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Nonlinear Processes
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Discussions
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Interactive comment on "Reversal in the nonlocal large-scale $\alpha\Omega$-dynamo" *by* L. K. Feschenko and G. M. Vodinchar

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Dear Referee, We appreciate your interest to our article and your remarks. We replay on them step by step.

REFEREE.

1.) General comments:

The length of the different sections does not coincide with their importance for the paper. The introduction and the description of the models are much longer than the actual results and their discussion. In my opinion there are three main parts missing:

A) Discussion on the applicability of the models for the geodynamo. Why do the authors

neglect the alpha in the generation of the toroidal field completely? Is the differential rotation really so important for the geodynamo? What are the consequences for the model? And for the achieved results?

AUTHORS.

We adhere to the view expressed in [1] that the prevalence of axial dipole is a sign of the dominant role of differential rotation. Therefore, in our opinion consider $\alpha^2\Omega$ -dinamo makes sense for sufficiently detailed models, and simple model generation, described in the article confine $\alpha\Omega$ - dynamo. If we consider a simple model of α^2 - dynamos, similar to that discussed in the work, it would be:

$$\frac{dB^T}{dt} = R_\alpha B^P - B^T,$$
$$\frac{dB^P}{dt} = \pm R_\alpha B^T - B^P.$$

Analysis system. At constant R_α we obtain in the case of the "minus" damped oscillatory solution, in the case of the "plus" get non oscillatory solution - a condition generation unit has the form $R_\alpha > 1$. By varying the R_α generate stable reception mode field inversions in such a model is not possible. In a much more general situation problematic occurrence oscillating solutions to α^2 - dynamo is shown for example in [2]. Therefore we do not consider α^2 mechanism. These considerations at this point we are adding to the text of the article:

Section 2, page 1719, line 8.

REFEREE.

B) Comparison of the achieved results with other results in the dynamo community for similar models and also for the reversal of the geodynamo. For example: Wicht Meduri, 2015 or Hubbart Brandenburg 2009 and reference therein.

AUTHORS.

We have compared their results with those of other authors for similar models and add them to the article:

Section 1, page 1717, line 11;

Section 2, page 1720, line 24.

REFEREE.

C) What do these new achieved results mean for the dynamo community in general and for the geodynamo community in particular?

AUTHORS.

Discussion of the results added to the text of the article:

Section 5, page 1727, line 16.

REFEREE.

2.) More specific comments:

A) The authors use 'mean field' and 'large-scale' interchangeable. But actually there are not the same. A large-scale field can be also obtained by Fourier filtering. This method does not follow the Reynolds rules, which are required to calculate for example alpha. Therefore, I would suggestion to use "mean field", after the mean field induction equation has been introduced.

AUTHORS.

Since we are talking about the model of $\alpha\Omega$ - dynamo, they have suggested that it is a mean-field dynamo. But most average field contains, in general, different scale structures. Our approach is consistent with the single-mode approximation for the toroidal and poloidal components. It is clear that in this case we can talk about the larger scale. Ie we are talking about a large-scale approach for the middle of the field.

Appropriate specification set:

Section 1, page 1718, line 20;

Section 2, page 1719, line 9;

Section 2, page 1721, line 1;

Section 2, page 1721, line 3.

REFEREE.

B) Section 2

i) What do the authors mean with: "... the spatial structure of the mean- field is axis is simple .." ? Do they mean axis symmetric?

AUTHORS.

Quotations are not sure. We wrote the following: "... the spatial structure of the mean-field is simple ...". This does not imply a mandatory axial symmetry, we mean that the dependence of the spatial components of the field variables can be neglected. More precisely, our views on this matter are set out in the answer to the following reviewers' comments.

REFEREE.

ii) How can the authors use a scale function for the poloidal field? It is more common to use instead the toroidal vector potential, because its curl is the poloidal field.

AUTHORS.

Used to represent the magnetic field two scalar function of time as follows. Consider the single-mode approximation for the toroidal and poloidal components: $\boldsymbol{B} = \boldsymbol{B}^T(t)\,\overline{\boldsymbol{b}^T}(\bar{\boldsymbol{r}}) + \boldsymbol{B}^P(t)\,\overline{\boldsymbol{b}^P}(\bar{\boldsymbol{r}})$.

When we say that "... the spatial structure of the mean-field is simple...", we mean the possibility of such a representation. If we substitute this expansion into the equation the middle of the field, and use the Galerkin method, we obtain a system of equations for the amplitudes of $\boldsymbol{B}^T(t)$ and $\boldsymbol{B}^P(t)$. This system is arranged as well as a system (3). This axial symmetry modes $\overline{\boldsymbol{b}^T}(\overline{\boldsymbol{r}})$ and $\overline{\boldsymbol{b}^P}(\overline{\boldsymbol{r}})$ is not required. We added the text of the article to be determined:

Section 2, page 1719, line 9.

REFEREE.

iii) Related to 1A, the authors should mention that they neglect the alpha in the first line of Equation (3) and give an explanation.

