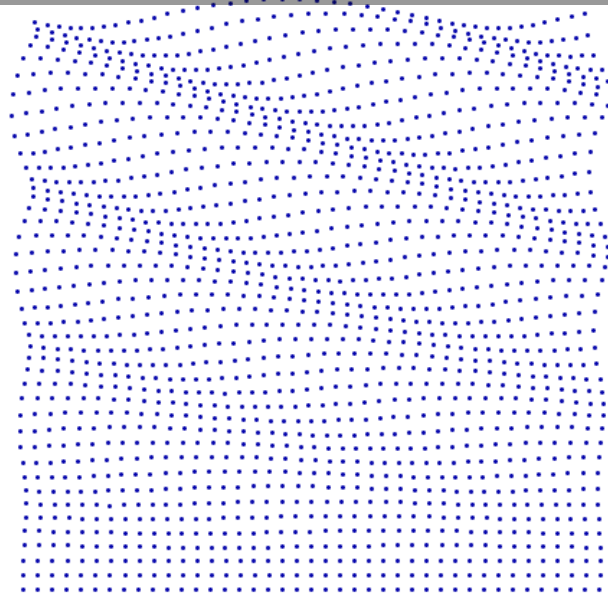


# The discrepancy between simulation and observation of electric fields in collisionless shocks

L.B. Wilson III<sup>1</sup>

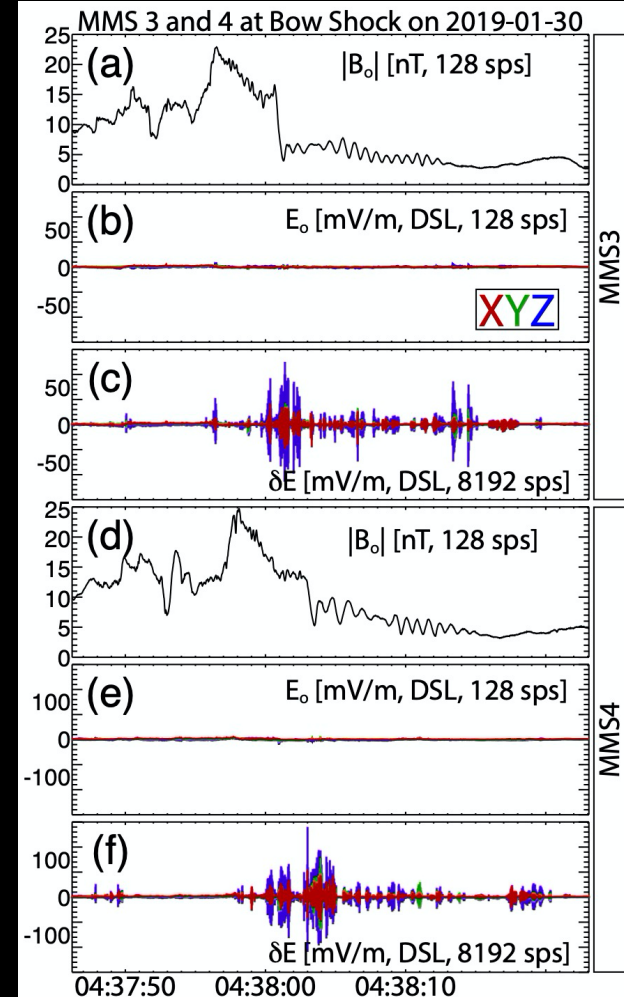


<sup>1</sup> NASA Goddard Space Flight Center, Greenbelt, MD USA

# Example Observations

Largest electric fields are in small-scale, electrostatic fluctuations (with  $\delta E/E_0 > 50$ ) such as:

