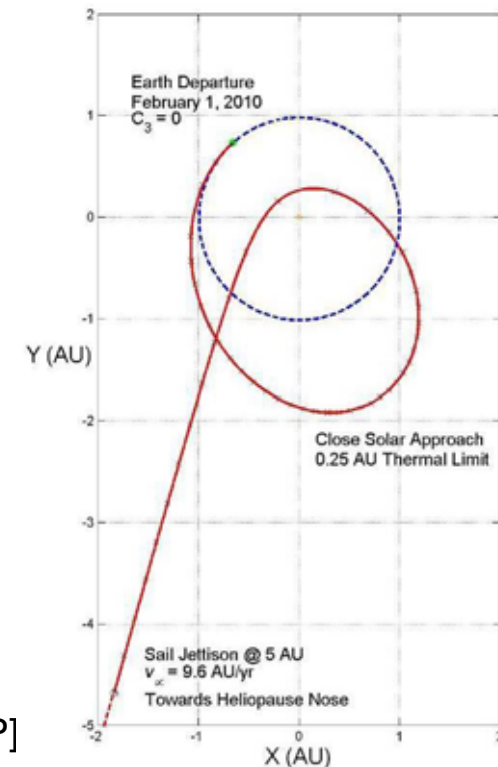


ESA technology reference studies

- 2 key sail missions identified through TRS contracts (+ GeoSail SMART demo)
- Solar Polar Orbiter - 90° solar polar orbit in 5 yrs with 540 kg launch mass
- Interstellar Heliopause Probe - 200 AU in 25 yrs with 625 kg launch mass



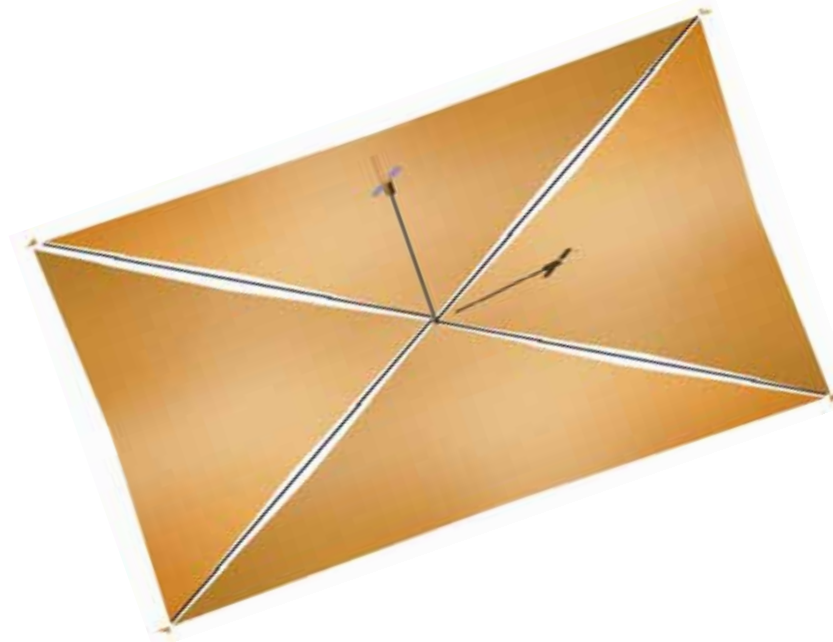
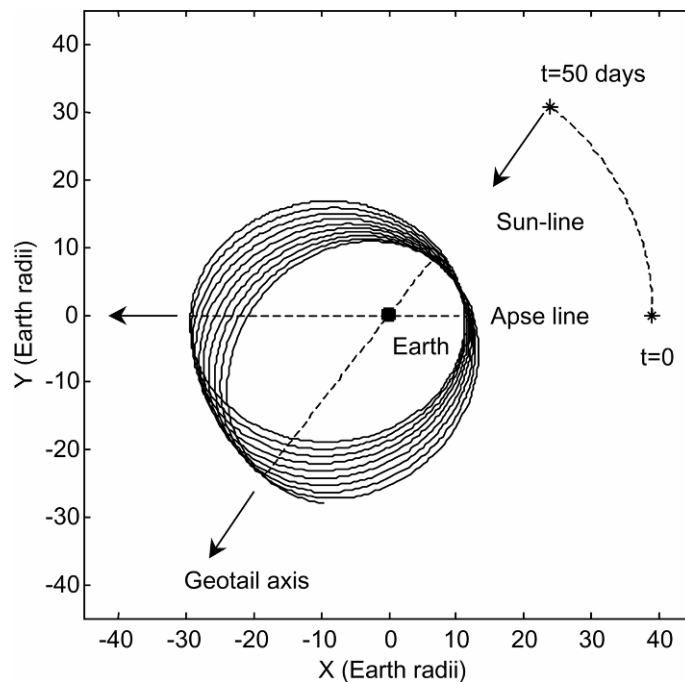
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ESA GeoSail study