AUTHORS.

We agree. Corresponding changes have been made:

Section 2, page 1720, line 2.

REFEREE.

C) Section 3: Please move the parts below line 14 that contains results to the Section 4: 'Simulation results'. It is always good to have a clear distinction between model/simulation descriptions and results.

AUTHORS.

Taken into account, the transfer is made:

Section 3, page 1723, line 14.

REFEREE.

D) Section 4: lines 7-14: The authors speak about an power asymptotic dependence and try to express their results in terms of $\zeta - \delta$. However, the plots shown to illustrate this posses a linear scale. I would strongly suggest to use a log-log scale instead of

a linear scale to illustrate the power law behavior. Also then another question rise: The data does not contain more than one order of magnitude. How reliable is to use a power law for this limited data? Furthermore, I would like to know, what are the methods applied to obtain the values δ? And more important: What are the errors related to this method and data?

AUTHORS.

Unfortunately, we failed to use labels on the coordinate axes. In fact, Figures 3 and 4 are constructed in a logarithmic scale, and the marks on the axes correspond to the order of magnitude. Therefore these figures show the relationship between two or three orders of magnitude. For δ calculation used the slope of the regression line for the data on a logarithmic scale. The coefficient of correlation modulo thus was not less than 0.92. This level of correlation suggests quite reliable choice of both the power relationship and the value of δ. We have added in Table 1 except the values of δ dependence on γ and ϵ value of the correlation coefficient for the corresponding straight sections of graphs to 10^3.

Figure 3, page 1733;

Figure 4, page 1734;

Table 1, page 1730;

Section 4, page 1726, line 9.

REFEREE.

3.) Technical and small comments:

A) The authors often use the expression: "large-scale model $\alpha\Omega$ - dynamo" or something similar. But the model is not "large-scale", the magnetic field or maybe the dynamo is large-scale. Please revise.

AUTHORS.

Corresponding changes have been made: Abstract, page 1716, line 2.

REFEREE.

B) Section 1, page 1716, line 14: Please move the parenthesis in front of 2002 behind 11 years, so that it is written: "... 11 years (Stix,2002)."

AUTHORS.

Corresponding changes have been made:

Section 1, page 1716, line 14.

REFEREE.

C) Section 1, page 1718, line 2: Please remove the three names before the citation.

AUTHORS.

Corresponding changes have been made:

Section 1, page 1718, line 2.

REFEREE.

D) Section 1, page 1718, line 7: The operator is not clearly recognizable as a divergence. The same occurs in line 25.

AUTHORS.

Corresponding changes have been made:

Section 1, page 1718, line 7;

Section 1, page 1718, line 25.

REFEREE.

E) Section 1, page 1718, line 8: Please mention at this location, thatn ν_m is assumed

to be constant in space.

AUTHORS.

Corresponding changes have been made:

Section 1, page 1718, line 8.

REFEREE.

F) Section 3, page 1725, line 4: Please introduce the abbreviation "pdf".

AUTHORS.

Abbreviation "PDF" (Probability Density Function) previously provided: Section 3, page 1724, line 11.

REFEREE.

G) Section 4, page 1725, line 15: Please introduce the abbreviation "SD".

AUTHORS.

Abbreviation SD (Standard Deviation) fixed:

Section 4, page 1725, line 15.

REFEREE.

H) Table 1: Is δ, what is shown here?

AUTHORS.

Yes, the table shows the value we received δ depends on γ and ϵ. We made a clarification to the title of Table 1:

Table 1, page 1730.

REFEREE.

I) Figure 1: Please add in the caption, that $B^P(t)$ is plotted as a function of time. How is the time normalized? Is it the diffusion time? In what units or using which normalization $B^P(t)$ is plotted ?

AUTHORS.

Section 2, page 1719, lines 22-23, it is shown that the units acts magnetic diffusion time at which it was made was made dimensionless and normalized.

In the equation, the magnetic field can be dimension by him for an arbitrary characteristic value. Thereafter, the output is stable generation of the value of the field $B = \sqrt{|B^T|^2 + |B^P|^2}$ on the value of one. It is this suppression mechanism is provided, represented by the formulas (5) and (7).

REFEREE.

J) Figure 2: How can B get negative, of it is defined via a positive square root?

AUTHORS.

Figure (2) scales for B^T and B^P linear, and for B – and marks on the logarithmic axis correspond to the order of magnitude. We used a bad mark, so make changes to the picture.

Figure 2, page 1732.

References cited:

[1] Ruzmaikin, A., Starchenko, S.: On the origin of Uranus and Neptune magnetic Fields, Icarus, 93, 82-87, doi:10.1002/asna.19692910201, 1991.

[2] Krause, F. and Rädler, K.-H.: Mean-filed magnetohydrodynamics and dynamo theory, Academic-Verlag, Berlin, 1980.

Interactive comment on Nonlin. Processes Geophys. Discuss., 1, 1715, 2014.