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Genesis, magnetic morphology and impulsive evolution of the coronal mass ejection associated with the X8.2 flare on 2017 September 10

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The extreme X8.2 event of 2017 September 10 provides unique observations to study the genesis, magnetic morphology, impulsive dynamics and shock formation in a very fast coronal mass ejection (CME). Combining GOES-16/SUVI and SDO/AIA EUV imagery, we identify a hot (T $\approx$ 10–15 MK) bright rim around a quickly expanding cavity, embedded inside a much larger CME shell (T $\approx$ 1–2 MK). The CME shell develops from a dense set of large AR loops (>0.5Rs) and seamlessly evolves into the CME front observed in LASCO C2. The strong lateral overexpansion of the CME shell acts as a piston initiating the fast EUV shock wave. The hot cavity rim is demonstrated to be a manifestation of the dominantly poloidal flux and frozen-in plasma added to the rising flux rope by magnetic reconnection in the current sheet beneath. The same structure is later observed as the core of the white-light CME, challenging the traditional interpretation of the CME three-part morphology. The large amount of added magnetic flux suggested by these observations explains the extreme accelerations of the radial and lateral expansion of the CME shell and cavity, all reaching values up to 5–10 km s^{-2}. The acceleration peaks occur simultaneously with the first RHESSI 100–300 keV hard X-ray burst of the associated flare, further underlining the importance of the reconnection process for the impulsive CME evolution. Finally, the much higher radial propagation speed of the flux rope in relation to the CME shell causes a distinct deformation of the white-light CME front and shock.