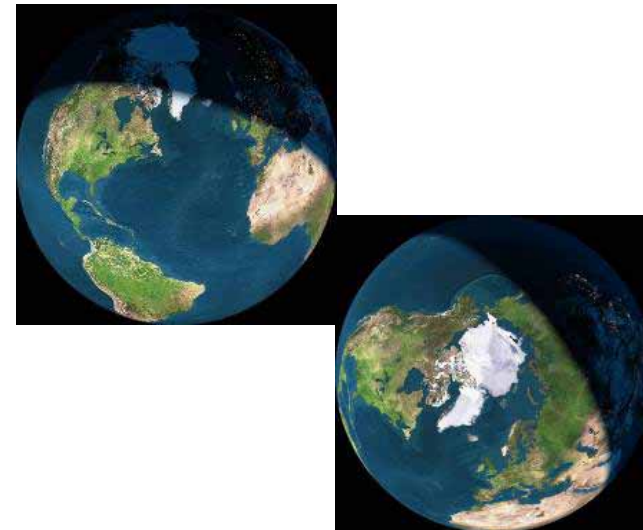
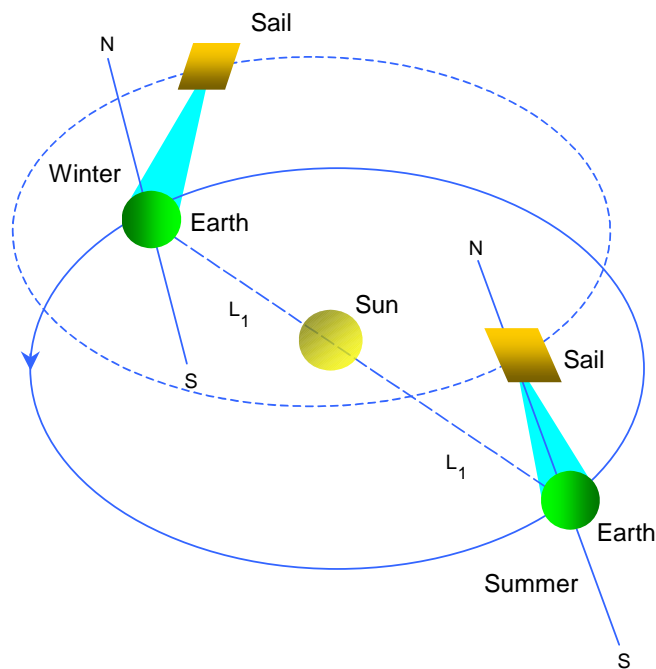
- Use 40 x 40 m sail to artificially precess long elliptical orbit at ~ 1 deg/day
- Keep small space physics payload permanently within the geomagnetic tail
- Current ESA Sci-A contract to Kayser-Threde, Astrium, SciSys, Strathclyde



Geosail [SMART demonstrator 170 kg]

Earth observation and telecomms

- Artificial 3-body equilibria with sail enables real-time observation of poles
- Future applications for real-time polar imaging (developed with NOAA/OSD)
- Continuous data relay function for large polar science facilities (NSF/NOAA)

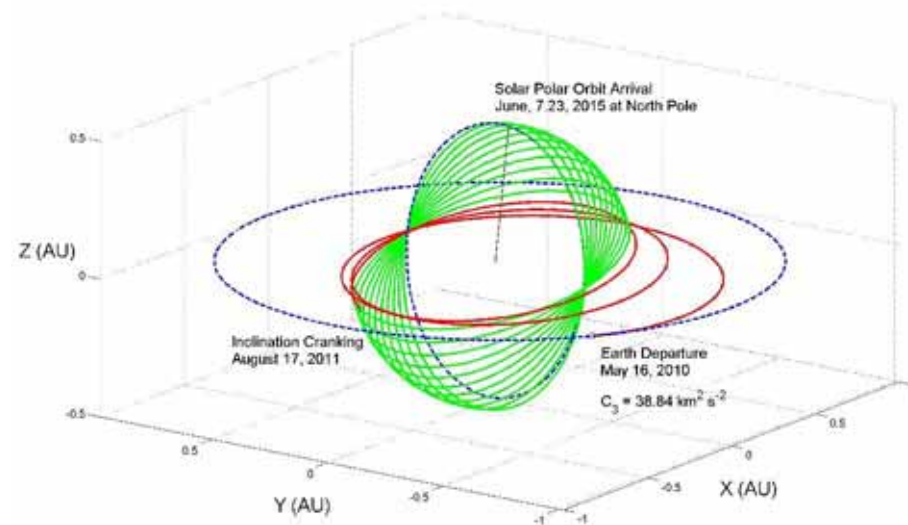


Future opportunities

- Reducing mass is the key to solar sailing (instruments and spacecraft bus)
- Opportunities for highly integrated low mass/power systems for future sails
- Solar sails provide high energy at low cost and enable new science missions



[ATK 70 g/m boom]



Summary

- **Solar sailing is moving up the agenda at ESA for future science missions**
- **Can deliver very large effective Δv with modest launch mass (Soyuz-Fregat)**
- **Low cost missions need not imply low energy missions (enable new science)**
- **Opportunities for science, low mass/power spacecraft bus and instruments**



EPSRC grant EP/D003822/1

"Dynamics, Stability and Control of Highly Non-Keplerian Orbits" [2006-2009]



ESA contract ESTEC/16534/02/NL/NR

"Science Payloads Transported Through Solar Sailing " [2002-2005]