Response to review by Martin Volwerk (Referee #2)

We wish to thank Martin Volwerk for his valuable input and evaluation of our manuscript. Below, we have included the referee comments in italics and our own response in regular text.

This paper deals with the very interesting topic of so-called "steepened waves" that have been observed in the Rosetta magnetometer data, in the inner coma of comet 67P. These objects also have a corresponding signature in the plasma data (even in the diamagnetic cavity, i.e. without a magnetic field), and therefore it is necessary to understand the characteristics of these waves. The authors make a thorough investigation of the data, where they show the various details of the waves in a statistical way. They find that the waves travel almost perpendicular to the magnetic field and are thus most-likely fast-mode waves. Unfortunately, the plasma velocity vector cannot be determined, and thus, using minimum variance analysis, this leaves a sign ambiguity. The authors then use a 1D MHD description to model these waves and compare these results with the characteristics determined from the data. This paper is well written, rather long (maybe a 2-papers version would have been an idea?), and goes deep into the material. It is definitely a great resource for further studies of these waves. There are some (mostly minor) comments that I have listed below.

It would be nice to give the date of perihelion, so "(13 August 2015)" instead of "(August)"
In lieu of changes made in regard to comments from referee #1 the reference to the date of perihelion was removed. The paragraph now reads: "Figure Fig. 1 shows two exemplary intervals with multiple of these waves in the magnetic field data and electron density on 16 July 2015 and 21 November

2015. During both intervals the outgassing rate was already high enough to facilitate the development of a diamagnetic cavity (Goetz et al. 2016a, Goetz et al. 2016b) and, with a high probability, a bow shock (Koenders et al. 2013, Koenders et al. 2015). The striking features of Fig. 1 are the asymmetric, large amplitude enhancements in the magnetic field and electron density. While properties like amplitude, width and strength of asymmetry can change significantly from event to event, they are still strikingly similar in respect to their general shape. In particular, for all instances of magnetic field enhancements, concurrent enhancements in the electron density are visible.

Is it really necessary to cite Glassmeier et al. a through g? I do not see much use in the references to these PSA documents.
We removed the citations.

forgotten space between distance and (Biermann
We added the space.

we use THE locally
Corrected.

The authors state that "after which the detection rate stagnates" referring to figure 3, after a mass-loading M >2 kg km-3 s-1. Another interpretation could be that the detection rate does not "stagnate", which can imply that Rosetta would not be able to measure more waves for some reason, but that the generation mechanism (which is not discussed in the paper) saturates. That somehow, above a certain mass-loading rate the generation of "solitons" (?? Like the input in the numerical part later in the paper) reaches a limit. Of course, finding the source for the steepened waves is rather difficult with the limited data that Rosetta delivered, if it is actually "solitons" or not, but those waves do steepen as shown later in the paper.
We have added a more thorough discussion about possible explanations for the plateau in the detection rate also following remarks from referee #1 (see response to referee #1).

The authors here discuss the direction of the field, which only slightly changes, and then two magnetic vectors are shown. This is difficult to interpret, I would rather see either normalized vectors or angles.

We have normalized the magnetic field vectors as suggested.

The authors have looked at differences in cometary outgassing activity to see how that influences the detection of the steepened waves. Later, they find differences in the correlation between mass-loading and skewness and amplitude. In the modeling section the authors assume a pure mass 18 plasma. However, we also know that CO and CO2 are major components in the outgassing, also depending on which hemisphere is more active. Indeed, Heritier et al (2017) say that the cops instrument is less sensitive for CO2 than for the water group, but it still is a significant species. Figure 8: In order to be able to really compare the top and bottom rows of plots, the Y-axes should be normalized by total number of points in each row.
While CO and CO_2 are major outgassing species, the period we consider is heavily water dominated (see e. g. Läuter, Matthias and Kramer, Tobias and Rubin, Martin and Altwegg, Kathrin, The gas production of 14 species from comet 67P/Churyumov–Gerasimenko based on DFMS/COPS data from 2014 to 2016, MNRAS 498 , pages 3995-4004, 2020, 10.1093/mnras/staa2643). Hence, we expect the effect of not taking the full composition into account to be less than 10 %. The Y-axes were normalized as suggested.

forgotten "," after Narita (2017)
We have added the ",".

Here I am not sure if the authors have looked at this or not. From the simulations the width of the waves is determined and in the simulation the velocity is also know. Thus one could calculate the duration in seconds of these steepened waves and compare them with the observed width in seconds.
We have computed the width of the waves in seconds as suggested and obtain values in the region of 10s to 150s, which are comparable to the durations observed by Rosetta. We have added the following remark in the manuscript: "As a consistency check we computed the temporal width of the simulated waves at different times in the simulation and compared them with observed temporal widths of the waves (Fig. 8). Depending on the parameters for the initial condition and $\Omega_i^{-1} \approx 10$ s/rad we obtained durations between 10 s up to 150 s, which is consistent with the observed durations."

A More complex ...
We have added the "A".

“above” should read “more than”
We replaced “above” with “more than” as suggested.

Here I do not understand the comparison. The authors write: “This yields a main resistivity eta, which is slightly larger than the value for the warm electron population but still significantly smaller than the viscosity.” How do the authors compare values of completely different units, resistivity and viscosity, and then determine which is “smaller”?
The comparison was meant in regards to the normalized values, which was indeed not clearly stated in the sentence. We have now changed the sentence to: “This yields a mean resistivity $\eta_{ros} = 0.55$ Vm/A, which is slightly larger than the value for the warm electron population. However, in normalized units the resistivity for the cold electron case is still significantly smaller than the viscosity.”

at an angle of pm 35 to the comet and at an angle of pm 65 to the sun. I think here some more direction information is needed, than just these angles, e.g. “to the comet-rosetta direction” or the “sun-rosette/comet direction”.
We have added the additional information as suggested.