Study notes for Chapter Six of *Solar Sailing: Technology, Dynamics, and Mission Applications* by Colin R. McInnes last edit 2016 April 11 MBM

pXXX.YY means page XXX, line YY. Making a guide is useful.

p230.02 "Geostorm" orbits around the Sol-Terra line displaced from L1 toward Sol. See p232 fig.6.1.

p233.36 Compare 29 g/m^2 with ~5 g/m^2 tab.3.1 p60t.

p234.09 "then spiral inward to operating station" but would not it get ahead of Terra in its orbit before arriving at final solar distance? Or does it stay within extended LaGrange point?

p234.36 Eq.6.1a same as eq.5.121a p217, eq.6.1b same as eq.5.122 p217.

p235.02 Eq.6.2a same as eq.5.144 p225 p226, eq.6.2b same as eq.5.148 p226.

p235.13 Eq.6.3a from modified fig.2.7 p47, eq.6.3b same as eq.5.149 p226.

p235.19 Add α to "and pitch angle α".

p235b Change to "As the sail reflectivity is decreased, the required sail loading ~~increases~~ decreases (sail must be more efficient), and the absolute value of the required pitch angle increases", see Tab.6.1 p236.

p236.01 Tab.6.1 In caption add "r~" to "reflectivity r~".

p236.29 Fig.6.2 Sol is far to left, Terra to rite.

p236.42 "29.6g/m^2" et cetera see p60.

p237.18 Fig.6.3 TBR?

p237.28 Attitude control. If sail is off balance conventional thrusters will not last long. "centre" is British for "center".

p238.15 Spiral again. Does the sailcraft get ahead of the Sol-Terra line?

p239.06 Add "of" to "periods of interest".

p239.41 "83° to ecliptic plane" or up to 90° the closer the orbit is to passing thru Terra's nodes.

p239.42 "normal to Sun-Earth line" Hwy, and hwy would N>1 work?

p240.14 Sail square, Terra round, note the proper illumination. Add tick marks for one and two months. Add second diagram for N=3, see p240.22

p240.35 "only from a solar polar orbit". Or from Sol-Terra L4 and L5. Maybe this mission should be separate from the Solar Polar mission. A sailcraft with β = 0.0702017719 can get to the trailing Trojan point by setting α = 0, arriving in 14 months. A sailcraft with β = 1 - 1/8 = 7/8 at 1/2 au is synchronous with Terra, and a few light minutes closer. Station keeping required.

p241.18 Eq.6.4a is from p120 with p = r and ω = 0.

p241.20 Eq.6.4b confirms misprint p120 eqs.4.15.

p241.29 "cranking orbit manoeuvres" spelled maneuvers in American. First spiral in, then crank.

p242.30 Change to "must ~~almost~~ also provide".

p243.08 "28°" add "28° from the Sun as see from Terra".

p244.23 Radiation from Mercury can add momentum to sail.

p244.36 "DLR" is Deutsche Zentrum fu"r Luft- und Raumfahrt.

p245.24 Eq.6.6 is eq.4.14d p120 with i = 90° since this is a polar orbit.

p245.29 "regression", of orbit orientation? Need help here.

p245.30 Change to "radius r = $p/(1+\cos f)$ of" from elliptical equations. Substitute into eq.6.7.

p246t Fig.6.7 Show Sol direction, sail tilt. Should be 0, 50, 152, 255, 305 minutes. R_P = 2440 + 200, r_A =2440 + 6350, e = 0.5380. At E = 0, 90, 180, 270, 360 degrees time is $\Delta t90° = (E - e\sin E)(p/2\pi) =$
$(\pi/2 - .5380*1(305/2\pi) = 50$ minutes

p248.04 gI_{SP} is probably the same as exhaust velocity. See p17 and notes.

p249.24 Is there momentum transfer to sail from sampler, or is it a soft catch?

p249.26 β ~ 0.13

p250.13 The outbound and return orbits are not symmetric, as lander mass is missing, so that the value of β goes up.

