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Foreshock ULF waves at Venus from Venus Express

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There exist large amplitude ultralow frequency (ULF) waves in the ion foreshock of the Venusian bow shock. With the magnetic field observations from Venus Express between 2006 and 2011, an abundance of quasi-monochromatic ULF waves (with frequency below and far enough from the local proton cyclotron frequency) have been identified by an automatic survey. One objective is to derive the relative occurrence of such foreshock waves and proton cyclotron waves associated to local pickup ions linked to exospheric hydrogen previously reported. The transverse part of the power spectrum dominates the parallel part for these foreshock ULF waves. The periods found are in the range from $\sim$20 to $\sim$40 seconds and most of the waves display left-hand polarization in the spacecraft frame. Taking into account the Doppler-shift by the high-speed solar wind, they may be right-hand polarized in the solar wind frame. These characteristics suggest that they are RH mode waves generated in the ion foreshock region by the field aligned beam protons reflected at the shock.