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Spontaneous Generation of Alfven Waves during three-dimensional Magnetic Reconnection in the Solar Corona

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Alfven waves contribute significantly to the solar coronal heating, the solar wind acceleration, as well as Alfvenic turbulence formation. As a universal process, magnetic reconnection has long been credited as a potentially crucial source of Alfven waves, but how magnetic reconnection trigger Alfven waves remains elusive. Here, with high-resolution simulations of three-dimensional interchange magnetic reconnection in high Lundquist number limit, for the first time, we find that Alfven waves are inherently excited during the reconnection mainly through two self-consistent ways. One refers to the fragmented and intermittent reconnection, where Alfven waves originate from reconnection sites and propagate both upwards and downwards even along the unreconnected magnetic fields. The other involves the turbulence developing in the reconnection outflow region. The turbulence activates kinks of the reconnected magnetic fields that travel out as Alfven waves. The launched Alfven waves have large amplitudes and high frequencies, carrying substantial energy for heating the quiet corona and accelerating the solar wind. Our findings demonstrate that Alfven waves are natural products of magnetic reconnection, bringing its fundamental significance for energy release, transport, and conversion occurring in the solar system, in the earth and planetary space, and even in astronomy.