XII International Summer School dedicated to the 105^{th} anniversary of the first passenger aircraft

Computer technologies of engineering mechanical problems

(LMSU Institute of Mechanics, July 2 — August 10, 2018)

Solar sail formation flying control

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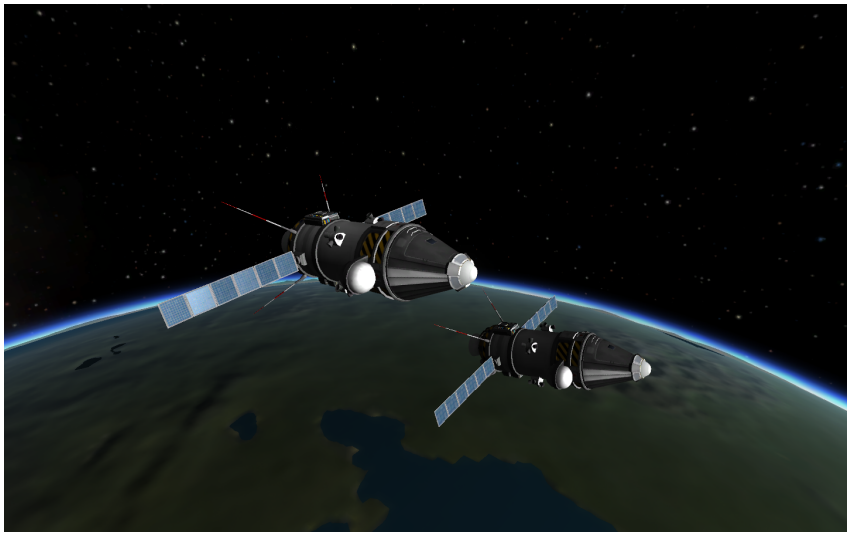
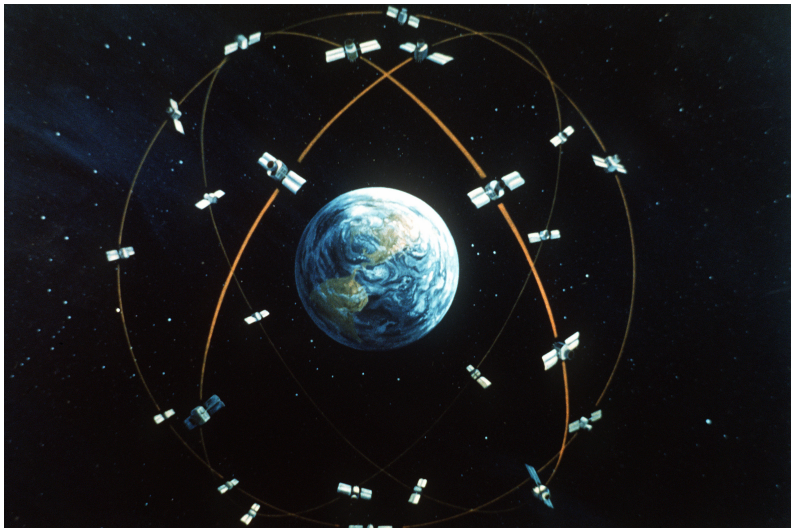
Satellite formation flying (FF)



