First observations of magnetic holes deep within the coma of a comet

T. Karlsson[1], F. Plaschke[2,3], C. Götz[4], C. Möstl[2], I. Richter[4], K.-H- Glassmeier[4], M. Volwerk[2], A. Eriksson[5], and E. Behar[6]

[1]Department of Space and Plasma Physics, School of Electrical Engineering and Computer Science, Royal Institute of Technology, Stockholm, Sweden.

[2]Institute of Physics, University of Graz, Graz, Austria.

[3]Space Research Institute, Austrian Academy of Sciences, Graz, Austria.

[4]Institute of Geophysics and Extraterrestrial Physics, Braunschweig Institute of Technology, Braunschweig, Germany.

[5]Swedish Institute of Space Physics, Uppsala, Sweden.

[6]Swedish Institute of Space Physics, Kiruna, Sweden.

Magnetic holes are significant depressions in the magnetic field strength, here for the first time observed in the environment of comet 67P/Churymov-Gerasimenko. We have used data from the Rosetta fluxgate Magnetometer (MAG) collected in April and May 2015. In that time frame of two months, we identified 23 magnetic holes. The cometary activity was intermediate and increasing due to Rosetta being on the inbound leg towards 5 the Sun: While in April solar wind protons were still observed by Rosetta near the comet, in May these protons were already completely replaced by heavy cometary ions. Magnetic holes have frequently been observed in the solar wind. We find, for the first time, that magnetic holes exist in the cometary environment, even in the absence of solar wind protons. Some of the properties of the magnetic holes are comparable to those of solar wind holes: They are associated with density enhancements, sometimes associated with co-located current 10 sheets and fast solar wind streams, and are of similar scales. However, particularly in May, the magnetic holes near the comet appear to be more processed, featuring shifted density enhancements and, sometimes, bipolar signatures in magnetic field strength rather than simple depressions. The magnetic holes are of global size with respect to the coma. However, at the comet, they are compressed due to magnetic field pile-up so that they change in shape. There, the magnetic holes become of comparable size to heavy cometary ion 15 gyro radii, potentially enabling kinetic interactions.