Dr. Michael E. Mauel

Editor

Physics of Plasmas

Columbia University

RE: Manuscript #POP50194 by Lugones et al.

Dear Dr. Mauel,

We thank you for providing this review, which we see is quite favorable. We address the reviewer’s minor comments below in a standard format in which we interlace our responses. The manuscript changes are listed explicitly.

Best Regards,

Rodrigo Lugones, for the Authors

>>Reviewer Comments:

>>The manuscript deals with a very important topic of plasma turbulence, namely the space-time >>decorrelation phenomenon. This topic, very little explored in the case of magnetized plasmas, is >>highly relevant for both laboratory and astrophysical settings. The methodology, based on driven >>numerical simulations of incompressible MHD, clearly shows the relevance of the so-called "sweeping >>effect". Different regimes of turbulence have been investigated, spanning from weakly to the strongly >>magnetized case.

>>These new results are important for the community, presenting a general and robust approach to the >>study of plasma dynamics. The paper is also clearly written. I therefore recommend the publication of >>the present manuscript on Physics of Plasmas, after minor revision.

We thank the Referee for a clear and accurate assessment of the paper, and for a positive recommendation.

>> As follows, I report some minor questions and suggestions.

We address these minor comments and suggestions below.

>>> 1) Typo on page 1, line 10, first column

This has been corrected.

b.k -> b(k).k

>>2) Page 2, expression for \tau\_{nl} in the case of the anisotropic case, subsection B.

>> Where this expression comes from? Can he authors provide a reference? More discussion

>> is welcome on this definition.

Start with the definition \tau\_{NL} (k) = 1 / (k v(k)), of a local-in-scale nonlinear time.

Here v(k) is the total amplitude of the velocity fluctuations near a wavenumber shell of radius k.

One inserts into this formula the average of the k-dependent fluctuation v(k) using the Kolmogorov estimate of the omnidirectional spectrum

E(k) = C\_K \epsilon^{2/3} k^{-5/3}

And the kinematic relation v(k) ^2 = k E(k). Then using the

Von Karman relation \epsilon ~ Z^3/L, one finds that

\tau\_{NL} (k) = (L/Z) 1/(kL)^{2/3}.

Finally, after recognizing that k = sqrt[ k\_\parallel^2 k\_perp^2], one arrives at the

expression we use on about the tenth line of Section II.

This estimate of the nonlinear time associated with scale 1/k assumed near equipartition of velocity and magnetic energy, ignores compressibility and has been useful for both isotropic and anisotropic research. It is discussed in

Y. Zhou et al, Rev Mod Phys., 76, 1015, 2004; and, for example, in Matthaeus et al, PRE 79, 035401R (2009) .

To clarify this a bit in the text, at the end of the first paragraph in Section II.B, we have added

For discussion of nonlinear time scale estimates, see Zhou et al (2004);

for more detailed discussion of anisotropic cases, see Matthaeus et al, (2009).

>> 3) Figure 2.

>> This figure is very interesting, but I think that the linear-k axes do not help too much

>> the presentation. Most of the plot, indeed, is "occupied" by the dissipative range (k>40). It would be >> interesting to see whether the logarithmic version of this figure (logarithmic axes) is more instructive >> (skipping obviously the k=0 cases). Moreover, it would be also interesting to know how the critical

>> balance theory fits into this scenario.

We add the logarithmic version of the figures for B0=4 and B0=8 because, as the referee suggests, it is really instructive to show with more detail the inertial range. But we also leave the linear figures, because we think that it’s important to show the kpara=0 and kperp=0. We also add the next sentence at the end of the fourth paragraph of the Section III.A.Energy spectra and dominant time scales:

It must be mentioned that the \tau\_A \sim \tau\_{nl} curve also occupies an important role in the theory of critical balance, see Sridhar and Goldreich (1994).

S. Sridhar and P. Goldreich. Toward a theory of interstellar turbulence. 1: Weak Alfvenic turbulence. The Astrophysical Journal, 432:612–621, September 1994.

>> 4) Figures 12 and 13

>> From my point of view, even the case with a very intense mean field, B0=8, is still strongly affected >> by the sweeping phenomenon, especially for k\_perp in the inertial range of turbulence (see figure

>> 13(a), (b) and (b).) If this is true, it means that even on the corona or in laboratory devices the role of >> Alfvenic linear modes is somehow limited. Since some of the authors are expert in space plasmas, a >> general comment on the possible decorrelation mechanism of turbulence in the solar wind,

>> where where deltab/B0 is order unity, is welcome.

The Referee brings up a good point. To discuss this better in the paper, we have added a short paragraph in the Discussion section, which reads:

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A compelling conclusion of the present work is that the influence of sweeping decorrelation extends over a wide range of global parameters. Even if sweeping is not the dominant time-decorrelation mechanism throughout the entire system, its importance relative to decorrelation via Alfv\’enic propagation persists in certain subregions of ${\bf k}$-space. This is found to be the case for moderate values of applied mean magnetic field $B\_0$, as seen in Figs 10 and 11. This influence of sweeping is even found for cases with very strong applied mean magnetic field ($B\_0 = 8$) as seen in Figs 12 and 13. Accordingly one is also driven to the conclusion that the effects of Alfv\’enic decorrelation are very important at least at strong $B\_0$ and in certain regions of wave vector space. While it is difficult to extrapolate such conclusions in any precise way to applications in space and astrophysics. For example, the solar wind typically admits order–one $\delta B/B\_0 $ at the outer scale. Even if this ratio is somewhat smaller, for example at smaller scales in the inertial range, the present results suggest that sweeping effect may remain important in establishing the rate of time decorrelation in the ierplanstary environment. This could have diverse implications, for example in quantifying prediction, in particle scattering and in understanding the realm if applicability of weak turbulence theory. In this regard observational techniques have begun to extract approximate measures of solar wind and magnetospheric time decorrelation in the plasma frame (Weygand et al, 2013; Matthaeus et al, 2015) but have not yet attained the precision to distinguish sweeping and Alfv\’enic effects as the present study has done using MHD simulation.

Weygand et al, 2013

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Matthaeus et al, PRL 116, 245101 (2016)

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We hope that the above revisions are fund to be suitable and that this paper may be recommended for publication.