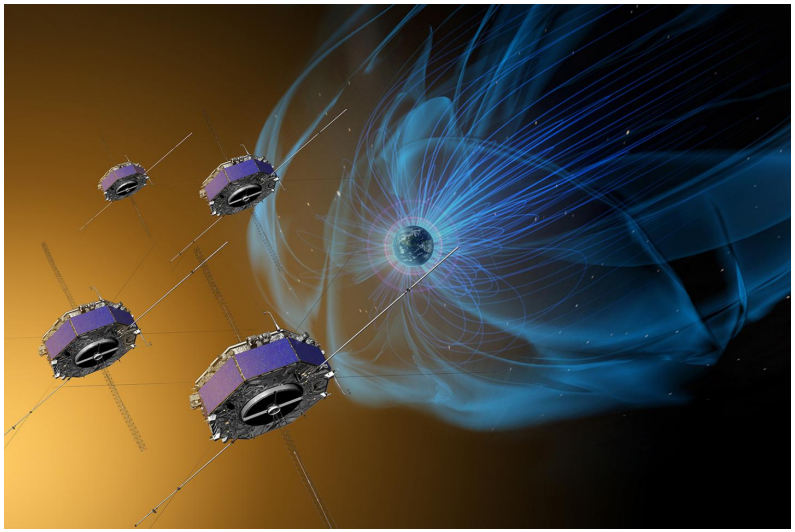
Earth's remote sensing

- launch cost
- fail-safety
- upgrade

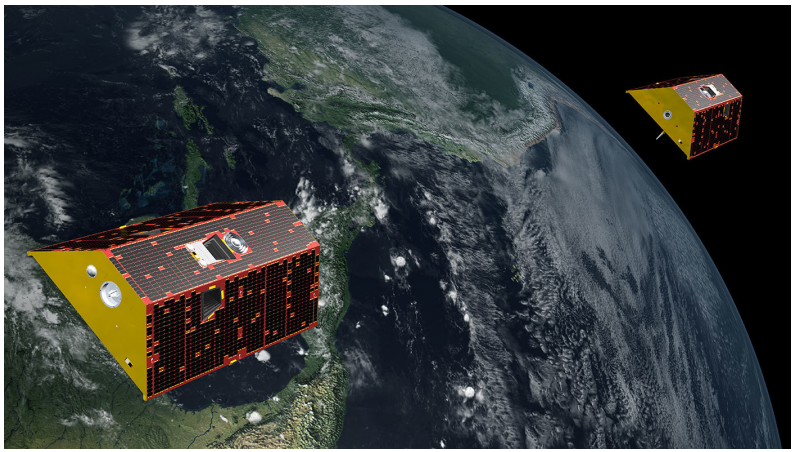
Examples of FF and constellations



GPS

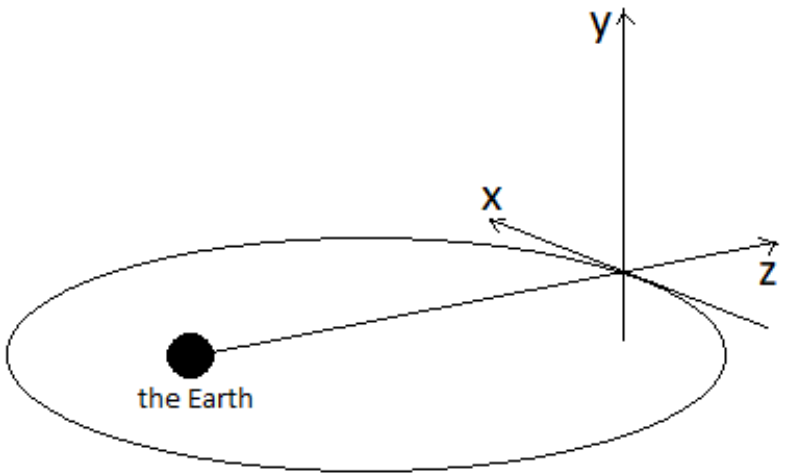


Magnetospheric Multiscale (MMS)



GRACE

Relative motion



Hill equations

$$\begin{cases} \ddot{x} + 2w\dot{z} = 0; \\ \ddot{y} + w^2 y = 0; \\ \ddot{z} - 2w\dot{x} - 3w^2 z = 0 \end{cases}$$

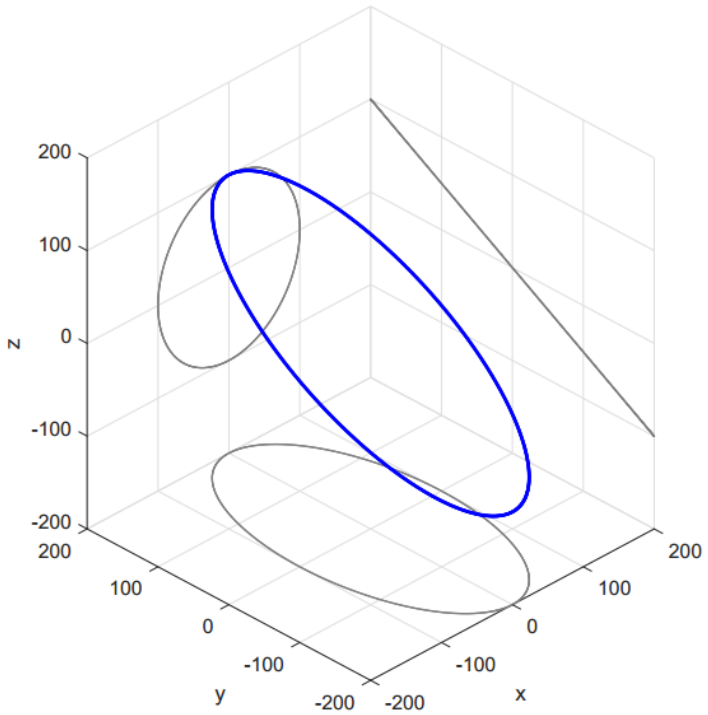
where w is an orbital velocity of the chief satellite.

