Spacecraft Attitude Control Lecture January 15th, 2008

MESSENGER flyby of Mercury occurred today.

MESSENGER stands for:

"MErcury Surface Space ENvironment Geochemistry and Ranging"

It's primary mission is to map the surface, take photographs, map the magnetic and gravitational fields of mercury. The pointing requirement of its payload helps determine the required attitude control system, example: the spectrometer on MESSENGER needs to point towards Mercury with a high level of accuracy. MESSENGER needs an pointing knowledge within 350 micro radians, which requires attitude control within 0.1 ~~micro radians~~. (degrees)

It has an IMU (Inertial Measurement Unit), Star Trackers, and Sun Sensors.

The IMU contains accelerometers and rate gyros. Very accurate for relative position measurements, but is subject to propagation errors over time without new fixed reference points.

The Star Tracker is highly accurate, used to produce fixed references, but at a slower data rate. Not good at tracking during fast maneuvers.

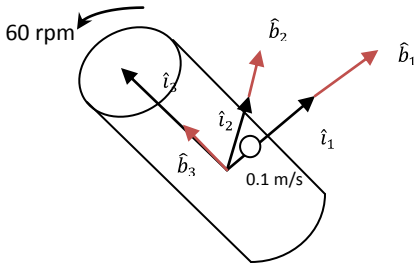
Sun Sensors are coarse sensors, on MESSENGER only used for backup.

MESSENGER's primary control mechanism are four *reaction wheels*. Reaction wheels operate by balancing momentum, accomplished by increasing or decreasing the spin rate. They are susceptible to becoming *saturated*, meaning that they hit a maximum spin rate, and they need to be slowed down using momentum *dumping*. This can be accomplished with thrusters (as with MESSENGER) or other torquers.

How do we model Spacecraft Kinematics/Kinetics?

➔ Attempt to relate information from a body-fixed frame back to an inertial reference frame.

$$\frac{{}^{A}d\vec{r}}{dt} = \frac{{}^{B}d\vec{r}}{dt} + {}^{A}\vec{\omega}^{B} \times \vec{r}$$



A particle leaves a rotating cylinder, moving radially along $\hat{b}_1$ at a speed of 0.1 m/s. The cylinder spins at 60 rpm. Find the acceleration of the particle as it leaves the cylinder.