p250.21 β ~ 0.17

p252t Fig.6.9 implies that Terra's axis shifts. Redraw.
Put Sol at center of diagram, Terra on each side to represent six month's difference. Label with Boreal Summer Solstice, et cetera. Still need tracking antenna. If sail is on Terra's axis at solstice, it will be

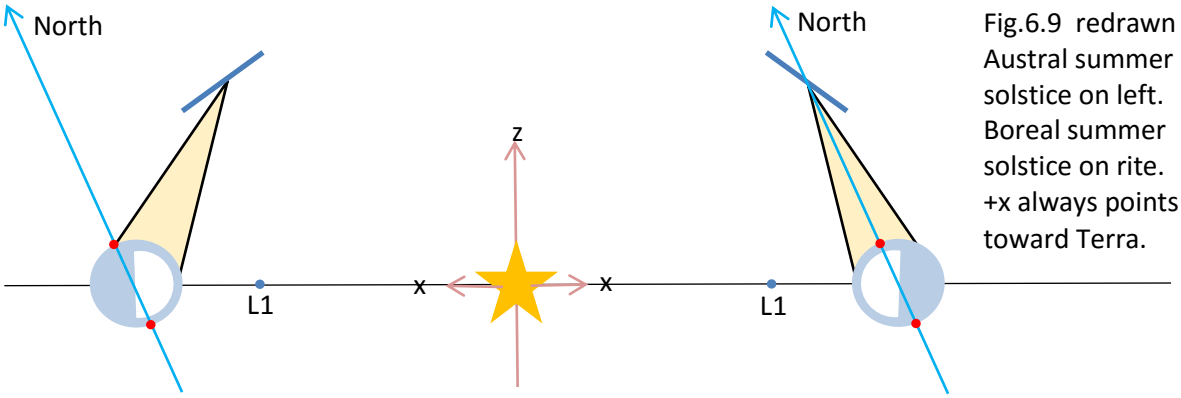

Fig.6.9 redrawn . Austral summer solstice on left. Boreal summer solstice on rite. +x always points toward Terra.

p253.20 Fig.6.11 Extend vertical axis to 1 km or smaller.

p253.38 I still need help with Statite concept. See Forward's *Indistinguishable From Magic.*

p254.30 Eq.6.3b, p235.

p255.19 Fig.6.12 Shade half of Terra to indicate Sol to left.

p258.20 Fig.6.14 Note that all orbits are initially outbound.

p259.15 Fig.6.15 See p175.

p259.30 Sail density 0.518 g/m^2.

p259.39 How does the phase relative to Terra change?

p262.21 “nett” is British usage.

p262.22 Lightness number 0.5 is parabolic, $0.5<\beta<1$ is hyperbolic, 1.0 is rectilinear, $\beta>1$ is again hyperbolic with Sol at empty focus.

p262.32 Can there be a resonance problem?

p263.21 Fig.6.17 has $\beta=0$ (edge on) for transfer orbit, $\beta>1$ for hyperbolic escape, gaining speed as it leaves Sol.

p264.27 From text and fig.6.18 and 6.19, fixed at -40° for all time. Not sure of the point, as changing to $\alpha = 0$ at perihelion lets you keep perihelion speed, as $\beta = 1$. Hwat is the advantage of H-reversal compared to prograde pass at Sol, using the most efficient pitch angle. Change to edge-on at the point hwere the resulting Keplerian orbit has perihelion at minimum approach distance. Set $\alpha = 0$ and ride linear orbit out of system.

p265.20 Fig.6.19a. As usual, initial orbit is outside that of Terra because spacecraft has Terra’s circular speed but reduced effective gravity.

p265.44 Fig.6l19b. $\beta = 1$. Graph shows that by staying with $\alpha = -40^\circ$ instead of changing to $\alpha = 0$ at perihelion there is a 10% loss in final speed.

p266m Need diagram or other explanation for two passes of Sol and yet reduces transit time. Just increased speed during 2nd perihelion pass? Hwat is 2-pass speed relative to Pluto?