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On the collisionless magnetic reconnection rate of order 0.1

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Magnetic reconnection is the process whereby a change in topology of the magnetic field allows for a rapid release of magnetic energy into thermal and kinetic energy of the surrounding plasma. The magnitude of the reconnection electric field parallel to the X-line (where magnetic field lines break) not only determines the rate that reconnection proceeds, but can also be crucial for efficiently accelerating highly energetic super-thermal particles. Observations and numerical simulations reveal that essentially collisionless magnetic reconnection of a Harris-type current sheet in the steady state tends to proceed with a normalized reconnection rate of order 0.1, independent of dissipation mechanism or physical model. However, the explanation of this value has remained unclear for decades. We propose a model that provides insight to this long standing problem. The prediction from this model compares favorably to particle-in-cell simulations of magnetic reconnection in both the non-relativistic and extremely relativistic limits. These results may be important for applications to solar, magnetospheric, fusion, and astrophysical settings.