
Report of the Referee -- WJ10056/Hirsch

The paper “How Alfven's theorem explains the Meissner effect” tries to give a new explanation for the Meissner effect in superconductors. The main idea is that upon cooling down the material to the superconducting transition temperature in the presence of magnetic field a mass current flows toward the boundary of the system in order for the magnetic field to be expelled. The theory relies on the connection between the current and the electric/magnetic field through the conductivity (Eq. 2). Following this equation and Maxwell equations the author concludes that BCS theory is incomplete. However, Eq. 2 does not consider the diamagnetic response of perfect conductors. This response (which for superconductors is known as London equation) is not phenomenological as the author hints. Rather, it is rigorously derived for superconductors.

Consequently, I failed to understand the puzzle that the author imposes and I find the basic equation that is used to solve the puzzle as inaccurate for describing superconductors. Since the author wishes to confront BCS theory, which is one of the most successful theories in condensed matter physics, he must explain better why the basic equation on which his theory relies does not give rise to diamagnetism. Currently, I am not convinced that the ambitious goal of replacing BCS theory is achieved and therefore, I cannot recommend the paper for publication.