

# PHYS:7730 Example of Annotated Bibliography

Publications relevant to the study of space physics processes in the laboratory.

1. *Laboratory measurements of the physics of auroral electron acceleration by Alfvén waves*  
Schroeder, J. W. R., **Howes, G. G.**, Kletzing, C. A., Skiff, F., Carter, T. A., Vincena, S., and Dorfman, S.  
Nat. Comm., **12**, 3103 (2021).  
(Schroeder et al., 2021)

This paper describes experimental measurements on the Large Plasma Device (LAPD) at UCLA, in agreement with analytical calculations and numerical modeling, which confirm the hypothesis that Alfvén waves can accelerate electrons under conditions corresponding to the auroral magnetosphere (Hasegawa, 1976; Goertz and Boswell, 1979), settling a long-standing question about the physical mechanisms governing the generation of discrete auroral arcs. The field-particle correlation technique (Klein and Howes, 2016; Howes et al., 2017; Klein et al., 2017) provided the theoretical basis for a definitive confirmation that the Alfvén wave launched in the plasma was responsible for the resonant acceleration of the electrons measured in the experiment.
2. *Measuring Collisionless Damping Using Field-Particle Correlations*  
Klein, K. G. and **Howes, G. G.**  
Astrophys. J. Lett., **826**, L30 (2016).  
(Klein and Howes, 2016)

This paper introduced the novel field-particle correlation technique as a means to assess the particle energization in the weakly collisional plasma turbulence that plays an important role in regulating the transport of energy in astrophysical plasmas throughout the universe.
3. *Diagnosing Collisionless Energy Transfer Using Field-Particle Correlations: Vlasov-Poisson Plasmas*  
**Howes, G. G.**, Klein, K. G., and Li, T. C.  
J. Plasma Phys., **83**, 705830102 (2017).  
(Howes et al., 2017)

This paper provides a detailed derivation of the field-particle correlation technique, characterizing its advantages and limitations, and shows the results of the technique when applied to explore the Landau damping of Langmuir waves in an electrostatic plasma.
4. *Diagnosing collisionless energy transfer using field-particle correlations: gyrokinetic turbulence*  
Klein, K. G., **Howes, G. G.**, and TenBarge, J. M.  
J. Plasma Phys., **83**, 705830102 (2017).  
(Klein et al., 2017)

This paper provides the first field-particle correlation analysis of gyrokinetic simulations of weakly collisional, astrophysical plasma turbulence, showing definitively that Landau damping plays a role in the dissipation of the turbulence and consequent heating of the ions in the plasma.
5. *Evidence for electron Landau damping in space plasma turbulence*  
Chen, C. H. K., Klein, K. G., and **Howes, G. G.**  
Nat. Comm., **10**, 740 (2019).  
(Chen et al., 2019)

This paper analyzes measurements from NASA's *Magnetospheric Multiscale* mission to provide the first observational identification of a particular mechanism for the dissipation of turbulence in any space plasma, specifically electron Landau damping in the Earth's turbulent magnetosheath plasma.
6. *Toward Astrophysical Turbulence in the Laboratory*  
**Howes, G. G.**, Drake, D. J., Nielson, K. D., Carter, T. A., Kletzing, C. A., and Skiff, F.  
Phys. Rev. Lett., **109**, 255001 (2012).  
(Howes et al., 2012)

This paper presents experimental results from the Iowa-UCLA collaboration led by Professor Howes that demonstrate for the first time how counterpropagating Alfvén waves can interact nonlinearly and transfer energy to a daughter Alfvén wave with a smaller perpendicular wavelength. Denoted an “Alfvén wave collision,” this nonlinear interaction represents the fundamental building block of astrophysical plasma turbulence.

7. *Alfvén Wave Collisions, The Fundamental Building Block of Plasma Turbulence I: Asymptotic Solution*  
**Howes, G. G.** and Nielson, K. D.  
Phys. Plasmas, **20**, 072302 (2013).  
(Howes and Nielson, 2013)

This paper presents a detailed asymptotic analytical solution for the nonlinear evolution of Alfvén wave collisions in the weakly nonlinear limit.

8. *Alfvén Wave Collisions, The Fundamental Building Block of Plasma Turbulence II: Numerical Solution*  
Nielson, K. D., **Howes, G. G.** and Dorland, W.  
Phys. Plasmas, **20**, 072303 (2013).  
(Nielson et al., 2013)

This paper presents a gyrokinetic numerical simulation that confirms the analytical solution (Howes and Nielson, 2013) for the nonlinear evolution of Alfvén wave collisions.

9. *The Dynamical Generation of Current Sheets in Astrophysical Plasma Turbulence*  
**Howes, G. G.**,  
Astrophys. J. Lett., **827**, L28 (2016).  
(Howes, 2016)

This paper shows numerically, and explains theoretically, how Alfvén wave collisions in the strongly nonlinear limit naturally generate current sheets. The development of current sheets in plasma turbulence has gained a significant amount of attention in recent years (Uritsky et al., 2010; Osman et al., 2011; Zhdankin et al., 2013), with no previous theoretical explanation for their generation.

10. *Spatially localized particle energization by Landau damping in current sheets produced by strong Alfvén wave collisions*  
**Howes, G. G.**, McCubbin, A. J., and Klein, K. G.  
J. Plasma Phys., **84**, 905840105 (2018).  
(Howes et al., 2018)

This paper uses the field-particle correlation technique to show that spatially localized dissipation in the vicinity of current sheets generated by strong Alfvén wave collisions is governed by ion and electron Landau damping.

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