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Interactive comment on "Influence of the Earth's ring current strength on the Størmer's allowed and forbidden regions of charged particles motion" *by* Alexander S. Lavrukhin et al.

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We would like to thank the referee for his opinion about an article and his comments. We have done changes in the paper according to the comments.

1) "Despite that, I do have some reservations about the presentation of the method & theory, having in mind that this paper should be useful not just for researchers with a strong interest in theory, but also to groups dealing with data analysis. Given that, I found it hard to associate certain parameters (e.g. "gamma") with typical observables, such as pitch angle, energy etc. The authors clearly state that particles of same energy can have different gamma, but still that wont be enough for many interested readers.

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Discussion paper

Certain equations describe gamma through the "generalized momentum", to which observers would have trouble to link with observable/measurable quantities e.g. by particle detectrors. Same may apply for the Strömer radius etc. e.g how does it relate to gyroradius. These could either be explained in text, or maybe through an extra illustration/figure."

We have made a plot of dependence of the Strömer radius of a particle on particle's energy in the Earth's magnetic field. Also we have considered the gamma parameter properties in more detail in the chapter 4, and showed, how the boundaries of allowed region of motion are determined in Stormer's analysis. Also we showed at the new plot the value of gamma, which a particle with specified energy will have for at a specified L shell. All this changes are made in chapter 3 and chapter 4 of the paper.

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2) "What I found a bit confusing is the definition of allowed vs. forbidden regions. E.g. in Fig. 1, white shaded areas are allowed for 100 keV protons, but that seems strange at a first sight/read - clearly, inward of the white shaded area, where the field is (much) stronger, trapping is obviously also allowed for 100 keV ions. It may be natural that the trapping limit/limit of adiabaticity may be confused with the character of the allowed region as allowed in this paper. Maybe this ties well to the definition of gamma or energy. E.g. is 100 keV in Fig. 1 the energy at infinity of at the injection point within the magnetosphere?"

In chapter 4 we have shown that the inner allowed region is not the only one and unique for the particle – it can be trapped either closer to the planet, or farther, but with different initial parameters (energy, gamma), which determines its trajectory and allowed region of motion. In order for a particle to get into the currently forbidden region, the parameter gamma must change as a result of some process occurring in the magnetosphere. Thus, the whole allowed region of motion is determined by change of gamma (or generalized momentum) from 0 to +infinity. The size of the allowed region of motion, which is shown on figures, equals to two the Larmor radius of a particle at a specific point.

3) Also, I would be interested to see some comments about the presence of the corotation ExB drift, since the authors do attempt to apply their formulation to keV particles too.

In the original Størmer analysis magnetic field is stationary and a particle does not receive energy from outside, so the parameter gamma will remain constant. To change it and thus to inject particle to the inner magnetosphere some process is needed. It can be for example either corotation ExB drift, or the large-scale potential electric fields. These two processes are responsible for the injection of particles to the inner magnetosphere and thus for the change of parameter gamma. Thus, we talk about electric field only in the way that it can be possible reason of change of parameter gamma. We discuss it in the modified chapter 4.

Extra minor comments: P2, line 5: Change “analytical analysis”

Thank you. Accepted, “analytical” removed.

P3, line 19: “directed to the west”: “located to the west” is maybe a better expression?

Directed to the west describes the direction of the current.

P5 , line 20: do I understand well that the inner boundary of the current is at Earth’s surface?

To remove misunderstanding we change the statement to “in the Earth’s center”. In our approach we propose that ring current localized at distance a from Earth’s center. We propose that all current concentrated at ring radius a. Of course, in reality the current distribution localized at some interval of distances but it doesn’t change our conclusions.

P9, First lines of section 4: not sure about the explanation of the partial ring current.

You write that there is a region where gradient drift dominates, while "in the intermediate region between the gradient and E x B drift regions, a partial ring current arises due to the fact that protons on one side of Earth, and electrons on another have oppositely directed gradient drift velocities.". But the oppositely drift velocities is also a feature of the field gradient, applicable also in the first region where "gradient drift dominates". So, I dont really understand what is the difference between the two regions and where does ExB come in.

Accepted. To make the text more clear we corrected this paragraph of Section 4 and didn't consider in detail the processes which leads to the partial ring current formation, because in Stormer's analysis we consider only symmetric ring current.

P8, line 19: what is it meant “momentum at one Strömer radius?

Størmer's parameter γ is the ratio of the azimuthal components of two different momenta of the particle: P_φ, taken at infinity, and pr_s at one Størmer radius, with a multiplying factor of 1/2 (taken for the convenience of demonstration); particles of any energy can have the same γ. In case of the negatively charged particles (Ze<0), the azimuth component of the generalized momentum is directed to the west (P_φ<0), and respectively γ<0. In case of the positively charged particles (Ze>0), the azimuth component of the generalized momentum is directed to the east (P_φ>0), and respectively γ>0. In our problem we will consider only protons and therefore gamma values greater than zero.

P9, line 22: add reference in parenthesis

Thank you. Accepted.

P10 line 13: which value –> the value of which

Accepted: “These two particle'stransport and acceleration mechanisms can act simultaneously Ebihara and Ejiri (2003) and are responsible for the injection ofparticles to the inner magnetosphere and thus for the change of parameterγ. It will increase when approaching the planet dueto the increase of the magnetic field strength, as mentioned above."

P18, line 21: correct "for At"

Thank you, "for" is deleted.

We attach a revised pdf version, where we have highlighted the insertions by yellow color.

Please also note the supplement to this comment:
https://www.ann-geophys-discuss.net/angeo-2018-104/angeo-2018-104-AC2-supplement.pdf

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