Ion-Scale Waves with Rising Frequency Tones Observed by Parker Solar Probe

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The solar wind is an extremely rarefied force-free plasma, so isotropization of and energy transfer between particle populations is achieved through wave transmission. Ion-scale waves are particularly significant in explaining the momentum transfer and super-adiabatic heating profile of the bulk solar wind flow. One of the wave modes most efficient at energy transfer between H+ ions is the electromagnetic ion cyclotron (EMIC) mode. This is typically a left-hand circularly polarized transverse wave mode. EMIC wave activity is ubiquitous in the inner heliosphere, and is often observed with varying spectral profiles ranging from faint emissions embedded within the turbulent cascade to isolated coherent wave storms in laminar flow.

We present here observations of isolated non-linear rising tone events recorded by the Parker Solar Probe. These events demonstrate a sweep from low to high frequency on the order of ~1 Hz over a period of several minutes. Similar rising tone behaviors are studied in regions such as Earth's magnetosphere, where the multitude of overlapping plasma populations and sporadic injections of anisotropic plasma lead to resonance and trapping configurations necessary for such wave generation. The unidirectional superalfvenic flow of the solar wind does not present similar circumstances, implying a different mechanism by which a coherent non-linear wave tone can be generated. Current efforts are underway to characterize the behavior and properties of ion cyclotron waves to better understand the processes that lead to plasma heating in the inner heliosphere. We examine the properties of these rising tone wave observations and their effects on the local plasma conditions in order to understand their source and effects on the solar wind.