# Review of “Revisiting Mirror Modes in the Plasma Environment of Comet 67P/Churyumov-Gerasimenko” by Fallau, Goetz, Simon Wedlund, Volwerk and Moeslinger

## Referee #2

This article revisits the presence of mirror modes in the plasma environment of the comet 67P with Rosetta data. If the findings are not completely conclusive, the methods and discussions are worth reading and nicely complement previous studies on mirror modes. I have mostly minor comments to this version.

We thank the reviewer for their constructive comments and address them below. Proposed changes to the manuscript have been highlighted in the attached pdf.

l52: the peculiarities due to the presence of heavier ions are more general and not restricted "to the solar wind".

–We have substituted “to the solar wind” by “to the plasma”

l61-62: do the authors mean that the field line draping at the MP acts to increase the anisotropy ? Does this come in competition with the reduction of the anisotropy under the action of mirror mode activity itself (the instability "consumes" the free energy contained in the anisotropy) ? How does this competition take place ?

–Yes, the field line draping at the MP increases the anisotropy of the electron temperature. This is one of the mechanisms that was invoked by Tsurutani et al 2011 as a generator of mirror modes. There is no discussion in literature of how this mechanism competes with the reduction of anisotropy through the mirror modes themselves.

l95-96: on the theoretical possibility to observe mirror modes (mostly dips) in mirror stable plasmas, the authors could refer to Passot et al., 2006 (https://doi.org/10.1063/1.2356485) together with Génot et al., 2011 (https://doi.org/10.5194/angeo-29-1849-2011) which presents a scenario of mirror mode evolution based on simulation and observations. This also applies to the discussion around l330.

–Both papers are very good suggestions and we have added them in the discussion on the peaks and dips.

l120: same sentence as l143

– This was deleted.

l179: is there a way to check file versions on the Rosetta database ? (at ESAC ?)

–To our knowledge only version 9.0 (the most up to date version used here) and version 6.0 are archived on the PSA. Version 6.0 was published in May 2018 and the version used in the Volwerk et al publication is not archived.

l204: if no IC waves have been detected at 67P, why putting so stringent constrains on mirror mode detection ? ie, a reduction of 32000 to 565 events. What other mode could this be ?

–Fast magnetosonic waves are also of a compressional nature. Usually, in the solar wind for example, they have small amplitudes and therefore are not identified by the algorithm that mandates large amplitude fluctuations. However, in the cometary environment there are fast magnetosonic waves with a large amplitude, so called steepened waves. We added mention of steepened waves in the introduction to make the reader aware of their existence.

l380: throughout the paper the term "magnetic-field only method" is used. Why is it well-known ? Also the present paper complements the analysis with a check of the B-N anti-correlation. So I don't understand why insisting on the ""magnetic-field only". This comment agrees with the one of another referee who recommends a better description of the method used in the paper (I think mostly the naming should be adapted).

– It is well-known since it has been used in previous studies. “magnetic-field only” is named in literature, eg Volwerk et al (2016) and Simon Wedlund et al (2022, 2023). We have made modifications to the text to explain this better.

l385: the down selection from 32000 to 500 could be repeated here.

– Done

l387: the very rare observation of mirror mode trains is very puzzling, if not strange. Could this be linked to the method itself ? Otherwise I agree with the conclusion that most of the observed events are linked to mirror activity happening elsewhere and are just remnants of this.

– The method by itself just identifies single events for each second of data (B-field and plasma data alike, when the latter is available). The time difference between the identified 565 mirror modes was too high (hours) in order to be considered as trains. The identified mirror mode train was the only one with 4 single events identified at a relatively close time (less than 15 minutes of difference between events). We agree that this is puzzling and unexpected, but we do not see how this could be related to the method, as a very similar method applied at Mars (Simon Wedlund et al. 2022) does identify wave trains.

l414-415: to my knowledge, mirror modes in cometary environments have already been studied. What is done for the first time exactly ?

– This is the first time that mirror modes in the cometary environment could be studied over a long period of time and at different gas production rates. This allows for a statistical treatment of events and to relate the occurrence to parameters such as gas production, background magnetic field and position of the spacecraft within the environment.

We have added this to the text.

last sentence: sure it would be good to have such measurements. But what exactly remains to be understood ? And what do we learn, from the mirror activity, on the comet itself and/or cometary processes in general ?

– Many questions on the generation and evolution of the mirror mode in the plasma environment of 67P remain. In more general terms, this addresses the question of how energy is transferred between the solar wind and the cometary ions. We have added more detail to this last section.