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Plasma waves near the diamagnetic cavity of comet 67P

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Abstract

We report the detection of large-amplitude, quasi-harmonic density-fluctuations with associated magnetic field oscillations in the region surrounding the diamagnetic cavity of comet 67P. Typical frequencies are ∼0.1 Hz and there is a ∼90° phase lag between density and magnetic field fluctuations. We speculate that these are possibly dissipative waves associated with the steepened structures surrounding the diamagnetic cavity.

1. Observations

The region surrounding the cavity is characterized by steepened plasma density (Fig. 1a, left-hand y-axis) and magnetic field (Fig. 1b) enhancements. Large-amplitude, quasi-harmonic waves at ∼0.1 Hz appear in the the Langmuir probe (RPC-LAP) fixed-bias ion current (a high time resolution proxy for the plasma density, Fig. 1a, right-hand y-axis), typically coincident with these structures (blue ellipses in Fig. 1a). A zoom-in in Fig. 1c (of the green rectangle in Fig. 1a) reveals that these waves are indeed observed also in the Mutual Impedance Probe (RPC-MIP) plasma density measurements and that their relative amplitude is $\delta n/n \gtrsim 1$. The waves also come through in the magnetic field, though with a much lower relative amplitude. A further zoom-in in Fig. 1d (of the black rectangle in Fig. 1c) of highpass-filtered B-field (y-component) overplotted on the LAP current reveals a phase lag of ∼90° of the B-field w.r.t. the density fluctuations. A spectrum of the LAP current measurements during this brief snapshot exhibits a clear peak, in this case at ∼80 mHz.

2. Conclusions

The typical frequencies of the observed waves of ∼0.1 Hz is in the same neighbourhood as the "singing comet waves" [1]. However, those waves have been reported to disappear during the high-activity phase of the comet. Their suggested generation mechanism also does not work in this region [2]. Finally, the ∼90° phase lag of the magnetic field observed here differs from the typically observed phases of 0° or 180° of the "singing comet waves". Thus, we conclude that the herein presented wave observations constitute the detection of a new type of plasma waves at the comet, possibly dissipative waves associated with the steepened structures surrounding the diamagnetic cavity. Further work is required to investigate their prevalence at other times and examine their polarization properties.

References

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[2] Meier, P.: Modified Ion-Wiebel Instability as a possible source of of low-frequency waves observed as 67P/Churyumov-Gerasimenko, Ann. Geophys., 34, 691-707 2016.

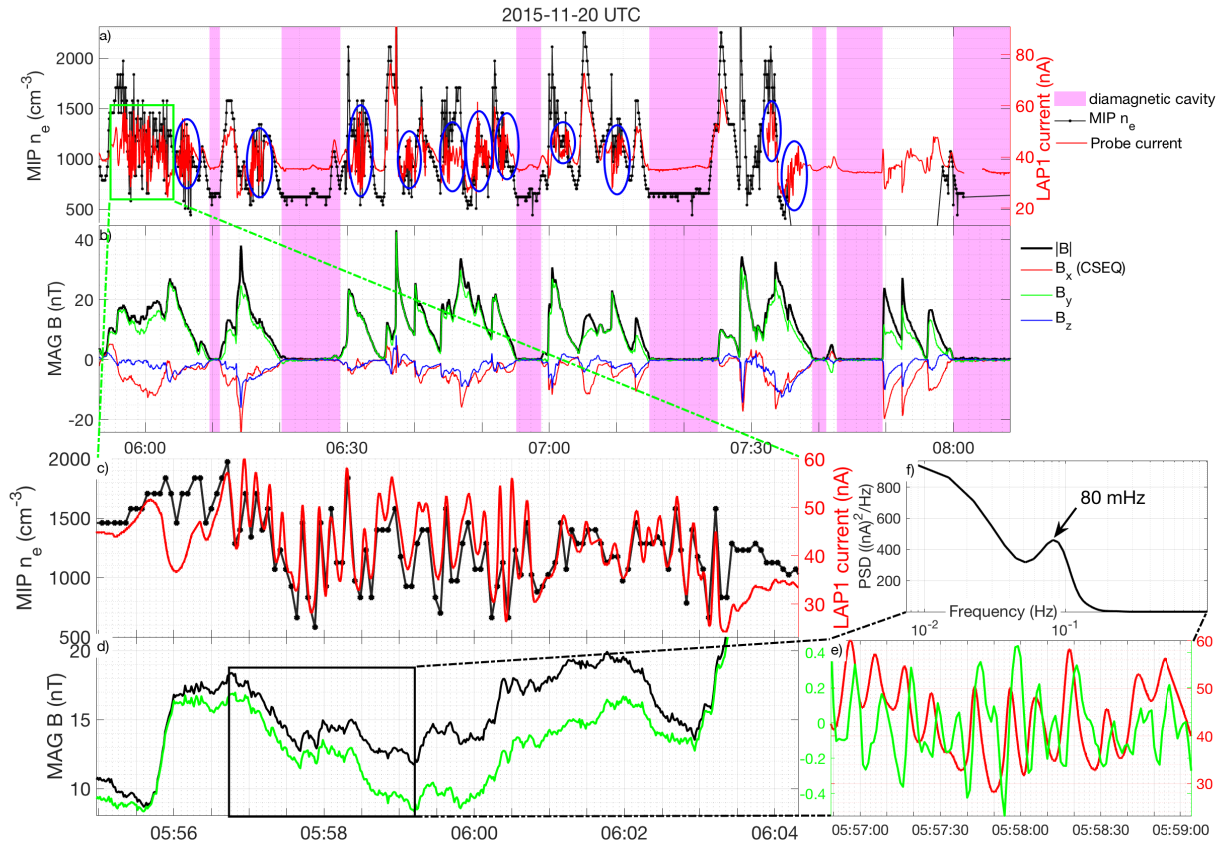

Figure 1: Wave observations near the diamagnetic cavity on Nov 20, 2015. a) MIP plasma density and LAP probe current, b) magnetic field, c-d) zoom-in from panels a-b, e) further zoom-in on LAP current (red) and highpass-filtered B-field (green), f) spectrum of LAP current in panel e.