Ion cyclotron waves at Mars: Evidence for a fast neutral disk

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Mars is an unmagnetized planet whose ionosphere stands off the solar wind forming an ionopause, magnetosheath and bow shock. Due to the small size of the bow shock, the Martian hydrogen exosphere can extend into the solar wind and proton cyclotron waves are created when the hydrogen atoms are ionized and picked up by the solar wind. Mars Global Surveyor data reveal that the occurrence of proton cyclotron waves in the solar wind near Mars to be very widespread, extending from the magnetosheath up to 15 RM with amplitudes that vary only slowly with distance. However, the waves are also intermittent, present only a small fraction of the time. Thus the exosphere must be either time varying or extremely non-spherical. Using the wave events in strong background magnetic fields to minimize the effects of changing spacecraft fields, the region of occurrence of ion cyclotron waves is examined in a magnetic-electric coordinate system. A strong asymmetry is seen in the direction of the interplanetary electric field. The extensive, yet asymmetric and intermittent, occurrence of waves can be understood if, after protons are first picked up near Mars and accelerated by the interplanetary electric field, the ions are neutralized by charge exchange and transported across field lines to distant regions, allowing the pickup process to extend far on only one side of the planet. Thus Mars appears to have a disk of fast hydrogen atoms that extends downstream of the planet on the side of Mars in the direction of the interplanetary magnetic field, a disk whose orientation is controlled by the orientation of the interplanetary magnetic field.