

# Numerical Relaxation of a 3D MHD Taylor-Woltjer State Subject to Abrupt Expansion

Thursday, 25 October 2018 08:30 (20 minutes)

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Since the advent of Taylor-Woltjer theory [1,2], it has been widely believed that situations with perfectly conducting boundaries and near ideal conditions, the final state of MHD system would be force-free Taylor-Woltjer states defined as  $\text{curl } \mathbf{B} = \alpha \mathbf{B}$  with  $\alpha$  as a constant and  $\mathbf{B}$  is the magnetic field defined over a volume  $V$ . These states are of fundamental importance in fusion plasmas [3]. More recently, several new MHD models have been proposed – for example Reduced Multi-region relaxed MHD [4] and arbitrary scale relaxation model to Taylor-Woltjer state [5] to mention a few.

In the present work, we use a 3D compressible MHD solver in cartesian geometry which can handle conducting or periodic as well as mixed boundary conditions to investigate numerically the arbitrary scale relaxation model proposed by Qin et al [5]. For this purpose, we consider two volumes  $V_{\text{init}}$  and  $V_{\text{final}}$ . We load the 3D MHD solver in the limit of zero compressibility with a Taylor-Woltjer state  $\mathbf{B}_{\text{init}}(x,y,z,t=0)$  and let it again numerically evolve with conducting boundaries at  $V_{\text{init}}$  to make sure that we have obtained a numerically steady Taylor-Woltjer state for volume  $V_{\text{init}}$ . Followed by this procedure, we “suddenly” relax the boundaries to a new volume  $V_{\text{final}}$ , such that  $V_{\text{init}} < V_{\text{final}}$  and evaluate whether or not the system attains quasi-steady state. Details of the numerical method used, the protocol followed, the expansion technique and the novelty of this numerical experiment and details of our results will be presented.

## References

- [1] J. B. Taylor, Phys. Rev. Lett, 33, 1139 (1974)
- [2] L. Woltjer, Proc. Nat. Acad. Sci U.S.A , 44, 489 (1958)
- [3] J. B. Taylor, Rev. Mod. Phys. 58, 741 (1986)
- [4] S R Hudson et al, Phys. Plasmas, 19, 112502 (2012)
- [5] H. Qin et al, Phys. Rev. Lett. 109, 235001 (2012)

## Country or International Organization

India

## Paper Number

TH/P5-3

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**Session Classification:** P5 Posters