Ann. Geophys. Discuss.,
https://doi.org/10.5194/angeo-2019-111-RC1, 2019

Annales Geophysicae Discussions

Interactive comment on "Overshoot dependence on the cross-shock potential" *by* Michael Gedalin et al.

Anonymous Referee #1

Received and published: 22 September 2019

This paper deals with the structure of the magnetic field (for instance the bow shock) downstream of the shock ramp. This structure depends on many parameters, in particular the Mach number (the shock being sub- or super-critical), plasma-β, width of shock ramp, shock potential and shock normal angle. All these parameters span a more-dimensional parameter space thus obscuring the relations between the structure of the magnetic field within a shock crossing. Most interesting in this structure is that super-critical shocks posses a magnetic overshoot while shocks at smaller Mach numbers, in particular sub-critical shocks exhibit an about coherent magnetic field oscillation across the shock ramp consisting of a few sequential maxima and minima the nature of which still remains unclear, while it seems that they should be produced by gyrating ions, partially maintaining their gyration phases when passing the shock.

The present paper investigates this interesting effect in order to pin down the nature of these coherent, so to say, oscillations in relation to the gyration of the shock-crossing ions under simplifying strictly quasi-perpendicular shock and low-β conditions. Electrons in this investigation, which restricts itself to the ion motion, are not considered as they are of no interest here where the ions are treated as a cold beam whose dynamics inside the ramp suffers from the presence of the shock potential in which the ions drift along the shock and gyrate around the field. The authors attack the problem in what they call an advanced test particle model (they developed) with predescribed magnetic field shock-ramp profile and magnetic compression ratio and tracing the coherently gyrating ion beam across the shock when varying other parameters, of course assuming quasineutrality being warranted by the electrons and their pressure through a polytropic electron equation of state. Within this model they are able to identify the location and amplitudes of the magnetic field maxima resulting from the coherent ion gyration across the shock in dependence of the various varied parameters. Their interest focusses in particular on the effect of the cross-shock potential. The authors define two kinds of critical shock potentials, one related to gyration in the shock ramp for given shock ratio, the other related to the potential necessary to reflect the ions from the ramp. They find interesting relations between these, the downstream ion dynamics and the location and damping rates of the coherent magnetic downstream maxima. This contributes to the illumination of the structure of the magnetic field in the shock-adjacent downstream layer.

Results are given as plots of the oscillating structure of the ion beam of given velocity spread as function of distance across and behind the ramp. These are compared to THEMIS observations. Moreover ion reflection effects are also discussed giving rise to the identification of an energy gap in the ion distribution located at the shock ramp front. Various dependencies on the shock potential and the two critical potentials are discussed.

I find this a very useful examination of gyrating ion motion across low Mach number

about perpendicular shocks and their effect on the magnetic structure of the shock magnetic field downstream behind the shock. Even though it was previously suggested qulitatively that the magnetic oscillations observed in this domain would relate to the shock passing ions the direct demonstration of it was still missing. The present paper provides it which is an important contribution to the understanding of a particular class of shocks: quasi-perendicular low-Mach number shocks.

I suggest that the paper, which contains a large number of illuminating figures, is published essentially without any larger modifications as the theory is lucid, straightforward and concisely presented, well illustrated and accompanied by comparisons with real measurements in space which confirm it. Moreover, the discussion of the two critical potentials is an important turn which helps understanding the ion-magnetic field dynamics under the influence of a given cross shock potential.

There is a typo in the $<, >$ signs in line 5ff which should be corrected.

I find the inserts in Fig 1, and in Fig 3 the descriptions on the ordinates and abscissas and color bar about unreadable.

I think it is not necessary to give any more decimals than the first on the color bar.

In Fig2 the high and low should also be enlarged.

Numbers like 100 and 1000 etc should be given as 10^2, 10^3. Same in Fig 9, 11, 12.

These figures will all become one column figures. This requires that the lettering must be large enough for the reader to deciffre it.

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