

Comments on “Magnetospheric Response to Solar Wind Forcing: ULF Wave – Particle Interaction Perspective” by Qiugang Zong

General comments:

As a review paper that was invited as part of the author’s EGU Hannes Alfvén Medal, this preprint summarizes current understanding and recent advances made by the author’s team from Peking University on magnetospheric response to solar wind forcing from the perspective of ULF wave – particle interaction. The solar wind forcing mainly includes interplanetary shock and/or solar wind dynamic pressure pulses. The manuscript is mainly focused on poloidal mode wave interaction with radiation belt energetic electron, ring current ions and plasmaspheric electrons. Generalized theory of drift and drift-bounce resonance with growth or decay localized ULF waves has been discussed and used to explain in situ spacecraft observations. Recent advances on nonlinear and multiple drift/drift-bounce resonance have also been discussed. The manuscript is generally well written and organized with clear presentation, the results described are of interest. I would recommend the paper for publication after my comments below are addressed.

Specific comments:

Line 64: “ULF waves containing larger power are the higher frequency ones”, in my opinion, it is the opposite way, i.e., ULF waves containing larger power are the **lower** frequency ones.

Lines 79-80: It would be better to mention here that the reason the D component of the ground magnetic field represents the poloidal mode ULF waves is due to the 90-degree rotation when passing through the ionosphere. You mentioned it later in the next paragraph. I would recommend reorganize the two paragraphs so that the logic is clear and the transition is smooth.

Line 180: “The representative values are given in Table 1.” You mentioned the **time scales** of the three kinds of particle motions in Equation (2), I am thus expecting the representative values in Table 1 to be time scales instead of frequencies, though they are somewhat interchangeable. If the manuscript is more focused on the wave period and particle motion time scales, I would recommend listing the time scales in Table 1 as well.

Lines 299 and 303: The Figure caption on line 299 indicates there are 641 IP shock events, but the text on line 303 says 215 shock events. Please double check the reference and be consistent.

Lines 315-320: Is there a way to separate the contribution of energetic particle acceleration due to the "one-kick" scenario (i.e., bipolar electric fields) and ULF wave-particle interaction? I guess it would be challenging in observations. How about in simulations? Any previous work on this?

Lines 349 and 578: “The eastward (westward) electric fields are indicated by plus and minus”. Is it “the azimuthal electric fields are indicated by plus (eastward) and minus (westward)”? Or you mean the waves are eastward (westward) propagating?

Lines 353-354: “since only **uniform** electric field can be experienced by the resonant electrons”. I understand what you mean here, but the electric field is not uniform, right? Is there a better word than uniform? The same applies on line 574.

Lines 354-356: Worthwhile mentioning here (or other place), to accelerate electrons in the radiation belt, the wave azimuthal propagation direction should be the same with the electron drift direction, i.e., eastward propagation (positive m-value). The same applies when talking about drift-bounce resonance with ions, a westward propagation wave (or negative m-value) is needed.

Lines 385 and 399: Please describe what τ is in Equation (6) and $k(\tau)$ in Equation (11).

Line 429: “where m is the ULF wave number, ” Please be specific that “m is the **azimuthal** wave number”.

Lines 569-570: ULF wave m-value is also needed to determine the resonant energy, right?

Lines 624-625: “Fishbone-like structures appear in the **electron** pitch angle distribution...” Should be **proton** rather than **electron**, right?

Lines 927-931: I cannot find the Ma et al., 2020 and Hartinger et al., 2018 in the reference. Duplicated references also exist, e.g., line 1240 and 1257. Please make sure all the references are listed appropriately.

Technical corrections:

Places that need reword:

Line 324-325: “...charged particles resonating with growth and damping ULF waves and charged particles resonating with **azimuthal localized** ULF waves will be described. Finally, I will show how radiation belt relativistic electrons **resonating** with localized growth and damping ULF waves in detail.”

Line 786: “Therefore, it is **fundamental important** to know how...”

Typos/errors:

Line 160-161: extra (or lack of) space and period.

Line 262: extra parenthesis before the reference.

Line 276: “...suggest that the shock-induced ULF waves **causes** the observed charged particle acceleration”

Line 346: “the bounce motion has no relationship with the ULF **wave** – particle interaction.”

Line 402: “, and the phase difference between **difference** electrons with a lower and a higher energy...”

Line 403: “Whereas, **In** the ULF wave damping stage,”

Line 461-462: extra space.

Line 473: “as well **asmodulations**”.

Line 480: “**Thus,, it is crucial** to ...” extra comma and space.

Lines 494 and 740: Check the font size of section titles for consistency.

Lines 507-508: “...ultra-relativistic electron fluxes have been observed **at by** Van Allen Probe B following **an interplanetary** shock...”

Lines 517 and 523: should be Figure 14 instead of Figure 13.

Line 554: extra space.

Line 590: Need a period and space “ULF **waveThe** acceleration...”.

Line 731: “**TheULF** waves are...”

Line 952: extra comma.