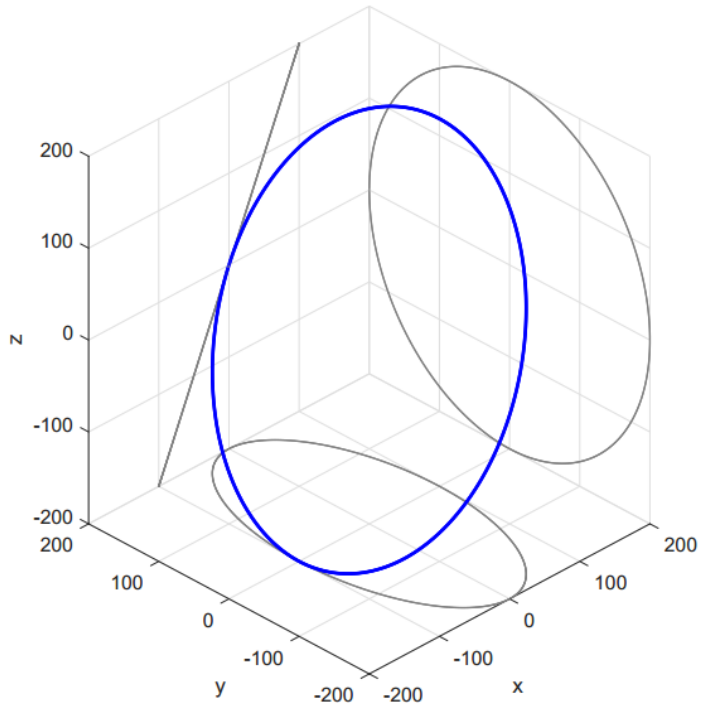
Decision and orbits

Decision of Hill equation

$$\begin{cases} x = -3C_1wt + 2C_2\cos\ wt - 2C_3\sin\ wt + C_4; \\ y = C_5\sin\ wt + C_6\cos\ wt; \\ z = 2C_1 + C_2\sin\ wt + C_3\cos\ wt \end{cases}$$

