Background:

Cassini is a 20-year-old joint mission carried out by the European Space Agency, Nasa and the Italian Space Agency. Cassini was launched from Florida, in 1997 and its journey to Saturn took 7 years. It was originally intended to explore the planet and its moons for just three years however, its life was extended by another decade. The space mission is regarded as one of the most ambitious and successful ever undertaken.
From the moment Cassini arrived at Saturn in 2004, its cameras and other instruments completely altered scientists' viewpoints and understanding of the most distant planet visible to the naked eye. Before the mission astronomers thought that Saturn was circled by thousands of rings. Cassini had astonishingly revealed that in fact it was millions. And rather than static bands of dust, the rings have a complex life of their own.

Aims:

Initially we had to learn the basics of MATLABs and find a way to visually display the data we were given. We would then have to workout the standoff distance of the crossing. The main aim of the project was to identify the solar wind pressures in Saturn's magnetosphere at different bow shock crossings. We had 3 revolutions to work with.

Method:

We first had to Identify the 'crossing KSM coordinates' at which the SC crossed over the Bow shock. To do this, we used a function called 'PlotSaturnData' (coded by N. Achilleos), which plotted the Magnetic field strength applied to the SC in nT against hours since an inputed date and time. Using this we identified the crossings by eye, looking for large increases or decreases in the magnetic field strength which were sustained for a period of time. We then used another script called 'GetCoordinates' to drag a rectangle over the crossing, which would then lead the function to output the KSM coordinates of the SC at that point. Although this gave us most of the crossings, it was quite a subjective method. In future, we would like to find a more precise and accurate way of identifying the crossings and their KSM coordinates, maybe using another function or even machine learning (which may be able to eventually identify the crossings with almost 100% accuracy). We recorded (in a new file for each orbit of Saturn) the KSM coordinates of the crossings. Then, by using 2 functions called 'JourneyPlotter' and 'FileRead' we plotted the path of the SC with axis of X KSM coordinates on the X axis and the distance from the X axis ((Y KSM coordinate squared + Z KSM coordinate squared) square rooted) on the Y axis. The functions then superposed the crossings onto the graph by reading the cell array in the files of the KSM coordinates. Finally the functions displayed the solar wind pressure. To get this, we used model H for modelling the surface of the bow shock, then using the equation:

$$r = L/(1 + \varepsilon \cos\theta)$$

We found the standoff distance when $\theta = 0$. We could then use the equation:

$$R_{SN} = c_1 P_{SW}^{-1/c2}$$

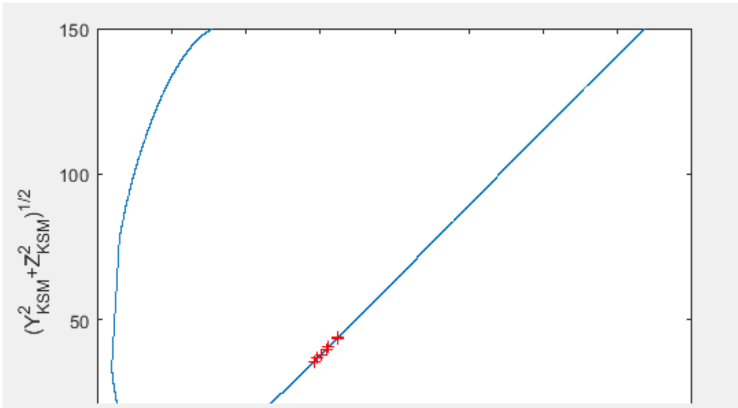
(where c_1 is 12.3 ± 0.7 and c_2 is 4.3 ± 0.3) To get the solar wind pressure at each crossing. Which we recorded alongside the KSM coordinates in the specific orbit file.

Results:

Data for crossings in 0th revolution

XKSM	YKSM	ZKSM	SWP

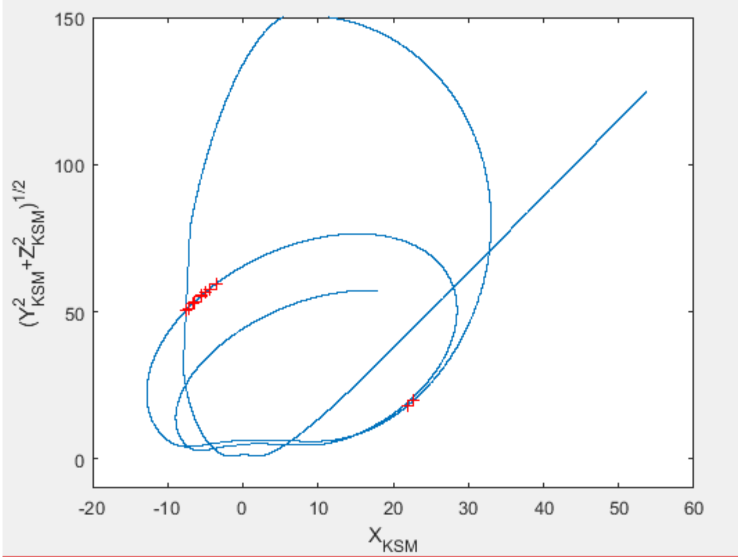
[redacted]



Data for crossings in revolution A

XKSM	YKSM	ZKSM	SWP

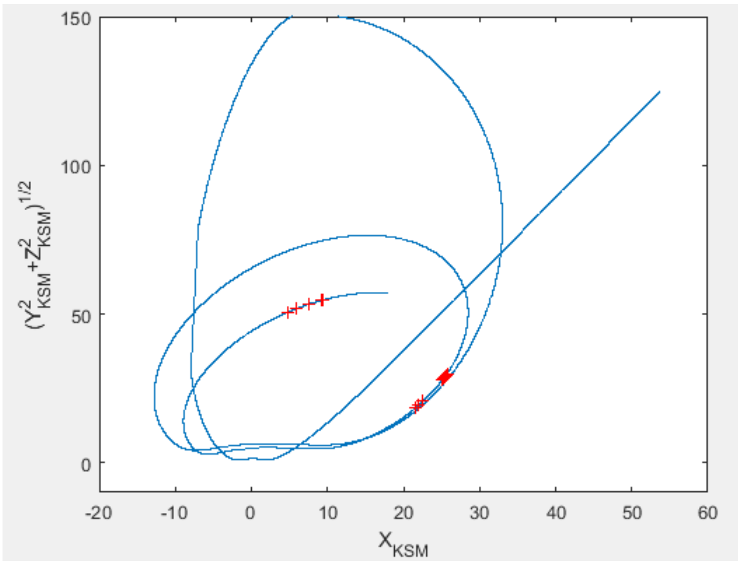
[redacted]



Data for crossings in revolution B

XKSM	YKSM	ZKSM	SWP

[redacted]



Conclusion:

During the 0th revolution, solar wind pressure varied from 0.0103 to 0.0225, a variation of 0.0122. The data for crossings in revolutions A and B varied both a smaller amount of 0.0093 and a larger amount of 0.0329. During the 0th revolution, as the X coordinate decreased, meaning the satellite moved further away from the sun, SWP increased. This concept is mirrored also in revolutions A and B, meaning that solar wind speed increases as the satellite got further from the sun.

NB: Data has been blacked off due to terms of its use