Shay and Swisdak Reply: The Comment by Shukla and Stenflo [1] can be summarized as follows. First, they argue that Eqs. (5) and (6) in [2] are "of no use for two-dimensional collisionless magnetic reconnection" because "the charge to mass ratio of the two-ion species are not distinctly apart." More specifically, they argue that the limit necessary for the heavy whistler, $\omega_{ch} \ll \omega \leq \omega_{cl}$, is "not satisfied in real plasmas" because there is not enough separation between the scales, where l signifies protons and h signifies O^+. Second, they state that Ref. [2] has not used a self-consistent steady state equilibrium. Third, they state that Ref. [2] should have used a resistive diffusion term in the induction equation instead of the ∇^4 diffusion.

The first comment stating the impracticality of $\omega_{ch} \ll \omega \leq \omega_{cl}$ is basically a statement that 16 is not much greater than 1. Although there are not many orders of magnitude between these two numbers, the separation is sufficient for the physics of the heavy whistler to become important in the O^+ case, as can be seen in the simulations. In two-species antiparallel reconnection, it has been well documented that the light whistler gives rise to electron currents near the separatrices which generate a quadrupolar B_y signature around the x line [3–5]. By analogy, the key signatures which signal the presence of the heavy whistler in reconnection are the widening of the quadrupolar B_y to scales larger than the proton inertial length and the parallel proton flows near the separatrices. Both signatures are clearly demonstrated for O^+ reconnection in Fig. 4 of [2]. Furthermore, in the case where $m_h/m_l = 10^4$ [Fig. 2(d) of [2]], the B_y signature length scale becomes nearly system size, and the Hall proton flows become the dominant global flows, which is consistent with c/ω_{ph} becoming larger than the simulation size. Thus, there is strong evidence from the simulations supporting the existence of the heavy whistler in the O^+ reconnection case.

The second comment stating that the simulations in Ref. [2] do "not [use] a self-consistent steady state (equilibrium) magnetic field profile deduced from their Eqs. (1)–(4)" is in error. In the 1D equilibrium used in the simulations, $\mathbf{E} = -\mathbf{V}_e \times \mathbf{B} - \nabla P_e/n_e = \mathbf{0}$ and $\partial n_\alpha/\partial t = 0$, $\partial \mathbf{V}_\alpha/\partial t = \mathbf{0}$, and $\partial \mathbf{B}/\partial t = \mathbf{0}$, where α stands for protons and heavy ions.

The third comment states that the $\mu_4 \nabla^4 \mathbf{B}$ on the right-hand side of the induction equation should be replaced by the plasma resistivity term $\eta \nabla^2 \mathbf{B}$. The use of any simple resistivity in a model of reconnection in Earth's magnetosphere should be considered *ad hoc* because the magnetosphere is strongly collisionless ($\nu_{ei} \ll \omega_{ci}$) and anomalous resistivity is not well understood. In addition, numerous studies have found that the specific type of electron dissipation has very little if any effect on the reconnection rate, as long as Hall physics is mediating the reconnection process [6–8].

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