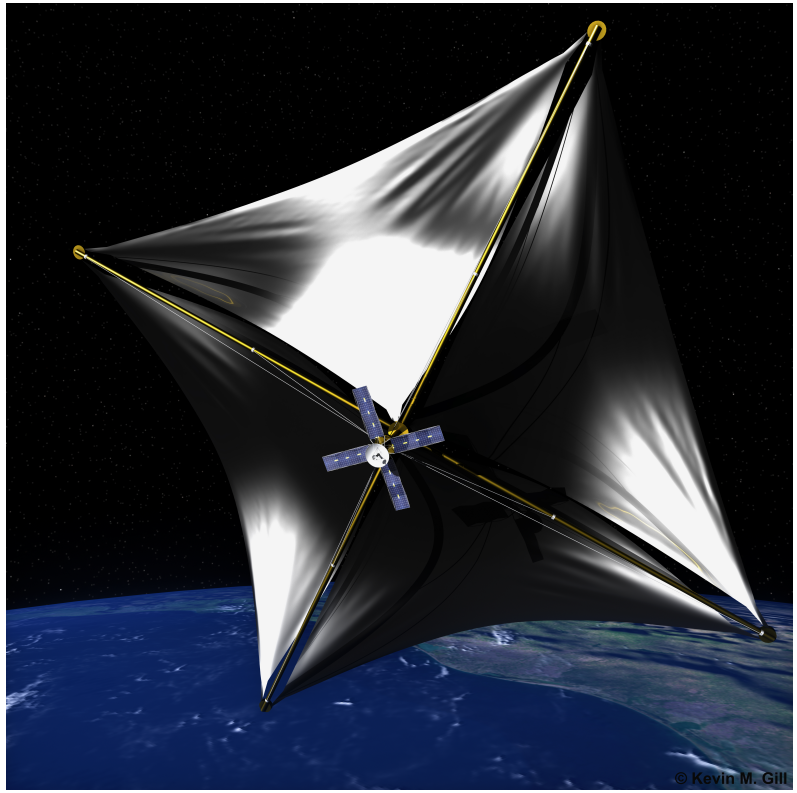
Orbits





Control

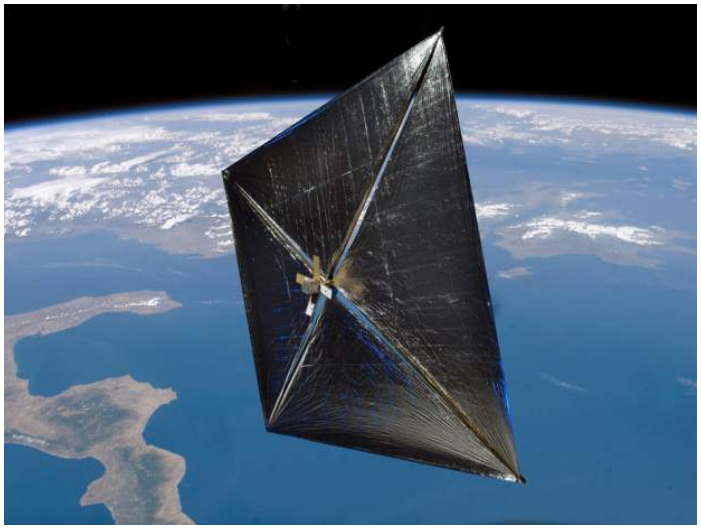
Plasma engine



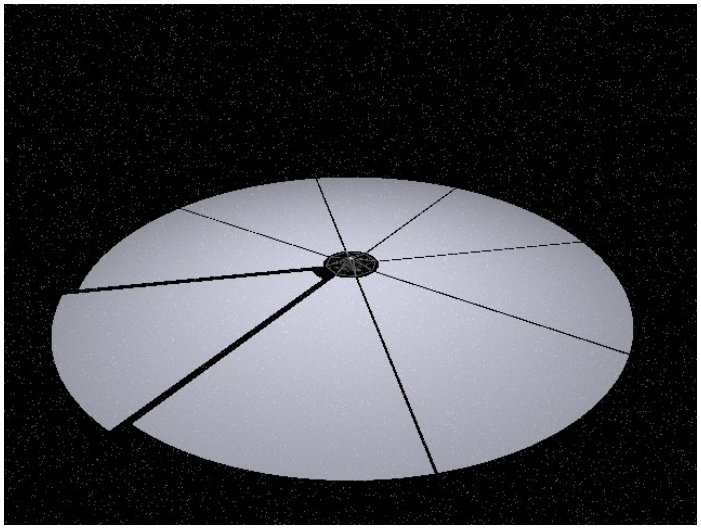
The solar radiation pressure force

- jet-propulsion engine
- plasma engine
- atmospheric drag
- the solar radiation pressure force

