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Interactive comment on "Mirror mode physics: Amplitude limit" *by* Rudolf A. Treumann and Wolfgang Baumjohann

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We thank the reviewer for the favorable comments. We would like to direct him to the General Response we have posted in the Discussion where most questions he has have been answered in the interest of all 4 Reviewers. Here some brief specific remarks on the questions raised by the report:

1. It is absolutely true: the pairs are not phase bunched. They are just all in gyration only which is sufficient for the surface current. Phase bunching cannot be achieved and is not necessary. It suffices that at zero parallel speed the surviving pairs are on a common shell. This we mean by coherence. We have said this now explicitly in the paper and weakened the expression o quasi-coherent.

2. The mirror mode provides the ideal conditions for pair formation. We would believe that this is a rare case because of the bounce motion. However, it might be that in magnetic holes which also probably permit for bouncing as well other places, say reconnection geometries or also the auroral magnetosphere (i.e. in all cases of magnetic trapping or quasi-trapping like in reconnection where the particles bounce between plasmoides) the possibility exists for this kind of pairing as it only requires reflecting at mirror points with conservation of the magnetic moment, presence of waves to resonate (here ion sound, otherwise parallel propagating waves mostly of electrostatic nature. The formal expression for the potential allows for all kinds of waves but the resonance condition sets another requirement which is not easy to satisfy.3. Yes, of course the London length could be used. However, at the present state of the theory which in these last subsections is rather speculative as it just suggest a possibility, I would dare to apply it. The factor α is purely heuristic and very uncertain yet. Before doing it one would have to solve the stability problem of the pairs which is a difficult task which we did not attack at this moment. At this time the value of$\alpha$is rather large, and one would expect that it is much less because some pairs will dissolve, being replaced by new pairs such that the number will strongly fluctuate. The London length itself is very uncertain, just a rough parameter even in super-conductivity theory which is certainly more precise than plasma theory at the high temperatures where for instance pressure balance is not better than better than 10% or so. The value of pairing is therefore less in the speculation on the susceptibility made in the last subsections than in the contribution of a perpendicular temperature/pressure anisotropy. This should drive other instabilities of various kind if possible in the mirror plasma. Those are in the first place electron mirror mode which have ultimately been observed again at much larger amplitude than quasi-linear, but also other waves Bernstein modes, whistlers (which have also been observed) etc. observation of these modes already proves the existence of electron pairs? It has not been checked it should. Also in application to ions one could put forward similar arguments. The interesting point is in any case that once the quasi-linear limits reached which is in pressure balance as it simply heats the trapped

component on the expense of the perpendicular anisotropy (whether electrons or ions) until pressure balance is achieved, the additional anisotropy of the pairs (electrons or ions) causes a pressure imbalanced depletion of the magnetic field which must be pressure compensated which happens mainly by sucking in additional cold non bouncing plasma of small magnetic moment from the surrounding. If this is forbidden, then one would expect that additional heating would be produced, and this would eat up the perpendicular anisotropy caused by the pairs, putting them back into the plasma and restoring pressure balance. In this case existence of pairs would be an intermediate state which leads to large mirror amplitudes (applicable to both electrons and ions).

4. Eq. 7, thanks this is trivial. Slightly changed.

5. Thanks for the language corrections.

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