The Energetics of a Global Shock Wave in the Low Solar Corona

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As the most energetic eruptions in the solar system, a coronal mass ejection (CME) can produce shock waves at both its front and sides as it erupts from the Sun into the heliosphere. However, the amount of energy produced in these eruptions, and the proportion of energy required to produce the wave, is not well characterised. Here we use observations of a solar eruption from 2014 February 25 to estimate the energy budget of an erupting CME and the globally-propagating “EIT wave” produced by the rapid expansion of the CME flanks in the low solar corona. The “EIT wave” is shown using a combination of radio spectra and extreme ultraviolet images to be a shock front with a Mach number greater than one. Its initial energy is then calculated using the Sedov-Taylor blast wave approximation, which provides an excellent approximation for a shock front propagating through a region of variable density. This approach provides an initial energy estimate of ~6×10^{31} ergs to produce the “EIT wave”, which is comparable to the energy of a flare. The kinetic energy of the associated CME is shown to be ~2.5×10^{32} ergs, indicating that the "EIT wave" had approximately 10% the energy of the associated CME. These results suggest that the energy of the "EIT wave" is significant and must be considered when estimating the total energy budget of a solar eruption.