The interpretation of ~1 Hz waves in Mercury's magnetosphere as Doppler shifted ion Bernstein mode waves?

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Coherent ~1 Hz waves with harmonics near the equatorial proton cyclotron frequency are frequently observed in Mercury's magnetosphere at radial distances of less than < 2 Mercury radii. The majority (~80%) of these waves exhibit large magnetic compressibility (~0.8) near the magnetic equator where the wave power peaks, and they transition to transverse waves at large magnetic |latitudes| (>15°). The wave occurrence peaks around 1.4 Mercury radii and the distribution in magnetic local time is not uniform, peaking in the night sector. Due to Mercury's weak internal magnetic field proton distributions with large planetary loss cones have been observed at these radial distances, and therefore the possibility exists that these waves are locally driven, as opposed to propagating inwards from the magnetopause. Linear theory has shown that these proton loss cone distributions are unstable to the generation of the proton Bernstein mode and that it is proposed that these observed waves are Doppler shifted ion Bernstein mode (Boardsen et al., *J. Geophys. Res.*, 120, 4213, 2015). Using warm plasma ray tracing we found that this mode is generated when its magnetic compressibility is weak, but as it propagates this mode transitions in a cyclic manner from weak to strong magnetic compressibility. Because the group velocity minimizes around peak compressibility there is a Poynting flux pile-up around peak compressibility, which might explain the dominance in the compressibility observed in the data.

One prediction from ray tracing is that for proton beta from ~0.1 to ~0.4 the compressibility will peak off the magnetic equator (straddling) it, while for proton beta > 0.6 the compressibility will peak at the magnetic equator. One event was shown in the cited paper shows that the compressibility peaks off (straddles) the magnetic equator when the proton beta was ~0.1, which is qualitatively consistent with ray tracing predications. We will quantity how frequently this is observed. Using the MESSENGER data set, while in orbit about Mercury, we will explore the spatial distribution of compressibility and proton beta in radial distance, magnetic local time, and in magnetic latitude, comparing these statistics with the predictions of the ray tracing model.