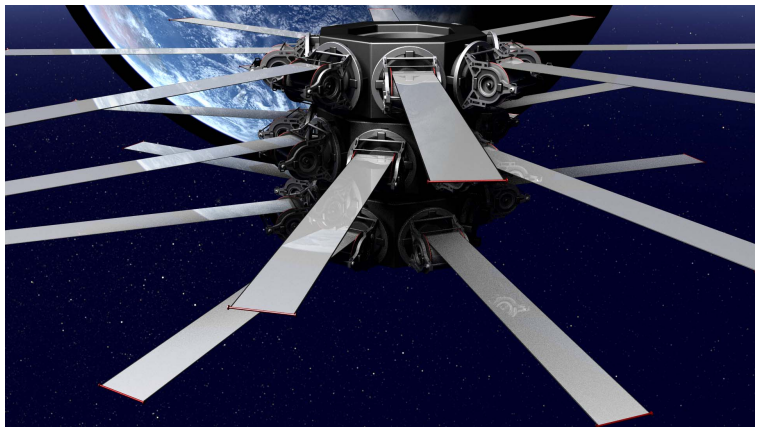
Types of solar sail designs



Square solar sail

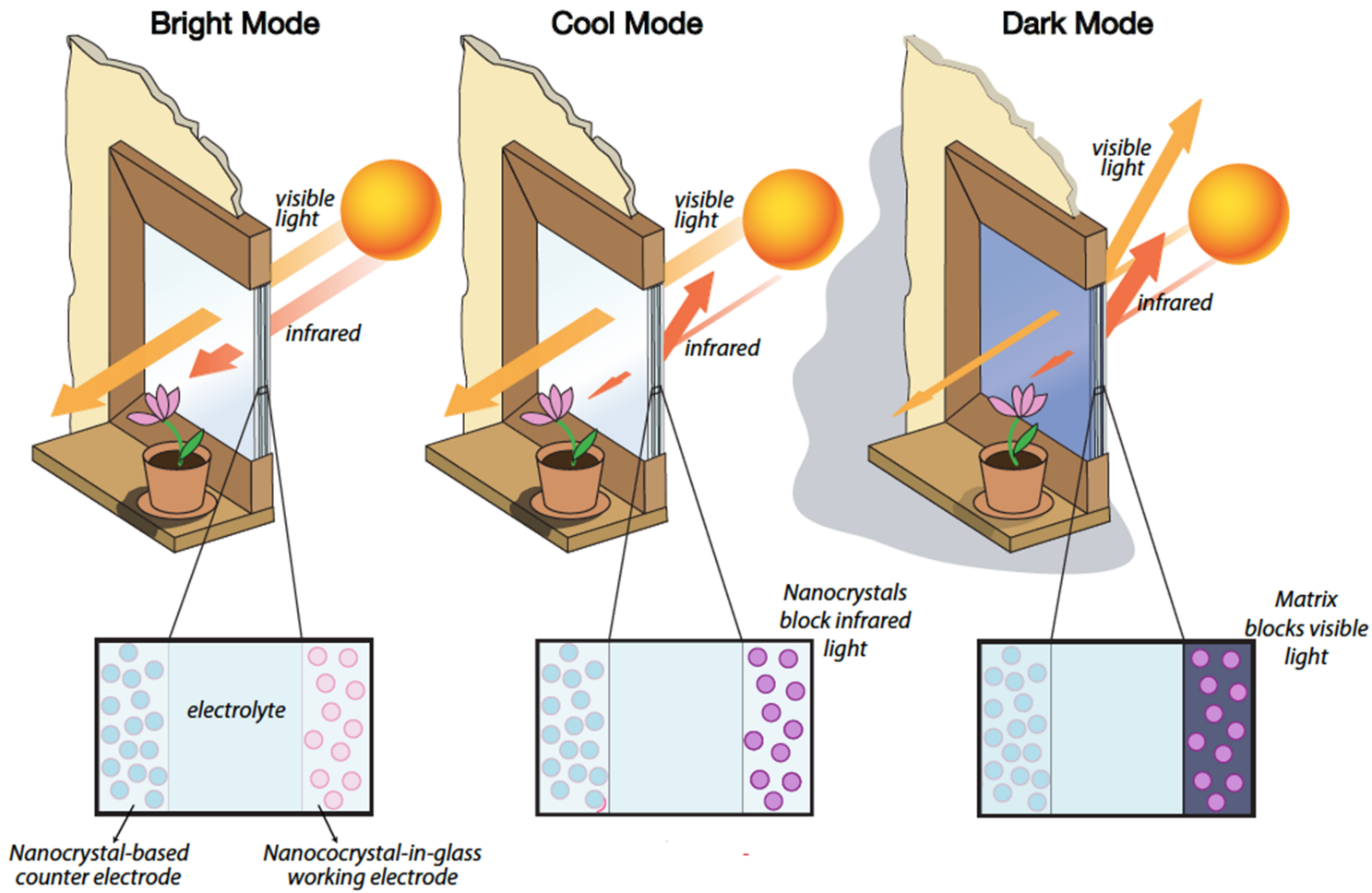


Spinning disk sail



Heliogyro sail

Smart window



The solar radiation pressure force

$$d\mathbf{F}_{SRP} = -\frac{\Phi_0}{c}\left[\rho_a(\mathbf{s},\mathbf{n})\mathbf{s} + 2\rho_s(\mathbf{s},\mathbf{n})^2\mathbf{n} + \rho_d(\mathbf{s},\mathbf{n})\left(\mathbf{s} + \frac{2}{3}\mathbf{n}\right)\right]dS$$

ρ_a — absorbed photons;
ρ_s — specularly reflected photons;
ρ_d — diffusely reflected photons;

Questions?