Ann. Geophys. Discuss., referee comment RC2
https://doi.org/10.5194/angeo-2021-68-RC2, 2021

Comment on angeo-2021-68

Abraham C.L. Chian (Referee)

Referee comment on "High bandwidth measurements of auroral Langmuir waves with multiple antennas" by Chrystal Moser et al., Ann. Geophys. Discuss., https://doi.org/10.5194/angeo-2021-68-RC2, 2021

Referee report

This paper discusses a data analysis of 5 short-duration auroral Langmuir wave burst events in the polar F-region ionosphere, consisted of a plasma line at frequencies ranging from 2470–2610 kHz with an associated diffuse feature occurring 5–15 kHz above this line, measured by a rocket flight with an apogee of 382 km. The aim of this study and the methodology adopted follow closely a recent paper by Moser et al. (2021) which reported a similar investigation based on the data from two sounding rockets with apogees of 1,042 and 756 km, respectively. The hypothesis of nonlinear wave interaction is tested using a dispersion solver, Wave in Homogeneous Anisotropic Multicomponent Plasma (WHAMP, Rönnmark 1982), to determine surfaces corresponding to the normal plasma modes: the Langmuir-Upper Hybrid and the Whistler-Lower Hybrid surfaces, that might take part in nonlinear 3-wave interaction. This paper concluded that the observed auroral Langmuir events can be explained by a Langmuir/z-mode wave coalescing with or scattering off the whistler/Lower Hybrid wave, confirming the results of two previous papers by Stasiewicz et al. (1996) and Bonnell et al. (1997). This paper is well-written and contains interesting results for understanding nonlinear space plasma processes in the aurora. It can be published after some minor revisions commented below.

1. The subject of Langmuir turbulence in the auroral ionosphere has been reviewed recently by Akbari, LaBelle and Newman (Front. Astron. Space Sci. 7, 617792, 2021) which should be inserted in the reference. In addition, a discussion should be added to explain the source of field-aligned electron beams that excite the auroral Langmuir waves, and if these substorm events are the ionospheric signatures of magnetic reconnection in the tail regions of the magnetosphere.

2. In addition to wave-wave processes involving Langmuir and Lower Hybrid waves, the authors should mention other nonlinear wave interaction studies in the auroral ionosphere. For example, Bohm et al. (JGR 95, 12157, 1990) showed that the most intense Langmuir and whistler waves measured by auroral rocket flights occur in

association with Alfven waves. The theory of auroral Langmuir-Alfven-whistler events were studied by Chian et al. (A&A 290, L13, 1994) and Lopes and Chian (A&A 305, 669, 1996). In particular, these theoretical papers showed the feasibility of a 3-wave process involving the parametric decay of a Langmuir wave into a whistler wave and an Alfven electromagnetic ion-cyclotron wave which may apply to the observation of electromagnetic ion-cyclotron waves in a flickering aurora by Lund and LaBelle (JGR 17, 241, 1996).

3. Although the approach of this paper is based on the concepts of linear wave dispersion and weakly nonlinear wave-wave interactions, for the sake of completeness a discussion should be inserted to relate these linear and weakly nonlinear wave studies to the description of Langmuir intermittent turbulence consisted of coherent structures such as cavitons discussed by Akbari et al. (JGR Space Phys. 118, 3576, 2013) and phase-space vortices such as electron and ion holes discussed by Ergun et al. (Phys. Rev. Lett. 81, 826, 1998) and Schamel et al. (Phys. Plasmas 27, 062302, 2020).