- Ion Acoustic Waves
  - $\lambda \lesssim$  few 10s of  $\lambda_{De}$  (i.e., 10's to 100s of meters near 1 AU)
  - $f_{sc} \sim 500$  Hz to 10 kHz (near 1 AU)
  - $\delta E \gtrsim 300$  mV/m (at shocks near 1 AU)
- Electrostatic Solitary Waves
  - $\lambda \lesssim$  few to few 10s of  $\lambda_{De}$  (i.e., 10's to 100s of meters near 1 AU)
  - $\tau_{sc} \sim$  few ms (near 1 AU)
  - $\delta E \gtrsim 500$  mV/m (at shocks near 1 AU)
- Electron Cyclotron Drift Instability Waves
  - $\lambda \lesssim$  few 10s of  $\lambda_{De}$  to  $\lambda_e$  (i.e., 10's of m to few km near 1 AU)
  - $f_{sc} \sim 500$  Hz to 10 kHz (near 1 AU) with cyclotron harmonics
  - $\delta E \gtrsim 500$  mV/m (at shocks near 1 AU)



L.B. Wilson III, L.-J. Chen, and V. Roytershteyn "The discrepancy between simulation and observation of electric fields in collisionless shocks," *Front. Astron. Space Sci.*, submitted Aug. 7, 2020.

# Example PIC Simulation Results

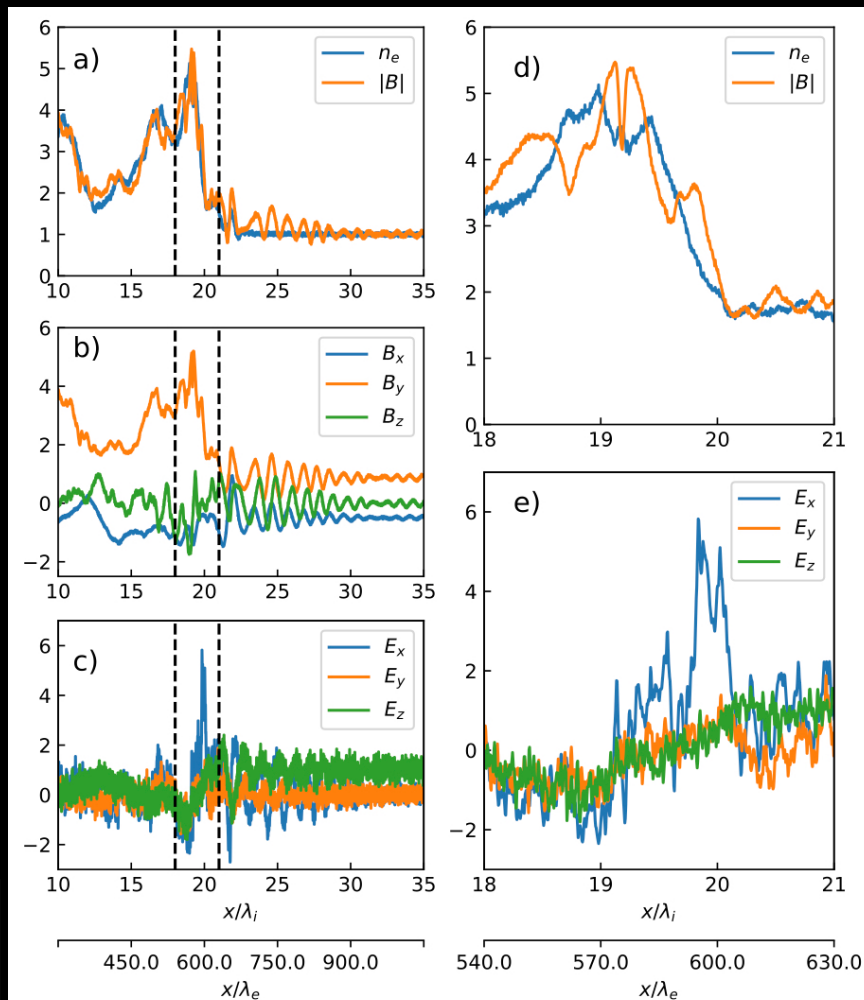
$$\frac{c}{V_A} = 120$$

$$\frac{c}{V_{Te}} \sim 5.7$$

$$\frac{M_i}{m_e} = 900$$

$$\frac{\omega_{pe}}{\Omega_{ce}} = 4$$

Largest electric fields are in moderate-to-large-scale (i.e.,  $k\lambda_e < 1$ ), fluctuations that tend to occur with amplitudes  $\delta E/E_o < 10$  [e.g., *Matsukiyo and Scholer, 2006; Umeda et al., 2012a,b*]



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